CITY OF AUSTIN
Austin Water

PROJECT MANUAL
Contract Documents and Technical Specifications

VOL. 2 of 6
City Standard Technical Specifications & Special Provisions

CONFORMED

Wild Horse Ranch Wastewater Treatment Plant Expansion

C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

CITY OF AUSTIN
Public Works Department
505 Barton Springs Rd. Ste. 800
Austin, TX 78704

November 2022

CONFORMED DOCUMENTS
These Conformed Documents unify addenda issued during the bid period. If discrepancies between the Conformed Documents and the Bid Documents are found, the Bid Documents with the original addenda shall govern. Original sealed by Danny M. Hurtado, July 22, 2022, State of Texas PE No. 104266.

carollo®
TBPELS No. F-882

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion
C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Danny M. Hurtado,
June 17, 2022,
TX PE No. 104266.

CIVIL/MECHANICAL

SECTION NUMBERS:

DIVISION 00	11366B	15117
DIVISION 01	11375	15118
SERIES 100	11377A	15119
SERIES 200	11378A	15120
SERIES 300	11395A	15121
SERIES 500	11635	15244
SERIES 600	13120	15259
SERIES 700	13446	15278
802S	13447	15286
SP130S	14650	15293
06608	15050	15956
08332	15052	15958
09960	15061	17101
11289	15075	17302
11294C	15076	17305
11305	15110	17404
11312D	15111	17502
11312J	15112	17506
11312X	15115	17522
11317	15116	

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion
C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Kwasi Duose,
June 17, 2022,
TX PE No. 100650.

STRUCTURAL

SECTION NUMBERS:

SERIES 400	03055
SP401S	03072
SP403S	03600
SP405S	04055
SP406S	05140
SP408S	05190
SP410S	05310
SP411S	05500
SP416S	13122
SP510	
SP511	
SP720S	
SP721S	

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion
C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Chad Green,
February 28, 2022,
TX PE No. 119980.

HVAC

SECTION NUMBERS:

10910	15812
15082	15814
15084	15815
15282	15820
15294	15830
15400	15936
15430	15954
15735	
15740	
15762	

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Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion
C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Jonathan P. Herrboldt,
February 28, 2022,
TX PE No. 135057.

MECHANICAL

SECTION NUMBERS:

11312R
11355A
11376A

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion

C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Casey G. Wauters,
February 28, 2022,
TX PE No. 93889.

CIVIL/MECHANICAL

RESPONSIBLE SPECIFICATION SECTIONS:

03160	11313	11333
09800	11323	11353
11312C	11324	14555
11312F	11327	

AECOM Technical Services, Inc.
13640 Briarwick Drive, Suite 200
Austin, Texas, 78729
TBPE REG. No. F-3580

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion

C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Stephanie D. Blew,
February 28, 2022,
TX PE No. 92682.

CIVIL

RESPONSIBLE SPECIFICATION SECTIONS:

15114 CHECK VALES (DUCK BILL)
SP436S P.C. CONCRETE VALLEY GUTTERS

CAS CONSULTING AND SERVICES, INC.
Civil Engineering | Program Management | Construction Management
TBPE REG. NO. F-003572
7908 CAMERON ROAD, AUSTIN, TX 78754; (512) 836-2388

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion

C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by K.A. Harutunian, February 28, 2022, TX PE No. 59181.	Original sealed by Anne H. Harutunian, February 28, 2022, TX PE No. 11571.	Original sealed by Shant Harutunian, February 28, 2022, TX PE No. 87735.

ELECTRICAL, INSTRUMENTATION AND CONTROL

RESPONSIBLE SPECIFICATION SECTIONS:

13390	16450
13851	16483
16120	16500
16121	16524
16130	16540
16140	16550
16150	16600
16200	16800
16205	17100
16222	17200
16264	17380
16300	17600
16350	SP16150
16444	SP16200

HARUTUNIAN ENGINEERING INCORPORATED (HEI)
Engineering and Environmental Consultants
8100 Cross Park Drive
Austin, Texas 78754
(512) 454-2788 FAX (512) 454-6434
TBPE Firm Registration No. F-2408

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion

C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Linda L. Barlow,
February 24, 2022,
TX PE No. 63878.

TRAFFIC CONTROL PLAN DESIGN

RESPONSIBLE SPECIFICATION SECTIONS:

803S BARRICADES, SIGNS AND TRAFFIC HANDLING

HVJ ASSOCIATES
TBPELS # f-646
1701 DIRECTORS BLVD, SUITE 900
AUSTIN, TEXAS 78744

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion

C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
David Negrete,
February 28, 2022,
TX PE No. 11640.

Architect

RESPONSIBLE SPECIFICATION SECTIONS:

02360	07212	08210	09902
02870	07213	08330	10100
03350	07214	08410	10400
03550	07301	08710	10500
04220	07415	08800	10520
06100	07468	09260	10615
06410	07600	09310	10810
07110	07714	09511	11400
07160	07900	09650	12486
07210	08110	09670	12494

NEGRETE & KOLAR
ARCHITECTS, LLP

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11720 North IH 35, Austin, TX 78753

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ITEM NO. 101S PREPARING RIGHT-OF-WAY 3-25-2021

101S.1 Description

This item shall govern the preparation of the right-of-way for construction operations by removal and disposal of all obstructions from the right-of-way and from designated easements, where removal of such obstructions is not otherwise indicated as a separate pay item.

Such obstructions shall be considered to include, but not be limited to, remains of houses not completely removed by others, foundations, floor slabs, concrete, brick, lumber, plaster, cisterns, water wells, septic tanks and drain fields, basements; abandoned utility pipes, conduits, underground service station tanks, fences, retaining walls, outhouses, shacks and all other debris.

This item shall also include, but not be limited to, the removal of trees, stumps, roots, bushes, shrubs, curb and gutter, driveways, paved parking areas, miscellaneous stone, brick, sidewalks, drainage structures, manholes, inlets, abandoned railroad tracks, scrap iron, and all rubbish and debris whether above or below ground. Care should be taken to identify and protect existing infrastructure.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text the inch-pound units are given preference followed by SI units shown within parentheses.

101S.2 Submittals

The submittal requirements of this specification item may include:

A. A permit when utility adjustments are made in the right-of-way, and

B. A plan for removal and deposition of all non-salvageable materials and debris.

101S.3 Construction Methods

Prior to commencement of this work, all required erosion controls and tree protection measures indicated on the Drawings shall be in place. The existing utilities shall be located and protected as specified in the Standard Contract Documents, Section 00700, "General Conditions" and/or as specified on the Drawings. A permit shall be required when utility adjustments are to be made in preparation for construction in the right-of-way, as specified in Section 5.2.0 of the City of Austin Utilities Criteria Manual.

Areas within the construction limits shall be cleared of all obstructions, abandoned structures, and other items as defined above. All vegetation, except trees or shrubs indicated for preservation, shall also be removed. Trees and shrubs, which are scheduled for preservation, shall be carefully trimmed as directed and shall be protected from scarring, barking or other injuries during construction operations in accordance with Item No. 610S, " Preservation of Trees and Other Vegetation". All exposed cuts over 2 inches (50 millimeters) in diameter, exposed ends of pruned limbs or scarred bark shall be treated with an approved asphalt material within 24 hours of the pruning or injury.

Construction equipment shall not be operated nor construction materials stockpiled under the canopies of trees, unless otherwise indicated on the Drawings and/or specified in the Contract Documents. Excavation or embankment materials shall not be placed within the drip line of trees until tree wells are constructed.

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

Unless otherwise indicated on the Drawings and/or Contract Documents, all underground obstructions, stumps and roots shall be removed to the following depths:

1. In areas to receive 6 inches (150 mm) or more embankment, a minimum of 12 inches (300 mm) below natural ground.
2. In areas to receive less than 6 inches (150 mm) of embankment, a minimum of 18 inches (450 mm) below the lower elevation of embankment, structure or excavation.
3. In areas to be excavated a minimum of 18 inches (450 mm) below the lower elevation of the embankment, structure or excavation.
4. In all other areas, a minimum of 12 inches (300 mm) below natural ground.

Holes remaining after removal of all obstructions, objectionable material, trees, stumps, etc. shall be backfilled with select embankment material and compacted by approved methods.

When a utility in service conflicts with the construction, it shall be modified as specified in the Standard Contract Documents, Section 00700, "General Conditions" and/or as specified on the Drawings.

Where an abandoned underground piped utility is found, it shall be cut and plugged with 6 inches (150 mm) of concrete (in accordance with Specification Item 403, "Concrete for Structures") brick and mortar (in accordance with Specification Item 506S, "Manholes") or a precast stopper grouted in place.

Material to be removed will be designated as salvageable or non-salvageable by the Engineer or designated representative prior to removal from the construction site by the Contractor. All material, which is located within the public right-of-way and is declared by the Engineer as salvageable, will remain the property of the City of Austin and will be stored at the site or loaded on city trucks as directed by the Engineer. All non-salvageable materials and debris shall become the property of the Contractor and shall be removed from the site and deposited at a permitted disposal site.

101S.4 Measurement

The preparation of right-of-way for new construction, when included in the contract as a pay item, will be measured by the acre (hectare: 1 hectare equals 2.471 acres), 100 foot (100 feet equals 30.5 meters) stations or lump sum, regardless of the width of the right-of-way.

Measurement for payment will be made only on areas indicated and classified as "Preparing Right-of-Way."

Source: Rule No. R161-21.01 , 3-25-2021.

101S.5 Payment

The work and material presented herein will not be paid for directly, but shall be included in the unit price bid for the item of construction in which this item is used unless specified as a separate pay item in the contract bid form. When included for payment, it shall be paid for at the contract bid price for "Preparing Right-of-Way." This price shall include full compensation for work herein specified, including the furnishing of all materials, equipment, tools, labor and incidentals necessary to complete the work.

When payment is made under the Lump Sum pay item the total payment of this item shall not exceed 5% of the original contract amount until final payment. Any remainder will be paid as part of final payment.

Payment, when included as a contract pay item, will be made under one of the following:

Pay Item No. 101S-A:	Preparing Right-of-Way -	Per Acre.
Pay Item No. 101S-B:	Preparing Right-of-Way -	Per 100 foot Station.

Pay Item No. 101S-C:	Preparing Right-of-Way -	Per Lump Sum.

Source: Rule No. R161-21.01 , 3-25-2021.

End

SPECIFIC CROSS REFERENCE MATERIALS	
Specification 101S, "PREPARING RIGHT-OF-WAY"	
City of Austin Standard Contract Documents	
Designation	Description
00700	General Conditions
City of Austin Utilities Criteria Manual	
Designation	Description
Section 5.2.0	Permit for Excavation in the Public Right-of-Way
City of Austin Standard Specifications	
Designation	Description
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 120S	Channel Excavation
Item No. 132S	Embankment
Item No. 403	Concrete for Structures
Item No. 506S	Manholes
Item No. 610S	Preservation of Trees and Other Vegetation

RELATED CROSS REFERENCE MATERIALS	
Specification 101S, "PREPARING RIGHT-OF-WAY"	
City of Austin Standard Contract Documents	
Designation	Description
01500	Temporary Facilities
01550	Public Safety and Convenience
The Code of the City of Austin, Code of Ordinances, Volume 2	
Designation	Description
Article 14-11-181	Permit Required
Article 14-11-189	Conditions for Permit Issuance
Article 14-11-190	Permit Term
City of Austin Standard Specifications	
Designation	Description
Item No. 102S	Clearing and Grubbing
Item No. 104S	Removing Portland Cement Concrete
Item No. 201S	Subgrade Preparation
Item No. 203	Lime Treatment for Materials In Place
Item No. 204S	Portland Cement Treatment for Materials In Place

Item No. 230S	Rolling (Flat Wheel)
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 234S	Rolling (Tamping)
Item No. 236S	Rolling (Proof)
Item No. 602S	Sodding for Erosion Control
Item No. 604S	Seeding for Erosion Control
Item No. 622S	Diversion Dike
Item No. 628S	Sediment Containment Dikes
Item No. 642S	Silt Fence
City of Austin Standard Details	
Designation	Description
610S-1	Tree Protection Fence Locations
610S-2	Tree Protection Fence, Type B Chainlink
610S-3	Tree Protection Fence, Type B Wood
610S-4	Tree Protection Fence, Modified Type A
610S-5	Tree Protection Fence, Modified Type B
621S-1	Diversion
622S-1	Diversion Dike
624S-1	Earth Outlet Sediment Trap
625S-1	Grade Stabilization Structure
627S-1	Grass Lined Swale
627S-2	Grass Lined Swale With Stone Center
628S	Triangular Sediment Filter Dike
628S-1	Hay Bale Dike
629S-1	Brush Berm
630S-1	Interceptor Dike
631S-1	Interceptor Swale
632S-1	Storm Inlet Sediment Trap
633S-1	Landgrading
634S-1	Level Spreader
635S-1	Perimeter Dike
636S-1	Perimeter Swale
637S-1	Pipe Slope Drain (Flexible)
637S-2	Pipe Slope Drain (Flexible)
638S-1	Pipe Outlet Sediment Trap
639S-1	Rock Berm
641S-1	Stabilized Construction Entrance
642S-1	Silt Fence
643S-1	Stone Outlet Structure
644S-1	Stone Outlet Sediment Trap
Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges	
Designation	Description
Item No. 100	Preparing Right-of-Way
Item No. 110	Excavation

Item No. 112	Subgrade Widening
Item No. 132	Embankment
Item No. 150	Blading
Item No. 158	Specialized Excavation Work
Item No. 160	Furnishing and Placing Topsoil
Item No. 164	Seeding for Erosion Control
Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges	
Designation	Description
Item No. 204	Sprinkling
Item No. 210	Rolling (Flat Wheel)
Item No. 211	Rolling (Tamping)
Item No. 213	Rolling (Pneumatic Tire)
Item No. 260	Lime Treatment for Materials Used as Subgrade (Road Mixed)
Item No. 265	Lime-Fly Ash (LFA) Treatment for Materials Used as Subgrade
Texas Department of Transportation: Manual of Testing Procedures	
Designation	Description
Tex-103-E	Determination of Moisture Content of Soil Materials
Tex-104-E	Determination of Liquid Limit of Soils
Tex-105-E	Determination of Plastic Limit of Soils
Tex-106-E	Method of Calculating the Plasticity Index of Soils
Tex-114-E	Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade & Embankment Soil
Tex-115-E	Field Method for Determination of In-Place Density of Soils and Base Materials

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ITEM NO. 102S CLEARING AND GRUBBING 3-25-2021

102S.1 Description

This item shall govern the removal and disposal of all trees, stumps, brush, roots, shrubs, vegetation, logs, rubbish and other objectionable material.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text the inch-pound units are given preference followed by SI units shown within parentheses.

102S.2 Submittals

The submittal requirements of this specification item may include:

A. A permit when utility adjustments are made in the right-of-way, and

B. A plan for removal and deposition of all clearing and grubbing materials and debris.

102S.3 Construction Methods

Prior to commencement of this work, all required erosion control and tree protection measures indicated on the Drawings shall be in place. The existing utilities shall be located and protected as specified in the Standard Contract Documents, Section 00700, "General Conditions" and/or indicated on the Drawings. A permit shall be required when utility adjustments are to be made in preparation for construction in the right-of-way, as specified in Section 5.2.0 of the City of Austin Utilities Criteria Manual.

Areas within the construction limits indicated on the Drawings shall be cleared of all trees, stumps, brush, etc., as defined in section 102S.1; except trees or shrubs scheduled for preservation which shall be carefully trimmed as directed, in accordance with Item No. 610S, " Preservation of Trees and Other Vegetation" and shall be protected from scarring, barking or other injuries during construction operations. All exposed cuts over 2 inches (50 millimeters) in diameter, exposed ends of pruned limbs or scarred bark shall be treated with an approved asphalt material within 24 hours of the pruning or injury.

Construction equipment shall not be operated nor construction materials stockpiled under the canopies of trees, unless otherwise indicated on the Drawings and/or specified in the Contract Documents. Excavation or embankment materials shall not be placed within the drip line of trees until tree wells are constructed.

Within the construction limits or areas indicated, all obstructions, stumps, roots, vegetation, abandoned structures, rubbish and objectionable material shall be removed to the following depths:

1. In areas to receive 6 inches (150 mm) or more embankment, a minimum of 12 inches (300 mm) below natural ground.
2. In areas to receive embankment less than 6 inches (150 mm), a minimum of 18 inches (450 mm) below the lower elevation of embankment, structure or excavation.
3. In areas to be excavated a minimum of 18 inches (450 mm) below the lower elevation of the embankment, structure or excavation.
4. In all other areas a minimum of 12 inches (300 mm) below natural ground.

Holes remaining after removal of all obstructions, objectionable material, trees, stumps, etc. shall be backfilled with select embankment material and compacted by approved methods. All cleared and grubbed material shall be

disposed of in a manner satisfactory to the Engineer or designated representative. Unless otherwise provided, all materials as described above shall become the property of the Contractor and removed from the site and disposed of at a permitted disposal site.

Burning materials at the site shall conform to Standard Contract Document Section 01550, "Public Safety and Convenience".

102S.4 Measurement

"Clearing and Grubbing", when included in the contract as a pay item, will be measured by the acre (hectare: 1 hectare is equal to 2.471 acres), 100 foot (100 feet is equal to 30.5 meters) stations or lump sum, regardless of the width of the right-of-way.

102S.5 Payment

The work and materials presented herein will not be paid for directly, but shall be included in the unit price bid for the item of construction in which this item is used, unless specified as a separate pay item in the contract bid form. When included for payment, it shall be paid for at the unit bid price for "Clearing and Grubbing". This price shall include full compensation for all work herein specified, including the furnishing of all materials, equipment, tools, labor and incidentals necessary to complete the Work.

When payment is made under the Lump Sum pay item, the total payment of this item shall not exceed 5% of the original contract amount until final payment. Any remainder will be paid at final payment.

Payment, when included as a contract pay items, will be made under one of the following:

Pay Item No. 102S-A:	Clearing and Grubbing	Per Acre.
Pay Item No. 102S-B:	Clearing and Grubbing	Per 100 foot Station.
Pay Item No. 102S-C:	Clearing and Grubbing	Lump Sum.

Source: Rule No. R161-21.01 , 3-25-2021.

End

SPECIFIC CROSS REFERENCE MATERIALS	
Specification Item 102S, "CLEARING AND GRUBBING"	
City of Austin Standard Contract Documents	
Designation	Description
00700	General Conditions
01550	Public Safety and Convenience
City of Austin Utilities Criteria Manual	
Designation	Description
Section 5.2.0	Permit for Excavation in the Public Right-of-Way
City of Austin Standard Specifications	
Designation	Description
Item No. 110S	Street Excavation
Item No. 111S	Excavation

Item No. 610S	Preservation of Trees and Other Vegetation

RELATED CROSS REFERENCE MATERIALS	
Specification 102S, "CLEARING AND GRUBBING"	
The Code of the City of Austin, Code of Ordinances, Volume 2	
Designation	Description
Article 15-12-166	Permit Required
Article 15-12-173	Conditions for Permit Issuance
Article 15-12-174	Permit Term
City of Austin Standard Contract Documents	
Designation	Description
01500	Temporary Facilities
City of Austin Standard Specifications	
Designation	Description
Item No. 101S	Preparing Right-of-Way
Item No. 104S	Removing Portland Cement Concrete
Item No. 120S	Channel Excavation
Item No. 132S	Embankment
Item No. 201S	Subgrade Preparation
Item No. 203	Lime Treatment for Materials In Place
Item No. 204S	Portland Cement Treatment for Materials In Place
Item No. 230S	Rolling (Flat Wheel)
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 234S	Rolling (Tamping)
Item No. 236S	Rolling (Proof)
Item No. 602S	Sodding for Erosion Control
Item No. 604S	Seeding for Erosion Control
Item No. 622S	Diversion Dike
Item No. 628S	Sediment Containment Dikes
Item No. 642S	Silt Fence
City of Austin Standard Details	
Designation	Description
610S-1	Tree Protection Fence Locations
610S-2	Tree Protection Fence, Type B Chainlink
610S-3	Tree Protection Fence, Type B Wood
610S-4	Tree Protection Fence, Modified Type A
610S-5	Tree Protection Fence, Modified Type B
621S-1	Diversion
622S-1	Diversion Dike
624S-1	Earth Outlet Sediment Trap
625S-1	Grade Stabilization Structure

627S-1	Grass Lined Swale
627S-2	Grass Lined Swale With Stone Center
628S	Triangular Sediment Filter Dike
628S-1	Hay Bale Dike
629S-1	Brush Berm
630S-1	Interceptor Dike
631S-1	Interceptor Swale
632S-1	Storm Inlet Sediment Trap
633S-1	Landgrading
634S-1	Level Spreader
635S-1	Perimeter Dike
636S-1	Perimeter Swale
637S-1	Pipe Slope Drain (Flexible)
637S-2	Pipe Slope Drain (Flexible)
638S-1	Pipe Outlet Sediment Trap
639S-1	Rock Berm
641S-1	Stabilized Construction Entrance
642S-1	Silt Fence
643S-1	Stone Outlet Structure
644S-1	Stone Outlet Sediment Trap
Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges	
Designation	Description
Item No. 100	Preparing Right-of-Way
Item No. 110	Excavation
Item No. 112	Subgrade Widening
Item No. 132	Embankment
Item No. 150	Blading
Item No. 158	Specialized Excavation Work
Item No. 160	Furnishing and Placing Topsoil
Item No. 164	Seeding for Erosion Control
Item No. 204	Sprinkling
Item No. 210	Rolling (Flat Wheel)
Item No. 211	Rolling (Tamping)
Item No. 213	Rolling (Pneumatic Tire)
Item No. 260	Lime Treatment for Materials Used as Subgrade (Road Mixed)
Item No. 265	Lime-Fly Ash (LFA) Treatment for Materials Used as Subgrade
Texas Department of Transportation: Manual of Testing Procedures	
Designation	Description
Tex-103-E	Determination of Moisture Content of Soil Materials
Tex-105-E	Determination of Plastic Limit of Soils
Tex-106-E	Method of Calculating the Plasticity Index of Soils
Tex-114-E	Laboratory Compaction Characteristics and Moisture Density Relationship of Subgrade & Embankment Soil
Tex-115-E	Field Method for Determination of In-Place Density of Soils and Base Materials

Item No. 104S
Removing Portland Cement Concrete

104S.1 Description

This item shall govern the demolition, removal and satisfactory disposal of existing Portland cement concrete, as classified, at locations indicated on the Drawings or as directed by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text inch-pound units are given preference followed by SI units shown within parentheses.

104S.2 Submittals

The submittal requirements of this specification item may include:

A. A permit when utility adjustments are made in the right-of-way, and

B. A plan for removal and deposition of all 'broken up' existing Portland cement (p.c.) concrete materials and debris.

104S.3 Classification

Existing Portland cement concrete, when removed under this section, will be classified as follows:

1. Concrete Curb will include curb, curb and gutter and combinations thereof,
2. Concrete Slabs will include, but not be limited to, house slabs, patio slabs, porch slabs, concrete riprap and concrete pavement,
3. Sidewalks and Driveways will include concrete sidewalks and driveways,
4. Concrete Walls will include all walls, regardless of height, and wall footings,
5. Concrete Steps will include all steps and combinations of walls and steps,
6. Abandoned Foundations will include abandoned utility foundations,
7. Miscellaneous Concrete shall include all other concrete items, which are not identified in items 1 through 6 above.

104S.4 Materials

Mortar shall conform to mortar specified in Standard Specification Item No. 403S, “Concrete for Structures”.

104S.5 Construction Methods

Prior to commencement of this work, all required erosion control and tree protection measures shall be in place. The existing utilities shall be located and protected as specified in the Standard Contract Documents, Section 00700, "General Conditions". A permit shall be required when utility adjustments are to be made in preparation for

highway construction, as specified in Section 5.2.0 of the City of Austin Utilities Criteria Manual.

The existing Portland cement concrete shall be broken up, removed in accordance with Item No. 101S, "Preparing Right of Way" and disposed of by the Contractor and deposited at a permitted disposal site.

When it is specified that only a portion of the existing Portland cement (p.c.) concrete is to be removed and that the remaining p.c. concrete will continue to serve its purpose, special care shall be exercised to avoid damage to that portion which will remain in place. Unless otherwise established by the Engineer or designated representative, existing p.c. concrete shall be cut to the neat lines, that are indicated on the Drawings, by sawing with an appropriate type circular type circular concrete saw to a minimum depth of 1/2 inch (12.5 mm). Any reinforcing steel encountered shall be cut off 1 inch (25 mm) inside of p.c. concrete sawed line. Any existing p.c. concrete, which is damaged or destroyed beyond the neat lines so established, shall be replaced at the Contractor's expense. Remaining p.c. concrete shall be mortared to protect the reinforcing steel and provide a neat clean appearance.

When reinforcement is encountered during the removal of portions of existing structures to be modified, a minimum of 1 foot (300 mm) of steel length shall be cleaned of all old p.c. concrete and left in place to tie into the new construction where applicable. All unsuitable material shall be removed and replaced with approved material. All foundations, walls or other objectionable material shall be removed to a minimum depth of 18 inches (450 mm) below all structures and 12 inches (300 mm) below areas to be vegetated.

104S.6 Measurement

When included in the contract as a separate pay item, the removal of p.c. concrete curb and p.c. concrete wall as prescribed above will be measured by the lineal foot (meter: 1 meter is equal to 3.281 feet) in its original position regardless of the dimensions or size. The removal of p.c. concrete slabs, p.c. concrete sidewalks and driveways, as prescribed above, will be measured by the square foot (square meter: 1 square meter is equal to 10.764 square feet) in original position, regardless of the thickness and existence of reinforcing steel. Portland cement concrete steps removed will be measured per lineal foot (meter: 1 meter is equal to 3.281 feet) of each individual step tread including the bottom step. The removal of p.c. concrete foundations will be measured per each individual foundation. The removal of miscellaneous concrete will be measured per lump sum.

104S.7 Payment

The work and materials presented herein will generally not be paid for directly, but shall be included in the unit price bid for the item of construction in which this item is used.

When specified in the contract bid form as a separate pay item, the item will be paid for at the contract unit bid price(s) for "Remove P.C. Concrete Curb", "Remove P.C. Concrete Slab", "Remove P.C. Concrete Sidewalks and Driveways", "Remove P.C. Concrete Walls", "Remove P.C. Concrete Steps", "Remove P.C. Concrete Foundations" and "Remove Miscellaneous P.C. Concrete". The bid prices shall include full compensation for all Work herein specified, including the disposal of all material not required in the

Work, the furnishing of all materials, equipment, tools, labor and incidentals necessary to complete the Work.

Payment will be made under one of the following:

Pay Item No.	**104S-A:**	Remove P.C. Concrete Curb	Per Lineal foot.
Pay Item No.	**104S-B:**	Remove P.C. Concrete Slab	Per Square foot.
Pay Item No.	**104S-C:**	Remove P.C. Concrete Sidewalks and Driveways	Per Square foot
Pay Item No.	**104S-D:**	Remove P.C. Concrete Wall	Per Lineal foot.
Pay Item No.	**104S-E:**	Remove P.C. Concrete Steps	Per Lineal foot.
Pay Item No.	**104S-F:**	Remove P.C. Concrete Foundations	Per Each.
Pay Item No.	**104S-G:**	Remove Miscellaneous P.C. Concrete	Per Lump Sum.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item 104S, "REMOVING CONCRETE"

City of Austin Standard Contract Documents

Designation	Description
00700	General Conditions

City of Austin Utilities Criteria Manual

Designation	Description
Section 5.2.0	Permit for Excavation in the Public Right-of-Way

City of Austin Standard Specifications

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 120S	Channel Excavation
Item No. 132S	Embankment
Item No. 403S	Concrete for Structures
Item No. 610S	Preservation of Trees and Other Vegetation

RELATED CROSS REFERENCE MATERIALS

City of Austin Standard Contract Documents

Designation	Description
01500	Temporary Facilities
01550	Public Safety and Convenience

The Code of the City of Austin, Code of Ordinances, Volume 1

Designation	Description
Article 14-11-181	Permit Required
Article 14-11-189	Conditions for Permit Issuance
Article 14-11-190	Excavation Sequence and Permit Term

City of Austin Standard Specifications

Designation	Description
Item No. 201S	Subgrade Preparation
Item No. 602S	Sodding for Erosion Control
Item No. 604S	Seeding for Erosion Control

Item No. 622S	Diversion Dike
Item No. 628S	Sediment Containment Dikes
Item No. 642S	Silt Fence

RELATED CROSS REFERENCE MATERIALS - Continued
Specification Item 104S, "REMOVING CONCRETE"

City of Austin Standard Details

Designation	Description
610S-1	Tree Protection Fence Locations
610S-2	Tree Protection Fence, Type B Chainlink
610S-3	Tree Protection Fence, Type B Wood
610S-4	Tree Protection Fence, Modified Type A
610S-5	Tree Protection Fence, Modified Type B
621S-1	Diversion
622S-1	Diversion Dike
624S-1	Earth Outlet Sediment Trap
625S-1	Grade Stabilization Structure
627S-1	Grass Lined Swale
627S-2	Grass Lined Swale With Stone Center
628S	Triangular Sediment Filter Dike
628S-1	Hay Bale Dike
629S-1	Brush Berm
630S-1	Interceptor Dike
631S-1	Interceptor Swale
632S-1	Storm Inlet Sediment Trap
633S-1	Landgrading
634S-1	Level Spreader
635S-1	Perimeter Dike
636S-1	Perimeter Swale
637S-1	Pipe Slope Drain (Flexible)
637S-2	Pipe Slope Drain (Flexible)
638S-1	Pipe Outlet Sediment Trap
639S-1	Rock Berm
641S-1	Stabilized Construction Entrance
642S-1	Silt Fence
643S-1	Stone Outlet Structure
644S-1	Stone Outlet Sediment Trap

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 104	Removing Concrete
Item No. 110	Excavation
Item No. 112	Subgrade Widening
Item No. 132	Embankment
Item No. 158	Specialized Excavation Work
Item No. 420	Concrete Structures

Item No. 111S
Excavation

111S.1 Description

This item shall govern: (1) the excavation and proper utilization or satisfactory disposal of all excavated materials, of whatever character, within the limits of the Work and (2) construction, compaction, shaping and finishing of all designated earthwork areas in accordance with the specification requirements outlined herein and in conformity with the required lines, grades and typical cross sections indicated on the Drawings or as directed by the Engineer or designated representative. When not otherwise included in the Contract Documents, this item shall include the work described in Specification Item Nos. 101S, "Preparing Right of Way", No. 102S, "Clearing and Grubbing", No. 104S, "Removing Portland Cement Concrete", No. 132S "Embankment" and No. 201S, "Subgrade Preparation".

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text inch-pound units are given preference followed by SI units shown within parentheses.

111S.2 Submittals

The submittal requirements of this specification item may include:

A. A permit when utility adjustments are made in the right-of-way,

B. A plan for removal and deposition of all 'Waste' materials, and

C. A Blasting Permit if blasting is required and allowed on the project.

111S.3 Classification

All excavation shall be unclassified and shall include all materials encountered regardless of their nature or the manner in which they are removed.

111S.4 Construction Methods

Prior to commencement of this work, all required erosion control and tree protection measures shall be in place. The existing utilities shall be located and shall be protected as specified in the Standard Contracts Document Section 00700, "General Conditions" and/or indicated on the Drawings. A permit shall be required when utility adjustments are to be made in preparation for construction in the right-of-way, as specified in Section 5.2.0 of the City of Austin Utilities Criteria Manual.

Construction equipment shall not be operated nor construction materials stockpiled under the canopies of trees, unless otherwise indicated on the Drawings. Excavation or embankment materials shall not be placed within the drip line of trees until tree wells are constructed, that conform to Specification Item No. 610S, “Preservation of Trees and Other Vegetation”.

All excavation shall be performed as specified herein and shall conform to the established alignment, grades and cross sections indicated on the Drawings. Suitable excavated

materials shall be utilized, insofar as practical, in constructing required embankments. The construction of all embankments shall conform to Specification Item No. 132S, "Embankment". No material shall be stockpiled within the banks of a waterway.

Unsuitable excavated materials or excavation in excess of that needed for construction shall be known as "Waste" and shall become the property of the Contractor. Unsuitable material encountered below the subgrade elevation in roadway cuts, when declared “Waste” by the Engineer or designated representative, shall be replaced with material from the roadway excavation or with other suitable material as approved by the Engineer. It shall become the Contractor’s responsibility to dispose of this material off the limits of the right of way in an environmentally sound manner at a permitted disposal site.

All blasting shall conform to the Provisions of the Standard Contract Document Section 01550, "Public Safety and Convenience". In all cases, a Blasting Permit must be obtained in advance from the City of Austin, Department of Public Works and Transportation.

Adequate dewatering and drainage of excavation shall be maintained throughout the time required to complete the excavation work.

111S.5 Measurement

All accepted excavation will be measured by either Method A or B as follows:

(1) Method A

Measurement of the volume of excavation in cubic yards (cubic meters: 1 square meter is equal to 1.306 square yards) by the average end area methods. Cross-sectional areas shall be computed from the existing ground surface to the established line of the subgrade, as shown on typical sections in the Drawings, over the limits of the right of way or other work limits, including parkway slopes and sidewalk areas.

(2) Method B

Measurement of the volume of excavation in cubic yards (cubic meters: 1 square meter is equal to 1.306 square yards), based upon the average end area method taken from pre-construction cross sections and planned grades. The planned quantities for excavation will be used as the measurement for payment for this item.

111S.6 Payment

This item will be paid for at the contract unit bid price for "Excavation", as provided under measurement Method A or B as included in the bid. The bid price shall include full compensation for all work herein specified including dewatering, drainage, subgrade preparation, unless otherwise indicated, and the furnishing of all materials, equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under one of the following:

Pay Item No. 111S-A:	Excavation	Per Cubic Yard.
Pay Item No. 111S-B:	Excavation, Plan Quantity	Per Cubic Yard.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item 111S, "EXCAVATION"

City of Austin Standard Contract Documents

Designation	Description
00700	General Conditions
01550	Public Safety and Convenience

City of Austin Utilities Criteria Manual

Designation	Description
Section 5.2.0	Permit for Excavation in the Public Right-of-Way

City of Austin Technical Specifications

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing-
Item No. 104S	Removing Portland Cement Concrete
Item No. 132S	Embankment
Item No. 201S	Subgrade Preparation
Item No. 236S	Proof Rolling
Item No. 610S	Preservation of Trees and Other Vegetation

RELATED CROSS REFERENCE MATERIALS
Specification Item 111S, "EXCAVATION"

City of Austin Standard Contract Documents

Designation	Description
01500	Temporary Facilities

City of Austin Standard Specifications

Designation	Description
Item No. 120S	Channel Excavation
Item No. 203	Lime Treatment for Materials In Place
Item No. 204S	Portland Cement Treatment for Materials In Place
Item No. 230S	Rolling (Flat Wheel)
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 234S	Rolling (Tamping)
Item No. 602S	Sodding for Erosion Control
Item No. 604S	Seeding for Erosion Control
Item No. 622S	Diversion Dike
Item No. 628S	Sediment Containment Dikes
Item No. 642S	Silt Fence

City of Austin Standard Details

Designation	Description
No. 610S-1	Tree Protection Fence Locations
No. 610S-2	Tree Protection Fence, Type B Chainlink
No. 610S-3	Tree Protection Fence, Type B Wood
No. 610S-4	Tree Protection Fence, Modified Type A

No. 610S-5	Tree Protection Fence, Modified Type B
No. 621S-1	Diversion
No. 622S-1	Diversion Dike
No. 624S-1	Earth Outlet Sediment Trap
No. 625S-1	Grade Stabilization Structure
No. 627S-1	Grass Lined Swale
No. 627S-2	Grass Lined Swale With Stone Center
No. 628S	Triangular Sediment Filter Dike

City of Austin Standard Details

Designation	Description
No. 628S-1	Hay Bale Dike
No. 629S-1	Brush Berm
No. 630S-1	Interceptor Dike
No. 631S-1	Interceptor Swale
No. 632S-1	Storm Inlet Sediment Trap
No. 633S-1	Landgrading
No. 634S-1	Level Spreader
No. 635S-1	Perimeter Dike
No. 636S-1	Perimeter Swale
No. 637S-1	Pipe Slope Drain (Flexible)
No. 637S-2	Pipe Slope Drain (Flexible)
No. 638S-1	Pipe Outlet Sediment Trap
No. 639S-1	Rock Berm
No. 641S-1	Stabilized Construction Entrance
No. 642S-1	Silt Fence
No. 643S-1	Stone Outlet Structure
No. 644S-1	Stone Outlet Sediment Trap

The Code of the City of Austin, Code of Ordinances, Volume 1

Designation	Description
Article 14-11-181	Permit Required
Article 14-11-189	Conditions for Permit Issuance
Article 14-11-190	Excavation Sequence and Permit Term

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 112	Subgrade Widening
Item No. 132	Embankment
Item No. 150	Blading
Item No. 158	Specialized Excavation Work
Item No. 160	Furnishing and Placing Topsoil
Item No. 164	Seeding for Erosion Control
Item No. 204	Sprinkling
Item No. 210	Rolling (Flat Wheel)
Item No. 211	Rolling (Tamping)
Item No. 213	Rolling (Pneumatic Tire)
Item No. 260	Lime Treatment for Materials Used as Subgrade (Road Mixed)
Item No. 265	Lime-Fly Ash (LFA) Treatment for Materials Used as Subgrade

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-103-E	Determination of Moisture Content of Soil Materials
Tex-104-E	Determination of Liquid Limit of Soils
Tex-105-E	Determination of Plastic Limit of Soils
Tex-106-E	Method of Calculating the Plasticity Index of Soils
Tex-114-E	Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade & Embankment Soil
Tex-115-E	Field Method for Determination of In-Place Density of Soils and Base Materials

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Item No. 130S
Borrow

130S.1 Description

This item shall govern required excavation, removal and proper utilization of materials secured from sources, selected by the Contractor and approved by the Engineer or designated representative. The compaction of embankments constructed from borrow as provided herein shall conform to the appropriate sections of Specification Item Nos. 132S, "Embankment" and 236S, “Proof Rolling”.

Borrow will be used only when indicated on the Drawings or directed by the Engineer or designated representative and shall only be acquired from approved sources.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text inch-pound units are given preference followed by SI units shown within parentheses.

130S.2 Submittals

The submittal requirements of this specification item may include:

A. Identification of Class, source and characteristics (P.I., linear shrinkage, etc.) of proposed borrow material, and

B. A plan for managing and maintaining borrow sites.

130S.3 Materials

All authorized borrow shall conform to one of the following classes:

Class A (Select Borrow)

Class A Borrow material shall consist of suitable granular material, free from vegetation or other objectionable matter and reasonably free from lumps of earth. When tested by standard TxDOT laboratory methods Tex-105-E, Tex-106-E and Tex-107-E, the Class A Select Borrow, shall meet the following requirements:

The Liquid Limit shall not exceed	45
The Plasticity Index shall not exceed	15
The bar linear shrinkage shall not be less than	2

Class B (Borrow)

Class B Borrow material shall consist of suitable non swelling [i.e. soils with a plasticity index (P.I.) less than 20] earth material such as loam, clay or other such materials that will form a stable embankment.

Class C (Topsoil)

See Standard Specification Item No. 601S.3(A)

130S.4 Construction Methods

Prior to commencing this work, all required erosion control and environmental measures shall be in place. All suitable materials removed from excavations shall be used, insofar as practicable in the formation of embankments conforming to Specification Item No. 132S, "Embankment", as otherwise indicated on the Drawings or as directed by the Engineer or designated representative. The completed work shall conform to the established alignment, grades and cross section as shown on the Drawings. The additional material necessary to complete the work described above shall be "Borrow" of the class specified.

The Contractor shall arrange for borrow from one of the following sources:

1. Existing borrow pit,
2. New borrow pit, or
3. Surplus excavated material from a site, with a site development permit.

The Contractor shall notify the Engineer 3 weeks prior to opening a pit or any other borrow source to allow necessary testing for approval of materials. All borrow sites shall comply with the requirements of the site development permit.

During construction, borrow sources shall be kept drained to permit final cross sections to be measured, when required.

Borrow sites shall be managed and maintained to minimize the impact of the appearance of the natural topographic features and at no time create a potential hazard to the public.

130S.5 Measurement

Borrow will be measured by the cubic yard (cubic meters: 1 cubic meter is equal to 1.196 cubic yards) in its final position based upon the average end areas, calculated from pre-construction cross sections and plan grades. The plan quantities for Borrow or Topsoil will be used as the measurement for payment for this item.

130S.6 Payment

All work performed as required herein and measured as provided under "Measurement" will be paid for at the unit bid price. The bid prices shall include full compensation for furnishing all labor; all materials; all royalty and freight involved; all hauling and delivering on the road; and all tools, equipment and incidentals necessary to complete the work. Payment will not be made for unauthorized work.

Payment will be made under one of the following:

Pay Item No. 130S-A: Class A (Select Borrow), Plan Quantity	Per Cubic Yard.
Pay Item No. 130S-B: Class B (Borrow), Plan Quantity	Per Cubic Yard.
Pay Item No. 130S-T: Class C (Topsoil), Plan Quantity	Per Cubic Yard.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification 130S, "BORROW"

City of Austin Standard Specifications

Designation	Description
Item No. 132S	Embankment
Item No. 236S	Rolling (Proof)

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-105-E	Determination of Plastic Limit of Soils
Tex-106-E	Method of Calculating the Plasticity Index of Soils
Tex-107-E	Determination of Bar Linear Shrinkage of Soils

RELATED CROSS REFERENCE MATERIALS
Specification 130S, "BORROW"

City of Austin Standard Contract Documents

Designation	Description
00700	General Conditions

City of Austin Standard Specifications

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 230S	Rolling (Flat Wheel)
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 234S	Rolling (Tamping)
Item No. 602S	Sodding for Erosion Control
Item No. 604S	Seeding for Erosion Control
Item No. 610S	Preservation of Trees and Other Vegetation
Item No. 622S	Diversion Dike
Item No. 628S	Sediment Containment Dikes
Item No. 642S	Silt Fence

City of Austin Standard Details

Designation	Description
No. 610S-1	Tree Protection Fence Locations
No. 610S-2	Tree Protection Fence, Type B Chainlink
No. 610S-3	Tree Protection Fence, Type B Wood
No. 610S-4	Tree Protection Fence, Modified Type A
No. 610S-5	Tree Protection Fence, Modified Type B
No. 621S-1	Diversion
No. 622S-1	Diversion Dike
No. 624S-1	Earth Outlet Sediment Trap
No. 625S-1	Grade Stabilization Structure
No. 626S-1	Grass Lined Swale
No. 627S-1	Grass Lined Swale With Stone Center
No. 628S	Triangular Sediment Filter Dike

No. 628S-1	Hay Bale Dike
No. 629S-1	Brush Berm
No. 630S-1	Interceptor Dike
No. 631S-1	Interceptor Swale
No. 632S-1	Storm Inlet Sediment Trap
No. 633S-1	Landgrading
No. 634S-1	Level Spreader

City of Austin Standard Details

Designation	Description
No. 635S-1	Perimeter Dike
No. 636S-1	Perimeter Swale
No. 637S-1	Pipe Slope Drain (Flexible)
No. 637S-2	Pipe Slope Drain (Flexible)
No. 638S-1	Pipe Outlet Sediment Trap
No. 639S-1	Rock Berm
No. 641S-1	Stabilized Construction Entrance
No. 642S-1	Silt Fence
No. 643S-1	Stone Outlet Structure
No. 644S-1	Stone Outlet Sediment Trap

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 132	Embankment
Item No. 158	Specialized Excavation Work
Item No. 160	Furnishing and Placing Topsoil
Item No. 164	Seeding for Erosion Control
Item No. 204	Sprinkling
Item No. 210	Rolling (Flat Wheel)
Item No. 211	Rolling (Tamping)
Item No. 213	Rolling (Pneumatic Tire)

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-103-E	Determination of Moisture Content of Soil Materials
Tex-104-E	Determination of Liquid Limit of Soils
Tex-114-E	Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade & Embankment Soil
Tex-115-E	Field Method for Determination of In-Place Density of Soils and Base Materials

Item No. 132S
Embankment

132S.1 Description

This item shall govern the placement and compaction of suitable materials obtained from approved sources for utilization in the construction of street or channel embankments, berms, levees, dikes and structures. When not otherwise included in the Contract Documents or indicated on the Drawings, this item shall include the work described in Specification Item Nos. 101S, "Preparing Right of Way", 102S, "Clearing and Grubbing", 104S, "Removing Portland Cement Concrete", 201S, "Subgrade Preparation" and No. 236S, “Proof Rolling.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text inch-pound units are given preference followed by SI units shown within parentheses.

132S.2 Submittals

The submittal requirements of this specification item may include:

A. A plan identifying source, material type, classification and characteristics (P.I., optimum moisture-density, etc.) of the proposed embankment material,
B. Type and size of equipment proposed to produce the required compaction, and
C. Compaction (Density-moisture, etc) test results for in-place embankment layers.

132S.3 Construction Methods

A. General

Prior to the placement of any embankment, all tree protection and tree wells and erosion control devices shall be in place and all operations involving Standard Specification Item No. 101S, "Preparing Right of Way" and/or Standard Specification Item No. 102S, "Clearing and Grubbing" shall have been completed for the areas over which the embankment is to be placed. Stump holes or other small excavations encountered within the limits of the embankments shall be backfilled with suitable material and thoroughly tamped by approved methods before commencement of the embankment construction.

The area of embankment placement shall be proof rolled (Specification Item No. 236S, “Proof Rolling”) and any unstable or spongy areas shall be undercut and backfilled with suitable material or otherwise mechanically manipulated and compacted by approved methods. Where shown on the Drawings or required by the Engineer or designated representative, the ground surface thus prepared shall be compacted by sprinkling and rolling. The surface of the ground, including those plowed and loosened or roughened by small washes, shall be restored to approximately its original slope and the ground surface thus prepared shall be compacted by sprinkling and rolling.

Construction equipment shall not be operated within the drip line of trees, unless otherwise indicated. Construction materials shall not be stockpiled under the canopies of trees. Excavation or embankment materials shall not be placed within the drip line of trees until tree wells are constructed in accordance with Item No. 610S, "Preservation of Trees and Other Vegetation".

Unless otherwise indicated on the Drawings and with the exception of rock, the surface of the ground of all unpaved areas, which are to receive embankment, shall be loosened by scarifying or plowing to a depth of not less than 4 inches (100 mm). The loosened material shall be re-compacted with the new embankment as hereinafter specified.

The surface of hillsides, which are to receive embankment, shall be loosened, by scarifying or plowing, to a depth of not less than 4 inches (100 mm) and benches constructed before the embankment materials are placed. The embankment shall then be placed in layers, as hereinafter specified, beginning at the low side with partial width layers and increasing the widths of the layers as the embankment is raised. The material, which has been loosened during preparation of the original ground surface, shall be re-compacted simultaneously with the embankment material placed at the same elevation.

Where embankments are to be placed adjacent to or over existing roadbeds, the roadbed slopes shall be plowed or scarified to a depth of not less than 6 inches (150 mm) and the embankment along the roadbed slopes shall be built up in successive layers, as hereinafter specified, to the elevation of the old roadbed. Then, if specified, the top surface of the old roadbed shall be scarified to a minimum depth of 6 inches (150 mm) and re-compacted along with the next layer of the new embankment. The total depth of the scarified and added material shall not exceed the permissible layer depth, specified hereinafter.

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

All embankment shall be constructed in layers approximately parallel to the finished grade and unless otherwise indicated, each layer shall be so constructed as to provide a uniform slope of 1/4 inch per foot (20 mm per meter) from the centerline of the roadbed to the outside. In the case of superelevated curves, each layer shall be constructed to conform to the specified superelevation or cross slope.

The embankment shall be continuously maintained at its finished section and grade until that portion of the work is accepted. After completion of the embankment to the finished section and grade, the Contractor shall proof roll the subgrade or finished grade in accordance with Specification Item No. 236S, "Proof Rolling". Any unstable or spongy areas shall be undercut and backfilled with suitable material or otherwise mechanically manipulated and compacted by approved methods. After acceptance of the embankment, re-vegetation activities shall commence immediately to minimize the soil loss and air pollution.

B. Earth Embankments

Earth embankments shall be defined as embankments composed of soil material other than rock and shall be constructed of acceptable material from approved sources.

Unless directed otherwise, earth embankments shall be constructed in successive layers, with a thickness of 8 inches (200 mm) or less in loose measure, for the full width of the individual cross section and in a length that is best suited to the sprinkling and compaction methods utilized.

Minor quantities of rocks with a maximum dimension of 4 inches (100 mm) may be incorporated in the earth embankment layers, provided that the rock is not placed immediately adjacent to structures.

Each layer of embankment shall be uniform as to material type and classification, density and moisture content before beginning compaction. Where layers of unlike materials abut each other, each layer shall be feathered on a slope of 1:20 or the materials shall be so mixed as to prevent abrupt changes in the soil. Any material placed in the embankment by dumping in a pile or windrows shall not be incorporated in a layer in that position. All such piles or windrows shall be incorporated in an embankment layer by blading and mixing or by similar methods. Clods or lumps of material shall be broken down into smaller sizes and the embankment material in a layer shall be mixed by blading, harrowing, discing or similar methods to insure that a uniform material of uniform density is secured in each layer.

The water required in sprinkling the layers, to obtain the moisture content necessary for optimum compaction, shall be evenly applied. It shall be the responsibility of the Contractor to secure uniform moisture content throughout the layer by such methods as may be necessary.

All earth cuts, whether full width or partial width side hill cuts and which are not required to be excavated below the subgrade elevation, shall be scarified to a uniform depth of at least 6 inches (150 mm) below grade. The material shall be mixed and reshaped by blading, sprinkled and rolled in accordance with the requirements outlined above for earth embankments to the same density required for the adjacent embankment.

Compaction of embankments shall conform to Item No. 201S, "Subgrade Preparation". Each layer shall be compacted to the required density by any method, and/or type and size of equipment, which will produce the required compaction. 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.

It is the intent of this specification to provide the required density and moisture control for each layer of earth embankment and select material based on the plasticity characteristics of the embankment soil. Each layer shall be sprinkled as required and compacted to the extent necessary to provide the density specified below, unless otherwise indicated.

Description	Density, Percent	Moisture
Non-swelling Soils (PI less than 20)	Not less than 95	
Swelling Soils (PI between 20 and 35)	Not less than 95 nor more than 102	Not less than optimum
Swelling Soils (P.I. greater than 35)	Not less than 95 nor more than 100	Not less than optimum

The Plasticity Index (PI) will be established in accordance with TxDoT Test Methods Tex-104-E, Tex-105-E and Tex-106-E and the density determination will be made in accordance with TxDoT Test Method Tex-114-E, “Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade and Embankment Soil”. Field density measurements will be made in accordance with TxDoT Test Method Tex-115-E, “Field Method for Determination of In-Place Density of Soils and Base Materials”.

After each layer of earth embankment or select material is complete, tests, as necessary, will be conducted as directed by the Engineer or designated representative. If the material fails to meet the density specified, the course shall be reworked as necessary to obtain the specified compaction.

C. Rock Embankments

Rock embankments shall be defined as those composed principally of rock and shall be constructed of accepted material from approved sources. Rock embankments shall not be placed immediately adjacent to structures.

Except as otherwise indicated on the Drawings, rock embankments shall be constructed in successive layers of 18 inches (450 mm) or less in thickness for the full width of the cross section. When, in the opinion of the Engineer or designated representative, the rock sizes necessitate a greater thickness of layer than specified, the layer thickness may be increased as necessary, but in no case shall the thickness of layer exceed 2 1/2 feet (750 mm). Each layer shall be constructed by starting at one end and dumping the rock on top of the layer being constructed then pushing the material ahead with a bulldozer in such a manner that the larger rock will be placed on either the ground or the preceding embankment layer. Each layer shall be constructed in such a manner that the interstices between the larger stones are filled with small stones and spalls which have been created by this operation and from the placement of succeeding layers of material.

The maximum dimension of any rock used in embankment shall be less than the thickness of the embankment layer and in no case shall any rock over 2 feet (600 mm) in its greatest dimension be placed in the embankment, unless otherwise approved by the Engineer or designated representative. All oversized rocks, which are otherwise suitable for construction, shall be broken to the required dimension and utilized in embankment construction where indicated. When preferred by the Contractor and acceptable to the Engineer or designated representative, oversized rocks may be placed at other locations where the embankment layer is of greater depth, thus requiring less breakage.

Each layer shall be compacted to the required density as outlined for "Earth Embankments", above, except in those layers where rock will make density testing difficult, the Engineer or designated representative may accept the layer by visual inspection or proof rolling conforming to Specification Item No. 236S, "Proof Rolling)".

Unless otherwise indicated, the upper 3 feet (1 meter) of the embankment shall not contain stones larger than 4 inches (100 mm) in their greatest dimension and shall be composed of material so graded that the density and uniformity of the surface layer may be secured in accordance with TxDoT Test Method Tex-114-E.

Exposed oversize material shall be broken up or removed.

D. At Culverts and Bridges

Embankment materials, which are to be placed adjacent to culverts and bridges and cannot be compacted by the blading and rolling equipment that was used in compacting the adjoining sections of embankment, shall be compacted in the manner prescribed under Item No. 401, "Structural Excavation and Backfill".

Embankment constructed around ‘spill through’ type abutments shall be constructed in 6 inch (150 mm) loose layers of a uniform suitable material and shall be placed so as to maintain approximately the same elevation on each side of the abutment. All materials shall be mixed, wetted and compacted as specified above. Embankment material placed adjacent to any portion of a structure or above the top of any culvert or similar structure shall be free of any appreciable amount of gravel or stone particles and shall be thoroughly compacted by mechanical compaction equipment.

132S.4 Measurement

All accepted embankment, when included in the contract as a separate pay item, will be measured in place and the volume computed in cubic yards (cubic meters: 1 cubic meter is equal to 1.196 cubic yards) by the method of average end areas. No allowance shall be made for shrinkage.

132S.5 Payment

The work and materials presented herein will generally not be paid for directly, but shall be included in the unit price bid for the item of construction in which this item is used.

However, when specified in the contract bid form as a separate pay item, it shall be paid for at the contract unit bid price for "Embankment". The bid price shall include full compensation for all work herein specified, including the furnishing of all materials, (except "Borrow" when paid as a separate bid item) compaction, equipment, tools, labor, water for sprinkling, proof rolling and incidentals necessary to complete the work.

Payment, when included in the contract as a separate pay item, will be made under:

Pay Item No. 132S-A: Embankment Per Cubic Yard.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification 132S, "EMBANKMENT"

City of Austin Standard Specifications

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 104S	Removing Portland Cement Concrete
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 130S	Borrow
Item No. 201S	Subgrade Preparation
Item No. 236S	Proof Rolling
Item No. 401	Structural Excavation and Backfill
Item No. 610S	Preservation of Trees and Other Vegetation

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-103-E	Determination of Moisture Content of Soil Materials
Tex-104-E	Determination of Liquid Limit of Soils
Tex-105-E	Determination of Plastic Limit of Soils
Tex-106-E	Method of Calculating the Plasticity Index of Soils
Tex-107-E	Determination of Bar Linear Shrinkage of Soils
Tex-114-E	Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade & Embankment Soil

RELATED CROSS REFERENCE MATERIALS - Continued

City of Austin Standard Contract Documents

Designation	Description
00700	General Conditions

City of Austin Standard Specifications

Designation	Description
Item No. 230S	Rolling (Flat Wheel)
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 234S	Rolling (Tamping)
Item No. 602S	Sodding for Erosion Control
Item No. 604S	Seeding for Erosion Control
Item No. 622S	Diversion Dike
Item No. 628S	Sediment Containment Dikes
Item No. 642S	Silt Fence

City of Austin Standard Details

Designation	Description
No. 610S-1	Tree Protection Fence Locations
No. 610S-2	Tree Protection Fence, Type B Chainlink
No. 610S-3	Tree Protection Fence, Type B Wood
No. 610S-4	Tree Protection Fence, Modified Type A
No. 610S-5	Tree Protection Fence, Modified Type B
No. 621S-1	Diversion
No. 622S-1	Diversion Dike
No. 624S-1	Earth Outlet Sediment Trap
No. 625S-1	Grade Stabilization Structure
No. 627S-1	Grass Lined Swale
No. 627S-2	Grass Lined Swale With Stone Center
No. 628S	Triangular Sediment Filter Dike
No. 628S-1	Hay Bale Dike
No. 629S-1	Brush Berm
No. 630S-1	Interceptor Dike
No. 631S-1	Interceptor Swale
No. 632S-1	Storm Inlet Sediment Trap
No. 633S-1	Landgrading
No. 634S-1	Level Spreader
No. 635S-1	Perimeter Dike
No. 636S-1	Perimeter Swale
No. 637S-1	Pipe Slope Drain (Flexible)
No. 637S-2	Pipe Slope Drain (Flexible)
No. 638S-1	Pipe Outlet Sediment Trap
No. 639S-1	Rock Berm
No. 641S-1	Stabilized Construction Entrance
No. 642S-1	Silt Fence
No. 643S-1	Stone Outlet Structure

No. 644S-1 Stone Outlet Sediment Trap

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 132	Embankment
Item No. 158	Specialized Excavation Work

RELATED CROSS REFERENCE MATERIALS - Continued
Specification 132S, "EMBANKMENT"

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 160	Furnishing and Placing Topsoil
Item No. 164	Seeding for Erosion Control
Item No. 204	Sprinkling
Item No. 210	Rolling (Flat Wheel)
Item No. 211	Rolling (Tamping)
Item No. 213	Rolling (Pneumatic Tire)

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-103-E	Determination of Moisture Content of Soil Materials
Tex-107-E	Determination of Bar Linear Shrinkage of Soils

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ITEM NO. 201S SUBGRADE PREPARATION 6-17-2021

201S.1 Description

This item shall govern scarifying; blading and rolling the subgrade to obtain a uniform texture and provide as nearly as practicable a uniform density for the top 6 inches (150 mm) of the subgrade.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

201S.2 Submittals

The submittal requirements of this specification item may include:

A. A plan identifying classification and characteristics (P.I., optimum moisture-density, etc.) of insitu subgrade soils, as well as the source, classification and characteristics of any proposed borrow material,

B. Type and size of equipment proposed to produce the required compaction, and

C. Compaction (moisture-density, etc) test results for in-situ subgrade soils and/or borrow materials.

201S.3 Construction Methods

Prior to initiation of subgrade preparation activities, all operations involving Standard Specification Item No. 101S," Preparing Right-of-Way" and/or Standard Specification Item No. 102S, "Clearing and Grubbing" shall be completed. The surface of the subgrade shall be scarified and shaped in conformity with the typical sections and the lines and grades indicated on the Drawings; by the removal of existing material or addition of approved material as established by the Engineer or designated representative. Any deviation in the subgrade cross section which exceeds ½ inch in a length of 10 feet (12 mm in a length of 3 meters), measured longitudinally, shall be corrected by loosening, adding or removing material, and then reshaping and compacting by sprinkling and rolling.

All unsuitable material shall be removed and replaced with approved material. All foundations, walls or other objectionable material shall be removed in accordance with Standard Specification Item No. 104S, "Removing Portland Cement Concrete" to a minimum depth of 18 inches (450 mm) under all structures and 12 inches (300 mm) under areas to be vegetated. All holes, ruts and depressions shall be filled with approved material and compacted by approved methods.

The subgrade shall be prepared sufficiently in advance to insure satisfactory prosecution of the Work. The Contractor will be required to set blue tops for the subgrade on the centerline, at the quarter points and along the curb lines or edge of pavement at maximum intervals of 50 feet (15 meters). The subgrade shall be tested by proof rolling in conformity with Standard Specification Item No. 236S, "Proof Rolling" prior to placement of the first course of base material. Any unstable or spongy subgrade areas identified by proof rolling shall be corrected either by additional re-working, drying and compaction, or by removal and replacement of unsuitable materials. When specifically directed by the Engineer or designated representative, the Contractor shall re-work the subgrade* as follows:

A. Remove the unstable subgrade to the full depth of the unstable insitu material or to a minimum depth of 6 inches (150 mm), whichever is greater;

B. Spread the material over a sufficient area to allow reworking of the excavated material;

C. Disc, scarify or otherwise breakup the excavated material and allow to dry (Note: If approved by the Engineer or designated representative, the addition of lime or other additive may be used to aid in the drying process or to stabilize the unstable material);

D. Fill the excavated area with the re-worked material and compact to specified densities; and

E. Proof roll the re-worked area.

* The Rework process will not be allowed for unstable organic subgrade soils. These type soils will be permanently removed and replaced with materials approved by the Engineer or designated representative.

All suitable material removed in accordance with Standard Specification Item No, 111S, "Excavation", may be utilized in the subgrade with the approval of the Engineer or designated representative. All other material required for completion of the Subgrade, including those defined in accordance with Specification Item No. 130S, "Borrow", shall also be subject to approval by the Engineer or designated representative.

It is the intent of this specification to provide the required density and moisture control for the subgrade based on the plasticity characteristics of the approved materials. The subgrade materials shall be sprinkled as required and compacted to the extent necessary to provide the density specified below, unless otherwise indicated on the Drawings. The Plasticity Index (P.I.) will be established in accordance with TxDOT Test Methods Tex-104-E, Tex-105-E and Tex-106-E. The density determination will be made in accordance with TxDOT Test Method Tex-114-E and field density measurements will be made in accordance with TxDOT Test Method Tex-115-E.

Description	Density, Percent	Moisture
Non-swelling Soils (P.I. less than 20)	Not less than 95	
Swelling Soils (P.I. between 20 and 35)	Not less than 95 nor more than 102	Not less than optimum
Swelling Soils (P.I. greater than 35)	Not less than 95 nor more than 100	Not less than optimum

Subgrade materials on which planting or turf will be established shall be compacted to a minimum of 85 percent of the density as determined in accordance with TxDOT Test Method Tex-114-E. Field tests for density in accordance with TxDOT Test Method Tex-115-E will be made as soon as possible after compaction operations are completed. If the material fails to meet the density specified, it shall be reworked as necessary to obtain the density required.

Prior to placement of any base materials, the in-place density and moisture content of the top 6 inches (150 mm) of compacted subgrade shall be checked. If the tests indicate that the relative density and moisture do not meet the limits specified in the table above, the subgrade shall be reworked as necessary to obtain the specified compaction and moisture content. All initial testing will be paid for by the City of Austin. All retesting shall be paid for by the Contractor.

201S.4 Measurement

All acceptable subgrade preparation when included in the contract as a separate pay item, will be measured by the square yard (square meter: 1 square meter equals 1.196 Square yards). The measured area includes the entire width of the roadway for the entire length as indicated on the Drawings.

201S.5 Payment

The work and materials presented herein will generally not be paid for directly, but shall be included in the unit price bid for the item of construction in which this item is used when specified as a separate pay item in the contract bid form, subgrade preparation shall be measured as specified above and paid for at the contract unit bid price for "Subgrade Preparation". The bid price shall include full compensation for all work herein specified,

including the furnishing of all materials, equipment, tools and labor and incidentals necessary to complete the work.

Payment, when included as a contract pay item, will be made under:

Pay Item No. 201S:	Subgrade Preparation	Per Square Yard.

End

SPECIFIC CROSS REFERENCE MATERIALS	
Specification Item 201S, "SUBGRADE PREPARATION"	
City of Austin Standard Specification Items	
Designation	Description
Item No. 101S	Preparing Right-of-Way
Item No. 102S	Clearing and Grubbing
Item No. 104S	Removing Portland Cement Concrete
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 130S	Borrow
Item No. 236S	Proof Rolling
Texas Department of Transportation: Manual of Testing Procedures	
Designation	Description
Tex-103-E	Determination of Moisture Content of Soil Materials
Tex-104-E	Determination of Liquid Limit of Soils
Tex-105-E	Determination of Plastic limit of Soils
Tex-106-E	Method of Calculating the Plasticity Index of Soils
Tex-114-E	Laboratory Compaction Characteristics & Moisture Density Relationship of Subgrade & Embankment Soil
Tex-115-E	Field Method for Determination of In-Place Density of Soils & Base Materials

RELATED CROSS REFERENCE MATERIALS	
Specification Item 201S, "SUBGRADE PREPARATION"	
City of Austin Standard Specifications	
Designation	Description
Item No.132S	Embankment
Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges	
Designation	Description
Item No. 100	Preparing Right-of-Way
Item No. 110	Excavation
Item No. 112	Subgrade Widening
Item No. 132	Embankment
Item No. 150	Blading
Item No. 158	Specialized Excavation Work
Item No. 204	Sprinkling

Item No. 210	Rolling (Flat Wheel)
Item No. 211	Rolling (Tamping)
Item No. 213	Rolling (Pneumatic Tire)
Texas Department of Transportation: Manual of Testing Procedures	
Designation	Description
Tex-103-E	Determination of Moisture Content of Soil Materials

ITEM NO. 202S HYDRATED LIME AND LIME SLURRY 6-17-2021

202S.1 Description

This item establishes the requirements for hydrated lime and commercial lime slurry of the type and grade considered suitable for use in the treatment of natural or processed materials or mixtures for stabilization of subgrade, subbase and base construction.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

202S.2 Submittals

The submittal requirements of this specification item may include:

A. A plan identifying type, grade, chemical and physical composition of proposed lime application, and

B. A plan for sampling and testing of lime slurry.

202S.3 Materials

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

A. Type A: (Hydrated Lime)

Type A Hydrated Lime shall consist of a dry powder obtained by treating quicklime with enough water to satisfy its chemical affinity for water under the conditions of its hydration. This material shall consist essentially of calcium hydroxide or a mixture of calcium hydroxide and a small allowable percentage of calcium oxide, magnesium oxide and magnesium hydroxide.

When sampled and tested according to prescribed TxDOT Standard Specification Item No. 264, hydrated lime shall conform to the following requirements as to chemical and physical composition:

Chemical Composition Requirements

Total "active" lime content, percent by weight (mass) {i.e., % by weight (mass) [Ca(OH)2] + % by weight (mass) [CaO]}	Minimum 90.0 %
Note: No more than 5 % by weight (mass) calcium oxide (unhydrated lime) will be allowed in determining the total 'active' lime content.	
Unhydrated lime content, % by weight (mass), CaO	Maximum 5.0 %
"Free water" content, % by weight (mass), H2O	Maximum 5.0 %

The percent by weight (mass) of residue retained, wet sieve, shall conform to the following requirements:

Wet Sieve Requirements

Residue retained on No. 6 (3.35 mm) sieve	Maximum. 0.2 %
Residue retained on No. 30 (600 µm) sieve	4.0 %

Specifications for Type A applies specifically to the normal hydrate of lime made from "high-calcium" type limestone. Hydrated Lime for stabilization purposes shall be applied as a dry powder or mixed to form a slurry before application as indicated on the Drawings. The slurry shall be free of liquid other than water.

B. Type B: (Commercial Lime Slurry)

Type B Lime Slurry shall be a pumpable suspension of solids in water. The slurry shall be furnished at or above the minimum "Dry Solids" content as approved by the Engineer or designated representative and must be of a consistency that can be handled and uniformly applied without difficulty. The water of the liquid portion of the slurry shall not contain dissolved material in sufficient quantity and/or nature to make it injurious or objectionable for the purpose intended. The solids portion of the mixture, when considered on the basis of "solids content", shall consist principally of hydrated lime of a quality and fineness sufficient to meet the requirements as to chemical composition and residue identified below.

When sampled and tested according to prescribed TxDOT Standard Specification Item No. 264, hydrated lime shall conform to the following requirements as to chemical and physical composition:

1. Chemical Composition. The "solids content" of lime slurry shall have a hydrate alkalinity Ca(OH)2 of not less than 87 percent by weight (mass).
2. Residue (Wet Sieve). The percent by weight (mass) of residue retained in the "solids content" of lime slurry shall conform to the following requirements:

Residue retained on No. 6 (3.35 mm) sieve	Maximum 0.2 %
Residue retained on No. 30 (600 µm) sieve	Maximum 4.0 %

C. Type C: Quicklime Pellets

Quicklime pellets shall conform to TxDOT Grade DS (TxDOT Specification Item 264) and are only allowable when indicated on the Drawings or when approved by the Engineer or designated representative. Quicklime pellets shall be of a gradation suitable for either "Dry Placing" or for preparation of a slurry for "Wet Placing".

When sampled and tested according to prescribed TxDOT Standard Specification Item No. 264, the quicklime lime shall conform to the following requirements as to chemical and physical composition:

1. Chemical Composition. The "solids content" of lime slurry shall have a hydrate alkalinity CaO of not less than 87 percent by weight (mass).
2. Residue (Wet and Dry Sieve)

   The percent by weight (mass) retained in the "solids content" of quicklime shall conform to the following requirements:

   Wet Sieve Requirements

Residue retained on No. 6 (3.35 mm) sieve	Maximum 8.0 %

Dry Sieve Requirements

Retained on 1 inch (25 mm) sieve	0.0 %
Retained on ¾ inch (19 mm) sieve	Maximum of 10.0 %
Retained on No. 100 (150 µm) sieve	Minimum of 80.0 %

D. Water

Water shall be clean and free of industrial wastes and other objectionable substances harmful to the lime and the environment.

202S.4 Sampling and Testing

The sampling and testing of lime slurry shall be conducted in accordance with TxDOT Test Methods: Tex-112-E, Tex-121-E and Tex-600-J.

202S.5 Measurement and Payment

Lime will be measured and paid for under the appropriate Lime pay item in Standard Specification Item 203S, "Lime Treatment for Materials in Place".

Source: Rule No. R161-21.12 , 6-17-2021.

End

SPECIFIC CROSS REFERENCE MATERIALS	
Specification Item 202S, "Hydrated Lime and Lime Slurry"	
City of Austin Standard Specification Items	
Designation	Description
Item No. 203S	Lime Treatment for Materials in Place
Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges	
Designation	Description
Item No. 264	Lime and Lime Slurry
Texas Department of Transportation: Manual of Testing Procedures	
Designation	Description
Tex-112-E	Methods of Admixing Lime to Reduce Plasticity Index of Soils
Tex-121-E	Soil Lime Testing
Tex-600-J	Sampling and Testing of Hydrated Lime, Quicklime and Commercial Lime Slurry

RELATED CROSS REFERENCE MATERIALS	
Specification Item 202S, "Hydrated Lime and Lime Slurry"	
City of Austin Standard Specifications	
Designation	Description
Item No. 101S	Preparing Right-of-Way
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 130S	Borrow
Item No. 132S	Embankment
Item No. 210S	Flexible Base
Item No. 236S	Proof Rolling
Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges	

Designation	Description
Item No. 100	Preparing Right-of-Way
Item No. 110	Excavation
Item No. 112	Subgrade Widening
Item No. 132	Embankment
Item No. 150	Blading
Item No. 158	Specialized Excavation Work
Item No. 204	Sprinkling
Item No. 210	Rolling (Flat Wheel)
Item No. 211	Rolling (Tamping)
Item No. 213	Rolling (Pneumatic Tire)
Texas Department of Transportation: Manual of Testing Procedures	
Designation	Description
Tex-103-E	Determination of Moisture Content of Soil Materials
Tex-104-E	Determination of Liquid Limit of Soils
Tex-105-E	Determination of Plastic limit of Soils
Tex-106-E	Method of Calculating the Plasticity Index of Soils
Tex-114-E	Laboratory Compaction Characteristics & Moisture Density Relationship of Subgrade and Soil
Tex-115-E	Field Method for Determination of In-Place Density of Soils & Base Materials

ITEM NO. 203S - LIME TREATMENT FOR MATERIALS IN PLACE 9-14-21

203S.1 - Description

This item shall govern the preparation and treatment of the subgrade, existing subbase or existing base by pulverizing the existing materials; furnishing and applying lime; mixing; mellowing for a minimum of 12 hours and compacting the mixed material to the required depth and density. This item applies to treatment of natural ground, embankment or existing pavement structure and shall be constructed as specified herein and in conformity with the typical sections, lines and grades on the drawings or as directed by the Engineer or designated representative. If the type of lime to be placed is not indicated on the drawings, the Contractor shall use Type B, Commercial Lime Slurry or Type C quick lime pebbles for all applications on areas larger than 100 square feet (10 square meters).

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text inch-pound units are given preference followed by SI units shown within parentheses.

203S.2 - Submittals

The submittal requirements of this specification item may include:

A. Mix design information (Transportation Criteria Manual Section 3.2.1.A, "Lime Stabilization"),
B. Type of lime and rate of lime application, and
C. Equipment proposed for use in proof rolling, pulverizing, mixing, placement and compaction operations.

203S.3 - Materials

A. Lime

The lime shall meet the requirements of Item No. 202S, "Hydrated Lime and Lime Slurry" for the type of lime specified in the drawings or as directed by the Engineer or designated representative.

When Type B, Commercial Lime Slurry, is specified, the Contractor shall select the "Dry Solids" content to be used in the slurry prior to construction and shall notify the Engineer in writing 5 working days before changing the "Dry Solids" content.

When dry placement of Type C quicklime pebbles are indicated on the Drawings or approved by the Engineer or designated representative, the pebbles shall conform to TxDOT Grade DS (TxDOT Specification Item 264) and shall have a gradation suitable for dry placement.

If lime is furnished in bags, each bag shall bear the manufacturer's certified weight (mass). Bags varying more than 5 percent from that weight (mass) may be rejected and the average weight (mass) of bags in any shipment, as shown by weighing 10 bags selected at random, shall not be less than the manufacturer's certified weight (mass).

B. Water

The water shall meet the material requirements of Standard Specification Item No. 220S, "Sprinkling for Dust Control".

C. Asphalt

The asphalt shall conform to the requirements of Standard Specification Item No. 301S, "Asphalts, Oils and Emulsions"

203S.4 - Equipment

The pulverizing, mixing and proof rolling machinery, tools and equipment, which are necessary for the proper execution of the work, shall be approved by the Engineer or designated representative. The equipment shall be located on the project site prior to the initiation of construction operations.

During the conduct of the Work all in-use machinery, tools and equipment shall be maintained in a satisfactory manner.

Hydrated lime shall be stored and handled in closed, weatherproof containers up to the time that mixing is initiated to form a slurry for distribution on the areas to be treated. If storage bins are used, they shall be completely enclosed. Hydrated lime in bags shall be stored in weatherproof buildings with adequate protection from ground dampness.

If lime is furnished in trucks, each truck shall have the weight (mass) of lime certified on public scales or the Contractor shall place a set of standard platform truck scales or hopper scales at a location approved by the Engineer or designated representative.

203S.5 - Construction Methods

A. General

Prior to commencement of the work, all required erosion control and tree protection measures shall be in place and the utilities located and protected as specified in the City of Austin Standard Contract Document Section 00700, "General Conditions". Construction equipment shall not be operated within the drip line of trees unless otherwise indicated on the drawings or directed by the Engineer or designated representative. Construction materials shall not be stockpiled under the canopies of trees. Excavation or embankment materials shall not be placed within the drip line of trees until appropriate tree wells are constructed.

The placement of lime shall not be allowed to adversely impact vegetation, drainageways or waterways, storm water inlets or overflow channels. Structures shall be screened, blocked or protected to prevent lime from entering any structure or waterway.

It is the primary requirement of this specification to secure a completed course of treated material, which contains a uniform lime mixture at the rate specified on the drawings or directed by the Engineer or designated representative, is free from loose or segregated areas, exhibits uniform density and moisture content, is well bound for its full depth and displays a smooth surface suitable for placement of subsequent courses. It shall be the responsibility of the Contractor to: regulate the sequence of his work, use the proper amount of lime, maintain the work and rework the courses as necessary to meet the above requirements.

B. Preparation of Subgrade or Existing Base.

Unless indicated otherwise on the drawings or directed otherwise by the Engineer or designated representative, the Contractor shall proof roll the roadbed/subgrade in accordance with Standard Specification Item No. 236S, "Rolling (Proof)" prior to pulverization or scarification of the existing material and/or subgrade. Any unstable or spongy subgrade areas identified by proof rolling shall be corrected either by additional re-working, drying and compaction, or by removal and replacement of unsuitable materials. When specifically directed by the Engineer or designated representative, the Contractor shall re-work the subgrade in accordance with Section 201S.3, "Construction Methods" of Standard Specification Item No. 201S, "Subgrade Preparation."

Prior to treatment of existing material and/or subgrade the layer to be treated shall be constructed shaped to conform to the typical sections, lines and grades as indicated on the Drawings or as established by the Engineer or designated representative. This work shall be done in accordance with the provisions of applicable bid items. When shown on the Drawings, any existing asphaltic concrete pavement shall be removed and the work will be paid for in accordance with the applicable bid items.

When the Contractor elects to use a cutting and pulverizing machine that will process the material to the specified 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.

The material, either before or after lime is applied, shall be excavated to the secondary grade (i.e. proposed depth of lime treatment) and removed or windrowed to expose the secondary grade. The secondary grade shall be blue topped at the edge, 1/4 points and along the centerline at not more than 50-foot (15.25 meters) centers. Any wet or unstable materials, located below the

secondary grade, shall be corrected, as directed by the Engineer or designated representative, by removing the unstable material or by scarifying, adding lime and compacting until uniform stability is attained.

The Contractor shall instruct their crews in the proper handling of lime to ensure that the workers and the public are adequately protected during lime handling and application operations.

C. Premixing Surface

When any material is uncovered during the premixing operation that exhibits properties different from the anticipated material, the Engineer or designated representative shall secure a sample of the material for appropriate testing to establish a suitable rate of lime application for the material.

D. Lime Application

The percentage of lime to be added by weight (mass) in pounds per square yard (kilograms per square meter) shall be as directed in this document or in accordance with the Lime mix design indicated on the Drawings and may be varied by the Engineer or designated representative if conditions warrant.

Unless otherwise approved by the Engineer or designated representative, the lime operation shall not be started when the air temperature is below 41oF (5oC) and falling, but may be started when the air temperature is above 35oF (2oC) 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 Engineer or designated representative are unsuitable.

Lime shall only be applied to those areas that can be properly processed during the same working day.

The application and mixing of lime with the existing material shall be accomplished by the methods hereinafter described as "Dry Placement" or "Slurry Placement." Dry placement will only be permitted for small isolated areas as indicated on the drawings or as directed by the Engineer or designated representative. The minimum rate of lime solids application shall be seven (7) percent by weight (mass), unless indicated otherwise on the Drawings or as directed by the Engineer or designated representative.

Any lime exposed to the air for more than six (6) hours and any lime lost or damaged before application due to rain, wind or other cause will be rejected and replaced by the Contractor at its own expense.

1. Dry Placement

   The lime shall be spread by a spreader approved by the Engineer or designated representative or by bag distribution at the rates shown on the Drawings or as directed by the Engineer or designated representative.

   The lime shall be distributed at a uniform rate and in such manner as to reduce the scattering of lime by wind. Lime shall not be applied when the wind conditions, in the opinion of the Engineer or designated representative, are such that blowing lime becomes objectionable to adjacent property owners or dangerous to traffic. A motor grader will not be used to spread Type A Hydrated lime but may be used to spread Type C Quicklime Grade "DS" pebbles.

   The material shall be sprinkled, as approved by the Engineer or designated representative, until the proper moisture content has been secured.

2. Slurry Placement

   The lime shall be mixed with water in a mixer or trucks with approved distributors to form a slurry with a solids content approved by the Engineer or designated representative. Application of the slurry shall be attained by successive passes over a measured section of roadway until the proper moisture and lime content has been secured. The distributor truck shall be equipped with an agitator, which will keep the lime and water in a uniform mixture.

E. Mixing

The mixing procedure shall be the same for "Dry Placement" or "Slurry Placement" as herein described.

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

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 time of 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 Engineer or designated representative. After curing, mixing shall continue until the material and lime are thoroughly blended to the satisfaction of the Engineer or designated representative.

The material and lime shall be thoroughly mixed by road pulverizer equipment approved by the Engineer or designated representative. The material and lime shall be brought to the proper moisture content and the mixing shall be continued until a homogeneous, friable mixture of

material and lime is obtained. The lime-material mixture shall be free from all clods or lumps so that, when all nonslaking aggregates retained on the #4 (4.75 mm) sieve are removed, the remainder of the material shall meet the following pulverization requirements, when tested in accordance with TxDOT Test Method Tex-101-E, Part III:

	Percent
Minimum Passing the 1¾ inch (45 mm) Sieve	100
Minimum Passing the ¾ inch (19 mm) Sieve	85
Minimum Passing the No. 4 (4.75 mm) Sieve	60

When the lime-material mixture satisfies the requirements above, the mixture shall be allowed to "mellow" for a minimum of 12 hours prior to the initiation of compaction.

F. Compaction

Prior to initiation of compaction, the material shall be aerated or sprinkled as necessary to provide the optimum moisture. The lime-conditioned materials shall then be shaped and uniformly compacted to the sections; lines and grades indicated on the drawings or as directed by the Engineer or designated representative. Compaction shall continue until the entire depth of mixture is uniformly compacted as shown on the Drawings, as specified herein, or as directed by the Engineer or designated representative.

When shown on the Drawings or approved by the Engineer or designated representative, multiple lifts will be permitted; however the 12-hour "mellowing" procedure is required for each lift. Individual lift thickness should not exceed 8 inches (200 mm).

The course shall be sprinkled as required and compacted to the extent necessary to provide the density specified below:

Description	Density, Percent
For lime-conditioned subgrade, existing subbase or existing base that will receive subsequent subbase or base courses.	Not less than 95% of 'optimum density' or as otherwise indicated on the drawings.

For lime-conditioned existing base that will receive surface courses	Not less than 98% of 'optimum density' or as otherwise indicated on the drawings.

Testing for the 'optimum density' used for compaction control shall conform to TxDOT Test Method Tex-113-E. In addition to the requirements specified for density, the full depth of the material indicated shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed and proof rolled in accordance with Specification Section No. 236S, in place compaction tests will be conducted, as necessary, by the Engineer or designated representative in accordance with TxDOT Test Method, Tex 115-E. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements. Throughout the 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 Drawings or as established by the Engineer or designated representative.

If the lime-conditioned material, due to any reason or cause, loses the required stability, density and finish before the next course is placed, it shall be re-compacted and refinished at the sole expense of the Contractor.

G. 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 original specified rate of lime application during the reworking operation.

Reworking shall include loosening, road mixing as approved by the Engineer or designated representative, compacting and finishing. When a section is reworked, a new optimum density will be determined from the reworked material in accordance with TxDOT Test Method Tex-113-E.

203S.6 - Finishing, Curing and Preparation for Surfacing

After the final layer or course of the lime conditioned subgrade, subbase or base has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections indicated on the drawings. The completed section shall then be "finished off" by rolling with a pneumatic tire or other suitable roller, approved by the Engineer or designated representative, that is sufficiently light in loading to prevent hair cracking.

The Contractor shall set blue tops at edges, 1/4 point, and along the centerline at not more than 50 foot (15.25 meter) spacing. The completed section shall be maintained in a moist cured condition for a minimum of 3 days either by maintenance of moist conditions by water sprinkling or by the prevention of moisture loss due to drying by the addition of an asphalt prime coat as indicated on the drawings or as directed by the Engineer or designated representative at the rate of 0.05 to 0.20 gallons per square yard (0.2 to 0.9 liters per square meter) before further courses are added or any through traffic is permitted, unless otherwise directed by the Engineer or designated representative. Curing shall continue for a minimum of seven (7) days before further courses are added or traffic is permitted access, unless a shorter curing period is approved by the Engineer or designated representative.

If the drawings require the lime-conditioned material to be sealed or covered by other courses of material, the seal or other course shall be applied within 14 days after final mixing is completed, unless otherwise directed by the Engineer or designated representative. If the 14 day limit cannot be achieved because of insufficient strength gain or other problem with the lime-treated layer, the Contractor shall rework the section in accordance with Section 203S.5(G) above.

203S.7 - Sampling and Testing

The lime-conditioned mixture shall be tested daily at the Project site for conformance to specification requirements. The Engineer or designated representative shall determine sample locations based on the Contractor's anticipated production. Each day's anticipated production shall be sectioned into three (3) equal, single-pass, sub-area lots. Each day's sample locations shall be equally distributed over the three (3) sub-areas. Also, no more than one location of the three (3) sub-areas is to be located in an irregular shaped area such as a cul-de-sac.

When, in the opinion of the Engineer or designated representative, test results appear unrepresentative, additional testing may be authorized. Retesting due to failures or to resolve unrepresentative results will be at the expense of the Contractor and the results of the retesting shall be averaged with the results of the original testing. If the results of retesting indicate that the original testing was erroneous, the original test results will be discarded.

The Engineer will obtain samples of completed work to conduct the following tests:

Testing Requirement	TxDOT Test Procedure
Optimum Moisture Density	Test Method Tex-113E
In-Place Density of Lime Conditioning	Test Method Tex 115-E

Thickness of Lime Conditioning	Test Method Tex-140-E & Tex-600-J
PI Reduction	Test Method Tex-106-E

The contractor shall repair areas disturbed while obtaining samples.

203S.8 - Tolerances

A. In-Place Density

The Work may be accepted provided no more than one (1) out of the most recent five (5) density tests performed is below the specified density, provided that the failing test is not more than three (3) pounds per cubic foot (50 kilograms per cubic meter) below the specified density.

B. Dimensional

Areas of lime conditioning which do not meet the tolerances specified below will be delineated and shall be corrected to drawing dimensions by scarifying, remanipulating and recompacting the deficient areas at the Contractor's sole expense.

1. Thickness Requirements:

   Under thickness shall not exceed ¾ inch (19 mm). Overthickness will be waived at no additional cost to the City.

2. Widths Requirements:

   Roadway under width shall not exceed six (6) inches (150 mm). Shoulder underwidth shall not exceed three (3) inches (75 mm). If lime conditioning for both roadway and shoulder is constructed at the same time, the 6-inch (150 mm) underwidth tolerance shall apply. Overwidth will be waived at no additional cost to the City.

203S.9 - Measurement

When lime is furnished in trucks, the weight of lime will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at a location approved by the Engineer.

When lime is furnished in bags, each bag must indicate the manufacturer's certified weight. Bags varying more than 5% from that weight may be rejected. The average weight of bags in any shipment, as determined by weighing 10 bags taken at random, must be at least the

manufacturer's certified weight.

1. Hydrated Lime.
    a. Dry. Lime will be measured by the ton (dry weight).
    b. Slurry. Lime will be measured by the ton (dry weight) of the hydrated lime used to prepare the lime slurry at the jobsite.
2. Commercial Lime Slurry. Lime slurry will be measured by the ton (dry weight) as calculated from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.
3. Quicklime.
    a. Dry. Lime will be measured by the ton (dry weight).
    b. Slurry. Lime slurry will be measured by the ton (dry weight) of the quicklime used to prepare the slurry, multiplied by a conversion factor of 1.28 to give the quantity of equivalent hydrated lime, which will be the basis of payment.

"Lime Treated Subgrade," "Lime Treated Existing Subbase" and Lime Treated Existing Base," of the type, grade and rate of application on the subgrade, existing subbase and existing base shall be measured by the square yard (square meter: 1 square yard equals 0.836 square meters) to neat lines as shown on the typical sections.

Source: Rule No. R161-21.17 , 9-14-2021.

203S.10 - Payment

Work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for as follows:

"Lime" will be paid for at the unit bid price per ton. The unit bid prices for "Lime" shall include full compensation for: furnishing all materials; all freight involved; public scales weighing charges or furnishing scales and labor involved in weighing the material.

"Lime Treated Subgrade," "Lime Treated Existing Subbase" and "Lime Treated Existing Base" will be paid for at the unit bid price per square yard. The unit bid prices for "Lime Treated Subgrade," "Lime Treated Existing Subbase" and "Lime Treated Existing Base" shall include full compensation for preparing the roadbed; loosening, mixing, pulverizing, spreading, drying, application of lime, sprinkling, rolling, shaping, proof rolling, maintenance and all manipulations, reworking, labor, equipment, fuels, tools and incidentals necessary to complete the work.

Payment will be made under one of the following:

Pay Item No. 203S-L:	Lime	Per Ton.
Pay Item No. 203S-A:	Lime Treated Subgrade, (___ in. Thick)	Per Square Yard.
Pay Item No. 203S-B:	Lime Treated Existing Subbase, (___ in. Thick)	Per Square Yard.
Pay Item No. 203S-C:	Lime Treated Existing Base, (___ in. Thick)	Per Square Yard.

Source: Rule No. R161-21.17 , 9-14-2021.

End

SPECIFIC CROSS REFERENCE MATERIALS	
Specification 203S, "Lime Treatment for Materials in Place"	
City of Austin Contract Documents	
Designation	Description
Section 00700	General Conditions
City of Austin Standard Specifications	
Designation	Description
Item No. 202S	Hydrated Lime and Lime Slurry
Item No. 220S	Sprinkling for Dust Control
Item No. 236S	Proof Rolling
Item No. 301S	Asphalts, Oils and Emulsions

Texas Department of Transportation: Manual of Testing Procedures	
Designation	Description
Tex-101-E, Part III	Preparation of Soil and Flexible Base Materials for Testing
Tex-106-E	Methods of Calculating the Plasticity Index of Soils
Tex-114-E	Laboratory Compaction Characteristics & Moisture Density Relationship of Subgrade & Embankment Soil
Tex-115-E	Field Method for Determination of In-Place Density of Soils & Base Materials
Tex-121-E, Part II	Soil Lime Testing
Tex-140-E	Measuring Thickness of Pavement Layer
Tex-600-J	Sampling and Testing of Hydrated Lime, Quicklime and Commercial Lime Slurry

RELATED CROSS REFERENCE MATERIALS	
Specification 203S, "Lime Treatment for Materials in Place"	
City of Austin Standard Specifications	
Designation	Description
Item No. 101S	Preparing Right-of-Way
Item No. 102S	Clearing and Grubbing
Item No. 110S	Street Excavation

Item No. 111S	Excavation
Item No. 130S	Borrow
Item No. 132S	Embankment
Item No. 210S	Flexible Base
Item No. 230S	Rolling (Flat Wheel)
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 306S	Prime Coat
Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges	
Designation	Description
Item No. 100	Preparing Right-of-Way
Item No. 110	Excavation
Item No. 112	Subgrade Widening
Item No. 132	Embankment
Item No. 150	Blading
Item No. 158	Specialized Excavation Work
Item No. 204	Sprinkling
Item No. 210	Rolling (Flat Wheel)
Item No. 211	Rolling (Tamping)

Item No. 213	Rolling (Pneumatic Tire)
Item No. 264	Lime and Lime Slurry
Item No. 300	Asphalts, Oils and Emulsions
Texas Department of Transportation: Manual of Testing Procedures	
Designation	Description
Tex-103-E	Determination of Moisture Content in Soil Materials
Tex-104-E	Determination of Liquid Limit of Soils
Tex-105-E	Determination of Plastic Limit of Soils

Item No. 204S
Portland Cement Treatment for Materials in Place

204S.1 Description

This item shall govern the treatment of materials in place by pulverizing soil or aggregate materials, adding Portland cement, mixing, wetting and then 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 Drawings or as established by the Engineer or designated representative. This item applies to natural subgrade soils, embankment materials, new base or existing base (with or without asphaltic concrete pavement layers) or combinations as shown on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text the inch-pound units are given preference followed by SI units shown within parentheses.

204S.2 Submittals

The submittal requirements of this specification item may include:

A. A mix design identifying classification of in-place materials, type of cement, source of water and quantities of cement and water required in the proposed application to yield the specified compressive strength requirements, and

B. An update in the mix design, if source of material changes during construction,

C. A plan describing the construction equipment proposed for the work and identifying the type and condition of each equipment item.

204S.3 Materials

A. Soil

Soil shall consist of approved material, free from vegetation or other objectionable matter, encountered in the existing roadway and/or other acceptable embankment or borrow material selected for use in preparation of the roadway in accordance with this specification.

B. Portland Cement

Portland cement shall be either Type 1, 1P or II and shall conform to TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges Item No. 524.

The Contractor may use bag or bulk cement.

C. Water

Water shall be free from oils, acids, organic matter or other substances deleterious to the cement treatment of materials. The water shall not contain more than 1000 parts per million of chlorides as Cl nor more than 1000 parts per million of sulfates as SO4. Water from municipal supplies approved by the State Health Department will not require testing, but water from other sources will be sampled and tested in accordance with AASHTO T-26. The water source shall be approved by the Engineer or designated representative.

204S.4 Equipment

The equipment utilized for materials, which are specified to be measured or proportioned by weight (mass) shall be approved by the Engineer or designated representative. Prior to the start of construction operations the equipment necessary for the proper construction of the work shall be on the project site, in first class working condition and approved by the Engineer or designated representative, both as to type and condition. The Contractor shall at all times provide sufficient equipment to enable continuous prosecution of the work and to insure completion in the required number of working days.

"Portland Cement Treatment for Materials in Place" may be constructed with any machine or combination of machines and auxiliary equipment that will produce results as outlined in this specification.

Mixing may be accomplished by (1) a multiple-pass traveling mixing plant or (2) a single-pass traveling mixing plant.

The equipment provided by the Contractor shall be operated by experienced and capable workers and shall be that necessary to provide a cement treatment meeting the requirements herein specified.

204S.5 Mix Design

Cement content will be selected by the Engineer or designated representative, based on compressive strength test results from a testing laboratory approved by the City of Austin. The mix design shall meet the strength requirements as shown on the Drawings or indicated in the Specifications.

Unless otherwise indicated in the Drawings or established by the Engineer or designated representative, the mix will be designed with the intention of producing a minimum average 7 day compressive strength of 400 pounds per square inch (2750 kilopascals) using the unconfined compression testing procedures described in TxDOT Test Method Tex-120-E.

When material properties or sources change, Contractor shall provide additional mix design tests and adjust the cement content as necessary to meet the compressive strength requirements.

204S.6 Construction Methods

A. General

Prior to commencement of this work, all required erosion control and tree protection measures shall be in place and the utilities located and protected as specified in the City of Austin Standard Contract Document Section 00700, "General Conditions".

Construction equipment shall not be operated within the drip line of trees unless otherwise indicated on the Drawings. Construction materials shall not be stockpiled under the canopies of trees. Excavation or embankment materials shall not be placed within the drip line of trees until tree wells are constructed.

It is the primary requirement of this specification to secure a uniformly treated course of cement treated material, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and with a smooth surface suitable for placing subsequent courses.

B. Preparation of Subgrade or existing surface

Prior to scarifying or pulverizing the existing material, the subgrade or existing surface shall be graded and shaped as required to construct the "Portland Cement Treatment for Materials in Place" in conformance with the lines, grades, thickness and cross section indicated on the Drawings or as approved by the Engineer or designated representative. Unsuitable material shall be removed and replaced with acceptable material.

The Contractor shall proof roll the subgrade or existing surface in accordance with Standard Specification Item No, 236S. The subgrade or existing surface shall be firm and able to support without displacement the construction equipment and the compaction hereinafter specified. Soft or yielding subgrade shall be corrected and made stable before construction proceeds.

When the Contractor elects to use a cutting and pulverizing machine that will process the material to the specified 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 provided at all times that the machine is cutting to the proper depth. If the machine fails to achieve the proper cutting depth, it shall be removed from the project or adjusted to the satisfaction of the Engineer or designated representative to accomplish the work as specified

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 Drawings or as established by the Engineer or

designated representative. The windrowed material shall be uniformly replaced before the cement is applied.

C. Pulverization

The existing subgrade material to be stabilized shall be so pulverized that, a minimum of 80 percent passes a No. 4 (4.75 mm) sieve, exclusive of gravel or stone retained on this sieve. When shown on the Drawings or approved by the Engineer or designated representative, this pulverization requirement may be waived if the material contains a substantial amount of aggregate.

Existing asphaltic concrete wearing surfaces, subbases and bases shall be pulverized so that 100 percent will pass a 2 inch (50 mm) sieve.

D. Application of Cement (Roadmix)

It shall be the responsibility of the Contractor to (1) regulate the sequence of work, (2) process a sufficient quantity of material to provide full depth as indicated on the Drawings, (3) use the proper amount of Portland cement, that is established by the approved job mix design or approved by the Engineer or designated representative and (4) maintain the work and rework the courses as necessary to meet the design strength requirements.

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 treatment shall not be mixed or placed when the wind velocity exceeds 15 miles (25 kilometers) per hour or when the air temperature is below 400F (40C) and falling, but may be mixed or placed when the air temperature is above 350F (20C) and rising. The temperature shall be taken in the shade and away from artificial heat. In any event cement treatment shall be mixed or placed only when weather conditions, in the opinion of the Engineer or designated representative, are suitable. If a bulk cement spreader is used, it shall be positioned with string lines or other approved method during spreading to insure a uniform distribution of cement.

Cement shall be applied only in that area where the mixing, compacting and finishing operations can be continuous and completed in daylight within 6 hours of such application.

The percentage of moisture in the soil at the time of cement application shall not exceed the quantity that will permit uniform and intimate mixture of material and cement during dry mixing operations. The percentage of moisture in the soil at the time of cement application shall not exceed the optimum moisture content for the cement-stabilized mixture.

No equipment, except that used in spreading and mixing, will be allowed to pass over the freshly spread cement until it is mixed.

E. Mixing and Processing

Either single or multiple soil stabilizer mixers shall be used.

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 (1) lift.

The mixer shall be provided with means for the visible and accurate gauging of the water application. The water shall be uniformly applied through a pressure spray bar.

After the cement is spread, the mixing operation shall proceed as follows:

1. The mixer shall in one continuous operation: mix the air-dry material and cement to the full depth indicated on the Drawings, provide for the addition of water uniformly, thoroughly moist-mix the material, cement and water, spread the completed cement mixture evenly over the machine processed width of the subgrade, and leave it in a loose condition ready for immediate compaction.

2. The stabilized cement mixture shall not remain undisturbed after mixing and before compacting for more than 30 minutes.

F. Compaction

Unless otherwise shown on the Drawings or established by the Engineer or designated representative, the cement treated 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 TxDOT Test Method Tex-120-E, Part II. The in place roadway density will be determined by TxDOT Test Method Tex-115-E.

At the start of compaction, the percentage of moisture in the mixture and in unpulverized soil lumps, shall be within 2 percentage points either side of the specified optimum moisture content as determined by TxDOT Test Method Tex-120-E, unless otherwise approved by the Engineer or designated representative. The percent of moisture will be determined in accordance with TxDOT Test Method Tex-103-E.

If the percent of moisture is outside the allowable tolerance, the Contractor shall adjust operations to meet this requirement. When the uncompacted cement stabilized mixture is wetted by rain so that the average moisture content exceeds the specified tolerance at the time of final compaction, the entire section shall be reconstructed in accordance with this specification at the sole expense of the Contractor.

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, the treated material shall be removed and replaced, unless otherwise approved by the Engineer or designated representative. Removal and replacement with acceptable treated material will be at the Contractor's expense. All initial density testing will be paid for by the City of Austin. All retesting shall be paid for by the Contractor.

G. Finishing

The resulting surface shall be "clipped", "skinned" or "tight bladed" by a maintainer or subgrade trimmer to a depth of approximately 1/4 inch (6 mm), removing all loosened materials. The loosened materials will be disposed of at the Contractor's expense and at a location approved by the Engineer or designated representative. The surface shall then be rolled with the pneumatic roller in accordance with Standard Specification Item No. 232S, 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 Drawings or as established by the Engineer or designated representative.

If plus No. 4 (4.75 mm) aggregate is present in the mixture, one complete coverage of the section with the flat wheel roller in accordance with Standard Specification Item No. 230S shall be made immediately after the "clipping" operation. When directed by the Engineer or designated representative, surface finishing methods may be varied from this procedure, provided a dense, uniform surface, free of surface compaction planes, is produced.

The moisture content of the surface material must be maintained within two (2) percentage points of optimum during all finishing operations. Surface compaction and finishing shall proceed in such a manner as to produce, in not more than 2 hours, a smooth, closely knit surface conforming to the crown, grade and line indicated which is free of cracks, ridges or loose material.

204S.7 Curing

A. Protection and Cover

After the cement treated course has been finished as specified herein, the surface shall be protected against rapid drying by either one of the following curing methods. The protection measures shall be continued: (a) for the specified period, but in no case less than 3 days, or (b) until the surface or subsequent courses are placed:

1. Maintain in a thorough and continuously moist condition by sprinkling.

2. Apply a 2 inch (50 mm) layer of earth on the completed course and maintain in a moist condition.

3. Apply an asphaltic material to the treated course at the rate of 0.05 to 0.20 gallon per square yard (0.25 to 0.90 liters per square meter), as determined by the Engineer or designated representative. The asphalt used shall be the type and grade shown on the Drawings or as approved by the Engineer or designated representative, in accordance with Standard Specification Item No. 301. The asphalt shall completely cover and seal the total surface of the base and fill all voids.

   If this method is used, it shall be the Contractor's responsibility to protect the asphalt membrane from being picked up by traffic by either sanding or dusting the membrane surface. The asphalt membrane may remain in place when the proposed surface or other base courses are placed.

B. Surface

The surface or other base courses may be applied on the finished base as soon after completion as operations will permit.

204S.8 Construction Joints

At the end of each day's construction, a straight transverse construction joint shall be formed by cutting back into the total width of completed work to form a vertical face free of loose and shattered material.

Cement treatment for large, wide areas shall be built in a series of parallel lanes of convenient length and width meeting the approval of the Engineer or designated representative.

204S.9 Traffic

Completed sections of cement treated material in place may be opened immediately to local traffic, construction equipment and all traffic after the curing period, provided the cement treated course has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic.

204S.10 Maintenance

The Contractor shall be required to maintain the cement treated course in good condition until all work has been completed and accepted. Maintenance shall include immediate repairs of any defects that may occur. This work shall be done by the Contractor at no additional cost to the Owner and shall be repeated as often as needed to keep the area continuously intact. Any improper, insufficient or faulty work shall be replaced to the full depth of treatment.

It is the intent of this specification that the Contractor construct the plan depth of cement treatment in one homogeneous mass. The addition of thin stabilized layers will not be permitted to provide the minimum specified depth.

204S.11 Measurement

"Portland Cement Treatment for Materials in Place" will be measured as follows:

Cement treatment for materials in place will be measured by the square yard (square meter: 1 square meter equals 1.196 square yards) of surface area of completed and accepted work.

Portland Cement, specified by the Engineer or designated representative for incorporation in the cement treatment, will be measured by the barrel of 376 pounds (170 kilograms) of cement.

204S.12 Payment

This item will be paid for at the contract unit bid price for "Portland Cement" and "Portland Cement Treatment of Materials in Place".

The unit bid prices shall each include full compensation for: (a) mix designs, (b) preparing the roadbed; (c) furnishing all material; (d) all freight charges involved; (e) furnishing scales and labor involved in weighing the material; (f) pulverizing; applying cement and water, (g) all processing, mixing, spreading, sprinkling, compacting, finishing and curing the cement treated soil; and (h) all manipulations, labor, equipment, fuels, tools and incidentals necessary to complete the work.

Payment will be made under one of the following:

Pay Item No. 204S-A:	Portland Cement Treatment of Materials in Place ___ inch thickness	Per Square Yard.
Pay Item No. 204S-B:	Portland Cement	Per Barrel.

End

SPECIFIC **CROSS REFERENCE MATERIALS**
Item 204S, "PORTLAND CEMENT TREATMENT FOR MATERIALS IN PLACE"

City of Austin Standard Contract Documents

Designation	Description
Section 00700	General Conditions

City of Austin Standard Specifications

Designation	Description
Item No. 230S	Rolling (Flat Wheel)
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 236S	Proof Rolling
Item No. 30S	Asphalts, Oils and Emulsions

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 524	Hydraulic Cement

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-103-E	Determination of Moisture Content of Soil Materials
Tex-115-E	Field Method for Determination of In-Place Density Soils & Base Materials

Tex-120-E	Soil Cement Testing

American Association of Highway and Transportation Officials, Standard Specifications

Designation	Description
T-26	Quality of Water Used in Concrete

RELATED **CROSS REFERENCE MATERIALS**
Item 204S, "PORTLAND CEMENT TREATMENT FOR MATERIALS IN PLACE"

City of Austin Standard Specification Items

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 104S	Removing Portland Cement Concrete
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 130S	Borrow
Item No. 132S	Embankment
Item No. 202S	Hydrated Lime and Lime Slurry
Item No. 203S	Lime Treatment for Materials in Place
Item No. 210S	Flexible Base

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 112	Subgrade Widening

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 132	Embankment
Item No. 150	Blading
Item No. 158	Specialized Excavation Work
Item No. 204	Sprinkling
Item No. 210	Rolling (Flat Wheel)
Item No. 211	Rolling (Tamping)
Item No. 213	Rolling (Pneumatic Tire)
Item No. 275	Portland Cement Treated Materials (Road Mixed)
Item No. 276	Portland Cement Treated Base (Plant Mixed)
Item No. 421	Portland Cement Concrete
Item No. 522	Portland Cement Concrete Plants

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description

Tex-101-E	Surveying and Sampling Soils for Highways
Tex-104-E	Determination of Liquid Limit of Soils
Tex-105-E	Determination of Plastic limit of Soils
Tex-106-E	Method of Calculating the Plasticity Index of Soils
Tex-112-E	Methods of Admixing Lime to Reduce Plasticity Index of Soils
Tex-114-E	Laboratory Compaction Characteristics & Moisture Density Relationship of Subgrade & Embankment Soil
Tex-117-E	Triaxial Compression Tests for Disturbed Soils and Base Materials

Item No. 210S
Flexible Base

210S.1 Description

This item governs furnishing and placing a crushed stone base course for surfacing, pavement, or other base courses. "Flexible Base" shall be constructed on an approved, prepared surface in one or more courses conforming to the typical sections and to the lines and grades, indicated on the Drawings or established by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

210S.2 Submittals

The submittal requirements of this specification item may include:

A. Source, gradation and test results for the crushed limestone material,

B. Notification that the crushed limestone stockpile is completed and ready for testing, and

C. Field density test results for in-place compacted flexible base,

210S.3 Material

A. Mineral Aggregate

The material shall be crushed argillaceous limestone meeting the requirements specified herein. The material shall be from sources approved by the City and shall consist of durable crushed stone that has been screened to the required gradation.

Flexible base materials shall be tested according to the following TxDoT standard test methods:

a) Preparation for Soil Constants and Sieve Analysis	Tex-101-E
b) Liquid Limit	Tex-104-E
c) Plastic Limit[1]	Tex-105-E
d) Plasticity Index	Tex-106-E
e) Sieve Analysis	Tex-110-E
f) Wet Ball Mill[2]	Tex-116-E
g) Triaxial Test	Tex-117-E, Part II

1. Plasticity Index shall be determined in accordance with Tex-107-E (Linear Shrinkage) when liquid limit is unattainable as defined in Tex-104-E.
2. When a soundness value is required on the drawings, the material shall be tested in accordance with Tex-411-A.

Base material shall be stockpiled after crushing, then tested by the City's designated laboratory and approved by the Engineer or designated representative prior to being hauled to the Project.

The material shall be well graded and shall meet the following requirements:

Sieve Designation		Other Requirements	% Retained	
US	SI			
1 3/4"	45 mm		0	
7/8"	22.4 mm		10-35	
3/8"	9.5 mm		30-50	
#4	4.75 mm		45-65	
#40	425 μm		70-85	
		Maximum Plasticity Index		10
		Maximum Wet Ball Mill		42
Maximum Increase in passing #40 (425 μm) sieve from Wet Ball Mill Test			20	

Minimum compressive strength when subjected to the triaxial test shall be 35 psi at 0 psi lateral pressure [240 kiloPascal (kPa) at 0 kPa lateral pressure] and 175 psi at 15 psi lateral pressure [1200 kiloPascal (kPa) at 100 kPa lateral pressure].

B. Asphaltic Material

Prime Coat. Prime Coat shall conform to the requirements of Standard Specification Item 306S, "Prime Coat", except for measurement and payment.

210S.4 Stockpiling, Storage and Management

A. Managing Material**:**

The stockpile shall be constructed on a relatively smooth area that has been cleared of debris, weeds, brush, trees and grass. Stockpiles shall contain between 25,000 and 50,000 cubic yards (19,100 to 38,200 cubic meters). The stockpile shall be constructed using scrapers, bottom dumps or other similar equipment that allows dumping and spreading without rehandling. The stockpile shall be constructed to allow dumping and spreading in one direction only. The height of the stockpile shall not exceed the capabilities of available equipment to make a full cut (bottom to top) on any of the four sides.

A stockpile shall be completed before being tested by the City. The Contractor's supplier shall notify the City when a stockpile has been completed and is ready to be tested. The stockpile shall not be added to after it has been tested.

The Contractor shall provide material only from stockpiles that have been inspected, tested and accepted by the City. A ticket showing the date, source, stockpile number, and net weight (mass) shall be provided to the Inspector with each load of material delivered to the Project.

Material shall be loaded from the stockpile by making successive vertical cuts through its entire depth.

B. Test Sampling:

The Contractor's supplier may choose the method of sample gathering for testing by the City's laboratory as follows:

1. The supplier shall make a full-height cut a sufficient distance into each side of the stockpile to obtain a uniform sample. The four samples (one from each side of the stockpile) shall then be combined and mixed into a single "test" specimen from which the City's laboratory can obtain a sample.

2. As the stockpile is constructed, a perpendicular cut will be made across the spreading direction at every two feet to four feet (0.6 to 1.2 meters) of height and the sample used to start a "mini" stockpile. The process shall be repeated in two feet to four feet (0.6 to 1.2 meter) increments of height, until the stockpile and the "mini" stockpile are completed. Samples shall be obtained from the "mini" stockpile in the same manner described in (1) above.

C. Testing and Acceptance:

When initial tests indicate
that the material is unacceptable, the City may, if requested by the Contractor's supplier, sample and test the material one more time. The additional sampling and testing shall be paid for by the supplier.

210S.5 Construction Methods

A. Preparation of Subgrade:

Flexible base shall not be placed until the Contractor has verified by proof rolling that the subgrade has been prepared and compacted in conformity with Standard Specification Item 201S, "Subgrade Preparation," to the typical sections, lines and grades indicated on the Drawings. Any deviation shall be corrected and proof rolled prior to placement of the flexible base material.

The Contractor shall not place flexible base until the subgrade has cured to the satisfaction of the Engineer or designated representative, regardless of whether or not the subgrade has been successfully proof rolled. As a minimum, this will be after the surface displays no damp spots and there is no evidence of "sponginess" in the subgrade.

B. First Lift:

Immediately before placing the flexible base material, the subgrade shall be checked for conformity with grade and section. The thickness of each lift of flexible base shall be equal increments of the total base depth. No single lift shall be more than six inches (150 mm) or less than three inches (75 mm) compacted thickness.

The material shall be delivered in approved vehicles. It shall be the responsibility of the Contractor to deliver the required amount of material. If it becomes evident that insufficient material was placed, additional material as

necessary shall be delivered and the entire course scarified, mixed and compacted.

Material deposited upon the subgrade shall be spread and shaped the same day unless otherwise approved by the Engineer or designated representative. In the event inclement weather or other unforeseen circumstances render spreading of the material impractical, the material shall be spread as soon as conditions allow.

Additionally, if the material cannot be spread and worked the same day it is deposited, the Contractor shall "close up" the dump piles before leaving the job site. “Closed up” shall be defined as the use of a motor grader to blade all dump piles together, leaving no open space between piles.

The material shall be spread, sprinkled, if required, then thoroughly mixed; bladed, dragged and shaped to conform to the typical sections indicated on the Drawings.

All areas and "nests" of segregated coarse or fine material shall be corrected or removed and replaced with well-graded material.

Each lift shall be sprinkled as required to bring the material to optimum moisture content, then compacted to the extent necessary to provide not less than the percent density specified in Section 210S.5.D, "Density." In addition to the requirements specified for density, the full depth of flexible base material shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section of flexible base material is completed, tests, as necessary, will be made by the Engineer or designated representative. As a minimum, three in-place density tests per section per day will be taken. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements. All initial testing will be paid for by the City. All retesting shall be paid for by the Contractor.

Throughout the entire operation, the surface of the material shall be maintained by blading and, upon completion, shall be smooth and shall conform to the typical section indicated on the Drawings and to the established lines and grades.

In that area on which pavement is to be placed, any deviation in excess of 1/4 inch (6.5 mm) in cross section or 1/4 inch in a length of 16 feet (6.5 mm in a length of 5 meters) measured longitudinally shall be corrected by loosening, adding or removing material, and by reshaping and recompacting. All irregularities, depressions or weak spots shall be corrected immediately by scarifying the areas affected, adding suitable material as required, and by reshaping and recompacting. Should the lift, due to any reason or cause, lose the required stability, density and/or finish before the surfacing is complete, it shall be recompacted and refinished at the Contractor's expense.

C. Succeeding Lifts:

Construction methods for succeeding lifts shall be the same as prescribed for the first lift. For that lift of the flexible base upon which the curb and gutter will be constructed, as well as the last flexible base lift (i.e. top of the flexible base), the Contractor shall check the surface of the lift for conformity to the lines and grades by setting "blue tops" at intervals not exceeding 50 feet (15 meters) on

the centerline, at quarterpoints, at curb lines or edge of pavement, and at other points that may be indicated on the Drawings.

When the thickness of a particular lift of the flexible base is in question, the Contractor shall check the surface of the lift for conformity to the lines and grades by setting "blue tops" at intervals not exceeding 50 feet (15 meters) on the centerline, at quarter points, at curb lines or edge of pavement, and at other points that may be indicated on the Drawings

D. Density:

The flexible base shall be compacted to not less than 100 percent density as determined by TxDoT Test Method Tex-113-E.

Field density determination shall be made in accordance with TxDoT Test Method Tex-115-E unless otherwise approved by the Engineer or designated representative. Each lift of the flexible base shall also be tested by proof rolling in conformity with Standard Specification Item 236S “Proof Rolling.”

E. Priming:

After the flexible base material has been compacted to not less than 100 percent density, and tested by proof rolling, a prime coat will be applied in accordance with Standard Specification Item 306S, "Prime Coat."

F. Curing:

Pavement materials, such as a tack coat or surface course, shall not be placed on the primed surface until the prime coat has been absorbed into the base course. At least 24 hours, or longer if designated by the Engineer or designated representative, shall be allowed when cutback asphalt is used as the prime coat.

210S.6 Measurement

"Flexible Base" will be measured by the cubic yard (cubic meter: 1 cubic meter equals 1.196 cubic yards), complete in place, as indicated in the Contract Documents.

210S.7 Payment

This item will be paid for at the contract unit bid price for "Flexible Base". The unit bid price shall include full compensation for all work specified herein, including the furnishing, hauling, placing and compacting of all materials; for rolling, proof rolling, recompacting and refinishing; for all water required; for retesting as necessary; for priming; and for all equipment, tools, labor and incidentals necessary to complete the Work.

Prime coat will not be measured and paid for directly but shall be included in the unit price bid for Standard Specification Item 210S, "Flexible Base.”

Payment will be made under one of the following:

Pay Item No. 210S-A: Flexible Base Per Cubic Yard.

End

SPECIFIC CROSS REFERENCE MATERIALS

City of Austin Standard Specifications

Designation	Description
Item No. 201S	Subgrade Preparation
Item No. 236S	Proof Rolling
Item No. 306S	Prime Coat

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Tex-101-E	Preparation of Soil and Flexible Base Materials for Testing
Tex-104-E	Determination of Liquid Limit of Soils
Tex-105-E	Determination of Plastic Limit of Soils
Tex-106-E	Method of Calculating the Plasticity Index of Soils
Tex-107-A	Determination of Bar Linear Shrinkage of Soils
Tex-110-E	Determination of Particle Size Analysis of Soils
Tex-113-E	Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Materials and Cohesionless Sands
Tex-115-E	Field Method for Determination of In-Place Density of Soils and Base Materials
Tex-116-E	Ball Mill Method for Determination of the Disintegration of Flexible Base Material
Tex-117-E	Triaxial Compression Tests for Disturbed Soils and Base Materials
Tex-411-A	Soundness of Aggregate By Use Of Sodium Sulfate Or Magnesium Sulfate

RELATED CROSS REFERENCE MATERIALS

City of Austin Standard Details

Designation	Description
No. 1000S-2	Flexible Base with Asphalt Surface Trench Repair-Existing Pavement
No. 510S-3	Typical Trench with Paved Surface
No. 1000S	Bus Stop Paving
No. 1000S-10	Local Street Sections
No. 1000S-11(1)	Residential and City of Austin Neighborhood Collector Street Sections
No. 1000S-11(2)	Industrial and Commercial Collector Street Sections
No. 1000S-12(1)	Primary Collector Street Sections
No. 1000S-12(2)	Primary Arterial Street Sections
No. 1000S-13(1)	Minor Arterial Street Sections (4 Lanes)
No. 1000S-13(2)	Minor Arterial Street Sections-(4 Lanes divided)
No. 1000S-14	Major Arterial Street Sections

City of Austin Utility Criteria Manual

Designation	Description
Section 5.8.2	Flexible Base
Section 5.7.3	Flexible Base with Asphalt Surface
Section 5.9.1	Excavation in Alley

City of Austin Transportation Criteria Manual

Designation	Description
Section 3.2.0	General Criteria
Section 3.4.3 .D	Layer Data-Minimum Thickness
Table 3-1	Minimum Layer Thickness
Section 3.4.3 .F	Layer Data- Minimum Thickness
Table 3-2	Layer Thickness Increment
Section 3.4.3 .J	Layer Data- Stiffness Coefficient
Table 3-3	Stiffness Coefficient
Table 3-9	Recommended Salvage values
Table 3-10	AASHTO Layer Coefficients

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Item No. 220S
Sprinkling for Dust Control

220S.1 Description

This item shall govern the authorized application of water for dust control on specified streets, detours, haul routes or construction sites, as shown on the Drawings or directed by the Engineer or designated representative, for the purpose of maintaining these areas relatively free of dust.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, inch-pound units are given preference with SI units shown within parentheses.

220S.2 Submittals

The submittal requirements of this specification item include

A. The manufacturer, model and description of the proposed dust control equipment,

B. The sprinkling plan including application rate, pattern of sprinkling and scheduled times of application.

220S.3 Materials

Water shall be furnished by the Contractor and shall be clean and free from industrial wastes and other objectionable matter.

220S.4 Construction Methods

Dust control shall only be conducted when directed by the Engineer or designated representative. The Contractor shall furnish and operate an approved sprinkler, equipped with positive and rapidly working cut-off valves and approved spray bars to insure the distribution of water in a uniform and controllable rate of application over the entire width sprinkled. The Contractor shall apply the water in the quantity specified on the Drawings or as directed by the Engineer or designated representative.

It shall be the Contractor's continuous responsibility at all times, including nights, holidays and weekends until acceptance of the project by the City, to maintain the specified areas relatively free of dust in a manner that will cause the least inconvenience to the public.

220S.5 Measurement

Sprinkling for dust control will be included in the unit price bid for other items of the contract unless included as a separate pay item in the contract. When included for payment in the contract as a separate contract pay item, it will be measured in units of 1,000 gallons (3.785 kiloliters) actually placed as authorized by the Engineer or designated representative.

220S.6 Payment

When this item is specified on the Drawings as a separate pay item, the water furnished and the work performed as prescribed by this item and measured as provided under Section 220S.5, "Measurement" will be paid for in accordance with the contract unit bid price for 'Sprinkling for Dust Control'. The unit bid price shall include total compensation for all labor, materials, tools, machinery, equipment and incidentals necessary to complete the work as indicated on the Drawings.

Payment, when specified in the contract, will be made under the following:

Pay Item No. 220S-A: Sprinkling for Dust Control (Water) - Per 1000 gallon Unit.

End

RELATED CROSS REFERENCE MATERIALS
Specification 220S, “Sprinkling For Dust Control”

City of Austin Standard Specification Items

Designation	*Description*
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 120S	Channel Excavation
Item No. 132S	Embankment
Item No. 201S	Subgrade Preparation

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 132	Embankment
Item No. 158	Specialized Excavation Work
Item No. 204	Sprinkling

Item No. 230S
Rolling (Flat Wheel)

230S.1 Description

This item shall govern compaction of subgrade, embankment, flexible base, surface treatments and asphalt surfaces by the operation of approved power rollers as herein specified and as directed by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

230S.2 Submittals

The submittal requirements of this specification item may include:

A. A plan describing the condition of each roller proposed for the work, as well as the type, size, weight, configuration (three wheel, tandem, etc) for each individual roller, and
B. The operating speed proposed for each individual roller.

230S.3 Equipment

A. Embankments and Flexible Bases

Power rollers shall be of the 3-wheel, self-propelled type, weighing not less than 10 tons (9 megagrams) and shall provide compression on the rear wheels of not less than 325 pounds per linear inch (5.80 kilograms per linear millimeter) of wheel width. All wheels shall be flat. The rear wheels shall have a diameter of not less than 48 inches (1.2 meters) and each shall have a wheel width of not less than 20 inches (510 millimeters).

B. Surface Treatments and Pavements

Power rollers shall be the 3-wheel or tandem, self-propelled type, weighing not less than 3 tons (2.7 megagrams) nor more than 6 tons (5.4 megagrams). All wheels shall be flat. Rollers shall be equipped with an adequate scraping or cleaning device on each wheel. Rollers used to compact asphalt mixture shall be equipped with a water system, which will keep all tires uniformly wet.

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

Rollers shall be maintained in good repair and operating condition and shall be approved by the Engineer or designated representative.

230S.4 Construction Methods

This work shall only be conducted at the direction of the Engineer or designated representative. A sufficient number of rollers shall be provided to compact the material in a satisfactory manner. When operations are isolated and a single roller unit cannot produce the required compaction satisfactorily, additional roller units shall be provided.

A. Subgrades, Embankments and Flexible Base

The subgrade, embankment layer or base course shall be sprinkled, if required by Standard Specification Item Nos. 201S, "Subgrade Preparation" and 210S, "Flexible Base". Rolling with a power roller shall start longitudinally at the sides of the designated area and proceed towards the center, overlapping on successive trips by at least 1/2 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 be conducted in accordance with Standard Specification Item Nos. 201S, "Subgrade Preparation" and 210S, "Flexible Base". The rollers, unless otherwise directed by the Engineer or designated representative, shall be operated at a speed between 2 and 3 miles (3 and 5 kilometers) per hour.

B. Surface Treatments and Pavements

Rolling shall be done as called for in the surface treatment (Items 310S and 320S) and asphalt pavement (Item 340S) Standard Specification Items. The sequence of work shall be as specified above for embankment layer or base course. The operating speed shall be determined by the Contractor and approved by the Engineer or designated representative.

230S.4 Measurement and Payment

Compensation will not be allowed for materials, equipment or labor required by this item, but shall be included in the unit price bid for the item of construction in which this item is used.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification 230S, "ROLLING (FLATWHEEL)"

City of Austin Standard Specifications

Designation	Description
Item No. 201S	Subgrade Preparation
Item No. 210S	Flexible Base
Item No. 310S	Emulsified Asphalt Treatment
Item No. 320S	Two Course Surface Treatment

Item No. 340S Hot Mix Asphaltic Concrete Pavement

RELATED CROSS REFERENCE MATERIALS
Specification 230S, “ROLLING (FLATWHEEL)”

City of Austin Standard Specifications

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 104S	Removing Portland Cement Concrete
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 130S	Borrow
Item No. 132S	Embankment
Item No. 202S	Hydrated Lime and Lime Slurry
Item No. 203S	Lime Treatment for Materials in Place
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 236S	Proof Rolling
Item No. 301S	Asphalts, Oils and Emulsions
Item No. 306S	Prime Coat
Item No. 307S	Tack Coat
Item No. 402S	Controlled Low Strength Material
Item No. 403S	Concrete for Structures

City of Austin Standard Details

Designation	Description
No. 1000S-10	Local Street Sections
No. 1000S-11(1)	Residential and City of Austin Neighborhood Collector Street Sections
No. 1000S-11(2)	Industrial and Commercial Collector Street Sections
No. 1000S-12(1)	Primary Collector Street Sections
No. 1000S-12(2)	Primary Arterial Street Sections
No. 1000S-13(1)	Minor Arterial Street Sections (4 Lanes)
No. 1000S-13(2)	Minor Arterial Street Sections- (4 Lanes divided)
No. 1000S-14	Major Arterial Street Sections

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 112	Subgrade Widening
Item No. 132	Embankment
Item No. 150	Blading

Item No. 158	Specialized Excavation Work
Item No. 204	Sprinkling
Item No. 210	Rolling (Flat Wheel)
Item No. 211	Rolling (Tamping)
Item No. 264	Lime and Lime Slurry
Item No. 300	Asphalts, Oils and Emulsions
Item No. 301	Asphalt Anti-stripping Agents
Item No. 310	Prime Coat (Cutback Asphaltic Materials)
Item No. 314	Emulsified Asphalt Treatment
Item No. 316	Surface Treatments
Item No. 345	Asphalt Stabilized Base (Plant Mixed)

RELATED CROSS REFERENCE MATERIALS
Specification 230S, “ROLLING (FLATWHEEL)”

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-101-E	Surveying and Sampling Soils for Highways
Tex-103-E	Determination of Moisture Content of Soil Materials
Tex-104-E	Determination of Liquid Limit of Soils
Tex-105-E	Determination of Plastic limit of Soils
Tex-106-E	Method of Calculating the Plasticity Index of Soils
Tex-114-E	Laboratory Compaction Characteristics & Moisture Density Relationship of Subgrade & Embankment Soil
Tex-115-E	Field Method for Determination of In-Place Density of Soils & Base Materials
Tex-117-E	Triaxial Compression Tests for Disturbed Soils and Base Materials
Tex-120-E	Soil Cement Testing
Tex-121-E	Soil Lime Testing
Tex-126-E	Molding, Testing and Evaluation of Bituminous Black Base
Tex-207-F	Determination of Density of Compacted Bituminous Mixtures
Tex-210-F	Determination of Asphalt Content of Bituminous Mixtures by Extraction
Tex-222-F	Method of Sampling Bituminous Mixtures
Tex-228-F	Determination of Asphalt Content of Bituminous Mixtures By The Nuclear Method
Tex-600-J	Sampling and Testing of Hydrated Lime, Quicklime & Commercial Lime Slurry

Item No. 232S
Rolling (Pneumatic Tire)

232S.1 Description

This item shall govern 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 Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

232S.2 Submittals

The submittal requirements of this specification item may include:

A. A plan describing the condition of each roller proposed for the work, as well as the type of traction (self propelled or drawn), Type, size, weight, tire pressure and configuration for each individual roller, and

B. The operating speed proposed for each individual roller.

232S.3 Equipment

A. General Requirements

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 Drawings. 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.

When turning is impractical or detrimental to the work and when specifically directed by the Engineer or designated representative, 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 of the Engineer or designated representative, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Engineer or designated representative, its use shall be discontinued and the Contractor will be required to furnish the specified equipment.

Rollers shall be maintained in good repair and operating condition and shall be approved by the Engineer or designated representative.

Tire pressure is critical to successful operation of the roller. The Contractor shall have equipment on the construction site to inflate tires as required.

B. Light Pneumatic Tire Roller

The light pneumatic tire roller shall consist of not less than 9 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 a 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 60 inches (1.5 meters) and shall be so designed that by ballast loading, the total load may be varied uniformly from 9,000 pounds (4 megagrams) or less to 18,000 pounds (8 megagrams) or more. The roller shall be equipped with tires that will afford ground contact pressures to 45 pounds per square inch (310 kiloPascals) or more. The operating load and tire air pressure shall be within the range of the manufacturer's chart 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 + 5 psi (+ 34 kiloPascals) of each other. The pneumatic tire roller shall be drawn by a suitable crawler type tractor, a pneumatic tired tractor, a truck of adequate tractive effort or may be of the self-propelled type. The roller, when drawn or propelled by either type of equipment, shall be considered a light pneumatic tire roller unit.

C. Medium Pneumatic Tire Roller (Type A)

The medium pneumatic tire roller (Type A) shall consist of not less than 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 a 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 (2.1 meters) and shall be so designed that, by ballast loading, the total load may be varied uniformly from 23,500 pounds (10.5 megagrams) or less to 50,000 pounds (22.5 megagrams) or more. The roller shall be equipped with tires that will afford ground contact pressures of 80 pounds per square inch (550 kiloPascals) or more. The operating load and tire air pressure shall be within the range of the manufacturer’s chart. The roller under working conditions shall provide a uniform compression under all wheels. Individual tire inflation pressures shall be within + 5 psi (+ 34 kiloPascals) of each other.

The pneumatic tire roller shall be drawn by a suitable crawler type tractor, a pneumatic tired tractor, a truck of adequate tractive effort or may be of the self-propelled type. The roller, when drawn or propelled by any 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 5 miles per hour (8 kilometers per hour).

D. Medium Pneumatic Tire Roller (Type B)

The medium pneumatic tire roller (Type B) shall conform to the requirements for Medium Pneumatic Tire Roller (Type A) as specified above, except that the roller shall be equipped with tires that will afford ground contact pressures to 90 psi (620 kiloPascals) or more.

232S.4 Construction Methods

The embankment layer or the base course shall be sprinkled in accordance with Standard Specification Item Nos. 201S, "Subgrade Preparation" and 210S, "Flexible Base". Rolling with a pneumatic tire roller shall start longitudinally at the sides of the designated area and shall proceed towards the center, overlapping on successive trips by at least 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.

The light pneumatic tire roller shall be operated at speeds, which shall be between 3 and 11 miles per hour (between 6 and 19 kilometers per hour) for asphalt surfacing work and between 2 and 6 miles per hour (between 3 and 10 kilometers per hour) for all other work.

The medium pneumatic tire roller shall be operated at speeds as directed by the Engineer or designated representative, which produce a satisfactory product.

Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another that 1 roller unit cannot produce the required compaction satisfactorily, additional roller units shall be provided.

232S.5 Measurement and Payment

Compensation will not be allowed for materials, equipment or labor required by this item. These items shall be included in the unit price bid for the item of construction in which this item is used.

End

SPECIFIC CROSS REFERENCE MATERIALS

Specification 232S, "Rolling (Pneumatic Tire)"

City of Austin Standard Specifications

Designation	Description
Item No. 201S	Subgrade Preparation
Item No. 210S	Flexible Base

RELATED CROSS REFERENCE MATERIALS

City of Austin Contract Documents

Designation	Description
Section 00700	General Conditions

City of Austin Standard Specifications

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 130S	Borrow
Item No. 132S	Embankment
Item No. 202S	Hydrated Lime and Lime Slurry
Item No. 203S	Lime Treatment for Materials in Place
Item No. 230S	Rolling (Flat Wheel)

RELATED CROSS REFERENCE MATERIALS-Continued

Specification 232S, "Rolling (Pneumatic Tire)"

City of Austin Standard Specifications

Designation	Description
Item No. 236S	Proof Rolling
Item No. 301S	Asphalts, Oils and Emulsions
Item No. 306S	Prime Coat
Item No. 307S	Tack Coat
Item No. 310S	Emulsified Asphalt Treatment
Item No. 320S	Two Course Surface Treatment
Item No. 340S	Hot Mix Asphaltic Concrete Pavement
Item No. 402S	Controlled Low Strength Material
Item No. 403S	Concrete for Structures

City of Austin Standard Details

Designation	Description
No. 1000S-10	Local Street Sections
No. 1000S-11(1)	Residential and City of Austin Neighborhood Collector Street Sections
No. 1000S-11(2)	Industrial and Commercial Collector Street Sections
No. 1000S-12(1)	Primary Collector Street Sections
No. 1000S-12(2)	Primary Arterial Street Sections
No. 1000S-13(1)	Minor Arterial Street Sections (4 Lanes)
No. 1000S-13(2)	Minor Arterial Street Sections- (4 Lanes divided)
No. 1000S-14	Major Arterial Street Sections

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 112	Subgrade Widening
Item No. 132	Embankment
Item No. 150	Blading
Item No. 158	Specialized Excavation Work
Item No. 204	Sprinkling
Item No. 210	Rolling (Flat Wheel)
Item No. 211	Rolling (Tamping)
Item No. 213	Rolling (Pneumatic Tire)
Item No. 264	Lime and Lime Slurry
Item No. 300	Asphalts, Oils and Emulsions
Item No. 301	Asphalt Anti-stripping Agents
Item No. 310	Prime Coat (Cutback Asphaltic Materials)
Item No. 314	Emulsified Asphalt Treatment
Item No. 316	Surface Treatments
Item No. 345	Asphalt Stabilized Base (Plant Mixed)

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-101-E	Surveying and Sampling Soils for Highways
Tex-103-E	Determination of Moisture Content of Soil Materials
Tex-104-E	Determination of Liquid Limit of Soils
Tex-105-E	Determination of Plastic limit of Soils
Tex-106-E	Method of Calculating the Plasticity Index of Soils

RELATED CROSS REFERENCE MATERIALS-Continued

Specification 232S, “Rolling (Pneumatic Tire)”

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-114-E	Laboratory Compaction Characteristics & Moisture Density Relationship of Subgrade & Embankment Soil
Tex-115-E	Field Method for Determination of In-Place Density of Soil & Base Materials
Tex-117-E	Triaxial Compression Tests for Disturbed Soils and Base Materials
Tex-120-E	Soil Cement Testing
Tex-121-E	Soil Lime Testing
Tex-126-E	Molding, Testing and Evaluation of Bituminous Black Base Materials
Tex-207-F	Determination of Density of Compacted Bituminous Mixtures
Tex-210-F	Determination of Asphalt Content of Bituminous Mixtures by Extraction
Tex-228-F	Determination of Asphalt Content of Bituminous Mixtures By The Nuclear Method
Tex-600-J	Sampling and Testing of Hydrated Lime, Quicklime & Commercial Lime Slurry

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Item No. 234S
Rolling (Tamping)

234S.1 Description

This item shall govern compaction of embankment, lime-treated subgrade or other courses by the operation of approved tamping rollers as herein specified and as directed by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

234S.2 Submittals

The submittal requirements of this specification item may include:

A. A plan describing the condition of each roller proposed for the work, as well as the type of traction (self propelled or drawn), Type of roller, size, weight, and configuration of each individual tamping roller, and

B. The operating speed proposed for each individual tamping roller.

234S.3 Equipment

The tamping rollers shall consist of 2 metal rollers, drums or shells of 40 inches (1 meter) minimum diameter; each not less than 42 inches (1.067 meters) in length. The drums shall be unit mounted in a rigid frame in such a manner that each roller may oscillate independently of the other.

Each roller, drum or shell shall be surmounted by metal studs with tamping feet projecting not less than 7 inches (180 millimeters) from the surface and spaced not less than 6 inches (150 millimeters) nor more than 10 inches (254 millimeters), measured diagonally center to center and the cross-sectional area of each tamping foot, measured perpendicularly to the axis of the stud, shall not be less than 5 nor more than 8 square inches (less than 3200 nor more than 5200 square millimeters). The roller shall be supplemented with cleaning teeth to provide self-cleaning.

The roller shall be so designed that, by ballast loading, the load on each tamping foot may be varied uniformly from 125 to 550 psi (860 to 3800 kiloPascals) of cross sectional area. The load per tamping foot will be determined by dividing the total weight (mass) of the roller by the number of tamping feet in 1 row parallel to or approximately parallel to the axis of the roller. The compression to be provided at any time shall be as directed by the Engineer or designated representative.

The tamping roller shall be drawn by suitable power equipment of adequate tractive effort. Two tamping rollers, consisting of 4 cylinders, conforming to the above prescribed requirements, drawn by approved power equipment, shall be considered a roller unit.

Where turning is impractical or detrimental to the work and when specifically directed by the Engineer or designated representative, the roller shall be capable of being operated in a forward and backward direction. When operations are confined to narrow widths and when specifically directed in writing by the Engineer or designated representative, 1

tamping roller consisting of 2 cylinders, fastened to the front end of approved power equipment shall be considered a roller unit.

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

Rollers shall be maintained in good repair and operating condition and shall be approved by the Engineer or designated representative.

234S.4 Construction Methods

The embankment layer, subbase or the base course shall be sprinkled in accordance with Standard Specification Item Nos. 201S, "Subgrade Preparation" and 203S, "Lime Treatment for Materials In Place". Rolling with a tamping roller unit shall start longitudinally at the sides of the designated area and proceed toward the center, overlapping on successive trips by at least 1/2 of the width of the tamping roller unit. On superelevated curves, rolling shall begin at the low sides and progress toward the high sides. Alternate trips of the unit shall be slightly different in length. The tamping roller unit, unless otherwise directed by the Engineer or designated representative, shall be operated at a speed between 2 and 3 miles per hour (3 and 5 kilometers per hour).

Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another that one roller cannot perform the required compaction satisfactorily, additional rollers shall be provided and operated as directed by the Engineer.

234S.5 Measurement and Payment

No additional payment will be made for the materials, equipment or labor required by this item, but shall be included in the unit price bid for the item of construction in which this item is used.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification 234S, "Rolling (Tamping)"

City of Austin Standard Specifications

Designation	Description
Item No. 201S	Subgrade Preparation
Item No. 203S	Lime Treatment for Materials in Place

RELATED CROSS REFERENCE MATERIALS
Specification 234S, "Rolling (Tamping)"

City of Austin Contract Documents

Designation	Description
Section 00700	General Conditions

RELATED CROSS REFERENCE MATERIALS – Continued
Specification 234S, "Rolling (Tamping)"

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 132	Embankment
Item No. 204	Sprinkling
Item No. 210	Rolling (Flat Wheel)
Item No. 211	Rolling (Tamping)
Item No. 213	Rolling (Pneumatic Tire)

City of Austin Standard Specifications

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 130S	Borrow
Item No. 132S	Embankment
Item No. 202S	Hydrated Lime and Lime Slurry
Item No. 210S	Flexible Base
Item No. 230S	Rolling (Flat Wheel)
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 236S	Proof Rolling
Item No. 301S	Asphalts, Oils and Emulsions
Item No. 306S	Prime Coat
Item No. 307S	Tack Coat
Item No. 310S	Emulsified Asphalt Treatment
Item No. 320S	Two Course Surface Treatment
Item No. 340S	Hot Mix Asphaltic Concrete Pavement
Item No. 402S	Controlled Low Strength Material
Item No. 403S	Concrete for Structures

City of Austin Standard Details

Designation	Description
No. 1000S-10	Local Street Sections
No. 1000S-11(1)	Residential and City of Austin Neighborhood Collector Street Sections
No. 1000S-11(2)	Industrial and Commercial Collector Street Sections
No. 1000S-12(1)	Primary Collector Street Sections
No. 1000S-12(2)	Primary Arterial Street Sections
No. 1000S-13(1)	Minor Arterial Street Sections (4 Lanes)
No. 1000S-13(2)	Minor Arterial Street Sections- (4 Lanes divided)
No. 1000S-14	Major Arterial Street Sections

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 112	Subgrade Widening
Item No. 132	Embankment
Item No. 150	Blading
Item No. 158	Specialized Excavation Work
Item No. 264	Lime and Lime Slurry

RELATED CROSS REFERENCE MATERIALS-Continued

Specification 234S, “Rolling (Tamping)”

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 300	Asphalts, Oils and Emulsions
Item No. 301	Asphalt Anti-stripping Agents
Item No. 310	Prime Coat (Cutback Asphaltic Materials)
Item No. 314	Emulsified Asphalt Treatment
Item No. 316	Surface Treatments
Item No. 345	Asphalt Stabilized Base (Plant Mixed)

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-101-E	Surveying and Sampling Soils for Highways
Tex-103-E	Determination of Moisture Content of Soil Materials
Tex-104-E	Determination of Liquid Limit of Soils
Tex-105-E	Determination of Plastic limit of Soils
Tex-106-E	Method of Calculating the Plasticity Index of Soils
Tex-114-E	Laboratory Compaction Characteristics & Moisture Density Relationship of Subgrade & Embankment Soil
Tex-115-E	Field Method for Determination of In-Place Density of Soils & Base Materials
Tex-117-E	Triaxial Compression Tests for Disturbed Soils and Base Materials
Tex-120-E	Soil Cement Testing
Tex-121-E	Soil Lime Testing
Tex-126-E	Molding, Testing and Evaluation of Bituminous Black Base Materials
Tex-207-F	Determination of Density of Compacted Bituminous Mixtures
Tex-210-F	Determination of Asphalt Content of Bituminous Mixtures
Tex-600-J	Sampling and Testing of Hydrated Lime, Quicklime & Commercial Lime Slurry

Item No. 236S
Proof Rolling

236S.1 Description

This item shall govern furnishing and operating heavy pneumatic tired compaction equipment for locating unstable areas of embankment, subgrade and flexible base courses.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

236S.2 Submittals

The submittal requirements of this specification item may include:

A. A plan describing the condition of each roller proposed for the work, as well as the type of traction (self propelled or drawn), Type of roller, size, weight, tire pressure (if appropriate) and configuration of each individual roller, and

B. The operating speed proposed for each individual roller.

236S.3 Equipment

A. Standard Proof Roller:

The proof rolling equipment shall have a loading platform or body suitable for ballast loading that is supported on a minimum of two (2) axles with not more than two (2) pneumatic tired wheels per axle. All wheels shall be arranged so that they will carry approximately equal loads when operating on uneven surfaces. Pneumatic proof rolling equipment with multiple pivotal axles and more than two tires along the front or rear axle axis shall have articulating axle supports to equally distribute the load to all tires over uneven surfaces.

The proof roller unit, under working conditions, shall have a minimum contact width of 7-1/2 feet (2.3 meters) and shall be so designed that the gross roller weight may be varied uniformly from 25 tons to 50 tons (23 megagrams to 45 megagrams) by ballast loading. The tires shall be capable of operating under various loads with variable air pressures up to 145 psi (up to 1000 kiloPascals). The tires shall be smooth tread and shall impart a minimum ground contact pressure of 75 pounds per square inch (520 kiloPascals). Tires shall be practically full of liquid (i.e. 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 or designated representative.

The proof roller shall be drawn by a power train of adequate tractive effort or may be of a self-propelled type. The proof rolling equipment shall be equipped with a reverse mode transmission or be capable of turning 180 degrees in the street width. When a separate power train is used to draw the proof roller, the power train weight shall not be considered in the weight of the proof roller. The power train shall be rubber-tired when rolling subgrade and base materials. A cleated or track-type power train may be used on earth and rock embankments.

B. Alternate Equipment:

With the written approval of the Engineer or designated representative, the Contractor may utilize alternate equipment on embankment courses, subgrade and base courses subject to the requirements of the standard proof roller except with respect to minimum contact width, axle/tire arrangement and tire tread.

Alternate equipment for stability testing of embankments shall be restricted to equipment that can be shown to impart a stress distribution on the embankment structure equivalent to or greater than the stress induced by the concentrated weight of a standard proof roller.

C. Equipment Submittals:

All standard proof rollers and proposed alternate equipment must be approved by the Engineer or designated representative prior to their use. The Contractor shall furnish the Engineer or designated representative with 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.

Alternate equipment submittals for proof rolling of embankments shall be signed and sealed by a registered Professional Engineer licensed in the State of Texas.

236S.4 Construction Methods

A. General:

Within the ranges set forth in Section 236S.3, the load and tire inflation pressures shall be adjusted as directed by the Engineer or designated representative. It is proposed to use a contact pressure corresponding as nearly as practical to the maximum supporting value of the earthwork or base. The entirety of prepared surfaces to be tested by this method shall be proof rolled by a minimum of two passes of the proof roller tires. Each succeeding trip of the proof roller shall be offset by not greater than one tire width.

When alternate equipment is proposed and only one axle meets minimum requirements, only the qualifying axle shall be used to proof roll. If the operation of the proof roller shows an area to be unstable, the substandard area shall be brought to satisfactory stability and uniformity by additional curing, compaction, or by removal and replacement of unsuitable materials. The re-worked area shall then be proof rolled.

Proof rollers shall be operated at speeds between 2 and 6 miles per hour (3 and 10 kilometers per hour) or as directed by the Engineer or designated representative.

Acceptable limits of elastic and plastic deformation of prepared subgrade courses shall be established by proof rolling Test Sections of representative soil conditions, previously tested and approved for density and moisture requirements of the governing subgrade and earth embankment items. Proof rolling of first course base over a plastic subgrade may be waived by the Engineer or designated representative if it is determined that the prepared first course base will be damaged by the proof roller.

B. Roadway Construction:

The subgrade and all lifts of base material shall be proof rolled in new roadway construction and in the reconstruction of existing streets. Proof rolling of the curb course base shall be substituted for proof rolling of final course base at the direction of the Engineer or designated representative. Proof rolling may be waived by the Engineer or designated representative where construction is limited to turn lanes, street widening less than 7-1/2 feet (2.3 meters) in width, or where the site is otherwise congested.

C. Trenches:

Trenches shall be proof rolled where no limitations to the operation of the proof roller exist as may be determined by the Engineer subject to the provisions hereunder.

All trenches shall be proof rolled in new roadways or in existing roadways under reconstruction. Trenches shall be proof rolled at the street subgrade elevation by longitudinal and perpendicular passes of the roller as may be dictated by the width of the trench.

Proof rolling of trenches in existing paved streets shall be limited to pavement cross-sections capable of sustaining the weight of the proof rolling equipment without imparting damage to the remaining pavement structure as determined by the Engineer. Trenches less than 4 feet (1.2 meters) in width shall be exempted of all proof rolling requirements. Only the final course base shall be proof rolled in trenches 4 feet (1.2 meters) or wider but narrower than the proof roller contact width. The subgrade, the first course and the final course base shall be proof rolled in trenches 7-1/2 feet (2.3 meters) or wider.

D. Embankment Construction:

All embankment courses shall be proof rolled, unless otherwise directed by the Engineer or designated representative.

If required by the Engineer or designated representative, stability testing of embankments constructed to the finished cross-section and elevation or to interim elevations shall either be conducted with a standard proof roller or alternate equipment, which can be proven to impart a horizontal and vertical pressure distributions equivalent to or greater than those induced by a standard proof roller.

236S.5 Measurement and Payment

No direct payment will be made for the materials, equipment or labor required by this item, but shall be included in the unit price bid for the item of construction in which this item is used.

End

RELATED CROSS REFERENCE MATERIALS
Specification Item 236S, “Proof Rolling”

City of Austin Contract Documents

Designation	Description
Section 00700	General Conditions

City of Austin Standard Specifications

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 130S	Borrow
Item No. 132S	Embankment

RELATED CROSS REFERENCE MATERIALS-Continued
Specification 236S, “Proof Rolling”

City of Austin Standard Specifications

Designation	Description
Item No. 201S	Subgrade Preparation
Item No. 202S	Hydrated Lime and Lime Slurry
Item No. 203S	Lime Treatment for Materials in Place
Item No. 204S	Portland Cement Treatment For Materials in Place
Item No. 206S	Asphalt Stabilized Base (Plant Mix)
Item No. 210S	Flexible Base
Item No. 230S	Rolling (Flat Wheel)
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 234S	Rolling (Tamping)
Item No. 301S	Asphalts, Oils and Emulsions
Item No. 306S	Prime Coat
Item No. 307S	Tack Coat
Item No. 310S	Emulsified Asphalt Treatment
Item No. 320S	Two Course Surface Treatment
Item No. 340S	Hot Mix Asphaltic Concrete Pavement
Item No. 402S	Controlled Low Strength Material
Item No. 403S	Concrete for Structures

City of Austin Standard Details

Designation	Description
No. 1000S-10	Local Street Sections
No. 1000S-11(1)	Residential and City of Austin Neighborhood Collector Street Sections
No. 1000S-11(2)	Industrial and Commercial Collector Street Sections
No. 1000S-12(1)	Primary Collector Street Sections
No. 1000S-12(2)	Primary Arterial Street Sections
No. 1000S-13(1)	Minor Arterial Street Sections (4 Lanes)
No.1000S-13 (2)	Minor Arterial Street Sections- (4 Lanes divided)
No. 1000S-14	Major Arterial Street Sections

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 112	Subgrade Widening
Item No. 132	Embankment
Item No. 150	Blading
Item No. 158	Specialized Excavation Work
Item No. 204	Sprinkling
Item No. 210	Rolling (Flat Wheel)
Item No. 211	Rolling (Tamping)
Item No. 213	Rolling (Pneumatic Tire)
Item No. 264	Lime and Lime Slurry
Item No. 300	Asphalts, Oils and Emulsions
Item No. 301	Asphalt Anti-stripping Agents
Item No. 310	Prime Coat (Cutback Asphaltic Materials)
Item No. 314	Emulsified Asphalt Treatment
Item No. 316	Surface Treatments
Item No. 345	Asphalt Stabilized Base (Plant Mixed)

RELATED CROSS REFERENCE MATERIALS-Continued
Specification 236S, “Proof Rolling”

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-101-E	Surveying and Sampling Soils for Highways
Tex-103-E	Determination of Moisture Content of Soil Materials
Tex-104-E	Determination of Liquid Limit of Soils
Tex-105-E	Determination of Plastic limit of Soils
Tex-106-E	Method of Calculating the Plasticity Index of Soils
Tex-114-E	Laboratory Compaction Characteristics & Moisture Density Relationship of Subgrade & Embankment Soil
Tex-115-E	Field Method for Determination of In-Place Density of Soils & Base Materials
Tex-117-E	Triaxial Compression Tests for Disturbed Soil and Base Materials
Tex-120-E	Soil Cement Testing
Tex-121-E	Soil Lime Testing
Tex-126-E	Molding, Testing and Evaluation of Bituminous Black Base Materials
Tex-207-F	Determination of Density of Compacted Bituminous Mixtures
Tex-210-F	Determination of Asphalt Content of Bituminous Mixtures
Tex-600-J	Sampling and Testing of Hydrated Lime, Quicklime & Commercial Lime Slurry

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Item No. 301S
Asphalts, Oils and Emulsions

301S.1 Description

This item includes the requirements for cutback asphalts, emulsified asphalts, polymer modified asphalt cements, performance graded asphalt binders and other miscellaneous asphaltic materials and latex additives.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text the inch-pound units are given preference followed by SI units shown within parentheses.

301S.2 Submittals

Submittals shall include test results for each the materials described herein when specifically identified on the Drawings and/or referenced in associated standard specification items and standard details.

Submittals may include samples of the base asphalt cement and polymer additives.

301S.3 Materials

When tested in accordance with designated TxDoT, AASHTO and/or ASTM Test Methods, the various materials shall meet the applicable requirements of this specification.

A. Acronyms

The acronyms used in this specification are defined in the following table.

Table 1: Acronyms

Acronym	Definition	Acronym	Definition
Test Method Prefix Tex T D	 TxDOT AASHTO ASTM	Polymer Modifier SBR or L SBS TR P	 Styrene-Butadiene Rubber (Latex) Styrene-Butadiene-Styrene Block Copolymer Tire Rubber, from ambient temperature grinding of truck and passenger tires Polymer Modified
AC	Asphalt Cement	SS	Slow Setting
RC	Rapid Curing	H-suffix	Harder Residue (Lower Penetration)
MC	Medium Curing	AE	Asphalt Emulsion
SCM	Special Cutback Material	S-suffix	Stockpile Usage
HF	High Float	AE-P	Asphalt Emulsion Prime
C	Cationic	EAP&T	Emulsified Asphalt Prime and Tack
RS	Rapid Setting	PCE	Prime, Cure, and Erosion Control
MS	Medium Setting	PG	Performance Grade

B. Asphalt Cement

The material shall be homogeneous, free from water, shall not foam when heated to 350°F (177°C) and shall meet the requirements in Table 2.

Table 2: Asphalt Cement Requirements

Viscosity Grade		AC-10		AC-20		AC-30	
Property	Test Method	Min	Max	Min	Max	Min	Max
Viscosity: 140°F, poises (60°C, pascals)	T202	800 (80)	1200 (120)	1600 (160)	2400 (240)	2400 (240)	3600 (360)
Viscosity: 275°F, stokes (135°C, pascals)	T202	1.9 (.19)	-	2.5 (.25)	-	3.0 (.30)	-
Penetration: 77°F (25°C), 100g, 5s	T49	85	-	55	-	45	-
Flash Point, C.O.C. °F (°C)	T48	450 (232)	-	450 (232)	-	450 (232)	-
% Solubility trichloroethylene	T44	99.0	-	99.0	-	99.0	-
Spot test	Tex 509-C						
Viscosity: 140°F stokes (60°C pascals)	T202	-	3000 (300)	-	6000 (600)	-	9000 (900)
Ductility 77°F (25°C), 5 cm/min, cm	T202	100	-	70	-	50	-

C. Polymer Modified Asphalt Cement.

Polymer modified asphalt cement must be smooth, homogeneous, and shall comply with the requirements listed in Table 3.

Table 3: Polymer Modified Asphalt Cement Requirements

Polymer Modified Viscosity Grade		AC-5		AC-10		AC-15P		AC-45P*	
Polymer Type		SBR		SBR		SBS		SBS	
Property	Test Method	Min	Max	Min	Max	Min	Max	Min	Max
Polymer in % (solids basis)	Tex-533-C	2.0	-	2.0	-	3.0	-	3.0	-
Viscosity									
140ºF, poise (60°C, pascals)	T 202	700 (70)	- -	1300 (130)	- -	1500 (150)	- -	4500 (450)	- -
275ºF, poise (135°C, pascals)	T 202	- -	7.0 (0.7)	- -	8.0 (0.8)	- -	8.0 (0.8)	14.0 (1.4)	
Penetration, 77ºF (25°C), 100 g, 5 s.	T 49	120	-	80	-	100	150	50	74
Ductility, 5cm/min., 39.2ºF, cm	T 51	70	-	60	-	-	-	15	-
Elastic Recovery, 50ºF (10°C), %	Tex-539-C	-	-	-	-	55	-		-
Polymer Separation, 48 hrs**.	Tex-540-C	None		None		None		None	
Flash Point, C.O.C., ºF (°C),	T 48	425 (218)	- -	425 (218)	- -	425 (218)	- -	425 (218)	- -
Tests on Residue from Thin Film Oven Test: (T179)									
Retained Penetration Ratio, 77ºF (25°C), % original	T 49	-	-	-	-	0.60	1.00	0.60	0.90

* The SBS block copolymer may be pre-blended with a polymer processing oil (up to a 1:1 ratio of polymer to oil) to aid the solution of the polymer in the asphalt.

** A 350-gram (0.77 pound) sample of the asphalt-SBS blend is stored for 48 hours at 325°F (163°C). Upon completion of the storage time, the sample is visually examined for separation of the SBS from the asphalt (smoothness and homogeneity). If a question still exists about the separation of the SBS, samples shall be taken from the top and bottom of the sample for Infrared Spectroscopy analysis. A difference of 0.4% or more in the concentration of the SBS between the top and bottom samples shall constitute separation.

D. Cutback Asphalt

Cutback Asphalt shall meet the requirements presented in tables 4, and 5 for the specified type and grade.

Table 4: RAPID CURING TYPE CUTBACK ASPHALT Requirements

Type-Grade		RC-250		RC-800		RC-3000	
Properties	Test Method	Min	Max	Min	Max	Min	Max
Water, percent	T55	-	0.2	-	0.2	-	0.2
Flash Point, T.O.C.,°F [°C]	T79	80 (27)	-	80 (27)	-	80 (27)	-
Kinematic viscosity @ 140°F, cst [60°C, mm²/s]	T201	250	400	800	1600	3000	6000
Distillation Test:	T78						
Distillate, % by volume of total distillate to 680°F [360°C]:							
to 437°F [225°C]:		40	75	35	70	20	55
to 500°F [260°C]:		65	90	55	85	45	75
to 600°F [316°C]:		85	-	80	-	70	-
Residue from Distillation, Volume %		70	-	75	-	82	-
Tests of Distillation Residue:							
Penetration, 100g, 5 sec., 77°F [25°C], cm	T49	80	120	80	120	80	120
Ductility, 5 cm/min., 77°F, 5 cm/min., cm	T51	100	-	100	-	100	-
[25°C, 50 mm/min., mm]		1000	-	1000	-	1000	-
Solubility in trichloroethylene, %	T44	99.0	-	99.0	-	99.0	-
Spot Test	Tex 509-C	ALL NEGATIVE					

Table 5: MEDIUM CURING TYPE CUTBACK ASPHALT Requirements

Type		MC-30		MC-70		MC-250		MC-800		MC-3000	
Properties	Test Method	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Water, %	T55	-	0.2	-	0.2	-	0.2	-	0.2	-	0.2
Flash Point, T.O.C.,°F [°C]	T79	100 [38]	-	100 [38]	-	150 [65]	-	150 [65]	-	150 [65]	-
Kinematic viscosity. @ 140°F. cst [60°C, mm²/s]	T201	30	60	70	140	250	500	800	1600	3000	6000
Distillation Test:	T78										
Distillate, as % by volume to total distillate to 680°F[360°C]:, shall be as follows:											
to 437°F [225°C]:		-	25	-	20	-	10	-	-	-	-
to 500°F [260°C]:		40	70	20	60	15	55	-	35	-	15
to 600°F [316°C]:		75	93	65	90	60	87	45	80	15	75
Residue from 80°F [225°C] distillation											
Volume Percent		50	-	55	-	67	-	75	-	80	-
Tests on Distillation Residue:											
Penetration @ 77°F [25°C], 100g, s, 01mm:	T49	120	250	120	250	120	250	120	250	120	250
Ductility	T51										
@ 77°F, 5 cm/min, cms		100*	-	100*	-	100*	-	100*	-	100*	-
[25°C, 50 mm/min., mm]		1000*	-	1000*	-	1000*	-	1000*	-	1000*	-
% Solubility in trichloroethylene	T44	99.0	-	99.0	-	99.0	-	99.0	-	99.0	-
Spot Test	Tex 509-C	ALL NEGATIVE									

* If penetration of residue is more than 200 and the ductility at 77°F [25°C] is less than 100 cm [1000 mm], the material will be acceptable if its ductility at 60°F [16°C] is more than 100cm [1000 mm].

E. Emulsified Asphalt

The material shall be homogenous. It shall show no separation of asphalt after thorough mixing and shall meet the requirements for the specified type and grade presented in Tables 6, 7 and 8.

Table 6: ANIONIC EMULSION Requirements

	Type	Medium Setting		Slow Setting			
	Grade	MS-2		SS-1		SS-1h	
Property	Test Method	Min	Max	Min	Max	Min	Max
Furol Viscosity @ 77°F [25°C], sec.	T72	-	-	20	100	30	100
@ 122°F[50°C], sec		100	300	-	-	-	-
Sieve Test, %.	T59	-	0.1	-	0.1	-	0.1
Miscibility (Standard Test)	T59	-	-	Passing		Passing	
Cement Mixing, %	T59	-	-	-	2.0	-	2.0
% Demulsibility: 35 cc 0.02N $CaCl_2$	T59	-	30	-	-	-	-
Storage Stability 1 day, %	T59	-	1	-	1	-	1
Freezing Test, 3 Cycles*	T59	Passing		Passing		Passing	
Distillation Test	T59						
Distillation Residue, %		65	-	60	-	60	-
Distillate Oil Portion, %		-	½	-	½	-	½
Tests of Residue from Distillation:							
Penetration @ 77°F [25°C], 100g, 5s	T49	120	160	120	160	70	100
Solubility in Trichloroethylene, %	T44	97.5	-	97.5	-	97.5	-
Ductility @ 77F, 5 cm/min., cm [@ 25°C, 50 mm/min., mm]	T51	100 1000	- -	100 1000	- -	80 800	- -

* Applies only when Engineer or designated representative specifies the material for winter use.

Table 7: HIGH FLOAT ANIONIC EMULSION Requirements

	Type	Rapid Setting		Medium Setting	
	Grade	HFRS-2		AES-300	
Property	Test Method	Min	Max	Min	Max
Viscosity, Saybolt Furol	T72				
@ 77°F [25°C], sec.		-	-	75	400
@ 122°F [50°C], sec.		150	400	-	-
Oil Portion of Distillate, %	T59	-	2	-	7
Sieve Test, %	T59	-	0.1	-	0.1
Particle Charge	T59	positive		positive	
Coating Ability and Water Resistance:	T59				
Coating, dry aggregate		-	-	good	
Coating, after spraying		-	-	fair	
Coating, wet aggregate				fair	
Coating, after spraying				fair	
% Demulsibility: 35 ml 0.02 N $CaCl_2$	T59	50	-	-	-
Storage Stability Test, 1 day, %	T59	-	1	-	1
Distillation Test	T59				
Residue by Distillation, % by weight		65	-	65	-
Oil Distillate, by volume of emulsion, %		-	1/2	-	5
Tests on Residue from Distillation:					
Penetration at 77°F [25°C], 100 g, 5s	T49	100	140	300	-
Solubility in Trichloroethylene, %	T44	97.5	-	97.5	-
Ductility @ 77°F., 5 cm/min, cms [25°C., 50 mm/min, mm]	T51	100 [1000}	-	-	-

Float Test at 140°F [60°C], sec.	Tex 509-C	1200	-	1200	-

Table 8: CATIONIC EMULSION Requirements

Type		Rapid Setting				Medium Setting				Slow Setting			
Grade		CRS-2		CRS-2h		CMS-2		CMS-2s		CSS-1		CSS-1h	
Property	Test Method	Min	Max	Min	Max	Min.	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T72												
@ 77°F [25°C], sec.		-	-	-	-	-	-	-	-	20	100	20	100
@ 122°F [50°C],sec.		150	400	150	400	100	300	100	300	-	-	-	-
Storage stability test, 1 day %	T59	-	1	-	1	-	1	-	1	-	1	-	1
% Demulsibility: *,**	T59	40	-	40	-	-	-	-	-	-	-	-	-
Coating, ability & water resistance	T59												
Coating, dry aggregate		-	-	-	-	good		good		-	-	-	-
Coating, after spraying		-	-	-	-	fair		fair		-	-	-	-
Coating, wet aggregate		-	-	-	-	fair		fair		-	-	-	-
Coating, after spraying		-	-	-	-	fair		fair		-	-	-	-
Particle charge test	T59	Positive		Positive		Positive		Positive		Positive		Positive	
Sieve test, %	T59	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10
Cement Mixing test, %	T59	-	-	-	-	-	-	-	-	-	2.0	-	2.0
Distillation Test:	T59												
% Oil distillate, vol. of emulsion		-	1/2	-	1/2	-	7	-	5	-	1/2	-	1/2
Residue by Distillation,% by wgt		65	-	65	-	65	-	65	-	60	-	60	-
Tests on Residue from Distillation:													
Penetration,77°F [25°C], 100g, 5s.	T49	120	160	80	110	120	200	300	-	120	160	80	110
Ductility,	T51												
77°F, 5 cm/min, cm		100	-	80	-	100	-	-	-	100	-	80	-
[25°C, 50 mm/min, mm]		1000	-	800	-	1000	-	-	-	1000	-	800	-
% Solubility in trichloroethylene	T44	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-

* At a level of 35 ml 0.8% sodium dioctyl sulfosuccinate.

** The demulsibility test shall be made within 30 days from date of shipment.

F. Polymer Modified Emulsions

The material shall be homogenous. It shall show no separation of asphalt after thorough mixing and shall meet the requirements for the specified type and grade presented in Tables 9 and 10.

G. Specialty Emulsions.

Specialty emulsions may be either asphaltic-based or resin-based and must meet the requirements included in Table 11.

H. Recycling Agent.

Recycling agent and emulsified recycling agent must meet the requirements of 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 drawings.

Table 9: Polymer Modified Emulsified Asphalt Requirements

Type-Grade	Rapid Setting				Medium Setting						Slow Setting	
	RS-1P		HFRS-2P		AES-150P		AES-300P		AES-300S		SS-1P	
Property Test Method	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	-	-	-	-	-	-	-	-
Sieve Test, % T 59	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1
Miscibility T 59	-		-		-		-		-		pass	
Coating Ability and Water Resistance: T59												
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-C	-	80	-	-	-	-	-	-	-	-	-	-
Distillation Test:[1] T 59												
Residue by Distillation, % by wt.	65	-	65	-	65	-	65	-	65	-	60	-
Oil Distillate, % by vol of emulsion	-	3	-	0.5	-	3	-	5	-	7	-	0.5
Tests: Residue from Distillation:												
Polymer Content, wt. % (solids basis) Tex-533-C	-	-	3.0	-	-	-	-	-	-	-	3.0	-
Penetration, 77ºF, (25ºC) 100 g, 5 sec. T 49	225	300	90	140	150	300	300	-	300	-	100	140
Solubility in Trichloroethylene, % T 44	97.0	-	97.0	-	97.0	-	97.0	-	97.0	-	97.0	-
Viscosity, 140ºF, poise 60ºC, Pa-s T 202	-	-	1500	-	-	-	-	-	-	-	1300	-
Float Test, 140ºF, sec. T 50	-	-	1200	-	1200	-	1200	-	1200	-	-	-
Ductility[2], 39.2ºF, 5 cm/min., cm (4ºC, 5 cm/min., mm) T 51	-	-	50 500	-	-	-	-	-	-	-	50 500	-
Elastic Recovery[2], 50ºF,(10ºC), % Tex-539-C	55	-	55	-	-	-	-	-	-	-	-	-
Tests on RTFO Curing of Distillation Residue: Tex-541-C												
Elastic Recovery, 50ºF,(10ºF) % Tex-539-C	-	-	-	-	50	-	50	-	30	-	-	-

[1] Exception to AASHTO T 59: Bring the temperature on the lower thermometer slowly to 350ºF +/- 10ºF. 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.

Table 10: Polymer Modified Cationic Emulsified Asphalt Requirements

Type-Grade		Rapid Setting				Slow Setting	
		CRS-1P		CRS-2P		CSS-1P	
Property	Test Method	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72						
77ºF (25ºC), sec.		-	-	-	-	20	100
122ºF (50ºC), sec.		50	150	150	400	-	-
Sieve Test, %	T 59	-	0.1	-	0.1	-	0.1
Demulsibility, 35 ml of 0.8% sodium dioctyl sulfosuccinate, %	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 volume 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, 77ºF (25ºC), 100 g, 5 sec.	T 49	225	300	90	150	55	90
Viscosity, 140ºF, poise (60ºC, Pa-s)	T 202	-	-	1300	-	-	-
Solubility in Trichloroethylene, %	T 44	97.0	-	97.0	-	97.0	-
Softening Point, ºF	T 53	-	-	-	-	135	-
Ductility, 77ºF, 5 cm/min., cm (25ºC, 5 cm/min., mm)	T 51	-	-	-	-	70 700	-
Ductility[2], 39.2ºF, 5 cm/min., cm (4ºC, 5 cm/min., mm)	T 51	-	-	50	-	-	-
Elastic Recovery[2], 50ºF (10ºC), %	Tex-539-C	45	-	55	-	-	-

[1] Exception to AASHTO T 59: Bring the temperature on the lower thermometer slowly to 350ºF +/- 10ºF. 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.

Table 11: Specialty Emulsion Requirements

Type-Grade		Medium Setting				Slow Setting	
		AE-P		EAP&T		PCE[1]	
Property	Test Method	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72						
77ºF (25ºC), sec.		-	-	-	-	10	100
122ºF (50ºC), sec.		15	150	-	-	-	-
Sieve Test, %	T 59	-	0.1	-	0.1	-	0.1
Miscibility[2]	T 59	-		pass		pass	
Demulsibility, 35 ml of 0.10 N $CaCl_2$, %	T 59	-	70	-	-	-	-
Storage Stability, 1 day, %	T 59	-	1	-	1	-	-
Particle Size[3], % by volume < 2.5 □m	Tex-238-F	-	-	90	-	-	-
Asphalt Emulsion Distillation to 500ºF (260ºC) followed by Cutback Asphalt Distillation of Residue to 680ºF (360ºC):	T 59 & T 78						
Residue after both Distillations, % by wt.		40	-	-	-	-	-
Total Oil Distillate from both distillations, % by volume of emulsion		25	40	-	-	-	-
Distillation:	T 59						
Residue by Distillation, % by wt.		-	-	60	-	-	-
Evaporation:[4]	T 59						
Residue by Evaporation, % by wt.		-	-	-	-	60	-
Tests on Residue after all Distillation(s):							
Viscosity, 140ºF, poise (60ºC, Pa-s)	T 202	-	-	800	-	-	-
Kinematic Viscosity, 140ºF, cSt [60°C, mm^2/s]	T 201	-	-	-	-	100	350
Flash Point, C.O.C., ºF [°C]	T 48	-	-	-	-	400 204	-
Solubility in Trichloroethylene, %	T 44	97.5	-	-	-	-	-
Float Test, 122ºF (50ºC), 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 or PCB's have been mixed with the product; and
- c) a Materials Safety Data Sheet.

[2] Exception to AASHTO T 59: In dilution, use 350 ml of distilled or deionized water and a 1000-ml beaker.

[3] Tex-238-F, beginning at "Particle Size Analysis by Laser Diffraction," "Procedure" (using - medium: distilled or deionized water and dispersant: none), or other approved method.

[4] Exception to AASHTO T 59: Leave sample in the oven until foaming ceases, then cool and weigh.

Table 12: Recycling Agent and Emulsified Recycling Agent Requirements

Property	Test Method	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	
Evaporation Test:[2]	T 59				
Residue by Evaporation, % by wt.		-	-	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 AASHTO T 59: Use 0.02 N $CaCl_2$ solution in place of water.

[2]Exception to AASHTO T 59: Maintain sample at 300ºF until foaming ceases, then cool and weigh.

I. Crack Sealer

This section sets forth the requirements for a polymer modified emulsion suitable for sealing fine cracks, and a rubber asphalt compound suitable for sealing cracks of 1/8 inch [3 mm] or greater width.

1. Polymer Modified Asphalt Emulsion Crack Sealer

For cracks on the order of 1/8 inch [3 mm] width, HFRS-2P polymer modified emulsion as described in the table included in Section F, Polymer Modified Emulsions of this item may be used. Requirements for the polymer modified emulsion and rubber-asphalt crack-sealing compound are presented in Table 13.

Table 13: Polymer Modified Asphalt Emulsion Crack Sealer Requirements

Property	Test Methods	Min	Max
Rotational Viscosity, 77ºF, cP	ASTM D 2196, Method A	10,000	25,000
Sieve Test, %	T 59	-	0.1
Storage Stability, 1 day, %	T 59	-	1
Evaporation	Tex-543-C		
Residue by Evaporation, % by wt.		65	-
Tests on Residue from Evaporation:			
Penetration, 77ºF, 100 g, 5 sec.	T 49	35	75
Softening Point, ºF	T 53	140	-
Ductility, 39.2ºF, 5 cm/min., cm	T 51	100	-

2. Rubber-Asphalt Crack Sealing Compound

This specification item may be a proprietary product. The compound shall be capable of being melted and applied at a temperature of 400°F [200°C] or less by a suitable oil jacketed kettle equipped with a pressure pump, a hose and a nozzle. It shall contain no water or highly-volatile matter. It shall not be tracked by vehicular traffic once it cools to road pavement temperature.

The rubber-asphalt crack sealing compound shall meet requirements in Table 14.

Table 14: Rubber-Asphalt Crack Sealer Requirements

Property	Test Methods	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, 150g, 5 sec.	T 49	30	50	30	50
Penetration[3], 32ºF, 200g, 60 sec.	T 49	12	-	12	-
Softening Point, ºF	T 53	-	-	170	-
Bond[4], 3 cycles, 20ºF	Tex-525-C	-		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 1/2 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 AASHTO 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 1/4 in. deep for any specimen after completion of the test.

a. Properties of Rubber Used in Sealer. The rubber shall be one of the following types;

1) Type I - Ground tire rubber.

2) Type II - A mixture of ground tire rubber and high natural reclaimed scrap rubber. The natural rubber content, determined by ASTM D 297, shall be a minimum of 25 percent.

b. Ground Rubber. The ground rubber shall comply with the following gradation requirements when tested by TxDoT Test Method Tex-200-F, Part I.

Table 15: Ground Rubber Gradation Requirements

Sieve Size		Percent Retained	
U.S.	SI	Type I	Type II
No. 8	2.36 mm	0	-
No. 10	2.00 mm	0-5	0
No. 30	600µm	90-100	50-70
No. 50	300µm	95-100	70-95
No. 100	150µm	-	95-100

The ground rubber shall be free from fabric, wire, cord or other contaminating materials.

c. Packaging. The rubber-asphalt crack sealing compound shall be packaged in boxes, which contain two (2) 30-35 pound [14-16 kilogram] blocks that are individually packaged in a liner made of polyethylene, or other packaging approved by the Engineer or designated representative.

J. Performance Graded Binders.

Performance graded binders must be smooth, homogeneous, show no separation when tested in accordance with Test Method Tex-540-C, and must meet the requirements in the following table.

Separation testing is not required if:

- a modifier is introduced separately at the mix plant either by injection in the asphalt line or mixer, or
- 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 16 Performance Graded Binder Requirements

Performance Grade	PG 58			PG 64				PG 70				PG 76				PG 82		
	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28
Average 7-day Max Pavement Design Temperature, °C[1]	58			64				70				76				82		
Min Pavement Design Temperature, °C[1]	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28
ORIGINAL BINDER																		
Flash Point, AASHTO T 48: Min,	230°C																	
Viscosity, AASHTO TP 48:[2, 3] Max, 3.0 Pas, Test Temperature,	135°C																	
Dynamic Shear, AASHTO TP 5:[4] G*/sin (δ), Min, 1.00 kPa Test Temperature @ 10 rad/sec.,	58°C			64°C				70°C				76°C				82°C		
Elastic Recovery, ASTM D 6084, 50°F, % Min	-	-	30	-	-	30	50	-	30	50	60	30	50	60	70	50	60	70
ROLLING THIN FILM OVEN (Tex-541-C)																		
Mass Loss, Max, %	1.0																	
Dynamic Shear, AASHTO TP 5: G*/sin (δ), Min, 2.20 kPa Test Temperature @10 red/sec.,	58°C			64°C				70°C				76°C				82°C		
PRESSURE AGING VESSEL (PAV) RESIDUE (AASHTO PP 1)																		
PAV Aging Temperature	100°C																	
Dynamic Shear, AASHTO TP 5: G*/sin (δ), Max, 5000 kPa Test Temperature10 rad/sec., °C	25	22	19	28	25	22	19	28	25	22	19	28	25	22	19	28	25	22
Creep Stiffness, AASHTO TP 1:[5, 6] S, Max, 300 mPa, M - value, Min, 0.300 Test Temperature @ 60 sec., °C	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18
Direct Tension, AASHTO TP 3:[6] Failure Strain, Min, 1.0% Test Temperature @1.0 mm/min., °C	-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 the PGEXCEL3.xls software program, may be provided by the Department or by following the procedures as 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 (AASTHO T 201 or T 202) or rotational viscometry (AASHTO TP 48).

[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 (□) at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary (AASHTO T 201 or T 202) or rotational viscometry (AASHTO TP 48).

[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.

301S.4 Equipment.

All equipment necessary to transport, store, sample, heat, apply, and incorporate asphalts, oils, and emulsions shall be provided.

301S.5 Construction

Typical materials used for specific applications are identified in table 17. These are typical uses only and circumstances may require use of other material.

Table 17: Typical Material Use

Material Application	Typically Used Materials
Hot-Mixed, Hot-Laid Asphalt Mixtures	PG Binders, Modified PG Binders
Surface Treatment	AC-5, AC-10, AC-5 w/2% SBR, AC-10 w/2% SBR, AC-15P, AC-15-5TR, HFRS-2, MS-2, CRS-2, CRS-2H, HFRS-2P, CRS-2P,
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	RC-250, SS-1, SS-1H, CSS-1, 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-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)
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

301S.6 Storage, Heating and Application Temperatures

Asphaltic materials should be applied at the temperature, which provides proper and uniform distribution. Within practical limits higher temperatures than necessary to produce the desired results shall be avoided. Satisfactory application usually should be obtained within the recommended ranges shown below.

No material shall be heated above the following maximum temperatures:

Table:18 Recommended Temperature Ranges

	Recommended Range; °F [°C]	Maximum Temperature; °F [°C] for	
Type-Grade	Application/Mixing	Allowable Application	Storage
AC-5, 10,20,30	275-350 [135-177]	375 [191]	400 [204]
AC-5 or AC-10 + 2% SBR	300-375 [142-191]	390* [199]	375 [191]
AC-10 + 3% SBR, AC-45P	300-350 [142-191]	350 [177]	360 [182]
RC-250	125-180 [52-82]	200 [93]	200 [93]
RC-800	170-230 [77-110]	260 [127]	260 [127]
RC-3000	215-275 [102-135]	285 [141]	285 [141]
MC-30, AEP	70-150 [21-66]	175 [79]	175 [79]
MC-70	125-175 [52-79]	200 [93]	200 [93]
MC-250	125-210 [52-99]	240 [116]	240 [116]
MC-800, SCM I, SCM II	175-260 [79-127]	275 [135]	275 [135]
MC-3000 & MC-2400 Latex	225-275 [107-135]	290 [143]	290 [143]
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, SS-1P, CSS-1, CSS-1h, PCE, EAP & T, SS-1P, RS-1P, CRS-1P, CSS-1P, recycling agent, emulsified recycling agent, polymer modified AE crack sealant.	50-130 [10-54]	140 [60]	140 [60]
RS-2, RS-2h, MS-2, CRS-2, CRS-2h, CRS-2p, CMS-2, CMS-2S, HFRS-2, HFRS-2p, AES-300	110-160 [43-71]	170 [77]	170 [77]
Special Precoat Material	125-250 [52-121]	275 [135]	275 [135]
PG Binders, Modified PG Binders	275 - 350	350	350
Rubber Asphalt Crack Sealers (Class A, Class B)	350 - 375	400	-
Rubber-Asphalt Crack Sealer	350-375 [177-191]	400 [204]	-

* AC-5 + 2% SBR and AC-10 + 2% SBR, which is designated for surface treatment work, may be heated to a maximum temperature of 390°F [200°C] by the supplier loading through an in-line heater, or with the permission of the Engineer or designated representative, these materials may be heated to maximum of 390°F [200°C] by the Contractor just prior to application. When any of the SBR-modified asphalt cements are used in asphaltic concrete, the storage temperature at the mix plant should not exceed 350°F [177°C].

Attention is called to the fact that asphaltic materials (except emulsions) are very flammable and constitute fire hazards. Proper precautions should be used in all cases, especially with RC cutbacks.

Utmost care shall 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.

301S.7 Measurement and Payment

All asphaltic materials included in this specification will not be paid for directly but shall be included in the unit price bid for the item of construction in which this item is used.

End

Specific CROSS REFERENCE MATERIALS
Specification Item 301S "Asphalts, Oils and Emulsions"

American Association of State Highway and Transportation Officials (AASHTO)

Designation	Description
AASHTO T-44	Solubility Of Bituminous Materials in Organic Solvents
AASHTO T-48	Flash and Fire Points By Cleveland Open Cup
AASHTO T-49	Penetration of Bituminous Materials
AASHTO T-50	Float Test for Bituminous Materials
AASHTO T-51	Ductility of Bituminous Materials
AASHTO T-53	Distillation of Road Tar
AASHTO T-55	Water in Petroleum Products and Bituminous Materials by Distillation
AASHTO T-59	Testing Emulsified Asphalt
AASHTO T-72	Saybolt Viscosity
AASHTO T-78	Distillation of Cut-Back Asphaltic (Bituminous) Products
AASHTO T-79	Flash Point With Tag Open-Cup Apparatus
AASHTO T-201	Kinematic Viscosity of Asphalts
AASHTO T-202	Viscosity of Asphalts by Vacuum Capillary Viscometer
AASHTO TP-1	Creep Stiffness
AASHTO TP-3	Direct Tension
AASHTO TP-5	Dynamic Shear
AASHTO TP-48	Rotational Viscometry

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-200-F	Sieve Analysis of Fine and Coarse Aggregates
Tex-238-F	Laser Diffraction Particle Size Distribution Analyzer
Tex-509-C	Spot Test of Asphaltic Materials
Tex-525-C	Tests for Asphalt and Concrete Joint Sealers
Tex-533-C	Determination of Polymer Additive Percentages in Polymer Modified Asphalt Cements
Tex-539-C	
Tex-540-C	
Tex-541-C	
Tex-542-C	
Tex-543-C	
Tex-544-C	

American Society for Testing and Materials (ASTM)

Designation	Description
D 217	Test Methods for Cone Penetration of Lubricating Grease
D 297	Test Methods for Rubber Products-Chemical Analysis
D 2186 Method A	Test Methods for Deposit-Forming Impurities in Steam
D 6084	Test Method for Elastic Recovery of Bituminous Materials by Ductilometer

RELATED CROSS REFERENCE MATERIALS
Specification Item 301S "Asphalts, Oils and Emulsions"

City of Austin Standard Specifications

Designation	Description
Item No. 206S	Asphalt Stabilized Base

Item No. 210S	Flexible Base
Item No. 302S	Aggregates for Surface Treatments
Item No. 306S	Prime Coat
Item No. 307S	Tack Coat
Item No. 310S	Emulsified Asphalt Treatment
Item No. 311S	Emulsified Asphalt Repaving

RELATED CROSS REFERENCE MATERIALS - Continued
Specification Item 301S "Asphalts, Oils and Emulsions"

City of Austin Standard Specifications

Designation	Description
Item No. 312S	Seal Coat
Item No. 313S	Rubber Asphalt Joint and Crack Sealant
Item No. 315S	Milling Asphaltic Concrete Paving
Item No. 320S	Two Course Surface Treatment
Item No. 340S	Hot Mix Asphaltic Concrete Pavement
Item No. 341S	Paving Fabric
Item No. 350S	Heating, Scarifying and Repaving
Item No. 351S	Recycling Agent

City of Austin Standard Details

Designation	Description
1000S-10	Local Street Sections
1000S-11(1)	Residential and Neighborhood collector Street Sections
1000S-11(2)	Industrial and Collector Street Sections
1000S-12(1)	Primary Collector Street Sections
1000S-12(2)	Primary Arterial Street Sections
1000S-13(1)	Minor Arterial Street Sections (4 Lanes)
1000S-13(2)	Minor Arterial Street Sections- (4 Lanes divided)
1000S-14	Major Arterial Street

Texas Department of Transportation: Standard Specifications for Construction And Maintenance of Highways, Streets, and Bridges

Designation	Description
Item 300	Asphalts, Oils and Emulsions
Item 301	Asphalt Antistripping Agents
Item 310	Prime Coat (Cutback Asphaltic Materials)
Item 314	Emulsified Asphalt Treatment
Item 316	Surface Treatments
Item 345	Asphalt Stabilized Base (Plant Mixed)
Item 354	Planing and/or Texturing Pavement
Item 520	Weighing and Measuring Equipment

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-126-E	Molding, Testing and Evaluation of Bituminous Black Base Materials
Tex-207-F	Determination of Density of Compacted Bituminous Mixtures
Tex-211-F	Recovery of Asphalt From Bituminous Mixtures By Abson
Tex-215-	Determination of Asphalt Content of Rock Asphalt Process by Hot Solvent Method
Tex-217-F	Determination of Deleterious Material and Decantation Test For Coarse Aggregates
Tex-224-F	Determination of Flakiness
Tex-400-A	Method of Sampling Stone, Gravel, Sand and Mineral Aggregates
Tex-410-A	Abrasion of Coarse Aggregate Using the Los Angeles Machine
Tex-411-A	Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
Tex-438-A	Accelerated Polish Test for Aggregate
Tex-460-A	Determination of Crushed Face Particle

Tex-501-C	Test for Water in Petroleum Products and Other Bituminous Materials
Tex-502-C	Test for Penetration of Bituminous Material
Tex-503-C	Test for Ductility of Bituminous Materials
Tex-504-C	Test for Flash and Fire Points of Petroleum Materials by Cleveland Open Cup

RELATED CROSS REFERENCE MATERIALS - Continued

Specification Item 301S "Asphalts, Oils and Emulsions"

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-505-C	Test for Softening Point of Bituminous Materials by Ring-and-Ball Method
Tex-506-C	Test for Loss on Heating of Oils and Asphaltic Compounds
Tex-507-C	Proportion of Bitumen Soluble in Trichloroethylene
Tex-510-C	Determining the Effect of Heat and Air on Asphaltic Materials when Exposed in Thin Films
Tex-512-C	Test for Flash Points of Volative Flammable Materials By Tag Open-Cup Apparatus
Tex-513-C	Test for Saybolt Viscosity
Tex-515-C	Distillation of Cut-Back Asphalt Products
Tex-519-C	Float Test for Bituminous Materials
Tex-520-C	Test for Residue of Specified Penetration
Tex-521-C	Testing Emulsified Asphalts
Tex-528-C	Test for Absolute Viscosity of Asphalt Cements
Tex-529-C	Test for Kinematic Viscosity of Asphalts

Item No. 306S
Prime Coat

306S.1 Description

This item shall govern the application of asphaltic material on the completed base course and/or other approved areas in accordance with the Drawings, these specifications or as directed by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

306S.2 Submittals

The submittal requirements of this specification item include:

A. List of recommended materials (i.e. prime material, dispersal agent, etc.).

B. Temperature Viscosity data and proposed temperature of application.

C. Characteristics (i.e. manufacturer, rate of application, speed, etc.) of the proposed pressure distributor including calibration documentation.

D. List of facilities and equipment proposed for temperature measurements.

E. List of facilities and equipment proposed for storage and handling of asphaltic materials.

306S.3 Materials

A. Asphalt Materials

The asphalt material for Prime Coat shall meet the requirements of Cutback Asphalt, MC-30, Emulsion, SS-1, Emulsion CSS-1 or AE-P, Standard Specification Item No. 301S, "Asphalts, Oils and Emulsions".

B. Water

Water shall be furnished by the Contractor and shall be clean and free from industrial wastes and other objectionable matter.

C. Dispersal Agent

Agent shall be added to water and sprayed on surfaces to be primed in accordance with asphalt manufacturer's recommendations.

306S.4 Construction Methods

When, in the opinion of the Engineer or designated representative, the base course or other surface is satisfactory to receive the prime coat, the surface shall be prepared by sweeping or other approved methods as directed by the Engineer or designated representative. The surface shall be lightly sprinkled with water just prior to application of the asphaltic material unless this

requirement is waived by the Engineer or designated representative. The Contractor shall submit a list of prime material(s) recommended for application on the work to the Engineer or designated representative for approval. When emulsions are approved, a dispersal agent shall be added to the water before sprinkling.

The asphaltic material shall be applied on the clean surface by an approved type of self-propelled pressure distributor operated so as to distribute the prime coat at a rate ranging from 0.1 to 0.3 gallons per square yard (0.45 to 1.36 liters per square meter) of surface area. The material shall be evenly and smoothly distributed under pressure sufficient to assure proper distribution. During the application of prime coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutters or structures. The Contractor shall be responsible for cleaning all splattered areas.

Prime Coat may be applied when the temperature of the surface on which the prime coat is to be placed is 60^{o}F (16^{o}C) or above and the air temperature is above 50^{0}F (10^{0}C) and rising; the air temperature being taken in the shade and away from artificial heat. Asphaltic material shall not be placed when general weather conditions, in the opinion of the Engineer or designated representative, are not suitable.

The Contractor shall provide all necessary facilities and equipment 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.

The distributor shall have been calibrated within three (3) years from the date it is first used on this project. The Engineer or designated representative shall be furnished an accurate and satisfactory record of such calibration. After beginning the work, if the yield on the asphaltic material applied appears in error, the distributor shall be calibrated in a manner satisfactory to the Engineer or designated representative before proceeding with the work.

The Contractor shall be responsible for the maintenance of the surface until the work is accepted by the Engineer or designated representative. No traffic, hauling or placement of any subsequent courses shall be permitted over the freshly applied prime coat for a minimum of 48 hours or until the prime coat is accepted as dry and cured completely by the Engineer or designated representative.

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 they shall be operated in such a 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 Engineer or designated representative will approve the temperature of application based on the temperature-viscosity relationship that will permit application of the asphalt within the limits recommended in Standard Specification Item No. 301S, "Asphalts, Oils and Emulsions". The Contractor

shall apply the asphalt at a temperature within 15^0F (8^0C) of the temperature specified in Standard Specification Item No. 301S, "Asphalt, Oils and Emulsions".

306S.5 Measurement

The prime coat will be included in the unit price bid for Standard Specification Item No. 340, "Hot Mix Asphaltic Concrete Pavement" unless included as a separate pay item in the contract. When included for payment, it shall be measured at point of delivery on the project in gallons (liters: 1 liter equals 0.264 gallons) at the applied temperature. The quantity to be paid for shall be the number of gallons used in the accepted prime coat.

306S.6 Payment

The work performed and materials furnished as prescribed by this item, when included as a contract pay item, will be paid for at the unit bid price per gallon for "Prime Coat". The price shall include full compensation for cleaning the base course or other surface, for furnishing, heating, hauling and distributing the prime coat specified; for all freight involved and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

Payment, when included as a contract pay item, will be made under:

Pay Item No. 306S: Prime Coat Per Gallon.

End

SPECIFIC *CROSS REFERENCE MATERIALS*

Specification Item 306S "Prime Coat"

City of Austin Standard Specifications

Designation	**Description**
Item No. 301S	Asphalts, Oils and Emulsions
Item No. 340S	*Hot Mix Asphaltic Concrete Pavement*

RELATED *CROSS REFERENCE MATERIALS*

City of Austin Standard Specifications

Designation	**Description**
Item No. 206S	Asphalt Stabilized Base
Item No. 210S	Flexible Base
Item No. 307S	Tack Coat
Item No. 310S	Emulsified Asphalt Treatment
Item No. 311S	Emulsified Asphalt Repaving
Item No. 320S	Two Course Surface Treatment

City of Austin Standard Details

Designation	Description
1000S-10	Local Street Sections
1000S-11 (1)	Residential and Neighborhood collector Street Sections
1000S-11 (2)	Industrial and Collector Street Sections
1000S-12 (1)	Primary Collector Street Sections
1000S-12 (2)	Primary Arterial Street Sections
1000S-13 (1)	Minor Arterial Street Sections (4 Lanes)
1000S-13 (2)	Minor Arterial Street Sections- (4 Lanes divided)
1000S-14	Major Arterial Street

RELATED *CROSS REFERENCE MATERIALS - Continued*

Specification Item 306S "Prime Coat"

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item 300	Asphalts, Oils and Emulsions
Item 301	Asphalt Antistripping Agents
Item 310	Prime Coat (Cutback Asphaltic Materials)
Item 314	Emulsified Asphalt Treatment
Item 345	Asphalt Stabilized Base (Plant Mixed)
Item 520	Weighing and Measuring Equipment

Item No. 307S
Tack Coat

307S.1 Description

This item shall govern the application of asphaltic material on completed base courses, existing pavement, bituminous surface, bridge deck, slab or prepared surface as indicated on the Drawings and as directed by the Engineer or designated representative. The application of asphaltic material on completed base courses shall only be applied after the prime coat has completely cured in accordance with Standard Specification Item No. 306S, "Prime Coat"

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

307S.2 Submittals

The submittal requirements of this specification item include:

A. List of recommended materials (i.e. tack coat material, sand type, etc.).

B. Temperature Viscosity data and proposed temperature of application.

C. Characteristics (i.e. manufacturer, rate of application, speed, etc.) of the proposed pressure distributor including calibration documentation.

D. List of facilities and equipment proposed for temperature measurements.

E. List of facilities and equipment proposed for storage and handling of asphaltic materials.

307S.3 Materials

A. Asphalt Materials

The asphalt material for "Tack Coat" shall meet the requirements for Cutback Asphalt or Emulsified Asphalt, Standard Specification Item No. 301S, "Asphalts, Oils and Emulsions" as listed below. Cutback asphalt shall be made by combining 50 to 70 percent by volume of the asphaltic material as specified for the type of paving mixture with 30 to 50 percent by volume of gasoline and/or kerosene. The type of material shall be selected from the following table:

Temperature of Surface, ^{0}F (^{0}C)	40 – 70 ^{0}F (5 to 21^{0}C)	Over 70^{0}F (Over 21^{0}C)
	RS-2	SS-1
	RS-2H	
	RC-250	MC-70
	CRS-2	CSS-1
	CRS-2H	CSS-1h

B. Water

Water shall be furnished by the Contractor and shall be clean and free from industrial wastes and other objectionable matter.

C. Sand

Sand may be Grade 1 conforming to Standard Specification Item No. 403S, "Concrete Structures" or washed sand, largely siliceous, with the following gradation:

Sieve Designation US	SI	**Percent Retained by Weight (Mass) Natural Sand**
No. 8	2.36 mm	0
No. 16	1.18 mm	0-40
No. 30	600μm	25-65
No. 50	300μm	65-85
No. 100	150μm	85-98
No. 200	75μm	98-100

There shall not be more than 50 percent of the aggregate retained between any 2 sieves listed above and not more than 25 percent of the aggregate retained between the No. 50 (300 μm) and the No. 100 (150 μm) sieves.

307S.4 Construction Methods

Tack coat shall be applied when the surface on which the tack coat is to be placed is 60^{o} F (16^{o}C) or above and the air temperature is above 50^{0}F (10^{0}C) and rising, where the air temperature is measured in the shade and away from any artificial heat. Asphaltic material shall not be placed when general weather conditions, in the opinion of the Engineer or designated representative, are not suitable.

Before the tack coat is applied, the surface shall be cleaned thoroughly to the satisfaction of the Engineer or designated representative. The asphaltic material shall be applied on the clean surface by an approved type of self-propelled pressure distributor, so operated as to distribute the tack coat at a rate not to exceed 0.10 gallon per square yard (0.45 liters per square meter) of surface, evenly and smoothly with sufficient pressure to provide proper distribution.

In those instances where the pavement 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 Engineer or designated representative. All contact surfaces of curbs and structures and all joints shall be cleaned thoroughly and painted with a thin uniform coat of the asphaltic material used for tack coat. The tack coat shall be rolled with a pneumatic tire roller to distribute the asphaltic material uniformly over the tacked area. During the application of tack coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutters or structures. The Contractor shall clean splattered areas.

The distributor shall have been calibrated within three (3) years from the date it is first used on this project. The Engineer or designated representative shall be

furnished an accurate and satisfactory record of such calibration. After beginning of the work, if the yield on the asphaltic material applied appears in error, the distributor shall be calibrated in a manner satisfactory to the Engineer or designated representative before proceeding with the work.

The Contractor shall provide all necessary facilities and equipment 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.

The Contractor shall be responsible for the maintenance of the surface until the HMAC is placed over the tack coat or the work is accepted by the Engineer or designated representative. No traffic, hauling or placement of any subsequent courses shall be permitted over the freshly applied tack coat unless it is blotted by the application of sand as directed by the Engineer or designated representative.

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 they shall be operated in such a 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 Contractor shall apply the asphalt at a temperature that will permit application of the asphalt within the limits recommended in Standard Specification Item No 301S, “Asphalts, Oils and Emulsions”. The application temperature shall be within 15^0 F (8^0C) of 160^0 F (71^0C).

307S.5 Measurement

The asphaltic material for "Tack Coat" will be included in the unit price bid for Standard Specification Item 340S, "Hot Mix Asphaltic Concrete Pavement" unless included as a separate pay item in the contract. When included for payment, "Tack Coat" shall be measured at point of delivery on the project in gallons (liters: 1 liter equals 0.264 gallons) at the applied temperature. The quantity to be paid for shall be the number of gallons used.

307S.6 Payment

The work performed and materials furnished as prescribed by this item, when included as a contract pay item, will be paid for at the unit bid price per gallon for "Tack Coat". The price shall include full compensation for cleaning the area to receive the "Tack Coat"; for furnishing, heating, hauling and distributing the tack coat specified; for all freight involved and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

Payment, when included as a contract pay item, will be made under:

Pay Item No. 307S:	Tack	Coat
	Per Gallon.	

End

SPECIFIC *CROSS REFERENCE MATERIALS*

Specification Item 307S "Tack Coat"

City of Austin Standard Specifications

Designation	Description
Item No. 301S	Asphalts, Oils and Emulsions
Item No. 340S	Hot Mix Asphaltic Concrete Pavement

RELATED *CROSS REFERENCE MATERIALS*

City of Austin Standard Specifications

Designation	Description
Item No. 206S	Asphalt Stabilized Base
Item No. 210S	Flexible Base
Item No. 306S	Prime Coat
Item No. 310S	Emulsified Asphalt Treatment
Item No. 311S	Emulsified Asphalt Repaving
Item No. 320S	Two Course Surface Treatment

City of Austin Standard Details

Designation	Description
1000S-10	Local Street Sections
1000S-11(1)	Residential and Neighborhood collector Street Sections
1000S-11(2)	Industrial and Collector Street Sections
1000S-12(1)	Primary Collector Street Sections
1000S-12(2)	Primary Arterial Street Sections
1000S-13(1)	Minor Arterial Street Sections (4 Lanes)
1000S-13(2)	Minor Arterial Street Sections- (4 Lanes divided)
1000S-14	Major Arterial Street

Texas Department of Transportation: Standard Specifications for Construction

And Maintenance of Highways, Streets, and Bridges

Designation	Description
Item 300	Asphalts, Oils and Emulsions
Item 301	Asphalt Antistripping Agents
Item 310	Prime Coat (Cutback Asphaltic Materials)
Item 314	Emulsified Asphalt Treatment
Item 345	Asphalt Stabilized Base (Plant Mixed)
Item 520	Weighting and Measuring Equipment

Item No. 312S
Seal Coat

312S.1 Description

This item shall govern the construction of a surface treatment composed of a single application of asphalt or latex-asphalt covered with aggregate for the sealing of existing pavements in accordance with the details on the Drawings and this specification item.

312S.2 Submittals

The submittal requirements of this specification item include:

A. Recommended design mix (emulsion type, aggregate type, type and % of polymer)

B. Test results on the emulsion (Saybolt Furol Viscosity, storage stability, demulsibility, sieve test, distillation test and residue tests).

C. Test results on the aggregate (gradation and percent wear).

D. Characteristics (i.e. manufacturer, rate of application, speed, etc.) of the proposed distributor and aggregate spreader.

E. List of facilities and equipment proposed for temperature measurements.

F. List of facilities and equipment proposed for storage and handling of asphaltic materials.

312S.3 Materials

A. Asphaltic Materials

Asphaltic material shall conform to Item No. 301S, "Asphalts, Oils and Emulsions" as follows:

1. Patching

Patching shall be completed with Class D HMAC conforming to Item No. 340S, "Hot Mix Asphaltic Concrete".

2. Sealing

a) Cool Weather of 65 to 80°F (18 to 27°C): HFRS-2.

b) Warm Weather over 81°F (27°C): RS-2.

B. Aggregate

Aggregate material shall conform to Item No. 302S, "Aggregate for Surface Treatments". Unless otherwise specified on the drawings, the aggregate grading shall meet Grade 5.

C. Aggregate (Stockpiled)

Aggregate may be stockpiled only with permission of the Engineer or designated representative at locations designated for stockpiling. The Contractor shall be responsible for all remedial pollution control measures during the clean up of the stockpiling.

D. Latex Additive

The latex shall be an emulsion of styrene-butadiene low-temperature copolymer in water. The emulsion shall have good storage stability and possess the following properties:

Monomer ratio, Butadiene/Styrene	(73 ± 5)/ (27 ± 5)
Minimum solids content, % by weight (mass)	45
Viscosity of emulsion at 77°F ± 1°F (25°C ± 1°C), Cps, Maximum (No. 3 spindle, 20 rpm, Brookfield RVT Viscometer	2000

The manufacturer shall furnish the actual styrene-butadiene rubber (SBR) content for each batch of latex emulsion. This information shall accompany all shipments to facilitate proper addition rates.

312S.4 Equipment

Equipment will consist of the following: asphalt storage and heaters, distributors, aggregate spreaders, blade equipped tractor and drag broom, pneumatic rollers, water truck with pump and rotary broom.

All storage tanks, piping, retorts, booster tanks and distributors used in storage or handling of asphaltic material shall be kept clean and in good operating condition at all times and they shall be operated in such manner that there will be no contamination of the asphaltic material. The Contractor shall provide and maintain in good working order a recording thermometer to continuously indicate the temperature of the asphaltic material at the storage-heating unit, when storing of asphalt is permitted.

The distributor shall have pneumatic tires of such width and number that the load produced on the street surface shall not exceed 650 pounds per inch (12 kilograms per millimeter) of tire width and shall be so designed, equipped, maintained and operated that asphaltic material at even heat may be applied uniformly on variable widths of surface at readily determined and controlled rates of from 0.05 to 0.2 gallons per square yard (0.25 to 0.9 liters per square meter), with a pressure range of from 25 to 75 pounds per square inch (170 to 515 kilopascals), and with an allowable variation from any specified rate not to exceed 5 percent. Distributor equipment shall include tachometer,

pressure gauges, volume measuring devices and a thermometer for reading temperatures of tank contents.

The aggregate spreading equipment shall be adjusted and capable of spreading aggregate at controlled amounts per square yard (square meter: 1 square meter equals 1.196 square yards) in a continuous manner.

The drag broom shall be lightweight street type, mounted on a frame, designed to spread aggregate uniformly over the surface of a bituminous pavement and equipped with pull plates for towing. Towing equipment shall be pneumatic tired.

Rollers shall conform to Item No. 232S, "Rolling (Pneumatic Tire)", Light Pneumatic Tire Roller.

Rotary brooms shall be suitable for cleaning the surfaces of bituminous pavements.

Vacuum sweepers shall be suitable for removing any loose aggregate without disturbing the compacted seal coat.

312S.5 Construction Methods

Prior to commencement of this work, all erosion control, environmental protection measures and all traffic control devices shall be in place.

Seal coats may be applied when the surface on which the seal coat is to placed is 60°F (16°C) or above and the air temperature is above 50°F (10°C) and rising, if the temperature is measured in the shade and away from artificial heat. Asphaltic material shall not be placed when general weather conditions are not suitable for a satisfactory seal coat or when the environment could be damaged.

A. Cracks and Holes

Cracks and holes will be patched by the Contractor prior to seal coat operations. Patching materials shall be hot mix, hot laid asphaltic concrete in conformance with Standard Specification Item No. 340S, "Hot Mix Asphaltic Concrete Pavement" or other asphaltic materials as approved by the Engineer or designated representative.

B. Cleaning Existing Surfaces Cleaning Existing Surfaces

Prior to placement of the seal coat, loose dirt and other objectionable material shall be removed from the existing surface. The surface will be cleaned with a rotary broom. Hand brooms will be used in areas not accessible to rotary brooms. The Engineer or designated representative must approve all streets before application of any asphalt.

C. Mixing Asphalt

When the air temperature is 80°F (27°C) or higher, latex shall be added to the asphalt at the rate of 1 1/2 to 2 percent by weight (mass) [solid bases]. The actual rate shall be in accordance with the drawings and/or as approved by the Engineer or designated representative. The asphalt shall be heated to 150°F (65°C) before adding the latex. The mixture shall be thoroughly mixed before application.

The finished latex-asphalt shall meet the following requirements:

Viscosity at 140° F, stokes (60°C, Pa-s)	1500 (150) maximum
Ductility at 39.2° F, 1 cm per min, cm (4°C, 1 mm/min, mm)	100 minimum

D. Application of Asphaltic Material

Immediately following the preparation of the existing surface by cleaning, the asphaltic material shall be applied at the rate of 0.25 to 0.30 gallon per square yard (0.9 to 1.1 liters per square meter) as determined by the Engineer or designated representative, so that uniform distribution is obtained at all points. Skip streaks on the pavement, due to defective distributor nozzles, will be reshot with a distributor at the expense of the Contractor.

The Contractor shall calibrate the spray bar nozzles by spreading building paper as required on the surface for a sufficient distance back from the end of each application so that flow through sprays may be started and stopped on the paper and so that all sprays will operate properly over the entire length being treated. Building paper so used shall be immediately removed and loaded on a truck. At the end of each day, the paper shall be disposed of at a permitted site approved by the Engineer or designated representative.

Application temperatures will be determined by weather conditions but the temperature of the asphaltic material to be applied shall be between 150 and 160°F (65 and 71°C) as determined by the Engineer or designated representative. When a street to be sealed is continuous through several intersections, sealed area will include all spandrels and stub-outs, unless otherwise directed by the Engineer or designated representative. Spandrels will be hand sprayed. Contractor shall not apply excessive amounts of asphaltic materials when hand spraying. Excessive materials applied shall be removed by the Contractor before spreading the aggregate.

The Contractor shall be required to seal all spandrels at the same time the adjacent streets are sealed, unless otherwise approved in writing by the Engineer.

During all applications, the surface of adjacent structures shall be protected in such a manner as to prevent their being splattered or marred. Building paper shall be spread on all manholes, valve boxes, junction boxes, etc. to protect the surface from asphaltic materials. The asphaltic material shall not be applied until the cover aggregate is available and ready to spread with assurance of continuous operation. No asphaltic material shall be placed which cannot be covered and rolled during daylight hours.

E. Spreading the Aggregate

The Contractor shall employ a mechanical aggregate spreader, which applies the aggregate uniformly over the surface at the rate of 15 to 20 pounds per square

yard (8 to 11 kilograms per square meter). The actual rate shall be as directed by the Engineer or designated representative.

The covering material in the quantity specified shall be spread uniformly over the bituminous material as soon after application as possible. The aggregate shall be spread in the same width of application as for the asphaltic material and spread uniformly with the aggregate spreading equipment.

Trucks spreading aggregate shall be operated backward so that bituminous material will be covered before truck wheels pass over it. The aggregate shall be applied to a thickness that will not produce blanketing or stacking. Any blanketing or stacking shall be removed prior to rolling. Backspotting or sprinkling cover aggregate shall be done by hand spreading, which will be continued during the operations whenever necessary, as directed by the Engineer or designated representative.

F. Brooming and Rolling and Rolling

Rolling shall be started as soon as sufficient aggregate is spread to prevent pick-up and continued until no more aggregate can be worked into the surface. The surface shall be blanket rolled. The Contractor shall manage the work so that all rolling of all cover aggregate applied that day is accomplished with a minimum of four complete coverages with pneumatic rollers prior to sundown.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the Engineer or designated representative, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment.

Rollers shall be maintained in good repair and operating condition and shall be approved by the Engineer or designated representative.

The Contractor will be responsible for maintaining all streets for 48 hours after each street has been seal coated. Maintenance will consist of brooming, rolling and adding more aggregate as directed by the Engineer or designated representative.

G. Asphaltic Material Contractor’s Responsibility Material Contractor's Responsibility

The Contractor shall furnish vendor's certified test report for asphaltic material shipped for the project. The report shall be delivered to the Engineer or designated representative before permission is granted for use of the material. Any change of source shall be reported prior to delivery.

312S.6 Traffic Control Facilities

The Contractor shall arrange the seal coat operation in such a manner as to avoid excessive inconvenience to the public in the seal coat area.

The Contractor shall notify all abutting property owners along the street prior to initiation of the seal coat operation.

The Contractor shall have on the project site sufficient barricades, flag-persons and traffic control devices to assure a minimum of inconvenience to traffic around the construction area in conformance with the General Conditions of the Standard Contract Documents. If the Contractor's arrangements are unsatisfactory to the Engineer or designated representative, the seal coat operation will not be allowed to commence.

After the seal coat has been applied, the Contractor shall post appropriate warning signs along these streets as directed by the Engineer or designated representative and maintain such signs for 48 hours.

312S.7 Final Cleanup

The Contractor shall vacuum sweep the completed seal coat and curb areas to remove loose aggregate as required during the first week after the traffic is allowed on the street.

312S.8 Measurement

All accepted Seal Coat will be measured by one of the following methods:

A. "Asphaltic Material" will be measured in gallons (liters: 1 liter equals 0.264 gallons) at the applied temperature at the point of application on the street.

B. "Aggregate" will be measured by the cubic yard (cubic meter: 1 cubic meter equals 1.31 cubic yards) in vehicles as applied on the street.

C. "Aggregate (Stockpiled)", if required to be furnished, will be measured by the cubic yard (cubic meter: 1 cubic meter equals 1.31 cubic yards) of material in vehicles at the point of stockpiling.

D. "Complete in Place" will be measured by the square yard (square meter: 1 square meter equals 1.196 square yards) of surface area treated.

312S.9 Payment

The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit bid prices stipulated in the bid for "Seal Coat, Asphaltic Material", "Seal Coat, Aggregate", "Seal Coat, Aggregate (Stockpiled)" or "Seal Coat, Complete in Place". The unit bid prices shall each include full compensation for: a) furnishing, delivering and placing all materials; b) patching, brooming, compacting and rolling; c) cleaning the existing surface, covering excess asphaltic material, removing excess aggregate and cleaning gutters and cleaning stockpiles sites; d) a 48 hour maintenance period and e) all labor, equipment, tools and incidentals necessary to complete the work required as indicated on the drawings.

Payment will be made under one of the following:

Pay Item No. 312S-A:	Seal Coat, Asphaltic Material	Per Gallon.
Pay Item No. 312S-B:	Seal Coat, Aggregate	Per Cubic Yard.
Pay Item No. 312S-C:	Seal Coat, Aggregate (Stockpiled)	Per Cubic Yard.
Pay Item No. 312S-D:	Seal Coat, Complete in Place	Per Square Yard.

End

SPECIFIC Cross Reference Materials
Specification Item No. 312S, " Seal Coat"

City of Austin Standard Specifications

Designation	Description
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 301S	Asphalts, Oils and Emulsions
Item No. 302S	Aggregates for Surface Treatments
Item No. 340S	Hot Mix Asphaltic Concrete Pavement

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-200-F	Sieve Analysis of Fine and Coarse Aggregates
Tex-410-A	Abrasion of Coarse Aggregate Using the Los Angeles Machine
Tex-502-C	Test for Penetration of Bituminous Material
Tex-503-C	Test for Ductility of Bituminous Materials
Tex-504-C	Test for Flash and Fire Points of Petroleum Materials by Cleveland Open Cup
Tex-506-C	Test for Loss on Heating of Oils and Asphaltic Compounds
Tex-507-C	Proportion of Bitumen Soluble in Trichloro-ethylene
Tex-513-C	Test for Saybolt Viscosity
Tex-519-C	Float Test for Bituminous Materials
Tex-520-C	Test for Residue of Specified Penetration
Tex-521-C	Testing Emulsified Asphalts

Tex-528-C	Test for Absolute Viscosity of Asphalt Cements
Tex-529-C	Test for Kinematic Viscosity of Asphalts

***RELATED* Cross Reference Materials**
Specification Item No. 312S, " Seal Coat"

City of Austin Standard Specifications

Designation	Description
Item No. 310S	Emulsified Asphalt Treatment
Item No. 313S	Rubber Asphalt Joint and Crack Sealant
Item No. 315S	Milling Asphaltic Concrete Paving and Non Portland Cement Concrete Bases
Item No. 316S	Polymerized Asphalt Interlayer Seal
Item No. 320S	Two Course Surface Treatment
Item No. 350S	Heating, Scarifying and Repaving
Item No. 801S	Construction Detours
Item No. 803S	Barricades, Signs and Traffic Handling
Item No. 870S	Work Zone Pavement Markings
Item No. 874S	Eliminating Existing Pavement Markings and Markers

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description

Item No. 300	Asphalts, Oils and Emulsions
Item No. 302	Aggregates for Surface Treatments
Item No. 314	Emulsified Asphalt Treatment
Item No. 315	Emulsified Asphalt Seal
Item No. 316	Surface Treatments
Item No. 345	Asphalt Stabilized Base (Plant Mixed)
Item No. 520	Weighing and Measuring Equipment

City of Austin Standard Contract Documents

Designation	Description
00700	General Conditions
01500	Temporary Facilities
01550	Public Safety and Convenience

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-509-C	Spot Test of Asphaltic Materials
Tex-510-C	Determining the Effect of Heat and Air on Asphaltic Materials when Exposed in Thin Films
Tex-512-C	Test for Flash Points of Volative Flammable Materials by Tag Open-Cup Apparatus

Item No. 313S
Cleaning and/or Sealing
Joints and Cracks (Asphaltic Concrete)

313S.1 Description

This item shall govern the cleaning and/or sealing of joints and cracks that are 1/16 inch (1.5 mm) or greater in asphaltic concrete pavement in conformity to the lines, grades and details indicated on the Drawings or as established by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

313S.2 Submittals

The submittal requirements of this specification item include:

A. Sealant Type (Polymer Modified Emulsion, Rubber-Asphalt or Self-Leveling Low Silicone) and method of application (crack sealing, joint sealing, squeegee, etc),

B. Manufacturer certification that the product to be supplied meets or exceeds the specification requirements,

C. Manufacturer recommended procedures for preparation, dispensing, application, curing etc of the sealant, and

D. Listing of the equipment proposed for the Work.

313S.3 Materials

Joints and/or cracks shall be sealed with the materials indicated on the Drawings. The materials shall meet the requirements shown below:

Material	Specification	Recommended Use
Polymer Modified Emulsion	301S;Subarticle 301S.3.I.1	Fine Cracks 1/16 to 1/8 in (1.5 to 3 mm)
Rubber-Asphalt Crack Sealing Compound	301S; Subarticle 301S.3.I.2	Cracks: >1/8 inches (> 3.2 mm)
Self-Leveling Low Modulus Silicon	Class 5, TxDot DMS-6310	Joints

Fine aggregate used to cover the crack-sealing compound shall meet with the approval of the Engineer or designated representative.

The sealing compound shall be delivered in the manufacturer's original sealed containers. Each container shall be legibly marked with the name of the manufacturer, the trade name of the sealer, the manufacturer's batch number or lot, the pouring temperature, and the safe heating temperature.

313S.4 Equipment

Equipment, tools and machinery necessary for proper prosecution of the Work shall be on the project and shall be approved by the Engineer or designated representative prior to the initiation of the joint and crack cleaning and sealing operations

313S.5 Heating and Application Equipment

A. Polymer Emulsified Emulsion

Polymer Emulsified Emulsion may be heated in a conventional asphalt distributor or in an asphalt heater equipped with an agitator to insure that the emulsified asphalt is circulated during the heating process and achieves a uniform temperature rise. Temperature gauges shall be provided at strategic locations to enable the operator to accurately control the temperature of the emulsion to avoid overheating the material. The unit shall be equipped with a gear-driven asphalt pump with adequate pressure to dispense the emulsion in joints and cracks.

B. Rubber-Asphalt Crack Sealing Compound

The sealant shall be heated in a double jacketed heater using a heat transfer oil so that no direct flame comes in contact with the shell of the vessel containing the sealing compound. The heater reservoir shall be equipped with an agitator to insure that the sealing compound is circulated during the heating process to achieve a uniform temperature rise and to maintain the desired temperature. Accurate temperature gauges and positive temperature controls shall be provided to monitor the temperature of the vessel contents and prevent overheating the material. The heater shall be equipped with a gear-driven asphalt pump with adequate pressure to dispense the rubber-asphalt crack sealing compound.

C. Self-Leveling Low Modulus Silicone

The sealant shall be prepared and dispensed using the manufacturer's recommended equipment.

313S.6 Joint and Crack Cleaning Equipment

All equipment used in cleaning joints and cracks shall be capable of delivering a sufficient volume of filtered air, free of oil, water or other contaminants, to insure the removal of all loose debris from the joints or cracks to be sealed.

When specified on the Drawings, joints shall be routed. The router shall be of sufficient size to rout the joints to the widths and depths shown on the Drawings.

313S.7 Construction Methods

The bonding surface of cracks and joints shall be cleaned of infiltrated material with compressed air or other methods approved by the Engineer or designated representative to a depth at least twice the joint or crack width. When routing of the joints is indicated on the Drawings, the joints shall be routed and blown clean with filtered compressed air. All material removed from joints and cracks shall be removed from the paved surface of the roadway.

No sealing of any joints or cracks shall be done when the joints or cracks are damp, unless drying of the joints and cracks with compressed air can be demonstrated and meets with the approval of the Engineer or designated representative.

The joint or crack sealing material shall be applied using a pressure nozzle. Polymer modified emulsion and rubber- asphalt crack sealing compound shall penetrate and completely fill each crack and/or joint. All cracks and/or joints filled with these materials shall be squeegeed. The amount of sealing compound used shall be limited so that after the squeegee has been applied, the finished band shall be no more than 1-1/2 inches (38 mm) wide and shall not exceed a depth of 1/8 in. (3.2 mm) above the pavement surface.

Self-leveling low modulus silicone joint sealing compound shall be applied so that it penetrates the joint and fills so that the top of the sealant shall be ¼ to 3/8 inch (6.4 to 9.5 mm) below the pavement surface.

When directed by the Engineer or designated representative, a light coating of fine aggregate shall be applied to the cracks and joints before opening to traffic to prevent tracking.

When the number of cracks is so great that crack sealing in the manner described previously is impractical, the area shall be squeegee sealed. Areas to be squeegee sealed shall be indicated on the Drawings or established by the Engineer or designated representative. When all cracks in the area have been cleaned, the crack sealing material shall be applied and the excess shall be squeegeed over the area between the cracks. All polymer modified emulsion or hot poured rubber squeegee sealed areas shall be covered immediately after application with a light coating of fine aggregate.

313S.8 Measurement

Accepted work performed under this item shall be included in the unit price bid for other pay items and will not be measured and paid for unless a separate pay item is provided in the contract documents.

If a pay item is included in the contract documents, acceptable work for “Polymer Modified Emulsion”, "Rubber Asphalt Joint and Crack Sealer" or “Self-leveling Low Modulus Silicone” shall be measured by the linear foot (meter: 1 meter equals 3.281 feet) of cracks sealed.

If a pay item is included in the contract documents, acceptable work for “Polymer Modified Emulsion”, "Rubber Asphalt Joint and Crack Sealer" or “Self-leveling Low Modulus Silicone” shall be measured by the pound (kilograms: 1 kilogram equals 2.205 pounds) of crack sealer used.

If a pay item is included in the contract documents, acceptable work for Squeegee seal with “Polymer Modified Emulsion” or "Rubber Asphalt Joint and Crack Sealer" shall be measured by the square yard (square meter: 1 square meter equals 1.196 square yards) of surface area sealed. The square yard (square meter) calculations will be based on neat dimensions of the sealed area

313S.9 Payment

When included as a pay item in the contract documents, the work performed and materials furnished as provided by this item and measured in accordance with Article 313S.8, "Measurement", will be paid for at the appropriate unit bid price bid. The unit bid prices shall include full compensation for cleaning and, if necessary, routing the crack/joint; furnishing, heating, hauling, and placing the crack sealer; all freight involved and all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

Payment, when included as a contract pay item, will be made under:

Pay Item No. 313S-A: Polymer Modified Emulsion Joint and Crack Sealer Per Lineal Foot.

Pay Item No. 313S-B: Rubber Asphalt Joint and Crack Sealer Per Lineal Foot.

Pay Item No. 313S-C: Self-leveling Low Modulus Silicone joint and Crack Sealer Per Lineal Foot.

Pay Item No. 313S-D: Polymer Modified Emulsion Joint and Crack Sealer Per Pound of Sealer Used

Pay Item No. 313S-E: Rubber Asphalt Joint and Crack Sealer Per Pound of Sealer Used.

Pay Item No. 313S-F: Self-leveling Low Modulus Silicone joint and Crack Sealer Per Pound of Sealer Used.

Pay Item No. 313S-G: Polymer Modified Emulsion Squeegee Sealing Per square yard.

Pay Item No. 313S-H: Rubber Asphalt Squeegee Sealing Per square yard.

End

SPECIFIC Cross Reference Materials
Item No. 313S, “Cleaning and/or Sealing Joints and Cracks (Asphaltic Concrete)”

City of Austin Standard Specifications

Designation	Description
Item No. 301S	Asphalts, Oils and Emulsions

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS 6310	Joint Sealants and Seals

RELATED Cross Reference Materials
Item No. 313S, “Cleaning and/or Sealing Joints and Cracks (Asphaltic Concrete)”

City of Austin Standard Specifications

Designation	Description
Item No. 413S	Cleaning and/or Sealing Joints and Cracks (Portland Cement Concrete)

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 300	Asphalts, Oils and Emulsions
Item No. 352	Cleaning and/or Sealing Joints and Cracks (Asphaltic Concrete)
Item No. 433	Joint Sealants and Fillers
Item No. 438	Cleaning and/or Sealing Joints and Cracks (Portland Cement Concrete)

Item No. 340S
Hot Mix Asphaltic Concrete Pavement

340S.1 Description

This item shall govern base, level up, and pavement surface courses composed of a compacted mixture of aggregate and asphaltic cement mixed hot in a mixing plant. The hot mix asphaltic (HMA) concrete pavement shall be constructed on a previously completed and approved subgrade, subbase material, base material, concrete slab or existing pavement.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

340S.2 Submittals

The submittal requirements of this specification item may include:

A. A mix design submittal including the plant corrected Job Mix Formula (JMF) for the hot mix asphaltic concrete,
B. Certification that the aggregate materials meet appropriate quality requirements.
C. Particle-size gradation and specific gravity tests on all aggregate materials.
D. Certification that the asphalt cement for paving materials meet appropriate quality requirements.

340S.3 Materials

The Contractor shall furnish materials to meet the requirements specified herein and shall be solely responsible for the quality and consistency of the product delivered to the Project.

A. Aggregate: The aggregate shall be composed of coarse aggregate, a fine aggregate and, if required or allowed, mineral filler and reclaimed asphalt pavement (RAP). RAP use will be allowed in all base course mixtures except as specifically excluded herein, in the Contract Documents or on the Drawings, provided no more than 20% RAP is used.

   RAP use will not be permitted in pavement surface courses.

   Aggregates 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 unless indicated otherwise on the Drawings.

   1. Coarse Aggregate: Coarse aggregate is defined as that part of the aggregate retained on the No. 10 (2.00 mm) sieve and shall consist of clean, tough, durable fragments of crushed stone or crushed gravel of uniform quality throughout.

      Gravel from each source shall be crushed to the extent that it has a minimum of 85% of the particles retained on the No. 4 (4.75 mm) sieve with two or more mechanically induced crushed faces as determined by TxDOT Test Method TEX-460-A (Part I). The material passing the No. 4 (4.75 mm) sieve and retained on the No. 10 (2.00 mm) sieve must be the produced from crushing aggregate that was originally retained on the No. 4 (4.75 mm) sieve.

   2. 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 2-inch (50 mm) sieve.

The RAP shall be stockpiled in such a manner that assures that it will not become contaminated by dirt or other objectionable materials. Unless indicated otherwise on the Drawings, stockpiled, crushed RAP must not exhibit a decantation more than 5 percent or a plasticity index more than 8, when tested in accordance with TxDOT Test Method Tex-406-A, Part I, or Test Method Tex-106-E, respectively.

3. Fine Aggregate: Fine aggregate is defined as that part of the aggregate passing the No. 10 (2.00 mm) sieve and shall be of uniform quality throughout. A maximum of 15 percent of the total aggregate may be field sand or other uncrushed fine aggregate.

   Screenings shall be supplied from sources whose coarse aggregate meets the abrasion and magnesium sulfate soundness loss requirements shown in Table 1.

   a) Unless indicated otherwise on the Drawings, stone screenings, which are the product of a rock crushing operation, are required and shall meet the following gradation requirements when tested in accordance with TxDOT Test Method Tex-200-F, Part I.

Material	Percent by Weight (Mass)
Passing 3/8 inch (9.50 mm) sieve	100
Passing No. 10 (2.00 mm) sieve	70-100
Passing No. 200 (75 µm) sieve	0-15

   b) Crushed gravel screenings may be used with, or in lieu of, stone screenings only when indicated on the Drawings. Crushed gravel screenings must be the product of crushing aggregate that was originally retained on the No. 4 (4.75 mm) sieve and must meet the gradation for stone screenings shown above.

4) Mineral Filler: Mineral filler shall consist of thoroughly dried stone dust, Portland cement, fly ash, lime or other mineral dust approved by the Engineer or designated representative. The mineral filler shall be free from foreign matter.

   Portland cement manufactured in a cement kiln fueled by hazardous waste shall be considered as an approved product if the production facility is authorized to operate under regulation of the Texas Natural Resource Conservation Commission (TNRCC) and the U. S. Environmental Protection Agency (EPA). Supplier shall provide current TNRCC and EPA authorizations to operate the facility.

   Fly ash obtained from a source using a process fueled by hazardous waste shall be considered as an approved product if the production facility is authorized to operate under regulation of the Texas Natural Resource Conservation Commission (TNRCC) and the U. S. Environmental Protection Agency (EPA). Supplier shall provide current TNRCC and EPA authorizations to operate the facility.

   The addition of baghouse fines or other collected fines will be permitted if the mixture quality is not adversely affected in the opinion of the Engineer or designated representative. In no case shall the amount of material passing the No. 200 (75 µm) sieve exceed the tolerances of the job-mix formula or the master gradation limits.

   When tested by TEX-200-F (Part I or Part III, as applicable), the mineral filler shall meet the following gradation requirements. Baghouse fines are not required to meet the gradation requirements.

Material	Percent by Weight (mass)
Passing No. 30 (600 µm) Sieve	95 - 100
Passing No. 80 (187.5 µm) Sieve, not less than	75
Passing No. 200 (75 µm) Sieve, not less than	55

TABLE 1: AGGREGATE QUALITY REQUIREMENTS *

Requirement	Test Method	Amount
COARSE AGGREGATE		
Deleterious Material, percent, maximum	Tex-217-F, I	1.5
Decantation, percent, maximum	Tex-217-F, II	1.5
Los Angeles Abrasion, percent, maximum	Tex-410-A	40
Magnesium Sulfate Soundness Loss 5 cycle, percent, maximum	Tex-410-A	30
FINE AGGREGATE		
Linear Shrinkage, maximum	Tex-107-E, II	3
COMBINED AGGREGATES		
Sand Equivalent Value, minimum	Tex-203-F	45

***** - Aggregates, without added mineral filler or additives, combined as used in the job-mix formula (Plant Corrected).

B. Asphaltic Material

1. Paving Mixture. Asphalt cement for the paving mixture shall conform to the requirements of Standard Specification Item No. 301S, “Asphalts, Oils and Emulsions”, for AC-20 or PG64-22, Styrene (SBS) Modified Asphalt Cement, AC-SBS Blend AC-45P or PG76-22S, unless otherwise indicated in the Project Documents.

2. Tack Coat: Tack Coat shall conform to Standard Specification Item No. 307S, “Tack Coat”.

C. Additives: Additives to facilitate mixing and/or improve the quality of the asphaltic mixture or tack coat may be used with the authorization of the Engineer or designated representative. The Contractor may choose to use either lime or a liquid anti-stripping agent to reduce moisture susceptibility of the aggregate.

340S.4 Paving Mixtures

An asphalt mixture design is developed by a laboratory process, which includes the determination of the quality and quantity of the asphalt cement and the individual aggregates, and the testing of the combined mixture (Laboratory Design). The Laboratory Design is subsequently revised to produce an appropriate job mix formula.

The job mix formula (JMF) lists the quantity of each component to be used in the mix after the laboratory design has been adjusted by running it through a particular plant (i.e. the mix design is Plant Corrected). The JMF will be the standard to which the Acceptance Plan will be applied. The JMF of one drum or batching unit shall not be used for another unit.

The Contractor shall submit to the Engineer on forms provided by the Engineer or designated representative, an asphalt mixture design reviewed, signed and sealed by a Registered Professional Engineer licensed in the State of Texas or certified by a TxDOT Level II Certified

Asphalt Technician. An asphalt mixture design shall be submitted for a comprehensive review every two (2) years. Mix designs older than one year will not be accepted without a review of current test data of the proposed materials and current mix design to ensure that the materials meet specification requirements.

The JMF (Plant Corrected) shall be submitted to the Engineer or designated representative on a form provided by the Engineer through the Construction Inspector or Project Manager of the Project for review, for each individual Project, a minimum of three (3) working days before the mixture is to be placed. Under no circumstances will a mixture be placed before its use is reviewed and approved by the Engineer or designated representative.

Performance of the mix design shall remain the responsibility of the Contractor.

A. Mixture Design: The mix shall be designed in accordance with TxDOT Construction Bulletin C-14 and Test Method Tex-204-F to conform with the requirements herein. The master grading limits of the appropriate type and the JMF will be plotted on a graduated chart with sieve sizes raised to the 0.45 power and will be submitted to the Engineer or designated representative with the asphalt mixture design.

   The Bulk Specific Gravity of aggregates in RAP will be determined on extracted aggregates.

B. Types: The blend of coarse aggregate, fine aggregate, and mineral filler, if allowed, that is established by TxDOT Test Method Tex-200-F, Dry Sieve Analysis, shall conform to the master gradation shown in Table 2 for the type of specified mixture. The voids in the mineral aggregate (VMA) will be determined as a mixture design requirement only, in accordance with TxDOT Test Method Tex-207-F, and shall not be less than the value indicated in Table 2.

TABLE 2: Master Grading - Percent Passing by Weight (Mass) or Volume

Sieve Size US (SI)	Type A Coarse Base	Type B Fine Base	Type C Coarse Surface	Type D Fine Surface	Type F Fine Mixture
1-1/2" (37.5 mm)	100				
1-1/4" " (31 mm)	95-100				
1" (25 mm)		100			
7/8" (22 mm)	70-90	95-100	100		
5/8 (15.5 mm)"		75-95	95-100		
1/2" (12.5 mm)	50-70			100	
3/8" (9.5 mm)		60-80	70-85	85-100	100
1/4" (6.25 mm)					95-100
No. 4 (4.75 mm)	30-50	40-60	43-63	50-70	
No. 10 (2.00 mm)	20-34	27-40	30-40	32-42	32-42
No. 40 (425 µm)	5-20	10-25	10-25	11-26	9-24
No. 80 (187.5 µm)	2-12	3-13	3-13	4-14	3-13
No. 200 (75 µm)	1-6*	1-6*	1-6*	1-6*	1-6*
VMA % minimum	11	12	13	14	15
Rec. Min. Lift	3" (75 mm)	2" (50 mm)	1-3/4" (45 mm)	1" (25 mm)	3/4" (20 mm)

C. Tolerances: Fluctuations in the aggregate gradation and asphalt content of the Job Mix Formula (JMF) shall not vary by more than the following criteria but the aggregate gradation shall be limited to the range of the master gradation as established by TEX-210-F.

SIEVES	Percent By Weight (Mass)
2" " (50 mm) Sieve through No. 10 " (2.00 mm) Sieve	±5.0
No. 40 (425 µm) through No. 200 (75 µm) Sieve	± 3.0
Asphalt Content	±0.5

D. Stability and Density: The mixture shall be designed at or near optimum density, as indicated on the Drawings, to conform to the following percent of Maximum Theoretical Density as measured by TxDOT Test Method TEX-227-F and Stability conforming to TxDOT Test Method TEX-208-F. The laboratory mixture shall be molded in accordance with TxDOT Test Method TEX-206-F and the Bulk Specific Gravity determined in accordance with TxDOT Test Method TEX-207-F.

	Optimum Laboratory Density (%)	Laboratory Density (%) Min.	Max.	Stability
Local Streets Surface Courses	96	94.5	97.5	35 Min.
Collectors & Arterials Surface Courses	96	94.5	97.5	40-60
All Base Courses	96	94.5	97.5	35 Min.

E. Job Mix Formula Field Adjustments: The Contractor shall produce a mixture of uniform composition closely conforming to the reviewed JMF, that falls within the limits of the tolerances given above and the Acceptance Plan.

If it is determined by the City of Austin that adjustments to the JMF are necessary to achieve the specified requirements, the Engineer or designated representative may allow adjustments of the JMF within the following limits without a laboratory redesign of the mixture. The adjusted JMF shall not exceed the master grading criteria for the type of mixture specified. The proposed JMF adjustments shall not exceed 5 percent on any one sieve, ½-inch (12.5 mm) size and larger, or 3 percent on the sieve size below the 1/2-inch (12.5 mm) sieve of the JMF (Plant Corrected) reviewed for the Project.

When the proposed adjustments exceed either the 5 or 3 percent limits, and the Engineer or designated representative determines that the impact of these changes may adversely affect pavement performance, a new laboratory mixture design will be required.

The asphalt content may be adjusted with the concurrence of the Engineer or designated representative to maintain desirable laboratory density near the optimum value while achieving other mix requirements. However, increasing the asphalt content of the mixture in order to reduce pavement air voids will not be allowed. Also, if the percent air voids is determined to be less than 4 percent, adjustments shall be made to the plant production by the Contractor, within the tolerances as outlined above, so that an adequate air void level is attained.

340S.5 Equipment

The trucks that deliver the hot mix asphalt concrete material to the project shall be of sufficient number to insure a continuous paving operation. All equipment used for the production, placement and compaction of the mixture shall be maintained in good repair and operating

conditions to the satisfaction of the Engineer or designated representative. All equipment shall be made available for inspection. If the Engineer or designated representative expresses concern about the condition of any equipment, it shall not be used until it is repaired to the satisfaction of the Engineer or designated representative.

A. Mixing Plants: Plants may be of the weigh-batch type, the modified weigh-batch type or drum-mix type equipped with suitable material conveyers, power units, mixing equipment, aggregate proportioning devices, dryers, bins, dust collectors and sensing and recording devices as appropriate for the mixing plant type. The mixing plants shall meet the requirements specified in Section 340.4, 'Equipment' of TxDOT Specification Item No. 340, "Hot Mix Asphaltic Concrete Pavement".

B. Spreading and Finishing Paving Machine: The paving machine shall be self-propelled and equipped with a heated compacting screed capable of producing a finish surface meeting the requirements of the street cross-section indicated on the Drawings and all surface criteria. Extensions to the screed shall have the same heating and compacting capabilities as the primary unit, except for use on variable depth tapered areas and/or as approved by the Engineer or designated representative.

   The paving machine shall be equipped with an approved automatic dual longitudinal screed control system and an automatic transverse screed control system. The longitudinal controls shall be capable of operating from any longitudinal grade reference including a string line, ski, mobile string line or matching shoe. Unless indicated otherwise on the Drawings, the Contractor may use any one of these grade references. The selected grade reference equipment shall be maintained in good operating condition by personnel trained in the use of the specific type of equipment.

   The Contractor shall furnish all labor and equipment required for establishing and maintaining appropriate grade reference.

C. Rollers: The Contractor shall select rollers conforming to Item 230S, "Rolling (Flat Wheel)" and Item 232S, "Rolling (Pneumatic Tire)". Rollers that do not conform to these requirements shall be immediately removed from the Project.

D. Motor Grader: A self-propelled power motor grader may only be used, when its use is approved by the Engineer or designated representative. It shall have a blade of not less than 12 feet (3.66 meters) and a wheelbase of not less than 16 feet (4.88 meters). Smaller graders may be used for small irregular areas when approved by the Engineer or designated representative.

E. Material Transfer Equipment: Equipment for transferring the HMA mixture from the hauling units or the roadbed to the spreading and finishing machine will be allowed unless indicated otherwise on the Drawings.

   Windrow pick-up equipment, if permitted by the Engineer or designated representative, shall be constructed in such a manner that substantially all of the HMA mixture deposited on the roadbed is picked up and loaded into the spreading and finishing machine. The HMA 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.

F. Straightedges and Templates: The Contractor shall provide a ten-foot (3.05 meter) straightedge acceptable to the Engineer or designated representative for surface testing. Satisfactory templates shall be provided as required by the Engineer or designated representative.

340S.6 Stockpiling Aggregates

Aggregates shall be stockpiled to facilitate blending. When the aggregate is not stockpiled on a hard, non-contaminant base, the bottom six-inch (150 mm) depth of the stockpiles shall not be used in asphaltic mixtures. Where space is limited at the plant site, the aggregate stockpiles shall be separated by walls or other appropriate barriers.

Aggregates shall be stockpiled and handled in a manner that will insure minimization of segregation and contamination. Aggregate and RAP stockpiles shall only contain material from a single source.

340S.7 Mixture Temperature

The Contractor shall select a target temperature for discharge of the HMA mixture from the mixer between 250°F (120°C) and 350°F (176°C) that is suitable to weather and Project conditions. The target temperature shall be reported to the Engineer or designated representative daily and recorded in the Daily Progress Report. The HMA mixture temperature shall not vary by more than 25°F (14°C) from the target temperature for discharge from the mixer. HMA mixtures that are discharged from the mixer at a temperature exceeding 360°F (182°C) or a temperature more than 50°F (28°C) below the target temperature shall not be accepted and shall not be placed on the Project.

340S.8 Mixture Storage

A surge-storage system may be used to minimize production interruptions during a normal day of operation. When approved by the Engineer or designated representative, overnight storage of HMA mixture in insulated storage bins may be used provided that material temperature and physical properties of the HMA mixture are not adversely affected. HMA mixtures that include hardened lumps shall not be used. Stored HMA mixtures shall not be exempt from any requirements provided in this specification.

When a surge-storage system is used, it shall be equipped with a device such as a gob hopper or other device approved by the Engineer or designated representative to prevent segregation in the surge-storage bin.

340S.9 Mixture Moisture Content

Hot mix asphalt (HMA) mixtures produced from any plant shall not have a moisture content in excess of 1 percent by weight (mass) when discharged from the mixer. The moisture content shall be determined in accordance with TxDOT Test Method Tex-212-F, Part II, except that the sample shall be left in the oven a total of not less than four (4) hours.

340S10 Construction Methods

A General: The Contractor shall be responsible for the production, transportation, placement and compaction of the specified HMA paving mixture to the requirements of this specification. The Contractor shall also be responsible for providing a safe environment for inspection personnel to inspect the equipment and to acquire samples.

All hot mix asphalt concrete pavement surface courses shall be placed with a spreading and finishing (lay-down) machine only. All hot mix asphalt concrete pavement base layers with the possible exception of the first lift of the base layer shall also be placed with a

spreading and finishing (lay-down) machine. Longitudinal pavement joints shall be located under the proposed lane lines. Density tests shall be taken prior to opening to traffic.

The first lift of a base layer may be placed with a motor grader if approved in advance by the Engineer or designated representative. The loose measure thickness of this first lift shall not exceed 6 inches (150 mm). If placed with a motor grader, the first lift shall achieve a minimum in-place relative density of 89% as determined by TxDOT test procedures TEX-207-F and TEX-227-F. All subsequent lifts should be placed with a spreading and finishing (lay-down) machine and shall be subject to the requirements of Section 340S.12, "Acceptance Plan". Density tests will be taken randomly to confirm compliance with the specification requirements.

For hot mix asphalt overlays, an automatic screed shall be used with outriggers.

Any material delivered to the Project that by visual inspection can reasonably be expected not to meet specification requirements (i.e. segregated or burned material, deficient or excess asphalt, low mixing temperature, visible contaminants, etc.), as determined by the Engineer or designated representative, shall not be used or left in place.

Equipment shall be inspected prior to use and, if found to be defective or in an operating condition that could potentially affect the quality of the finished pavement, as determined by the Engineer or designated representative, its use shall not be allowed. Leakage of fuels, oils, grease, hydraulic or brake fluids or other contaminants onto the prepared surface or newly-laid HMA layer will not be allowed and may require replacement of the affected pavement area.

The HMA paving mixture, when placed with a spreading and finishing machine, shall not be placed when the air temperature is below 50°F (10°C) and is falling, but it may be placed when the air temperature is above 40°F (4°C) and is rising.

The paving mixture, when used as a level-up course or when spread with a motor grader, shall not be placed when the air temperature is below 60°F (15°C) and is falling, but it may be placed when the air temperature is 50°F (10°C) and is rising. An HMA layer with a thickness of 1-1/2 inches (37.5 mm) and less shall not be placed when the temperature of the surface on which the layer is to be placed is below 50°F (10°C). The temperature shall be taken in a shaded area away from artificial heat.

Additional surface temperature requirements may be included in the Contract Documents or indicated on the Drawings.

Surfaces to be paved shall be finished, primed, cured, broomed and tacked, as appropriate, to the satisfaction of the Engineer or designated representative. If the surface on which the first course of the paving mixture is to be placed is a flexible base course, and a cut-back asphalt is to be used as a prime coat, the flexible base shall have been primed and cured a minimum of 24 hours before the paving mixture may be placed. The 24-hour restriction will not apply to a flexible base that has been primed with material other than a cutback. However, the surface on which the tack coat and/or paving mixture are to be placed shall be in a dry condition.

Pavement shall be opened to traffic as soon as possible after temporary pavement markings or permanent markings are in place as indicated on the Drawings) or as directed by the Engineer or designated representative. Construction traffic allowed on pavements open to the public will be subject to all laws governing traffic on streets and highways.

B. Tack Coat: The surface upon which the tack is to be placed shall be cleaned thoroughly to the satisfaction of the Engineer or designated representative. The surface shall be given a

uniform application of tack coat as governed by Standard Specification Item No. 307S, "Tack Coat". The tack coat shall be applied, as directed by the Engineer or designated representative, with an approved sprayer at a rate not to exceed 0.05 gallons per square yard. (0.225 liters per square meter) of surface area. Where the paving 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 when approved by the Engineer or designated representative. All contact surfaces of curbs, castings and all 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. Before the Work can be accepted, all splatter shall be removed by the Contractor at the Contractor's expense.

C. Transporting Hot Mix Asphaltic (HMA) Concrete: The HMA mixture shall be hauled to the Work site in tight vehicles that were previously cleaned of all foreign material. Dispatching of the vehicles shall normally be arranged so that all material delivered is placed and all rolling completed during daylight hours. Nighttime paving may be allowed, when approved in advance by the Engineer or designated representative.

In cool weather or for long hauls, truck bodies containing the HMA mixture shall be covered.

If necessary, to prevent the HMA mixture from adhering to the truck body, the inside of the truck may be given a light coating of a release agent satisfactory to the Engineer or designated representative.

D. HMA Placement: The HMA mixture shall be dumped and spread on the approved prepared surface with the 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 placement of the HMA mixture shall be done without tearing, shoving, gouging or segregating the mixture and without producing streaks in the HMA layer.

Discharge of the HMA mixture into the finishing machine shall be controlled so that the spreading and finishing machine is not bounced or jarred and the required lines and grades shall be obtained without resorting to hand finishing except as permitted below in this Section.

Unless indicated otherwise on the Drawings, dumping of the HMA material in a windrow and then placing the HMA mixture in the finishing machine with windrow pick-up equipment will be permitted provided the temperature of the HMA mixture does not drop more than 50^{o}F (28^{o}C) below the target temperature before being placed by the finishing machine.

Under no circumstances will the HMA material be permitted to be dumped on or near the job site and then reloaded for hauling to the site of placement. Exceptions may be allowed if approved by the Engineer or designated representative.

The windrow pick-up equipment shall be operated in such a manner that substantially all the mixture deposited on the roadbed or prepared surface is picked up and loaded into the finishing machine without contamination by foreign material. The windrow pick-up equipment will also 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 accumulation and subsequent shedding of accumulated material into the HMA mixture will not be permitted.

When approved by the Engineer or designated representative, level-up courses may be spread with a motor grader that meets the requirements of this specification item.

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. Stopping of the spreading and finishing machine between trucks is to be held to a minimum. If, in the opinion of the Engineer or designated representative, delivery of material is adversely affecting the condition of the HMA layer (excessive stopping of the spreading and finishing machine, loss of mixture temperature, etc.), the Engineer or designated representative may require paving operations to cease until acceptable methods are provided to minimize starting and stopping of the spreading and finishing machine.

The hopper gates of the spreading and finishing machine shall be adjusted to provide an adequate and consistent flow of material. This 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 being placed, as approved by the Engineer or designated representative. Augers should be kept approximately one-half to three-quarters full of HMA mixture at all times during the paving operation.

When the HMA mixture is placed in a narrow strip along the edge of an existing pavement, or is used to level up small areas of an existing pavement or is placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated when permitted by the Engineer or designated representative.

The paving material adjacent to castings and flush curb and gutter and structures shall be finished uniformly high so that when compacted, it will be slightly above but not more than 1/8 inch (3 mm) above the edge of the casting or gutter lip.

Construction joints of successive courses of HMA material shall be offset at least 6 inches (150 mm). Longitudinal joints in the layer shall be placed to coincide with lane lines as directed the Engineer or designated representative. Transverse joints shall be offset a minimum of 5 feet (1.5 meters).

E. Compaction: The pavement layers/lifts shall be compacted thoroughly and uniformly to obtain the compaction and cross section meeting the requirements indicated on the Drawings and this specification item.

Regardless of the method used for compaction, all rolling to achieve specified density shall cease before the temperature of the HMA mixture drops below 175^{o}F (80^{o}C).

Rolling with a pneumatic tire roller shall be used to seal the surface. Rolling with a tandem or other steel-wheel roller shall be provided if required to iron out any roller marks. Surface sealing and removal of roller marks may be accomplished at HMA temperatures below 175^{o}F (80^{o}C).

Vibratory rollers shall not be allowed in the vibrating mode on layers with a plan thickness less than 1-1/2 inches (37.5 mm).

The motion of the rollers shall be slow enough to avoid other than usual initial displacement. If any displacement occurs, it shall be corrected to the satisfaction of the Engineer or designated representative.

The roller shall not be allowed to stand on pavement, which has not been compacted to minimum density requirements. In order to prevent adhesion of the surface mixture to the steel-wheel rollers, the wheels shall be thoroughly moistened with water; however an excess

of water will not be allowed. 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.

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.

Rolling with a trench roller will be required on widened areas, in trenches and other limited areas where satisfactory density cannot be obtained with the approved rollers.

340S.11 Sampling and Testing

The HMA mixture shall be tested daily at the Project site for conformance to specification requirements. The Engineer or designated representative shall utilize a random selection method to determine sample locations based on the Contractor's anticipated production. Each day's anticipated production shall be divided into three (3) essentially equal single-pass, sub-area lots. Each day's sample locations shall be equally distributed over the three (3) sub-areas. If, due to the weather or plant malfunctions, the Contractor's daily-anticipated production is not attained, the random locations will not be recalculated. Also, no more than one location of the three (3) sub-areas shall be located in an irregular shaped area such as a cul-de-sac.

Unless directed otherwise by the Engineer or designated representative, a minimum of three bag samples and three correlating 6-inch (150-mm) cores will be obtained from each day's production.

Bag samples shall be taken during lay-down operations. The primary sampling point for the bag samples shall be from the windrow if a windrow elevator is used. If a windrow elevator is not used, the sample shall be taken from the middle of the paving machine hopper. This sampling location will require a stoppage in the paving operation in order for the Inspector to safely secure a sample from the hopper.

One core shall be taken for every 2,000 single-pass square yards (1 675 single-pass square meters) with a minimum of three (3) cores for all projects. One core shall be taken at the same station and pass sampled for each of the bag samples. Cores shall be taken by the City's laboratory within 48 hours of pavement laydown unless otherwise directed by the Engineer or designated representative.

For total areas of less than 500 square yards (420 square meters), a total of only two bag samples and two correlating cores will be obtained. If the Contractor desires additional testing, it shall be at its own entire expense.

The Engineer or designated representative may alter, increase or waive the testing schedule to ensure that the Work performed and the material used meet specification requirements. Acceptability of the completed pavement shall be based on the average of test results for the Project as defined in Section 340S.12, "Acceptance Plan" of this item.

Gradation, asphalt content and stability value of the HMA mixture shall be reported for each of the bag samples. The stability value reported for each of the bag samples shall be the average of three (3) tests per bag.

Pavement thickness and density shall be determined from 6-inch (150 mm) field cores. For each day's placement, density of cores for which no corresponding bag samples were taken shall be determined by using the average Maximum Theoretical Density of the day's three (3) bag samples or as may otherwise be determined by the Engineer or designated representative.

When, in the opinion of the Engineer or designated representative, test results appear unrepresentative, additional testing may be authorized. The retesting will be at the expense of the Contractor and the results of the retesting shall be averaged with the results of the original testing. If the results of retesting indicate that the original test results were erroneous, the original test results will be discarded. In the instance of erroneous original test results the subsequent first set of retests will be at the expense of the City of Austin.

Pavements with low-density results may be recored; but the pavement shall not receive any additional compactive effort.

Pavements that will not or cannot be cored within 48 hours shall be closed to both public and construction traffic.

340S.12 Acceptance Plan

For the purpose of the Acceptance Plan only, the "Paving Project" of each of the specified mixture types shall be defined by the Engineer or designated representative before the paving operation begins

Considerations for defining the Paving Project shall include paving operations staged due to traffic considerations, pavement structural section (i.e. with varying layer thicknesses), time required for paving, changes to the Job Mix Formula, phasing of large projects, or other factors affecting the consistency in the production, lay-down/compaction, use of completed portions, and/or aging of in-place material.

Acceptability of the completed pavement structure for a Paving Project shall be based on all daily averages of three test results and when approved by the Engineer or designated representative the overall average of all test results for each of the mixture/layer types specified on the Drawings.

Pay adjustments for two or more acceptance factors shall be accumulative. Pay adjustments of 100% unit price reduction shall require removal and replacement of the Work. Replacement materials shall be subject to all requirements of this specification. Alternatively, the Engineer or designated representative may allow the Work to remain in place without payment provided that the Work is warranted for an extended period under conditions as determined by the Engineer or designated representative. The decision of the Engineer or designated representative related to the removal and replacement of the Work shall be the final authority.

A. Non-Pay-Adjustment Acceptance Factors:

1 Surface Characteristics: Unless otherwise directed by the Engineer or designated representative, all pavements shall be tested for smoothness. Surfaces shall be tested with a 10-foot (3.05 meter) straightedge parallel to the roadway centerline and perpendicular to the centerline on flat, cross-slope sections. Maximum allowable deviation in 10 feet shall be 1/8 inch (1-mm per meter) parallel to the centerline and 1/4 inch (2-mm per meter) perpendicular to the centerline. Sections exceeding these maximums shall be corrected to the satisfaction of the Engineer or designated representative. The completed surface must meet the approval of the Engineer or designated representative for surface smoothness, finish and appearance.

If the surface ravels, ruts or deteriorates in any manner prior to the end of the warranty period, it will be the Contractor’s responsibility to correct this condition at its own entire expense to the satisfaction of the Engineer or designated representative in conformance with the requirements of this specification.

For HMAC rehabilitation and overlay projects, if cracks develop in the pavement surface within the one-year warranty period, the Contractor shall seal the cracks in accordance with Standard Specification Item No. 313S, “Cleaning and/or Sealing Joints and Cracks (Asphaltic Concrete). Payment for this work will be measured and paid for as Mobilization (LS) and Crack Sealing (LF).

For new HMAC roadways constructed in accordance with the Drawings and specifications, if cracks less than 1/4 inch (6 mm) in width develop in the pavement surface within the one year warranty period the Contractor shall seal the cracks in accordance with Standard Specification Item No. 313S, “Cleaning and/or Sealing Joints and Cracks (Asphaltic Concrete). Payment for this Work will be measured and paid for as Mobilization (LS) and Crack Sealing (LF).

If cracks equal to or greater than 1/4 inch (6 mm) in width develop in the pavement surface within the one-year warranty period, the cracking shall be reviewed and evaluated by the Engineer or designated representative before corrective action is taken.

2. Stability: Stability test results shall be used as indicators of potential problems. Where stability test results fall below the range specified in this specification, additional tests shall be taken as directed by the Engineer or designated representative for further evaluation and monitoring of the paving mixture. This additional stability testing will be at the expense of the Contractor. When, in the opinion of the Engineer or designated representative, the stability is deemed unacceptable for the intended use of the pavement, the paving mixture shall be removed and replaced to the limits indicated by test results or may be left in place on conditions acceptable to the Engineer or designated representative. When the paving mixture is removed and replaced, it shall be at the sole expense of the Contractor.

3. Laboratory Density: Laboratory density results as determined by TxDOT Test Method Tex-207-F shall be used as indicators of potential problems. Where laboratory density test results are less than 94.5% or more than 97.5% of mix design maximum density, additional tests shall be taken as directed by the Engineer or designated representative for further evaluation and monitoring of the paving mixture. This additional laboratory density testing will be at the expense of the Contractor. When, in the opinion of the Engineer or designated representative, the laboratory density is deemed unacceptable for the intended use of the pavement, the paving mixture shall be removed and replaced to the limits indicated by test results.

   The removal and replacement of the paving mixture shall be at the sole expense of the Contractor.

4. Limited Areas: Irrespective of an acceptable overall Paving Project average for any or all of the Pay-Adjustment Acceptance Factors, limited substandard portions of the Work, as determined by the Engineer or designated representative, shall be remedied or removed and replaced to the satisfaction of the Engineer or designated representative at the sole expense of the Contractor.

B. Pay-Adjustment Acceptance Factors: Contract unit prices shall be adjusted for paving mixtures that fail to meet acceptance criteria for gradation, asphalt content, density and mat thickness in accordance with the following:

Gradation Acceptance Schedule (TEX-210-F)

Sieve	Deviation From Job Mix Formula		Percent Contract Unit Price Reduction
	Daily Average	Overall Average	
Total retained on No. 10 (2.00 mm)	± 6.5 6.6±	± 5.0 5.1±	0 10
Passing No. 200 (75 µm)	± 3.9 4.0±	± 3.0 3.1±	0 5

Asphalt Content Acceptance Schedule (TEX-210-F, PartII)

Deviation from the Job Mix Formula		Percent Contract Unit Price Reduction	
Daily Average	Overall Average	Local Streets*	All Others
± 0.5	± 0.4	0	0
±0.51 to ±0.60	±0. 41 to ±0.50	15	25
+0.61 to +0.70	+0.51 to +0.60	25**	100; Remove and Replace
-0.61 to -0.70	-0.51 to -0.60	100: Remove and Replace	100; Remove and Replace
Over ±0.70	Over ±0.60	100: Remove and Replace	100; Remove and Replace
*A local or residential street that serves as access to residence or other abutting property.			
**If the street has an ADT of 500, or less, with 1%, or less, of truck traffic, plus a 2 year warranty; otherwise, Remove and Replace			

Density Acceptance Schedule (TEX-207-F/TEX-227-F)

*Percent Density		Percent Contract Unit Price Reduction	
Daily Average	Overall Average	1-1/2" (38 mm) Thickness or Greater	Less than 1-1/2" (38 mm) Thickness
Above 96.5	Above 96	100; Remove and Replace	100; Remove and Replace
90.5 to 96.5	91 to 96	0	0
90.5 to 87.6	90.9 to 88.1	0.625 per 0.10% deficiency in density	0.50 per 0.10% deficiency in density
Less than 87.6	Less than 88.1	100: Remove and Replace	100; Remove and Replace
*Core bulk density divided by max. theoretical density			

Thickness Acceptance Schedule

Variance Percent of Thickness		Percent Contract Unit Price Reduction
Daily Average	Overall Average	
0 – 15.0	0 - 10	0
15.1 – 20.0	10.1 - 16	20
20.1 – 30.0	16.1 - 25	50
Over 30.0	Over 25	100; Remove and Replace or mill/overlay 1" (25 mm) minimum

The Density Acceptance Schedule For Irregularly Shaped Areas; Hike And Bike Trails And Utility Trenches (see following table) will apply to utility trenches of widths less than 4 feet

(1.2 meter) and to irregular shaped areas and hike and bike trails in which an appropriate rolling pattern cannot be established making it difficult to achieve compaction.

Density Acceptance Schedule For Irregularly Shaped Areas; Hike And Bike Trails and Utility Trenches (TEX-207-F/TEX-227-F)

*Percent Density	Percent Contract Unit Price Reduction	
Daily Average	1-1/2" (38 mm) Thickness or Greater	Less than 1-1/2" (38 mm) Thickness
Above 96.5	100; Remove and Replace	100; Remove and Replace
96.5 to 89.0	0	0
89.0 to 86.1	0.625 per 0.10% deficiency in density	0.50 per 0.10% deficiency in density
Less than 86.1	100: Remove and Replace	100; Remove and Replace
*Core bulk density divided by maximum theoretical density		

The Density Acceptance Schedule will apply to utility trenches 4 feet (1.2 meter) or wider.

Core thicknesses greater than Drawing requirements shall be factored into the average thickness calculation as the Drawing required thickness. If total thickness of lift(s) proves to be less than required, the Contractor may remove and replace the overlay deficient areas as agreed to by the Engineer or designated representative. Overlays to correct thickness deficiencies shall be not less than one (1) inch (25-mm) thick. Overlays shall require milling of the asphalt in order to prevent a “featheredge” of the overlaying pavement.

The extent of the area to be overlaid or removed and replaced shall be determined by additional cores with thicknesses greater than or equal to the required thickness. All additional coring that is necessary to determine the area shall be paid for by the Contractor.

340S.13 Measurement

Work performed and material placed shall be measured under one of the following methods. When Drawing quantity measurement is specified, adjustment of quantity may be made as follows. If the quantity measured as outlined vary from those shown on the Drawings by more than 5%, either party to the Contract may request in writing and adjustment of the quantity by each separate bid item. The party to the Contract which requests the adjustment shall present to the other party one copy of measurements and calculations showing the revised quantity in question. This revised quantity, when approved by the Engineer or designated representative, shall constitute the final quantity for which payment will be made. However, no adjustment will be made for any quantity, which exceeds the Drawing required thickness.

A. Method A: Asphaltic concrete pavement shall be measured by the ton (2,000 pounds) of the type actually used in completed and accepted Work in accordance with the Drawings and specifications.

   The measurement shall be made on approved truck scales that meet the requirements of the National Institute of Standards and Technology Handbooks 44 and 112 except that the required accuracy shall be 0.4 percent of the load being weighed. The Contractor shall furnish a report of calibration from a scale mechanic licensed by the Texas Department of Agriculture certifying that the scales meet this requirement.

B. Method B: Asphaltic concrete pavement shall be measured by the square yard of specified total thickness of the type of paving mixture actually used in completed and accepted Work in

accordance with Drawings and specifications. Multiple lifts of the same type shall be considered as one for square yard measurement purposes.

C. Method C: Asphaltic concrete pavement shall be measured by the lineal foot of specified total thickness of the type of paving mixture actually used in completed and accepted Work in accordance with Drawings and specifications. Multiple lifts of the same type shall be considered as one for linear foot measurement purposes.

340S.14 Payment

Work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit bid prices or pay adjusted unit price for Hot Mix Asphaltic Concrete Pavement, of the types and thicknesses specified. The unit bid prices shall include full compensation for furnishing all labor, equipment, time, materials and incidentals necessary to complete the Work.

Removal of existing hot mix asphalt concrete transition areas prior to overlay, tack coat, saw cutting and temporary pavement markings will not be measured or paid for directly but shall be included in the unit price bid for Standard Specification Item No. 340S, "Hot Mix Asphaltic Concrete Pavement".

Payment for Work meeting these specifications will be made under one of the following:

Pay Item No. 340S-A:	Hot Mix Asphaltic Concrete Pavement, Type ____,	Per Ton.
Pay Item No. 340S-B:	Hot Mix Asphaltic Concrete Pavement, ___Inches, Type ____,	Per Square Yard.
Pay Item No. 340S-C:	Hot Mix Asphaltic Concrete Pavement, ___Inches, Type ____,	Per Lineal Foot.
Pay Item No. 340S-PQ:	Hot Mix Asphaltic Concrete Pavement, ___Inches, Type ____, Plan Quantity,	Per Ton
Pay Item No. 340S-L:	Hot Mix Asphaltic Concrete Pavement, ___In., Type ____, Level-up Course,	Lump Sum.
Pay Item No. 340S-M:	Crack Sealing Mobilization,	Lump Sum.
Pay Item No. 340S-S:	Crack Sealing,	Per Lineal Foot.

End

SPECIFIC CROSS REFERENCE MATERIALS
Special Specification Item 340S "Hot Mix Asphaltic Concrete Pavement"

City of Austin Standard Specifications

Designation	Description
Item No. 230S	Rolling (Flat Wheel)
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 301S	Asphalts, Oils and Emulsions
Item No. 307S	Tack Coat
Item No. 313S	Cleaning and/or Sealing Joints and Cracks (Asphaltic Concrete)

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-106E	Method of Calculating the Plasticity Index of Soils
Tex-107E	Determination of Bar Linear Shrinkage of Soils
Tex-200-F	Sieve Analysis of Fine and Coarse Aggregates
Tex-203-F	Sand Equivalent Test
Tex-204-F	Design of Bituminous Mixtures
Tex-207-F	Determination of Density of Compacted Bituminous Mixtures
Tex-208-F	Test for Stabilometer Value of Bituminous Mixtures
Tex-210-F	Determination of Asphalt Content of Bituminous Mixtures by Extraction
Tex-212-F, Part II	Determination of Moisture Content of Bituminous Mixtures (by oven drying)
Tex-217-F	Determination of Deleterious Material and Decantation Test For Coarse Aggregates
Tex-227-F	Theoretical Maximum Specific Gravity of Bituminous Mixtures
Tex-410-A	Abrasion of Coarse Aggregate Using the Los Angeles Machine
Tex-460-A	Determination of Crushed Face Particle

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item 340	Hot Mix Asphalt Concrete Pavement

RELATED CROSS REFERENCE MATERIALS
Special Specification Item 340S "Hot Mix Asphaltic Concrete Pavement"

City of Austin Standard Specifications

Designation	Description
Item No. 206S	Asphalt Stabilized Base
Item No. 210S	Flexible Base
Item No. 306S	Prime Coat
Item No. 310S	Emulsified Asphalt Treatment
Item No. 311S	Emulsified Asphalt Repaving
Item No. 320S	Two Course Surface Treatment

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-215-F	Determination of Asphalt Content of Rock Asphalt By Hot Solvent Method
Tex-224-F	Determination of Flakiness
Tex-400-A	Method of Sampling Stone, Gravel, Sand and Mineral Aggregates

Tex-411-A	Soundness of Aggregate by Use of Sodium Sulfate or magnesium Sulfate
Tex-438-A	Accelerated Polish Test for Aggregate

Item No. 360S
Concrete Pavement

360S.1 Description

This item shall consist of a pavement and/or base of Portland Cement concrete, with or without reinforcement as indicated on the Drawings, with or without monolithic curbs, constructed as herein specified, on prepared subgrade or base course in conformity with the thickness and typical cross sections indicated on the Drawings. Concrete to be considered of satisfactory quality provided it is made (a) of materials accepted for job, (b) in the proportions established by the Contractor and (c) mixed, placed, finished and cured in accordance with the requirements of this specification.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

360S.2 Submittals

The submittal requirements of this specification item may include:

Mix design option(s) of the class of concrete required on the project,

The supplier of the concrete mix design(s) and type of mixing equipment, and

Type of admixtures to be used with the concrete mixes.

360S.3 Materials

A. Cementatious Materials

Portland cement shall conform to ASTM C 150, Type I (General Purpose) and Type III (High Early Strength). Type III cement shall be used when high early strength concrete is indicated on the Drawings. If the use of high early cement is not specified and the Contractor desires to use it, the Contractor shall obtain written permission from the Engineer or designated representative prior to its use and shall assume all additional costs incurred by the use of such cement. All cement shall be of the same type and from the same source for a project unless written permission if first received from the Engineer or designated representative.

Portland cement manufactured in a cement kiln fueled by hazardous waste shall be considered as an approved product if the production facility is authorized to operate under regulation of the Texas Commission on Environmental Quality (TCEQ) and the United States Environmental Protection Agency (USEPA). Supplier shall provide current TCEQ and EPA authorizations to operate the facility.

Bulk or sacked cement may be used and a bag shall contain 94 pounds (42.6 KG) net. All bags shall be in good condition at the time of inspection. Bulk cement shall be weighed on approved scales as herein prescribed.

All cement shall be stored in a suitable weather tight building or bin, which will protect the cement from dampness. The cement shall be so stored as to provide easy access for proper inspection. Any cement, which has become partially set or which contains hard lumps or cakes or cement salvaged from discarded or used bags, shall not be used.

Fly ash (denoted by Texas DOT designations Type A and Type B) may replace 20 to 35 percent of a mix design's Portland cement content by absolute volume. Fly ash shall not be used in mix designs with less that five (5) sacks of Portland cement per cubic yard [six and a half (6.5) sacks of Portland cement per cubic meter] unless specifically permitted by the Contract plans of project manual. Fly ash shall conform to the requirements of Item 405S, "Concrete Admixtures".

B. Admixtures

Concrete admixtures conforming to Item No. 405S, "Concrete Admixtures" may be used when approved by the Engineer or designated representative to minimize segregation, improve workability, reduce the amount of mixing water and to provide normal hot weather concreting provisions. The use of admixtures shall not alter the approved mix designs, except for water content.

C. Coarse Aggregate

Coarse aggregate shall consist of durable particles of gravel, crushed blast furnace slag and/or crushed stone of reasonably uniform quality throughout, free from injurious amounts of salt, alkali, vegetable matter or other objectionable material, either free or as an adherent coating on the aggregate. It shall not contain more than 0.25 percent by weight of clay lumps nor more than 1.0 percent by weight of shale nor more than 5.0 percent by weight of laminated and/or friable particles when tested in accordance with TxDOT Test Method Tex-413-A.

Coarse aggregate shall have a wear of not more than 45 percent when tested according to TxDOT Test Method Tex-410-A and when tested by standard laboratory methods shall meet the following grading requirements:

Retained on 1 3/4 inch (43.75 mm) sieve	0%
Retained on 1 1/2 inch (37.5 mm) sieve	0 to 5%
Retained on 3/4 inch (19.0 mm)sieve	30 to 65%
Retained on 3/8 inch (9.5 mm) sieve	70 to 90%
Retained on No. 4 (4.75 mm) sieve	95 to 100%

Loss by Decantation TxDOT Test Method *Tex-406-A. 1.0% Maximum

* In the case of aggregate made primarily from 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 TxDOT Test Method Tex-406-A, the percent may be increased to 1.5.

When the plans do not require a monolithic pour of curb or curb and gutter, the Contractor may elect to use the following gradation of coarse aggregate for curb or curb and gutter:

Retained on 1 1/2 inch (37.5 mm) sieve	0%
Retained on 3/8 inch (9.5 mm) sieve	5 to 30%
Retained on No. 4 (4.75 mm) sieve	75 to 100%

Where the coarse aggregate is delivered on the job in 2 or more sizes or types, each type and/or size shall be batched and weighed separately.

All aggregates shall be handled and stored in such a manner as to prevent size segregation and contamination by foreign substances and maintain as nearly as possible in a uniform condition of moisture. When segregation is apparent, the aggregate shall be remixed with suitable equipment as required. At time of its use, the aggregate shall be free from frozen material and aggregate containing foreign materials will be rejected. Coarse aggregate that contains more than 0.5 percent free moisture by weight shall be stockpiled for at least 24 hours prior to use.

Adequate storage facilities shall be provided for approved materials. The intermixing of non-approved materials with approved materials either in stockpiles or in bins will not be permitted. Aggregates from different sources shall be stored in different stockpiles unless otherwise approved by the Engineer or designated representative.

D. Fine Aggregate

Fine aggregate shall be free from injurious materials of salt, alkali or vegetable matter. It shall not contain more than 0.5 percent by weight of clay lumps. When subjected to the color test for organic impurities, TxDOT Test Method Tex-408-A, the fine aggregate shall not show a color darker than standard.

Unless shown otherwise on the drawings, fine aggregate shall have an acid insoluble residue of at least 60% by weight when tested in accordance with Tex 612-J.

Unless specified otherwise, fine aggregate shall meet the following grading requirements:

Retained on 3/8 inch (9.5 mm) sieve	0%
Retained on No. 4 (4.75 mm) sieve	0 to 5%

Retained on No. 8 (2.36 mm) sieve	0 to 20%
Retained on No. 16 (1.185 mm) sieve	15 to 30%
Retained on No. 30 (600 µm) sieve	35 to 75%
Retained on No. 50 (300 µm) sieve	70 to 90%
Retained on No. 100 (150 µm) sieve	90 to 100%
Retained on No. 200 (75 µm) sieve	97 to 100%

Fine aggregate will be subjected to the Sand Equivalent Test, TxDOT Test Method Tex-203-F. The sand equivalent value shall not be less than 80.

E. Mineral Filler

Mineral filler shall consist of clean stone dust, crushed sand, crushed shell or other approved inert material. It shall meet the following requirements when tested in accordance with TxDOT Test Method Tex-401-A:

Retained on No. 30 (600 µm) sieve	0%
Retained on No. 200 (75 µm) sieve	0 to 35%

Where fine aggregate is delivered to the job in 2 or more sizes or types, each type and/or size of material shall be batched and weighed separately. Where mineral filler is used, it shall be batched and weighed separately. At the time of its use the fine aggregate shall be free from frozen material and aggregate containing foreign material will be rejected.

All fine aggregate shall be stockpiled for at least 24 hours prior to use.

F. 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 1,000 parts per million of chlorides as Cl nor more than 1,000 parts per million of sulfates as SO4.

Water from municipal supplies approved by the State Health Department will not require testing. Contractor shall sample and test water from other sources and submit test results to the Engineer or designated representative for approval 10 days prior to proposed use.

Tests shall be made in accordance with "Standard Method of Test for Quality of Water to be used in Concrete", AASHTO Method T-26.

G. Transit-mixed Concrete

The use of transit-mixed (ready-mixed) concrete will be permitted by the Engineer or designated representative provided the batching plant and mixer trucks meet requirements of quality specified herein.

When ready-mixed concrete is used, additional mortar (1 sack cement, 3 parts sand and sufficient water) shall be added to each batch to coat the drum of the mixer or agitator truck. Delivery of concrete to the site of the work and its discharge from the truck mixer, agitator or non-agitating equipment shall be in accordance with the requirements of Item No. 410S, "Concrete Structures".

Ready-mixed concrete, batching plant and mixer truck operation shall include the following:

1) A ticket system will be used that includes a copy for the construction inspector. The ticket will have machine stamped time/date of the concrete batch, weight of cement, sand and aggregates; exact nomenclature and written quantities of admixtures and water. Any item missing or incomplete on the ticket may be cause for rejection of the concrete.

2) Sufficient trucks will be available to support continuous slab placements. The Contractor will satisfy the Engineer or designated representative that adequate standby trucks are available to support monolithic placement requirements.

3) A portion of the mixing water, required by the batch design to produce the specified slump, may be withheld and added at the job site but only with the permission of the Engineer or designated representative and under the Inspector's observation. When water is added under these conditions, it will be thoroughly mixed before any slump or strength samples are taken.

H. Joint Sealer

Unless otherwise shown on the plans, joint sealant for concrete pavement used on airport runways and/or taxiways shall be TxDOT Class 5. All other joint sealant shall be TxDOT Class 2.

As a minimum, the joint sealant shall comply with the following. The manufacturer of the joint sealant shall furnish certification that the product to be supplied meets or exceeds the specification.

1) Class 2 (Hot Poured Rubber-Asphalt). This sealer shall conform to Standard Specification Item No. 313S, “Cleaning and/or Sealing Joints and Cracks (Asphaltic Concrete)The sealer must be compatible with asphaltic concrete.

2) Class 5 (Low Modulus Silicone Sealant for Concrete Pavement). This material shall conform to Item 413S, “Cleaning and/or Sealing Joints and Cracks (PCC) and shall be furnished in a one-part silicone formulation, which does not require a primer for bond to concrete. A backer rod shall be

required which will be compatible with the sealant. No bond or reaction shall occur between the rod and sealant. The sealant shall adhere to the sides of the concrete joint. It shall not crack or break when exposed to temperatures below 32°F (0°C).

The sealant material shall have the following properties:

Color	Gray
Flow, MIL-2-8802D, Sec 4.8.4, max	0.2
Working time, minutes	10
Tack-free time at 77° F +/- 2 o F (25°C +/- 1.1°C), MIL-2-8802D,	
Sec 4.8.7, minutes	60
Cure time at 77°F (25oC), days	7-14
Full Adhesion, days	14-21

As Cured - after 7 days at 77°F (25°C), and 40% Relative Humidity

Elongation, minimum percent	1200
Durometer Hardness, Shore A, ASTM D 2240, min	15
Joint movement capability, percent	+100/-50
Tensile Strength, maximum elongation, percent	100
Peal strength, psi	25 (172 kPa)

I. Backer Rod

Backer Rod shall be expanded closed cell polyethylene foam compatible with sealant. No bond or reaction shall occur between rod and sealant. Backer Rod shall be of sufficient width to be in compression after placement.

J. Joint Filler

Boards for expansion joint filler and for contraction and longitudinal joints shall be of the size, shape and type indicated.

Board shall be obtained from Redwood, Cypress, Gum, Southern Yellow Pine or Douglas Fir timber. They shall be solid heartwood and shall be free from sapwood, knots, clustered birdseye, checks and splits. Occasional sound or hollow birdseye, 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. With the exception of Redwood and Cypress, all boards shall have a creosote or pentachlorophenol treatment of 6 pounds per cubic foot (96 kg/m3). When oven dried at 230°F (110oC) to a constant weight, the weight of the board per cubic foot (minus treatment), shall not be less than 20 pounds nor more than 35 pounds (not less than 320 nor more than 561 kgs per cubic meter).

K. Asphalt Board

Asphalt board when used as indicated shall be of required size, full depth of concrete placement and uniform thickness. When used in transverse joints, it shall conform approximately to shape of the pavement crown as indicated. Asphalt board shall consist of 2 liners of 0.016-inch (0.4 mm) asphalt impregnated paper filled with a mastic mixture of asphalt and vegetable fiber and/or mineral filler. Boards shall be smooth, flat and straight throughout and shall be sufficiently rigid to permit easy installation. Boards that crack or shatter during installing and finishing operations will not be acceptable. Board shall be furnished in lengths equal to 1/2 the pavement width or in lengths equal to the width between longitudinal joints and may be furnished in strips or scored sheets of the required shape. When tested in accordance with TxDOT Test Method Tex-524-C the asphalt boards shall not deflect from the horizontal more than 3/4 inch in 3 1/2 inches (19.3 cm in 90 cm). The asphalt board shall be placed such that they will not interfere with the bonding of the joint sealer.

L. Load Transmission Devices for Expansion and Contraction Joints

Approved load transmission devices, when indicated, shall meet the requirements specified herein:

Smooth steel bar dowels, used when indicated, shall be of the size and type indicated and shall be open-hearth, basic oxygen or electric-furnace steel conforming to the properties specified for grade 60 in ASTM A 615. The free end of dowel bars shall be smooth and free of shearing burrs.

When indicated, one end of each dowel bar shall be encased in an approved cap having an inside diameter of 1/16 inch (16 mm) greater than the diameter of the dowel bar. The cap shall be of such strength, durability and design as to provide free movement of the dowel bar and shall be approved by the Engineer or designated representative prior to use. One end of the cap shall be filled with a soft felt plug or shall be void in order to permit free movement of the dowel bar for a distance equivalent to 150 percent of the width of the expansion joint used. The dowel caps and dowel bars shall be held securely in place by bar ties as indicated on the drawings. Mechanical methods of implanting dowel bars in the plastic concrete may be used when approved by the Engineer or designated representative.

Where required, dowel bars shall be coated with a plastic material meeting the requirements indicated.

Where red lead and oil bar coating is indicated, the red lead may be of any standard commercial grade and the oil shall be clean and no lighter than Standard No. 30 SAE grade. Approved thinner and dryer may be added to the red lead, but the material upon application shall be of such consistency that will provide a uniform and heavy coating on the bar. Where asphalt bar coating is indicated, the material may be any standard grade of oil asphalt and shall be applied hot. Cutback asphalt will not be permitted for bar coating.

M. Metal Installing Devices for Joint Assembly

Metal installing devices for expansion and contraction joint assemblies (such as welded wire bar chairs, bar stakes and marker channels, channel caps, etc.) shall be as indicated or may be similar devices of equivalent or greater strength, approved by the Engineer or designated representative, that will secure joint assembly in correct position during the placing and finishing of concrete. Load transmission devices used in joint assemblies shall be secured in position by a transverse metal brace of the type and design indicated or may be secured in position by other approved devices of equivalent or greater strength that will provide positive mechanical connection between the brace and each unit (or than by wire tie) and prevent transverse movement of each load transmission device.

N. Steel Reinforcement

Steel reinforcing bars as required including tie bars shall be open-hearth, basic oxygen or electric-furnace new billet steel of Grade 60 or Grade 40 for concrete reinforcement as indicated. Bars that require bending shall be Grade 40 conforming to the requirements of ASTM A 615.

High yield reinforcing steel shall be either (a) open-hearth, basic oxygen or electric-furnace new billet steel conforming to ASTM A 615 Grade 60 or (b) rail steel bars for concrete reinforcement, conforming to ASTM A 616 Grade 60. Bars produced by piling method will not be accepted. High yield reinforcing steel bars shall be further identified by a special marking rolled into each bar. All reinforcing steel shall be deformed bars conforming to the requirements of pertinent ASTM Specifications.

Where prefabricated deformed wire mats are indicated or permitted, the wire shall be cold worked deformed steel wire conforming to the requirements of ASTM A 496, except that steel shall be made by open-hearth, electric-furnace or basic oxygen processes. The prefabricated deformed wire mats shall conform to the requirements of ASTM A 497, except that wires used shall be deformed and transverse wires shall project beyond the centerline of each edge longitudinal wire as indicated. Mats that have been bent or wires dislocated or parted during shipping or project handling shall be realigned to within 1/2 inch (13 mm) of original horizontal plane of the mat. Mats with any portion of the wires out of vertical alignment more than 1/2 inch (13 mm) after realignment and/or wires dislocated or mutilated so that, in the opinion of the Engineer, they do not represent the original mat, shall be rejected. The reinforcement may be clamped or wired so that the reinforcement will retain the horizontal and vertical alignment as indicated or as approved by the Engineer or designated representative. Deformed wire may be

used for tie bars and load transfer bars that require bending. The nominal size, area and theoretical weight of reinforcing steel wires covered by this provision are as listed in Table II. When fabricated steel bars or rod mats are indicated, the mats shall meet requirements of ASTM A 184.

Steel wire fabric reinforcement shall be of the gage and spacing indicated and shall conform to the requirements of ASTM A 82. Longitudinal and transverse wires shall be electrically welded together at all points of intersection and the welds shall be of sufficient strength that they will not be broken during handling or placing. All welding and fabrication of fabric sheets shall conform to the requirements of ASTM A 185. Welded steel wire fabric shall be furnished in sheets as indicated and steel having been previously bundled into rolls will not be accepted. An approved hinge will be permitted in each sheet to provide for each sheet longitudinally. When wire fabric is used, it will replace only the longitudinal and transverse bars. The tie bars and load transmission units at joints will not be affected.

Table II: DIMENSIONAL REQUIREMENTS FOR DEFORMED STEEL WIRE FOR CONCRETE REINFORCEMENT

Deformed Wire	Unit Weight	Diameter	Cross-Sectional Area,	Perimeter
Size No	Pounds Per Ft. (Kgs per Meter)	Inches (Centimeters)	Sq. inches (Sq, Centimeters)	Inches (Centimeters)
D-1	0.034 (.051)	0.113 (.287)	0.01 (.06)	0.355 (.902)
D-2	0.068 (.101)	0.159 (.404)	0.02 (.13)	0.499 (1.267)
D-3	0.102 (.152)	0.195 (.495)	0.03 (.19)	0.612 (1.554)
D-4	0.136 (.202)	0.225 (.572)	0.04 (.26)	0.706 (1.793)
D-5	0.170 (.253)	0.252 (.640)	0.05 (.32)	0.791 (2.009)
D-6	0.204 (.304)	0.276 (.701)	0.06 (.39)	0.867 (2.202)
D-7	0.238 (.354)	0.296 (.752)	0.07 (.45)	0.936 (2.377)
D-8	0.272 (.405)	0.319 (.810)	0.08 (.52)	1.002 (2.545)
D-9	0.306 (.455)	0.338 (.859)	0.09 (.58)	1.061 (2.695)
D-10	0.340 (.506)	0.356 (.904)	0.10 (.65)	1.118 (2.840)

D-11	0.374 (.557)	0.374 (.950)	0.11 (.71)	1.174 (2.982)
D-12	0.408 (.607)	0.390 (.991)	0.12 (.77)	1.225 (3.112)
D-13	0.442 (.658)	0.406 (1.031)	0.13 (.84)	1.275 (3.239)
D-14	0.476 (.708)	0.422 (1.072)	0.14 (.90)	1.325 (3.366)
D-15	0.510 (.759)	0.437 (1.110)	0.15 (.97)	1.372 (3.485)
D-16	0.544 (.810)	0.451 (1.146)	0.16 (1.03)	1.416 (3.600)
D-17	0.578 (.860)	0.465 (1.181)	0.17 (1.10)	1.460 (3.708)
D-18	0.612 (.911)	0.478 (1.214)	0.18 (1.16)	1.501 (3.813)
D-19	0.646 (.961)	0.491 (1.247)	0.19 (1.23)	1.542 (3.917)
D-20	0.680 (1.012)	0.504 (1.280)	0.20 (1.29)	1.583 (4.021)
D-21	0.714 (1.063)	0.517 (1.313)	0.21 (1.35)	1.624 (4.125)
D-22	0.748 (1.113)	0.529 (1.344)	0.22 (1.42)	1.662 (4.221)
D-23	0.782 (1.164)	0.541 (1.375)	0.23 (1.48)	1.700 (4.318)
D-24	0.816 (1.214)	0.553 (1.405)	0.24 (1.55)	1.737 (4.412)
D-25	0.850 (1.265)	0.564 (1.433)	0.25 (1.61)	1.772 (4.500)
D-26	0.884 (1.316)	0.575 (1.461)	0.26 (1.68)	1.806 (4.587)
D-27	0.918 (1.366)	0.586 (1.488)	0.27 (1.74)	1.841 (4.676)
D-28	0.952 (1.417)	0.597 (1.516)	0.28 (1.81)	1.876 (4.765)
D-29	0.986 (1.467)	0.608 (1.544)	0.29 (1.87)	1.910 (4.851)
D-30	1.020 (1.518)	0.618 (1.570)	0.30 (1.94)	1.942 (4.933)
D-31	1.054 (1.569)	0.628 (1.595)	0.31 (2.00)	1.973 (5.011)

O. Polyethylene Film

Polyethylene film shall be opaque pigmented white in color and shall be manufactured from virgin resin without additives or scrap. It shall be sufficiently strong and tough to permit its use under the conditions existing on street paving work without being torn or otherwise rendered unfit for the purpose during the curing period. The film shall have a minimum thickness of 4 mils (0.004 inch), shall have a minimum tensile strength of 1,700 psi at 77°F (11,720 kPa at 25°C) in the longitudinal direction and 1,200 psi at 77°F (8,275 kPa at 25°C) in the transverse direction and shall have a minimum elongation of 200 percent at 77°F (25°C)in the longitudinal direction and 150 percent at 77°F(25°C) in the transverse direction. The permissible percent moisture loss shall not exceed 2 percent after 24 hours and 4 percent after 72 hours. Tests for tensile strength and elongation will be conducted in accordance with ASTM Designation: D 882, Method A. Tests for moisture retention will be conducted in accordance with ASTM Designation: C 156.

P. Membrane Curing Compound

Membrane curing compound shall conform to Item No. 409S, "Membrane Curing", Type 2 white pigmented.

Q. Asphalt Curing

Where asphalt is to be placed on a concrete base, asphalt shall be used for curing concrete base, the material shall conform to Item No. 301S, "Asphalts, Oils and Emulsions" for RS-2 or RS-2h or as indicated on the drawings.

360S.4 Equipment

A. General

All equipment necessary for construction of this item shall be on the Project and shall be approved by Engineer or designated representative as to conditions before the Contractor will be permitted to begin construction operations on which the equipment is to be used. When approved by the Engineer or designated representative in writing, a commercial or independently operated batching plant for measuring materials outside limits of the project may be used.

B. Mixer

The mixer furnished may be either a paving mixer (operated at site of construction or centrally located), a stationary mixer (central mixer) or a paving mixer (truck mounted) that will produce adequately mixed concrete meeting the specified requirements. The mixer, or mixers, shall conform to the following requirements:

1) Each mixer shall have attached in a prominent place a manufacturer's plate showing rated capacity of the drum in terms of volume of mixed concrete and the recommended speed of rotation of the mixing drum or blades.

2) The stationary mixer (central mixer) or truck mounted paving mixer shall be operated at the manufacturer's recommended speed.

3) The size of the paving mixer shall not be less than that of a 27-E paver, as established by the Mixer Manufacturer's Bureau of Associated General Contractors. The paving mixer shall be operated at a drum speed of not less than 16 revolutions per minute and not more than 22 revolutions per minute. Pickup and throw over blades in the drum of the mixer shall be replaced when worn down 3/4 inch (19 mm) or more.

4) Each truck mounted paving mixer shall be approved by the Engineer or designated representative prior to use on the project. It shall be classified as a "paving mixer" by the manufacturer and shall be so designed that a uniform and low slump concrete (approximately 1 1/2 inch [38 mm] slump) can be mixed without aggregate size segregation. The mixer shall be capable of discharging the low slump concrete at a speed of 10 seconds per cubic yard (13 seconds per cubic meter) or faster.

5) Each mixer shall be equipped with an approved automatic device for satisfactorily timing the mix and locking the discharging device in order to prevent the discharging of the mixer before the end of the required mixing period. This timing device shall operate a sounding device to signal plainly the completion of the mixing time. When permitted by the Engineer a light signal device may be used.

6) Multiple drum mixers will be permitted provided their operation is properly synchronized. The mixing time shall be determined exclusive of the time required to transfer concrete from one drum to the next drum.

7) Each mixer shall be equipped with a water-measuring device so constructed that it will measure the water within 1 percent of the total amount required for each batch. Unless the water is to be weighed, the water measuring equipment shall include an auxiliary tank with a capacity greater than that of the measuring tank and from which the measuring tank will be filled by gravity flow. The measuring tank shall be open to the atmosphere and shall be so placed and constructed that the water for a batch can be discharged into a calibrated tank or weighing device for checking the accuracy of water measurement without seriously delaying the paving operations. The Contractor shall have a calibrated tank or weighing device available at all times at a location satisfactory to the Engineer or designated representative.

8) If a paving mixer is furnished and operated at the site of construction, it shall be equipped with a power controlled boom and bucket, so designed as to permit uniform distribution of the concrete for the full width between pavement forms. Alternate equipment for distributing concrete may be substituted when approved by the Engineer in writing, provided uniform distribution is obtained without segregation.

9) If central mixed concrete is used on the project, the Contractor shall provide equipment designed to provide uniform distribution for the concrete for the full width between pavement forms without segregation.

C. Transit-mix Trucks

When transit-mix (ready-mix) concrete is used, additional mortar (1 sack cement, 3 parts sand and sufficient water) shall be added to the batch to coat the drum of the mixer or agitator truck. This shall be required for every load of concrete. The mixing speed shall be attained as soon as all ingredients are in the mixer. Each complete batch (containing all the required ingredients) shall be mixed not less than 70 nor more than 100 revolutions of the drum at mixing speed.

A portion of the mixing water, required by the batch design to produce the desired slump, may be withheld and added at the job site, but only with permission of the Engineer and under the Engineer's supervision. When water is added at the job site, 25 revolutions (minimum) at mixing speed, will be required to flush down the blades after charging shall be accurately measured and included in the quantity of mixing water. The introduction of the initial mixing water, except blade wash down water and that permitted in this Article shall be prior to or simultaneous with the charging of the aggregates and cementitious material.

Mixing and agitating speed shall be as designated by the mixer manufacturer. All revolutions after prescribed mixing shall be at agitating speed. Except for short periods of time during discharge, the drum shall be kept in continuous motion from the time the mixing is started until the discharge is completed.

Additional mortar, consisting of 1 sack cement, 3 parts sand and sufficient water, shall be added to the batch to coat the drum of the transit mixer or agitator truck. This shall be required for every load of concrete.

The loading of transit-mixers shall not exceed 63 percent of the drum volume. When used as an agitator only, the loading of truck mixers shall not exceed 80 percent of the drum volume.

The batching plant and transit-mix trucks shall operate under the following system:

1) A ticket system will be used that includes a copy for the construction inspector. The ticket will have machine stamped time/date of water/cement batch; weight of cement, fly ash (if applicable), water, sand and aggregates; exact nomenclature and quantities of admixture. Any item missing or incomplete on the ticket will be cause for rejection. Coded readouts may be used if approved in advance by the Engineer.

2) Sufficient trucks will be available to support continuous placements. The Contractor will satisfy the Engineer that adequate standby trucks are available to support monolithic placement when required.

3) A portion of the mixing water, required by the batch design to produce the desired slump, may be withheld and added at the job site, but only with the permission of the Engineer and under the Inspector's observation. When water is added under these conditions, it will be thoroughly mixed before any slump or strength beam samples are taken.

D. Hauling Equipment

Batch hauling equipment for the transportation of measured materials from the batching plant to the mixer shall be equipped with tight covers, which shall be used to prevent excessive evaporation of moisture or any loss of material.

If a central mixer is used, concrete may be transported to the point of delivery in truck agitators or non-agitating trucks.

If a truck mounted paving mixer is used, it may be used to transport the concrete after mixing is complete.

If non-agitator trucks are used they shall conform to the following requirements:

The bed of non-agitating hauling equipment shall be a smooth, mortar-tight, metal container. The hauling equipment shall be capable of delivering the concrete to the work site in a thoroughly mixed and uniform mass and capable of discharging the concrete at a satisfactory controlled rate without segregation. If in the opinion of the Engineer any appreciable segregation or accumulation of excess water and/or mortar occurs on the surface of the concrete, this may be cause for rejection and this method of transporting the concrete to the point of delivery shall be suspended as directed by the Engineer.

E. Subgrade or Subbase Planer and Templates

Unless a stabilized subbase is provided, an approved subbase planer shall be provided, mounted on visible rollers riding on the forms and having adjustable cutting blades which shall trim the subgrade to the exact section as indicated. The planer frame shall be heavy enough to remain on the forms at all times and shall be of such strength and rigidity that, under a test made by changing the support from the wheels to the center, it shall not develop a deflection for more than 1/8 inch (3 mm). Tractive power equipment used to pull the planer shall not be such as to produce ruts or indentations in the subgrade.

When the slip form method of paving is to be used, the subgrade planer will be operated on a prepared track grade or controlled by an electronic sensor system operated from a string line that establishes the horizontal alignment and the elevation of the subbase.

A template for checking the contour of the subbase shall be provided and operated by the Contractor. The template shall rest upon the side forms and shall be of such strength and rigidity that, under a test made by changing the support to the center, it shall not show a deflection of more than 1/8 inch (3 mm). It shall be provided with accurately adjustable rods projecting downward to the subgrade at 1-foot (30 cm) intervals and these rods shall be adjusted to the required cross section of the bottom of the slab when the template is resting upon the side forms. Where stabilized subbase is provided, use of a scratch template will be required.

F. Forms

Side forms shall be of metal of approved cross section. The preferred depth of the form shall be equal to the required edge thickness of the pavement. Forms with depth greater than the required edge thickness of the pavement will be permitted.

The length of form sections shall not be less than 10 feet (0.3 meters) and each section shall provide for staking in position with not less than 3 pins. Flexible or curved forms of wood or metal of proper radius shall be used for curves of 200-foot (61 meter) radius or less. Forms shall be of ample strength and shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible springing or settlement, the impact and vibration of the spreading

and finishing machinery. In no case shall the base be less than 6 inches (15.2 cm) for a form 6 inches (15.2 cm) 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. The top of each form section, when tested with a straightedge shall conform to the requirements specified for the surface of the completed pavement. Sufficient forms shall be provided for satisfactory prosecution of the work.

Outside curb forms shall be of wood or metal of a section satisfactory to the Engineer or designated representative, straight, free of warp and shall be in a depth at least equal to the depth of the curb. They shall be mounted on the paving forms and securely attached thereto 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 forms.

G. Concrete Spreader

Use of concrete spreader shall be required and it shall be a self-propelled machine having sufficient power and traction to spread and strike off concrete without slippage on the forms. It shall be equipped with a power driven device for spreading the concrete uniformly between the forms. The spreading device may be either a reciprocating blade, a screw conveyer or a belt conveyer. The spreader shall be capable of striking off the surface of the concrete between the forms in the longitudinal direction of the slab at any required elevation.

Mechanically operated concrete spreaders of other designs, which uniformly distribute the concrete with a minimum of segregation, may be used when approved by the Engineer.

H. Slipform Paver

With prior approval, the Contractor may place concrete with slip form paver. This paver shall be equipped with a longitudinal trans-angular finishing float adjustable to crown and grade and be satisfactory to the Engineer or designated representatve. The float shall extend across the pavement practically to the side forms and/or the edge of slab. A "string line" shall be used to provide grade control for the paver.

I. Mechanical Vibratory Equipment

All concrete placed for pavement shall be consolidated by approved mechanical vibrators operated ahead of the transverse finishing machine and designed to vibrate the concrete internally and/or from the surface. Vibratory members shall extend across the pavement practically to, but shall not come in contact with the side forms. Mechanically operated vibrators shall be mounted in such manner as not to interfere with transverse or longitudinal joints. The internal-type vibrators shall be spaced at not more than 24 inches (61 cm) and shall be equipped with synchronized vibratory units. Separate vibratory units shall be spaced at sufficiently close intervals to provide uniform vibration and consolidation to the entire width of the pavement. The frequency in air of the interval spud type vibratory units shall be not less than 8,000 cycles per minute and not less than 5,000 cycles per minute for tube types and the method of operation shall be as

directed by the Engineer or designated representative. The Contractor shall have a satisfactory tachometer available for checking vibratory the elements.

The pavement vibrators shall not be used to level or spread the concrete but shall be used only for purposes of consolidation. The vibrators will not be operated where the surface of the concrete, as spread, is below the elevation of the finished surface of the pavement, except for the first lift of concrete where double strike off method of placement is employed and the vibrators shall not be operated for more than 15 seconds while the machine upon which they are installed is standing still.

The pan type vibratory units shall apply the vibrating impulses directly to the surface of the concrete. The operating frequency shall be not less than 3,500 cycles nor more than 4,200 cycles per minute in air. The Contractor shall have a satisfactory tachometer available for checking the speed of the vibratory elements.

Approved hand manipulated mechanical vibrators shall be furnished in the number required for provision of proper consolidation of the concrete along forms, at joints and in areas not covered by mechanically controlled vibrators. These vibrators shall be sufficiently rigid to insure control of the operating position of the vibrating head.

Complete and satisfactory consolidation of the concrete pavement is a most important requirement of this specification. Cores taken shall be carefully examined for voids, honeycombing or other evidence of incomplete consolidation. If such evidence is present, changes in the consolidation procedures and/or equipment will be made to insure satisfactory consolidation.

J. Finishing Equipment

1. Transverse Finishing Machine

The Transverse finishing machine shall be provided with 2 screeds accurately adjusted to the crown of the pavement, shall be self-propelled and mounted in a substantial frame equipped to ride on the forms, or may be slip form finished, and shall be so designed and operated as to strike off and consolidate the concrete.

2. Longitudinal Finishing

A transverse drag float may be used in lieu of the longitudinal finishing machine with the Engineer's approval. Finishing machines shall be maintained in a tight and good operating condition, accurately adjusted to the required crown or profile and free from deflection, wobble or vibration tending to affect the precision of finish. Machines failing to meet these requirements will be rejected by the Engineer or designated representative and the Contractor shall provide approved equipment.

Where hand finishing is permitted under this specification, the Contractor shall provide a strike template and a tamping template both of 4 by 10 inch (10 by 25 cm) lumber or equivalent metal section and at least 2 feet longer than the width of the pavement. Both templates to conform to the crown section of the pavement and the tamp, if of wood, shall have a steel face not less than 3/8 inch (9.5 mm) in thickness. The Contractor shall also provide a

longitudinal float of approved design and not less than 14 feet (4.25 meters) in length.

The Contractor shall furnish and maintain at least two standard 10-foot (3.05 meter) steel straightedges on the work site at all times during the paving operations. The Contractor shall operate same in the presence of the Engineer or designated representative.

The Contractor shall furnish a sufficient number of bridges to ride on the forms and span the pavement for finishing operations and for the installation and finishing of joints. All necessary finishing and edging tools shall be furnished as may be required to complete the pavement as indicated.

360S.5 Proportioning of Concrete

A. Proportions

Concrete shall be composed of Cementitious Materials, fine aggregate, coarse aggregate, mineral filler and/or admixture if used and water, mixed in the proportions designated by the approved Mix Design and in the manner set forth in this specification. On the basis of job and laboratory investigations of the proposed materials, the Contractor will fix proportions by weight of water, coarse aggregate, fine aggregate, cementitious materials, admixture and mineral filler where required, in order to produce concrete of the specified strength and workability for the actual delivery time and site conditions to be encountered. Where curbs are placed separately, the Engineer or designated representative. may allow aggregate gradation conforming to Class A Concrete, Item No. 403S, "Concrete for Structures".

B. Concrete Strength

The concrete mix to be designed to produce a concrete with the following requirements:

Table 1: CONCRETE PAVEMENT		
Item	Test	Value
Entrained Air	Tex-416-A	3 to 6 percent
Water-Cement Ratio gal.(liter)/sack, Maximum		6.25 (23.66)
Sacks Cement, Minimum, 4 pounds (42.6 KG) ea		6 per cubic yard (7.85 per cubic meter)
Coarse Aggregate Factor		0.65 min - 0.85 max.
Compressive Strength after 7 Day, psi	Tex-418-A	4000 (27,600)

(kPa)		
Compressive Strength after 28 day, psi (kPa)	Tex-418-A	4500 (31,000)
Maximum Concrete Mix Temperature ^{o}F (^{o}C)		95 (35)
Retarder: Regular Concrete increase in time over 360S.7(3) , minutes, Maximum		60

Table 2: HIGH EARLY STRENGTH CONCRETE

Item	Test	Value
Cement Type		III
Entrained Air	Tex-416-A	3 to 6 percent
Water-Cement Ratio gal. .(liter)/sack, Maximum		6.25 (23.66)
Sacks Cement, Minimum, 94 pounds (42.6 KG) ea		7 per (9.16 per cubic meter)
Coarse Aggregate Factor		0.65 min-0.85 max
Slump, inches (Centimeters)	Tex-415-A	1/2 to 2 (1.25 to 5.0)
Compressive Strength, after 24 hours, psi (kPa)	Tex-418-A	2,100 (14,500)
Compressive Strength, after 3 days, psi (kPa)	Tex-418-A	2,750 (19,000)
Compressive Strength, after 7 Days, psi (kPa)	Tex-418-A	4,500 (31,000)
Compressive Strength, after 28 Days,	Tex-418-A	4,925 (34,000)

psi (kPa)		
Maximum Concrete Mix, Temperature oF (oC)		95 (35)

The Contractor may submit a mix design using high range water reducing admixtures conforming to Item No. 405S, "Concrete Admixtures" in lieu of the concrete pavement mix specified and shall meet the following requirements:

Table 3: HIGH RANGE WATER REDUCING ADMIXTURES: SUPERPLASTERSIZER
CONFORMING TO SPECIFICATION ITEM NO. 405S, "CONCRETE ADMIXTURES"

Item	Test	Value
Entrained Air	Tex-416-A	3 to 6 percent
Water-Cement Ratio, (liter)//sack, Maximum		6.25
Sacks Cement, Minimum, 94 pounds (42.6 KG) ea		6 per cubic yard(7.85 per cubic meter)
Coarse Aggregate Factor		0.65 min. - 0.85 max.
Slump, inches (cms) before Admixture	Tex-415-A	1/2 to 2 (1.25 to 5)
Slump, Inches (cms) after Admixture	Tex-415-A	4 to 10 (2.5 to 25)
Compressive Strength, after 3 days, psi (kPa)	Tex-418-A	3,125 (21,500)
Compressive Strength, after 7 days, psi, (kPa)	Tex-418-A	4,500 (31,000)
Compressive l Strength, after 28 days, psi (kPa)	Tex-418-A	4,925 (34,000)
Maximum Concrete Mix, Temperature, ^{o}F (^{o}C)		100 (37.8)
Retarder, Regular Concrete Over 360S.7C, Minutes, Maximum		120

Table 4: Over Design Required to Meet Compressive Strength Requirements1					
Number Of Tests2,3	Standard Deviation, psi (mPa)				
	300 (2.06)	400 (2.75)	500 (3.44)	600 (4.13)	700 (4.82)
15	470 (3.24)	620 (4.27)	850 (5.85)	1,120 (7.71)	1,390 (9.57)
20	430 (2.96)	580 (3.99)	760 (5.23)	1,010 (6.95)	1,260 (8.67)
30 or more	400 (2.75)	530 (3.65)	670 (4.61)	900 (6.20)	1,130 (7.78)

Notes:

1. When designing the mix, add the tabulated amounts to the minimum design strength in Tables 1, 2 or 3.Maximum water-cement or water-cementitious ratio by weight

2. Number of tests of a concrete mixture used to estimate the standard deviation of a concrete production facility. Test of another mix within 1,000 psi (6.88 MPa) of the specified strength may be used.

3. If less than 15 prior tests are available, the overdesign should be 1,200 psi (8.26 MPa) for specified strengths from 3,000 to 5,000 psi (20.65 to 34.42 MPa) and 1,400 psi (9.64 MPa) for specified strengths greater than 5,000 psi (34.42 MPa).

High range water reducing admixtures shall be capable of maintaining the original slump until placement and screeding, which may be 2 hours, without the addition of water, additional admixture or other retempering or remixing techniques.

C. Workability of Concrete

Concrete shall be uniformly plastic, cohesive and workable. Workable concrete is defined as concrete which can be placed without honeycomb and without voids in the surface of the pavement after the specified finishing machine has been over a given area twice. Workability shall be obtained without producing a condition such that free water appears on the surface of the slab when being finished as specified. Where water appears on the surface of the concrete after finishing and this condition cannot be corrected by reasonable adjustment in the batch design, the bleeding to be immediately corrected by one of the following measures or a combination of two or more of the following listed measures:

1. Redesign of the batch.

2. Addition of mineral filler to fine aggregates.

3. Increase of cement content.

4. Use of an approved air entraining agent or approved admixture.

In the event that the measures taken do not eliminate the bleeding immediately, concrete placement operations will be suspended, as directed by the Engineer or designated representative, by placing a bulkhead or "header" as indicated and

according to applicable requirements for intentional stoppage of placement of concrete under Item No. 360S, "Concrete Pavement" and will remain suspended until such time as additional trial mixes demonstrate that a non-bleeding batch design has been achieved. Failing to achieve a satisfactory laboratory batch design the Contractor will be required to use different materials and to submit samples thereof for additional trial mixes and pilot beams.

The mix will be designed with the intention of producing concrete, which will have a slump of 1 1/2 inches (3.8 cms). The slump shall not be less than 1/2 inch (1.25 cms) nor more than 2 inches (5 cms).

D. Mix Design

The Contractor shall be responsible for the design of the concrete mix. The mix design shall be prepared and sealed by a person qualified and experienced in such work. Establish proportions on the basis either of laboratory trial batches or of field experience with the materials to be employed.

When ice is used to lower the concrete temperature during hot weather concrete placement (Section 13 of Standard Specification Item No.410S, “Concrete Structures”), the Contractor shall furnish a mix design (Section 6 of Standard Specification Item No. 403S, “Concrete for Structures”) acceptable to the Engineer or designated representative for class of concrete specified. The addition of ice shall not exceed 50% of the total mix water weight.

Complete concrete mix design data shall be submitted to the Engineer or designated representative for approval at least 10 days before concrete placement begins. Submittal of the mix shall be accompanied by such test data and certifications as may be necessary to demonstrate compliance with specification requirements. Approval of this mix design shall in no way relieve the Contractor of responsibility for the quality of the concrete.

It shall also be the responsibility of the Contractor to determine and measure batch quantity of each ingredient, including water, not only for batch designs but for all concrete produced for the project, so that the mix conforms to these specifications.

Trial batches shall be made and tested using all the proposed ingredients prior to the placing of concrete and also when the aggregate and/or type, brand or source of cement or admixture is changed. When the brand and/or source of cement only is changed, the Engineer or designated representative may waive trial batches only if a prior record of satisfactory performance of the cement has been established.

Mix designs used successfully on previous or concurrent jobs may be approved by the Engineer or designated representative without trial batches if it is shown that there is no substantial change in any of the proposed ingredients.

The Contractor shall prepare a minimum of four concrete test beams of each mix design, cure and test two each at the age of 7 and 28 days. From these preliminary tests the water-cement ratio required to produce concrete of the specified strength will be selected by the Contractor for approval by the Engineer or designated representative. The Contractor may at any time present in writing a suggested mix design and if the Engineer or designated representative concurs with the suggested design, the Contractor shall conduct trial batches necessary to determine its acceptability under these specification requirements.

The Contractor shall furnish and operate the mixer approved for use on this project unless the concrete is to be furnished from a transit mix (ready-mix) plant. For mixing the concrete to be used in making the preliminary test specimens, a minimum 1 cubic yard (1 cubic meter) batch shall be mixed or a batch of sufficient size to afford proper mixing, whichever is the greater. In lieu of the above mixer and procedure, the Contractor may furnish a portable mixer of sufficient rated capacity to mix a minimum 3-sack batch; in which case, the batch mixed for the preliminary test not to be less than the rated capacity of the mixer furnished. A coating batch will be mixed prior to mixing for test beams.

No additional compensation to be allowed for equipment, materials or labor involved in making job mix design test specimens.

After the mix proportions and water-cement ratio required to produce concrete of the specified strength have been determined, placing of the concrete may be started. The strength of the concrete in the completed pavement will be determined by a minimum of four compressive strength test specimens made, cured with a minimum of two each tested at 7 and 28 days as provided in Texas DOT Bulletin C-11. Modifications of the mix design may be requested by the Contractor on basis of conformity of the strength of these test specimens with the requirements and intent of this specification.

Changes in the water-cement ratio and the mix design, including an increase in cement factor if necessary, will be made when the average 7 day and/or 28 day compressive strength of the concrete, as indicated by the last 10 compressive strength values obtained from tests of cylinders made from concrete of the same water-cement ratio, departs from the desired minimum average strength by more than 4 percent.

E. Construction Testing:

Straightedge surface testing to be carried out as prescribed above.

The Engineer shall take test cylinders for compressive strength values on a random basis. The comparative results shall consist of the average of 2 cylinders each at 7 and 28 days for regular concrete, High early strength concrete and high range water reducing admixture concrete. Tests shall be made for each 500 square yards constructed, in accordance with TxDOT Bulletin C-11. Additional tests may be taken as determined by the concrete placement conditions or for adequately determining the strength of concrete where the early opening of the pavement to traffic is dependent upon concrete strength tests. No extra compensation will be allowed for materials and work involved in fulfilling these requirements.

360S.6 Construction Methods

A. Preparation of Subgrade

Where stabilized subbase is not provided, the subgrade shall be excavated as required, all unstable or otherwise objectionable material removed and all holes, ruts and depressions filled with approved material and compacted. Rolling and sprinkling shall be performed when and to the extent required and the roadbed

shall be completed to or above the plane of the typical sections, lines and grades indicated or as established by the Engineer or designated representative. The subgrade shall be proof rolled and any soft areas shall be repaired before the forms are placed. In the event that the proof rolled subgrade is exposed to rainfall or other conditions, which may soften the subgrade, corrective measures shall be taken and the subgrade shall be proof rolled again.

The subgrade planer shall be operated from approved forms immediately ahead of paving operations and the subgrade shall be finished to the exact section of the bottom of the pavement as indicated. Where traveling form pavers are used, the subgrade planer shall operate on a prepared track grade or be controlled by electronic sensors operating from a stringline that establishes line and grade. It shall be tested with the approved template, operated and maintained by the Contractor. The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the pavement is placed and shall be kept thoroughly wetted down sufficiently in advance of placing any pavement to insure its being in a firm and moist condition for at least 2 inches (5 cms) below the prepared surface. Sufficient subgrade shall always be prepared in advance to insure satisfactory prosecution of the work.

No equipment or hauling shall be permitted on the prepared subgrade, except by special permission of the Engineer or designated representative, which will be granted only in exceptional cases and only where suitable protection in the form of 2-ply timber mats or other approved material is provided.

B. Placing and Removing Forms

The subgrade under the forms shall be firm and cut true to grade so that each form section when placed will be firmly in contact for its whole length and base width and exactly at the established grade. Any subgrade under the forms below established grade shall be corrected, using suitable material, placed, sprinkled and rolled as directed. Forms shall be staked with at least 3 pins for each 10-foot (3-meter) section. A pin shall be placed at each side of every joint. Form sections shall be tightly joined and keyed to prevent relative displacement. Forms shall be cleaned and oiled each time they are used.

Forms shall be set for a sufficient distance in advance of the point where concrete is being placed to permit a finished and approved subgrade length of not less than 300 feet (90 meters) ahead of the mixer. Conformity of the grade and alignment of forms shall be checked immediately prior to placing concrete and necessary corrections made by the Contractor. Where any form has been disturbed or any subgrade becomes unstable, the form shall be reset and rechecked. In exceptional cases, the Engineer or designated representative may require suitable stakes driven to the grade of the bottom of the forms to afford additional support. Sufficient stability of forms to support the equipment operated and to withstand its vibration without springing or settlement shall be required. If forms settle and/or deflect over 1/8 inch (3 mm) under finishing operations, paving operations shall be stopped and the forms shall be reset to line and grade.

Forms shall be leveled using cement-stabilized material containing not less than 1 1/2 sacks of cement per ton (1 2/3 sacks of cement per MG) of mix as placed. The aggregate gradation and water content shall be determined by the Contractor. The cement-stabilized material shall be sufficiently plastic to insure filling voids

underneath the paving forms. Paving equipment will not to be permitted on the forms until the cement-stabilized material has cured for at least 12 hours.

Forms shall remain in place for not less than 8 hours after the concrete has been placed. Forms shall be carefully removed in such a manner that little or no damage will be done to the edge of the pavement. Any damage resulting from this operation shall be immediately repaired. After the forms have been removed, the ends of all joints shall be cleaned and any honeycombed areas pointed up with approved mortar and the surfaces protected with curing material conforming to Item No. 409S, "Membrane Curing".

Immediately after pointing is complete, the form trench, if used, shall be filled with granular material or earth from the shoulders in such manner as to shed water from rainfall and prevent curing material from washing away from the edge of pavement. On completion of the required curing, the subgrade or shoulders adjacent to the pavement shall be placed and compacted in condition to maintain drainage.

360S.7 Concrete Mixing and Placing

A. Mixing Methods

The concrete shall be mixed in a mixer conforming to the requirements of this item.

B. Mixing

The aggregates, mineral filler if required, cementitious materials and water shall be measured separately, introduced into the mixer and mixed for a period of not less than 50 seconds nor more than 90 seconds, measured from the time the last aggregate enters the drum to the time discharge of the concrete begins. The required water shall be introduced into the mixing drum during the first 15 seconds of mixing. The entire contents of the drum shall be discharged before any materials of the succeeding batch are introduced.

The Engineer or designated representative may increase the minimum mixing time to that necessary to produce thoroughly mixed concrete based on inspection or appropriate uniformity tests. The mixing time may be varied at any time as necessary to produce acceptable concrete.

If a central mixer is used, the concrete shall be discharged into the specified hauling equipment and delivered to the road site. If truck agitators are used, the concrete shall be continuously agitated at not less than 1 nor more than 6 rpm as directed by the Engineer or designated representative.

The maximum size of the concrete batch, absolute volume, shall not exceed 120 percent of the rated size of the mixer (40.8 cubic feet maximum batch for 34 cubic foot paver-1.2 cubic meter maximum batch for 1 cubic meter paver). Spilling of material from the mixer drum shall be corrected by reducing the size of the batch. Retempering or remixing of concrete will not be permitted.

The initial batch of concrete mixed after each time the mixer is washed out shall be enriched by additional mortar. The additional mortar shall be 1 sack of cement and 3 parts of sand.

When transit-mix (ready-mix) concrete is permitted, the batching plant shall meet the requirements of Item 403S, "Concrete for Structures".

C. Placement

Unless otherwise indicated, the concrete may be placed by using forms or by use of a slipform paver. Any concrete not placed as herein prescribed within 30 minutes after mixing shall be rejected and disposed of as directed except as provided otherwise herein. If in the opinion of the Engineer or designated representative, the temperature, wind and/or humidity conditions are such that the quality of concrete will not be adversely affected, the specified placing time may be extended by a maximum of 45 minutes. Concrete with high range water reducing admixture shall not be placed after the slump has dropped by 3 inches (7.5 cms) or more. Except by specific written authorization of the Engineer or designated representative, concrete shall not be placed when the temperature is below 40oF (4.5oC) and falling but may be placed when the temperature is above 35oF (1.7oC) and rising, the temperature being taken in the shade and away from artificial heat.

When the temperature of the air is above 85oF (29.4oC), an approved retarding agent will be required in concrete. The maximum temperature of all regular concrete placed shall not exceed 95oF (35.0oC), unless otherwise specified.

When concrete is being placed in cold weather, the Contractor shall have available a sufficient supply of an approved covering material to immediately protect concrete if the air temperature falls to 32oF (0oC) or below, before concrete has been placed 4 hours. Such protection shall remain in place during the period the temperature continues below 32oF (0oC) or for a period of not more than 5 days. Neither salt nor other chemical admixtures shall be added to the concrete to prevent freezing. The Contractor shall be responsible for the quality and strength of concrete under cold weather conditions and any concrete damaged by freezing shall be removed and replaced at the Contractor’s expense. Concrete shall not be placed before sunrise and shall not be placed later than will permit finishing of the pavement during sufficient natural light.

Concrete shall be placed only on approved subgrade or subbase and unless otherwise indicated on the drawings, the full width of the pavement shall be constructed monolithically. The concrete shall be deposited on the subgrade or subbase in such manner as to require as little rehandling as possible. 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. Workers will not be permitted to walk in the concrete with any earth or foreign material on their boots or shoes. The placing of concrete shall be rapid and continuous.

When the concrete is to be placed in separate lanes, the junction line shall not deviate from the true line more than 1/2 inch (1.25 cm) at any point and shall be finished as indicated on the drawings.

The mixer shall not be located on completed pavement, except as herein provided, but may be located on the subgrade of that lane of the pavement being constructed, as provided under "Preparation of Subgrade". When limited space, in the opinion of the Engineer or designated representative, requires operation of the mixer on completed pavement, the mixer may be so operated provided the concrete has attained the minimum average compressive strength required and

provided suitable protection to the pavement in the form of 2 ply timber mats or otherwise approved material is provided.

Concrete shall be distributed to such depth that when consolidated and finished, the slab thickness indicated will be obtained at all points and the surface shall not, at any point, be below established grade. Special care shall be exercised in placing and spading concrete against forms and at all joints to prevent the forming of honeycombs and voids.

Concrete for the monolithic curbs shall be the same as for the pavement and if carried back from the paving mixer shall be placed within 20 minutes after being mixed. It may be placed from the separate mixer, if desired, but in any case must be placed while the pavement concrete is still plastic. When sawed joints are used, curbs shall be doweled as indicated and poured after sawing. Curbs doweled on and placed separately may be placed with an extrusion machine.

If a central mixer or batcher is used, the Contractor shall provide a system satisfactory to the Engineer or designated representative for determining that concrete delivered to the road meets the specified requirements for mixing and time of placing.

Unless otherwise indicated, 2 mixers or transit mixers will be required where the double strike off method is employed.

D. Reinforcing Steel and Joint Assemblies

All reinforcing steel, including steel, welded wire fabric reinforcement, tie bars, dowel bars and load transmission devices used in accordance with plan provisions shall be accurately placed and secured in position in accordance with details indicated on the drawings. Reinforcing bars shall be securely wired together at alternate intersections, following a pattern approved by the Engineer or designated representative and at all splices and shall be securely wired to each dowel intersected. When wire fabric is used, it shall replace only the longitudinal and transverse bars and shall be securely wired together at all splices and to each dowel intersected. When welded wire fabric is selected, the Contractor shall pour the lower half of the slab, place the welded wire fabric and place the remaining concrete. Tie bars shall be installed in the required position by the method and device indicated. Bar coating indicated and of material specified, shall be completed and the bars and coating shall be free of dirt or other foreign matter at the time of installation in the concrete.

Tightly adhered scale or rust which resists removal by vigorous wire brushing need not be removed except that excessive loss of section to the reinforcement due to rust shall be cause for rejection. Excessive loss of section shall be defined as loss of section to the extent that the reinforcement will no longer meet the physical requirements for the size and grade of steel specified.

Where indicated on the drawings, an assembly of parts at pavement joints, the assembly shall be completed, placed at required location and elevated and all parts rigidly secured in required position by the method and devices indicated on the drawings. Dowel bars shall be accurately installed in joint assemblies as indicated on the drawings, each parallel to the pavement surface and to the center line of the pavement and shall be rigidly secured in the required position by such

means as indicated that will prevent their displacement during placing and finishing of the concrete. Unless specifically authorized by the Engineer or designated representative in writing, the load transmission devices shall be accurately installed in joint assemblies indicated, each unit vertical with its length parallel to the center line of the pavement and all units shall be rigidly secured in required position by such means as indicated that will prevent their displacement during placing and finishing of the concrete. Header boards, joint filler and other material used for forming joints shall be accurately notched to receive each load transmission device. All load transmission devices shall be free of rust and clean when installed in the concrete.

The Contractor has the option of substituting welded wire fabric in place of reinforcement bars. The welded wire fabric selected shall have an area and distribution of steel at least equal to the plan requirements. The Contractor shall submit their proposed design to the Engineer for approval before any material is ordered.

If welded wire fabric is used, the entire width of the bottom layer of concrete shall be struck off to conform to the cross section and elevation indicated on the drawings. The reinforcement shall then be placed immediately upon the concrete, after which the top layer of concrete shall be placed, struck off and screeded. Any portion of the bottom layer of concrete which has been placed more than 15 minutes without being covered with the top layer of concrete shall be removed and replaced with freshly mixed concrete at the Contractor's expense.

E. Joints

1. General

All transverse and longitudinal joints when required in the pavement shall be of the types indicated and shall be at required location, on required alignment, in required relationship to tie bars and joint assemblies and in accordance with details indicated. When no transverse joints are indicated, joints shall not exceed 40 feet (13.1 meters). Such stakes, braces, brackets or other devices shall be used as necessary to keep the entire joint assembly in true vertical and horizontal position. Where concrete base is overlaid by asphaltic concrete, the joints to be prepared as specified herein, but joint sealing will not be required unless indicated.

If necessary for proper installation of the sealer, excessive spalling of the joint groove shall be repaired to the satisfaction of the Engineer.

Care shall be exercised during 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 outline indicated on the drawings. The Contractor shall install joint materials, which will function as a compatible system. Joint sealer shall not be placed where a bond breaker is present.

Green concrete or wet sawed joints are permitted provided the Contractor cleans the joint within 5 minutes after cutting with a 3000 psi (20.7 mPa) water blast followed by a minimum of 7 day cure and sand blast the saw cut immediately prior to placing joint sealer.

Dry sawed joints are permitted provided the Contractor sand blasts the saw cut immediately prior to placing joint sealer.

2. Expansion Joints

Transverse expansion joints shall be formed perpendicular to the centerline and surface of pavement and shall be constructed in accordance with the sequence of operations indicated on the drawings. After the transverse finishing machine and before the longitudinal finishing machine have passed over the joint, the Contractor shall test the joint filler for correctness of position and make any required adjustment in the position of the filler and shall install the joint seal space form as indicated on the drawings. After removal of the joint seal form as indicated on the drawings, the joint seal space above the joint filler shall be thoroughly sandblasted or machine routed to remove all projecting concrete, laitance, dirt or foreign matter. The concrete faces of the joint seal space shall be left true to line and section throughout the entire length of the joint. On completion of curing of the pavement, the joint sealing filler of the type specified shall be placed as indicated. The faces of the joint seal space shall be clean and surface dry at the time joint sealing filler is placed. On completion of the joint seal, the pavement adjacent to the joint shall be left free of joint sealing material. The joint seal space shall be exactly above and not narrower than the joint filler with no concrete overhangings.

3. Weakened Plane Joints

Weakened plane joints shall consist of transverse contraction joints and longitudinal joints and shall be formed or sawed as indicated on the drawings. When the joints are sawed, the saw shall be power driven, shall be manufactured especially for the purpose of sawing concrete and shall be capable of performing the work. Saw blades shall be as indicated. Tracks adequately anchored, the chalk, string line or other approved methods shall be used to provide true alignment of the joints. The concrete saw shall be maintained in good operating condition and the Contractor shall keep a standby power saw on the project at all times when concrete operations are under way.

If membrane curing is used, the portion of the seal, which has been disturbed by sawing operations, shall be restored by the Contractor by spraying the areas with additional curing seal.

Forming, finishing and sealing of the joint seal space shall conform to this item, described above and details indicated on the drawings.

4. Contraction Joints

Transverse contraction joints shall be formed or sawed joints perpendicular to the centerline and surface of the pavement and shall be constructed by the method and in the sequence of operations as indicated. Where sawed joints are used, contraction joints at intervals indicated shall be sawed as soon as sawing can be accomplished without damage to the pavement and before 24

hours after the concrete has been placed, the exact time to be approved by the Engineer or designated representative. The remaining contraction joints shall be sawed in a uniform pattern as directed by the Engineer or designated representative and they shall be completed before uncontrolled cracking of the pavement takes place. All joints shall be completed before placing concrete in succeeding lanes and before permitting traffic to use the pavement.

5. Longitudinal Joints

Longitudinal joints shall be of the type or alternate types indicated and shall be constructed of specified materials in accordance with provisions indicated on the drawings. Longitudinal joints shall be constructed accurately to required lines, shall be perpendicular to the pavement surface at the joint and the pavement surface over and adjacent to the joint shall be finished as specified on the drawings.

Longitudinal joints shall be sawed as soon as sawing can be accomplished without damage to the pavement. Sawing shall not cause damage to the pavement and the groove shall be cut with a minimum of spalling. No traffic (including construction traffic) shall be permitted on pavement until the longitudinal joint is cut.

6. Construction Joints

Intentional stoppage of the placing of the concrete shall be at either an expansion joint or at a weakened plane joint. The following provisions shall govern for each type of joint at which the placing of concrete is stopped:

a) When the placing of concrete is stopped at an expansion joint, the complete joint assembly shall be installed and rigidly secured in required position as indicated. A bulkhead of sufficient cross sectional area to prevent deflection, accurately notched to receive the load transmission devices or dowels, as the case may be, and shaped accurately to the cross section of the pavement shall be provided and installed as a back-up for the joint filler and rigidly secured in required position to permit accurate finishing of the concrete up to the joint. After the concrete has been finished to the joint, formation of the joint seal space and finishing of the joint shall be executed as specified herein and as indicated. The backup bulkhead shall remain in place until immediately prior to the time when concrete placement is resumed, then it shall be carefully removed in such manner that no element of the joint assembly will be disturbed. The exposed portion of the joint assembly shall be free of adherent concrete, dirt or other material at the time placing of concrete is resumed.

b) When placing of concrete is stopped at a weakened plane joint, all applicable provisions of paragraph (a) above shall apply in addition to the following requirement:

The face of the bulkhead adjoining the slab end shall be notched and grooved to fit the exposed half section of the joint assembly and shall be shaped to form the slab end at the center of the joint as indicated on

the drawings. The 1/2 width of joint seal space may be formed by a strip of required section placed and removed as indicated for construction of transverse contraction joints. The Contractor shall have available a bulkhead shaped to section of the pavement. This bulkhead must be drilled to permit the continuation of all longitudinal reinforcing steel through the construction joint and shall be of sufficient section and strength to prevent deflection.

c) When load transmission devices are not provided in the design, intentional stopping of placement of concrete shall occur in the middle of a slab. Provisions shall be made to provide a bulkhead, which will accommodate tie bars of the same length, size and spacing as tie bars used for the longitudinal joints. When the concrete placement is resumed, the bulkhead shall be removed without bending tie bars or damaging the concrete. The joint seal space and sealer shall be the same as for longitudinal joints.

Immediately upon the unintended stoppage of the placing of concrete, the Contractor shall 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 Engineer or designated representative. When placing 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 rodded with the first. An edge created by a construction joint of this type shall have a joint seal space and shall be sealed as required for contraction joints.

F. Joint Sealers

1. Class 2 Material

This material shall conform to Standard Specification Item No. 313S, ""Cleaning and/or Sealing Joints and Cracks (Asphaltic Concrete).

For placement in vertical joints (curb faces, etc.) either of the following procedures may be used.

a) An amount of the mixed material may be set aside until partial curing has taken place and carefully trowelled into the joint with a suitable tool.

b) The portion of the joint in the roadway shall be poured and cured. The vertical curb faces shall then be taped or formed and the material poured into the vertical joint from the top.

2. Class 5 Material

This material together with backer rods shall be applied as indicated in accordance with manufacturer's recommendations.

G. Asphalt Board

Premolded materials, wherever used, shall be anchored to the concrete on one side of the joint by means of copper wire or nails not lighter than No. 12 B and S gage. Such anchorage shall be sufficient to overcome the tendency of the material to fall out of the joint. The Contractor shall not contaminate joints to receive Class 5 Joint Material with asphalt from the asphalt board.

H. Curbs

The curb shall be constructed in lengths equal to the adjoining pavement slab lengths and expansion joints shall be provided in the curb opposite each transverse expansion joint in the pavement. Expansion joint material shall be of the same thickness, type and quality as indicated for the pavement and shall be of the section as indicated for the curb. All expansion joints shall be carried through the curb, sidewalk and retaining walls when these items are indicated.

When sawed joints are provided for the pavement, the curb placement shall be delayed until all transverse joints have been sawed. To provide bond for the curb, dowel bars shall be placed as indicated on the drawings, while the pavement concrete is still plastic.

Weakened plane joints shall be formed in monolithic curbs at a spacing to coincide with the joints in the concrete pavement. The joints shall be formed by inserting in the curb an asphaltic board strip cut to conform to the shape of the curb. When the concrete is sufficiently set, the joint on the top and face of curb shall be grooved with an approved type of grooving tool.

A finish coat of mortar shall be applied on the exposed surfaces of the monolithic curbs. The mortar shall be composed of 1 part of Portland Cement and 2 parts of fine aggregate. A mortar coat will not be required for extruded curbs.

The curb face, lower radius and top of curb shall be plastered with the sand-cement mortar. The mortar shall be applied with a template or "mule" made to conform to the curb dimensions as indicated. All exposed surfaces of the curb shall be finished with a steel trowel and brushed to a smooth and uniform surface. The mortar finish as required shall be included in the unit price bid for this item.

I. Machine Finishing

All concrete pavement shall be finished mechanically with approved self-propelled machines, except as herein provided. Hand finishing will be permitted on the transition from a crowned section to a superelevated section without crown on curves, on straight line superelevation sections less than 300 feet (91.4 meters) in length, on that portion of a widened pavement outside normal pavement width and on sections where the pavement width is not uniform, isolated, narrow in width or required monolithic widths are greater than that of available finishing machines.

Machine finishing of pavement shall include the use of power-driven vibrators, power-driven transverse strike off and screed or such alternate equipment as may be substituted and approved under this item.

All concrete pavement shall be consolidated by a mechanical vibrator. As soon as concrete has been spread between the forms, the approved mechanical vibrator

shall be operated to consolidate the concrete and remove all voids. Hand manipulated vibrators shall be used for areas not covered by the mechanical vibratory unit.

The transverse finishing machine shall first be operated to compact and finish pavement to the required section and grade, without surface voids. The machine shall be operated over each area as many times and at such intervals as directed. At least 2 trips will be required and the last trip over a given area shall be a continuous run of not less than 40 feet (12.2 meters). After completion of finishing with the transverse finishing machine, a transverse drag float may be used.

The consistency of the concrete as placed should allow completion of finishing operations without the addition of water to the surface. When field conditions are such that additional moisture is needed for the final concrete surface finishing operation, the required water shall be applied to surface by fog spray only and shall be held to a minimum.

After finishing is complete and the concrete still workable, the surface shall be tested by the Contractor for trueness with an approved 10 foot (3.05 meter) straightedge. The straightedge shall be operated from the side of the pavement, placed parallel to the pavement centerline and passed across the slab to reveal any high spots or depressions. The straightedge shall be advanced along the pavement in successive stages of not more than 1/2 its length. Practically perfect contact of the straightedge with the surface will be required and the pavement shall be leveled to this condition, in order to insure conformity with the surface test required below after the pavement has fully hardened. Any correction of the surface required shall be accomplished by adding concrete if required and by operating the longitudinal float over the area. The surface test with the straightedge shall then be repeated.

For one lane pavement placement and uniform widening, the equipment for machine finishing of concrete pavement shall be as directed by the Engineer or designated representative but shall not exceed requirements of these specifications.

After completion of the straightedge operation, as soon as construction operations permit, texture shall be applied with 1/8 inch (3 mm) wide metal tines with clear spacing between the tines being not less than 1/4 inch (6.3 mm)nor more than 1/2 inch (12.7 mm).

If approved by the Engineer or designated representative, other equipment and methods may be used, provided that a surface texture meeting the specified requirements is obtained. The texture shall be applied transversely. It is the intent that the average depth resulting from the number of tests directed by the Engineer or designated representative be not less than 0.060 inch (1.52 mm) with a minimum texture depth of 0.050 inch (1.27 mm) for any one test when tested in accordance with TxDOT Test Method Tex-436-A. Should the texture depth fall below that intended, the finishing procedures shall be revised to produce the desired texture.

1. Emergency Procedures

The Contractor shall have available at all times hand rakes with tines for the purpose of providing textures in the event of equipment breakdown.

The Contractor also shall have available a conventional garden spray type can containing a commercially available monomolecular film compound. This shall be applied in the case of equipment breakdown or other emergencies to prevent the pavement from drying too rapidly. The use of this product will give the Contractor additional time to provide adequate texturing.

After completion of texturing and about the time the concrete becomes hard, the edge of the slab and joints shall be carefully finished with an edger and the pavement shall be left smooth and true to line.

J. Hand Finishing

Hand finishing shall be resorted to only in those conditions provided for above and upon specific authorization by the Engineer or designated representative. When hand finishing is permitted, concrete shall be struck off with an approved strike off screed to such elevation that when consolidated and finished the surface of the pavement to conform to the required section and grade. The strike template shall be moved forward with a combined transverse and longitudinal motion in the direction work is progressing, maintaining the template in contact with the forms and maintaining a slight excess of material in front of the cutting edge. The Concrete shall then be tamped with an approved tamping template to compact the concrete thoroughly and eliminate surface voids and the surface screed to required section.

After completion of a strike off, consolidation and transverse screeding, a hand-operated longitudinal float shall be operated to test and level the surface to the required grade.

Workers shall operate the float from approved bridges riding on the forms and spanning the pavement. The longitudinal float shall be held in contact with the surface and parallel to the centerline and operated with short longitudinal strokes while being passed from one side of the pavement to the other. If contact with the pavement is not made at all points, additional concrete shall be placed, if required and screed and the float shall be used to produce a satisfactory surface. Care shall be exercised to keep the ends of the float from digging into the surface of the pavement. After a section has been smoothed so that the float maintains contact with the surface at all points in being passed from one side to the other, the bridges may be moved forward half the length of the float and the operations repeated.

Other operations and surface tests shall be as required for machine finishing.

K. Surface Testing:

After the concrete has been placed 12 hours or more, the Engineer or designated representative will test the surface of the pavement with a 10-foot (3.05 meter) straightedge placed parallel to the centerline. Unless specified otherwise, the surface shall not vary from the straightedge by more than 1/16 inch per foot (5 mm per meter) from the nearest point of contact and in no case shall the maximum

ordinate from a straightedge to the pavement be greater than 1/8 inch (3 mm). Any high spots causing a departure from the straightedge in excess of that specified shall be ground down by the Contractor to meet the surface test requirements. Where the texture of the pavement is removed by extensive grinding, the texture shall be restored by grooving the concrete to meet the surface finishing specifications.

L. Curing

All concrete pavement shall be cured by protecting it against loss of moisture for a period of not less than 72 hours from the beginning of the curing operations. Immediately after finishing operations have been completed, the entire surface of the newly laid concrete shall be covered and cured in accordance with the requirements specified for whichever of the following methods the Contractor may elect. Newly laid concrete base to be overlaid by asphaltic concrete shall not be cured by "Membrane Curing" and surfaces not to be overlaid by asphaltic concrete shall not be cured by "Asphalt Curing". In all cases in which curing requires the use of water, the curing shall have prior right to water supply or supplies. Failure to provide sufficient cover material of the type the Contractor elects to use, failure to maintain saturation in wet curing methods, lack of water to adequately take care of both curing and other requirements or other failures to comply with curing requirements shall be cause for immediate suspension of concreting operations. The covering material used in curing shall be removed as necessary to saw joints or to comply with the requirements for "Surface Test". The concrete surface shall be maintained wet with a water spray if indicated and the covering material replaced immediately on completion of sawing and testing and any required surface correction.

1. Waterproofed Paper Curing

Immediately after the finishing of the surface has been completed and the concrete has taken its initial set, it shall be wetted with water applied in the form of a fine spray and covered with waterproofed paper so placed and weighted as to cause it to remain in intimate contact with the surface. Waterproofed paper used for the curing of concrete pavement shall be of a type and quality approved by the Engineer. It shall be sufficiently strong and tough to permit its use under the conditions existing on street paving work without being torn or otherwise rendered unfit for the purpose during the curing period. The paper covering shall be maintained in place continuously for not less than the specified curing period.

The waterproofed paper shall be prepared to form blankets of sufficient width to cover the entire surface and both edges of the pavement slab and such blankets shall not be more than 60 feet in length. All joints in the blankets occasioned by joining paper sheets shall lap not less than 5 inches (12.7 cms) and shall be securely sealed with asphalt cement having a melting point of approximately 180o F (82.2 oC). Blankets shall be placed to secure an overlap of at least 12 inches (30.5 cms) and this lap securely weighted to form a closed joint.

The waterproofed paper blankets shall be adequately weighted to prevent displacement or billowing due to wind and the paper folded down over the

side of the pavement shall be secured by a continuous bank of earth. Plowing of this windrow into place will not be permitted.

All tears or holes appearing in the paper during the curing period shall be immediately repaired by cementing patches over such defects. It shall be the Contractor's responsibility to prevent damage to paper blankets, which would affect their serviceability and effectiveness as a concrete curing method. Blankets may be rejected by the Engineer or designated representative at any time if it appears they do not provide an airtight covering.

Paper blankets rejected on account of pinholes or minor tears may be continued in service by folding the blanket over lengthwise, first thoroughly spraying 1/2 the blanket with the asphalt cement used for seams. The 2 thicknesses shall be firmly pressed together and well cemented. Blankets shall be of a width sufficient to cover the pavement surface and both edges. Doubled blankets may be rejected for the same cause as provided for single blankets. All paper blankets rejected by the

Engineer shall be immediately marked by the Contractor for identification and then destroyed or stored entirely separate from approved blankets.

No walking on paper shall be permitted at any time and, in locations where pedestrian traffic cannot be entirely controlled, the Contractor shall provide walkways and barricades or shall substitute other permissible curing methods on such sections of pavement.

2. Polyethylene Film Curing

Immediately after the finishing of the surface has been completed and the concrete has taken its initial set, it 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 cause it to remain in intimate contact with the surface. The polyethylene film covering shall be maintained in place continuously for not less than the specified curing period.

The film shall be prepared to form blankets of sufficient width to cover the entire surface and both edges of the pavement slab. All joints in the blankets occasioned by joining film sheets shall lap not less than 12 inches (30.5 cms). All joints shall be sealed in a manner acceptable to the Engineer or designated representative 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. Plowing of this windrow into place not to be permitted.

All tears or holes appearing in the polyethylene film during the curing period shall be immediately repaired by placing acceptable moisture proof patches over such defects or by replacing the blankets. It shall be the Contractor's responsibility to prevent damage to the film blankets, which would affect their serviceability and effectiveness as a concrete curing method. Blankets may be rejected by the Engineer at any time if it appears they do not provide an airtight covering.

Polyethylene film blankets rejected on account of pinholes or minor tears may be continued in service when repaired to an airtight condition. All polyethylene film blankets rejected by the Engineer or designated representative shall be immediately marked by the Contractor for identification and then destroyed or stored entirely separate from approved blankets.

Should the film blanket be damaged or torn for any cause during the first 72 hours of the curing period such damage shall be repaired immediately.

3. Membrane Curing

Immediately after the finishing of pavement has been completed and after the free surface moisture has disappeared, the pavement shall be sprayed uniformly with a curing compound. Membrane curing shall conform to Standard Specification Item No. 409S, "Membrane Curing", Type 2 white pigmented. Should the film of compound be damaged from any cause before the expiration of 72 hours after original application, the damaged portions shall be repaired with additional compound. Unless otherwise indicated on the drawings, membrane curing shall be used when the concrete (except that concrete to be used as a base) is placed with a slip form paver.

4. Asphalt Curing

Where emulsified asphalt is used for curing concrete base, the material shall conform to Item No. 301S, "Asphalts, Oils and Emulsions", for the type and grade shown on the drawings. The rate of application may vary between the limits of 1 gallon per 180 square feet and 1 gallon per 90 square feet (1 liter per 4.4 square meters and 1 liter per 2.2 square meters). The rate of application will be determined by the Engineer or designated representative, after observation of sections where amounts varying between the above limits have been applied. If it is found necessary to add water to the emulsion for the proper distribution through the spray, this may be done upon approval of the Engineer or designated representative. When the emulsion is diluted with water the amount of the applied mixture shall be increased to give a coverage of the original emulsion between the limits as set out herein. Care shall be taken to properly mix the emulsion and water and to keep the mixture well agitated during application.

M. Protection of Pavement

The Contractor shall erect and maintain the barricades indicated on the drawings and such other standard and approved devices as will exclude public traffic and traffic of the Contractor's employees and agents from the newly placed pavement for a minimum of 14 days. Portions of the roadway or crossings of the roadbed required to be maintained open for use by traffic shall not be obstructed by above required barricades. Crossings of the pavement indicated on the drawings or by construction sequence, during the period prior to opening to traffic as herein indicated, shall be provided with an adequate and substantial bridge approved by the Engineer or designated representative.

Curb shall be backfilled to the full height of the concrete, tamped and sloped as indicated on the drawings or as directed by the Engineer. The top 4 inches (10

cms) of backfill shall be of clean, friable soil capable of supporting plant life. This material shall also be free of stones and all other debris.

N. Opening Pavement to Traffic

The pavement shall be closed to traffic, including vehicles of the Contractor, until the concrete is at least 14 days old and has attained an average compressive strength acceptable to the Engineer or designated representative. This period of closure to traffic may be extended if, in the opinion of the Engineer or designated representative, weather or other conditions make it advisable to provide an extension of the time of protection.

At the end of the 14 day period and as long thereafter as ordered by the Engineer or designated representative and if so desired by the Contractor, the pavement may be opened for use by vehicles of the Contractor provided the gross weight (vehicle plus load) of such vehicles does not exceed 14,000 pounds (6350 KGs). Such opening, however, shall in no manner relieve the Contractor from responsibility for the Contractor's work. On those sections of the pavement thus opened to traffic, all joints shall first be sealed, the pavement cleaned and topsoil placed against the pavement edges or behind the curb where turf or vegetation is to be established before permitting vehicles thereon.

After the concrete in any section is 14 days old or as long thereafter as ordered by the Engineer, such section of pavement may be opened to all traffic indicated on the drawings or when so directed by the Engineer or designated representative. On those sections of the pavement thus opened to traffic, all joints shall first be sealed, the pavement cleaned and 4 inches (10 cms) of top soil placed against the pavement edges and all other work performed as required for the safety of traffic. Such opening, however, shall in no manner relieve the Contractor from responsibility for the Contractor's work.

When High Early Strength Concrete, resulting from the use of Type III cement as indicated on the drawings is used, the pavement may be opened to all traffic after the concrete is 7 days old or as long thereafter as ordered by the Engineer or designated representative, subject to the same provisions governing the opening after 14 days as above indicated.

Where the Contractor desires to move any equipment not licensed for operation on public streets, on or across any pavement opened to traffic, the Contractor shall protect the pavement from damage by means of 2 ply timber mats of 2 inch (5 cm) stock or runways of heavier material laid on a layer of earth, all as approved by the Engineer or designated representative.

1. Emergency Opening to Traffic

The Engineer or designated representative may require the opening of pavement to traffic prior to the minimum time specified above under conditions of emergency, which in the Engineer's or designated representative's opinion require such action in the interest of the public. In no case will the Engineer or designated representative order opening of the pavement to traffic within less than 72 hours after the last concrete in the section is placed. The Contractor shall remove all obstructing materials, place earth against pavement edges and perform other work involved in

providing for the safety of traffic as required by the Engineer or designated representative in ordering emergency opening. Orders for emergency opening of the pavement to traffic will be issued by the Engineer or designated representative in writing.

360S.8 Penalty for Deficient Pavement Thickness or Strength

The adjustment in unit prices provided for in this item will apply only when measurement for payment is by the square yard.

It is the intent of this specification that the pavement be constructed in strict conformity with the thickness, strength and typical sections indicated on the drawings. Where any pavement is found not so constructed, the following rules relative to adjustment of payment for acceptable pavement and to replacement of faulty pavement shall govern.

A. Pavement

The pavement will be core drilled after any grinding operations have been completed for surface corrections prior to final acceptance. Locations of core tests may be selected by the Engineer or designated representative; however, spacing interval for core tests, as specified herein, shall be maintained. The thickness of the pavement will be determined by measurement of the cores in accordance with TxDOT Test Method Tex-424-A.

For the purpose of establishing an adjusted unit price for pavement, units to be considered separately are defined as 1000 linear feet of pavement in each traffic lane starting at the end of the pavement bearing the smaller station number. The last unit in each lane shall be 1000 feet plus the fractional part of 1000 feet remaining. Traffic lane width will be as shown on typical sections and pavement design standards.

For the purpose of establishing an adjusted unit price for ramps, widening, acceleration and deceleration lanes that are machine placed, isolated pavements of traffic lane width but less than 1000 feet in length and other areas designated by the Engineer or designated representative, units will be considered separately and are defined as 1000 square yards of pavement or fraction thereof.

One core will be taken at the location selected by the Engineer or designated representative or at random in each unit. When the measurement of the core from any unit is not deficient more than 0.2 inches from the plan thickness, full payment will be made. When the measurement of the core from any unit is deficient more than 0.2 inch but not more than 0.75 inch from the plan thickness, 2 additional cores will be taken from the unit and the average of the 3 cores determined. The 2 additional cores from any 1000-foot unit will be taken at intervals of not less than 300 feet. The 2 additional cores from any 1000 square yard unit will be taken at locations such that the pavement in the unit will be well represented. If the average measurement of these 3 cores is not deficient more than 0.2 inches from the plan thickness, full payment will be made. If the average thickness of the 3 cores is deficient by more than 0.2 inch but not more than 0.75 inch from the

indicated thickness, an adjusted unit price as provided below will be paid for the areas represented by these cores.

In calculating the average thickness of the pavement, measurements which are in excess of the specified thickness by more than 0.2 inch will be considered as the specified thickness plus 0.2 inch and measurements which are less than the specified thickness by more than 0.75 inch will be considered as the specified thickness less 0.75 inch.

When the measurement of any core is less than the specified thickness by more than 0.75 inch, the actual thickness of pavement in this area will be determined by taking additional cores at 10 foot intervals parallel to the center line in each direction from the deficient core until, in each direction, a core is taken which is not deficient by more than 0.75 inch. Exploratory cores for deficient thickness will not be used in averages for adjusted unit price. Exploratory cores are to be used only to determine the length of pavement in a unit that is to be left in place without pay and/or removed and replaced as provided herein.

For new Concrete Pavement roadways, and for Concrete Pavement rehabilitation and overlay projects, if cracks develop in the pavement surface within the one year warranty period, the Contractor shall seal the cracks in accordance Standard Specification Item No. 313S, “Cleaning and/or Sealing Joints and Cracks (Asphaltic Concrete), or perform other corrective measures as directed by the Engineer. Payment for this work will be included in the unit price bid for Concrete Pavement, unless included as a separate pay item in the Contract.

For new Concrete Pavement roadways constructed in accordance with the plans and specifications, if cracks greater than or equal to 1/4 inch in width develop in the pavement surface within the one year warranty period, complete replacement of pavement sections as directed by the Engineer shall be performed by the Contractor at no additional expense to the City.

Irrespective of an acceptable overall project average for any or all of the Pay-Adjustment Acceptance Factors, limited substandard portions of the work, as determined by the Engineer or designated representative, shall be remedied or removed and replaced to the satisfaction thereof.

B. Price Adjustments

After any grinding or milling operations have been completed to meet the surface-testing requirement of this specification, if average thickness of pavement is deficient in thickness by more than 0.2 inch, but not more than 0.75 inch, payment will be made at an adjusted price as specified in the following table:

Concrete Pavement Deficiency	
Deficiency in Thickness Determined by Cores, Inches	Proportional Part of Contract Price Allowed

0.00 to 0.20	100 percent
0.21 to 0.30	80 percent
0.31 to 0.40	72 percent
0.41 to 0.50	68 percent
0.51 to 0.75	57 percent

Any area of pavement found deficient in thickness by more than 0.75 inch but not more than 1 inch or 1/8 of the indicated thickness, whichever is greater, shall be evaluated by the Engineer. If, in the judgment of the Engineer, the area of such deficiency should not be removed and replaced, there will be no payment for the area retained. If, in the judgment of the Engineer, the area of such deficiency warrants removal, the area shall be removed and replaced at the Contractor's entire expense, with concrete of the thickness indicated on the drawings.

Any area of pavement found deficient in thickness by more than 1 inch or more than 1/8 of the indicated thickness, whichever is greater, shall be removed and replaced, at the Contractor's entire expense, with concrete of the thickness indicated on the drawings.

No additional payment over the Contract unit price will be made for any pavement of a thickness exceeding that indicated on the drawings.

If the average compressive strength based on concrete test cylinders at 28 days is less than the specified minimum strength of the concrete, then payment will be made at an adjusted price as specified in the following table.

Pay Adjustment Factor for Deficient Compressive Strength	
Ratio of Average Strength from Test Cylinders to Specified Minimum Compressive Strength both at 28 Days	Proportional Part of Contract Price Allowed
More then 0.95	100 percent
0.90 to 0.95	85 percent
0.85 to 0.90	70 percent
0.80 to 0.85	60 percent
Less than 0.80	0 percent (Remove & Replace)

When, in the opinion of the Engineer or designated representative, the compressive strength test results appear unrepresentative, additional testing of field cores may be authorized. To be considered acceptable for consideration the

field cores shall be acquired, properly handled and tested in accordance with ASTM C 42/C 42M, "Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete" within 45 days of the original concrete placement date. The retesting will be at the expense of the Contractor and the results of the retesting shall be averaged with the results of the original testing. If the results of retesting indicate that the original test results were erroneous in the opinion of the Engineer or designated representative, the original test results will be discarded. In the instance of erroneous original test results the subsequent first set of retests will be at the expense of the City of Austin.

When, in the opinion of the Engineer or designated representative, the concrete compressive strength is deemed unacceptable for the intended use of the pavement, the concrete shall be removed and replaced to the limits indicated by test results.

360S.9 Measurement

A. When indicated, concrete pavement will be measured by the square yard of surface area of completed and accepted work. The surface area shall be so measured to also include that portion of pavement slab extending beneath the curb. When concrete pavement is to be measured by the square yard and monolithic curb is required, measurements for "Monolithic Curb" will be by the linear foot complete in place.

B. When indicated on the drawing, concrete pavement, including monolithic curb when required, will be measured by the cubic yard of absolute volume of materials entering the mixture.

360S.10 Payment

The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Pavement", of the depth indicated on the drawings, "Concrete Pavement (High Early Strength)" of the depth indicated on the drawings and "Monolithic Curb" of the type indicated on the drawings (when pavement is measured by the square yard), as required or adjusted unit price for pavement of deficient thickness as provided under "Deficient Pavement Thickness", which price shall be full compensation for shaping and fine grading the roadbed, including furnishing and applying all water required; for furnishing, loading and unloading, storing, hauling and handling all concrete ingredients, including all freight and royalty involved; for placing and adjusting forms, including supporting material or preparing track grade; for mixing, placing, finishing, sawing, cleaning and sealing joints and curing all concrete; 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 and wire and devices for placing, holding and supporting steel bars, load transmission devices and joint filler material in proper position, for coating steel bars where complete the work.

Excavation required by this item in the preparation of the subgrade and for completion of the parkway will be measured and paid for in accordance with provisions governing the Items of "Street Excavation" and "Borrow", respectively, with provision that yardage to be measured and paid for once only, regardless of manipulations involved. Measurement of subgrade excavation for payment shall be limited to a total width of that of pavement plus 1 foot on each side.

Sprinkling and rolling required for the compaction of the rough subgrade in advance of fine grading will be measured and paid for as indicated in the governing items of excavation. Maintenance of a moist condition of the subgrade in advance of fine grading and concrete placing will not be paid for directly but shall be included in the unit price bid, as provided above.

Payment will be made under one of the following:

Pay Item No.	360S-A:	__In. Concrete Pavement	Per Square Yard.
Pay Item No.	360S-AH:	__In. Concrete Pavement (High Early Strength)	Per Square Yard.
Pay Item No.	360S-AS:	__In. Concrete Pavement (High Range Water Reducing Admixture)	Per Square Yard.
Pay Item No.	360S-B:	Monolithic Curb	Per Linear Foot.
Pay Item No.	360S-C:	__Concrete Pavement Including Monolithic Curb	Per Cubic Yard.

End

SPECIFIC CROSS REFERENCE MATERIALS
Standard Specification Item 360S, "Concrete Pavement"

City of Austin Standard Specification Items

Designation	Description
Item No. 301S	Asphalts, Oils and Emulsions
Item No. 313S	Cleaning and/or Sealing Joints and Cracks (Asphaltic Concrete)
Item No. 403S	Concrete for Structures
Item No. 405S	Concrete Admixtures
Item No. 410S	Concrete Structures
Item No. 411S	Surface Finishes for Concrete
Item No. 413S	Cleaning and/or Sealing Joints and Cracks (PCC)

American Society for Testing and Materials, ASTM

Designation	Description
ASTM C 42/C 42M	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete"
ASTM A 82	Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 184	Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 185	Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 496	Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497	Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement

ASTM A 615	Specification for Deformed and Plain Billet-Steel Bars, for Concrete Reinforcement
ASTM A 616	Specification Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM C 94	Specification for Ready-Mixed Concrete
ASTM C 150	Specification for Portland Cement
ASTM C 156	Test Method for Water Retention by Concrete Curing Materials
ASTM D 2240	Test Method for Rubber Property-Durameter Hardness
ASTM D 882, Method A	Test Methods for Tensile Properties of Thin Plastic Sheeting

Texas Department of Transportation: Publications

Designation	Description
Bulletin C-11	Construction Bulletin

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
TEX-203-F	Sand Equivalent Test
TEX-401-A	Sieve Analysis of Fine and Coarse Aggregate
TEX-406-A	Mineral Finer than 75 µm (No. 200) Sieve in Mineral Aggregates (Decantation Test for Concrete Aggregates)
TEX-408-A	Organic Impurities in Fine Aggregate for Concrete
TEX-410-A	Abrasion of Coarse Aggregate Using The Los Angeles Machine
TEX-411-A	Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
TEX-413-A	Determination of Deleterious Materials in Mineral Aggregate

TEX-415-A	Slump of Portland Cement Concrete
TEX-416-A	Air Content of Freshly-Mixed Concrete by the Pressure Method
Tex-424-A	Obtaining and Testing Drilled Cores of Concrete
Tex-436-A	Measurement of Texture Depth by the Sand Patch Method
Tex 418-A	Compressive Strength of Cylindrical Concrete
Tex-524-C	Testing Premolded Joint Filler for Concrete
Tex-612	Acid Insoluble Residue

Texas Department of Transportation: Departmental Material Specifications

Designation	Description
DMS 8900	Fly Ash

American Association of State Highway & Transportation Officials, AASHTO Standard

Designation	Description
Method T 26	Quality of Water to be Used in Concrete

RELATED CROSS REFERENCE MATERIALS
Standard Specification Item 360S, "Concrete Pavement"

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item 360	Concrete Pavement
Item 420	Concrete Structures

Item 421	Hydraulic Cement Concrete
Item 427	Surface Finishes for Concrete
Item 431	Pneumatically Placed Concrete
Item 520	Weighing and Measuring Equipment

Texas Department of Transportation: Departmental Material Specifications

Designation	Description
DMS-4650	Hydraulic Cement Concrete Curing Materials and Evaporation Retardants"
DMS-6100	Epoxy and Adhesives

American Society for Testing and Materials, ASTM

Designation	Description
ASTM C 685	Concrete Made By Volumetric Batching and Continuous Mixing
ASTM C-1260	Standard Test Method for Potential Alkali Reactivity of Aggregates
ASTM D-512	Test Methods for Chloride Ion in Water
ASTM D-516	Test Methods for Sulfate Ion in Water
ASTM D-4191	Test Method for Sodium in Water by Atomic Absorption
ASTM D-4192	Test Method for Potassium Water by Atomic Absorption

American Concrete Institute, ACI

Designation	Description
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
TEX-418-A	Compressive Strength of Cylindrical Concrete Specimens

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Item No. 401S
Structural Excavation and Backfill

401S.1 Description

This item shall govern the excavation for placement of structures, except pipe sewers, the disposal of such excavated material and the backfill around completed structures to the level of the original ground or grade indicated on the Drawings. The work shall include all necessary pumping or bailing, sheathing, drainage, and the construction and removal of any required cofferdams. Unless otherwise indicated on the Drawings, the work included hereunder shall provide for the removal of old structures or portions thereof (abutments, buildings, foundations, wingwalls, piers, etc.), trees and all other obstructions necessary to the proposed construction.

Where excavation is not classified, it will be grouped under "Unclassified Structural Excavation", which shall include the removal of all materials encountered regardless of their nature or the manner in which they are removed.

Where excavation is classified, it shall be classed as "Common Structural Excavation" or "Rock Structural Excavation" in accordance with the following criteria:

"Common Structural Excavation" shall include the removal of all materials other than rock.

"Rock Structural Excavation" shall include the removal of firm and compact materials that cannot be excavated with power equipment, without first being loosened or broken by blasting, sledging or drilling.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

401S.2 Submittals

The submittal requirements of this specification item may include:

Supplier and certified test results for fine aggregate/sand material

Supplier and certified test results for flexible base material

Mix design and test results for lime stabilized subgrade material

Mix design and test results for Class J Concrete Base

Supplier and certified test results for granular material (coarse aggregate, foundation rock and pea gravel)

Mix design and test results for cement-stabilized backfill

Mix design and test results for controlled low strength material (CLSM)

Excavation Safety System Plan for proposed cofferdams, trench excavation and special shoring installations

401S.3 Materials

A. Sand

1. Fine aggregate sand shall be Grade 1 conforming to Standard Specification Item No. 302S, "Aggregates for Surface Treatments".

2. Native Sand shall be local material obtained from approved sources and subject to the approval of the Engineer or designated representative.

B. Flexible Base

Flexible base shall conform to the requirements of Standard Specification Item No. 210S, "Flexible Base".

C. Lime Stabilized Base

Lime stabilized base shall conform to the requirements of Standard Specification Item No. 202S, "Hydrated Lime and Lime Slurry" and Item No. 203S, "Lime Treatment for Materials in Place".

D. Concrete Base

Concrete base shall conform to a Class J Concrete as defined in Standard Specification Item No. 403S, "Concrete for Structures".

E. Granular Material

1. Coarse aggregate shall conform to the requirements of section 403S.3.C of Standard Specification Item No. 403S "Concrete for Structures".

2. Foundation Rock

Foundation rock shall be well graded, hard, durable coarse aggregate ranging in size from 2 to 6 inches (50 to 150 mm).

3. Pea Gravel

Pea gravel shall consist of hard, durable, opaque gravel, free of clay, loam, sand or other foreign substances, ranging in size from 1/4 inch to 3/8 inch (6.4 to 9.5 mm) conforming to ASTM C 33.

F. Cement Stabilized Backfill

Cement stabilized backfill shall contain aggregate, water and a minimum of 7% hydraulic cement based on the dry weight of the aggregate in accordance with TxDoT Test Method Tex-120-E, “Soil-Cement Testing". Unless directed otherwise

on the Drawings, the aggregate shall be clean sand approved by the Engineer or designated representative.

G. Controlled Low Strength Material

Controlled low strength material (CLSM) shall conform to Standard Specification Item No. 402S, "Controlled Low Strength Material" and shall be approved by the Engineer or designated representative.

401S.4 Construction Methods

A. Erosion Control and Tree Protection

Prior to commencement of this work, all required erosion control and tree protection measures indicated on the Drawings shall be in place. The existing utilities shall be located and protected as specified in the Standard Contract Documents, Section 00700, "General Conditions" and/or indicated on the Drawings. A permit shall be required when utility adjustments are to be made in preparation for construction in the right-of-way, as specified in Section 5.2.0 of the City of Austin Utilities Criteria Manual.

Areas within the construction limits indicated on the Drawings shall be cleared of all trees, stumps, brush, etc., except trees or shrubs scheduled for preservation which shall be carefully trimmed as directed by the Engineer or designated representative, in accordance with Standard Specification Item No. 610S, " Preservation of Trees and Other Vegetation" and shall be protected from scarring, barking or other injuries during construction operations. All exposed cuts over 2 inches (50 millimeters) in diameter, exposed ends of pruned limbs or scarred bark shall be treated with an approved asphalt material within 24 hours of the pruning or injury.

Construction equipment shall not be operated nor construction materials stockpiled under the canopies of trees, unless otherwise indicated on the Drawings and/or specified in the Contract Documents. Excavation or embankment materials shall not be placed within the drip line of trees until tree wells are constructed.

Within the construction limits or areas indicated, all obstructions, stumps, roots, vegetation, abandoned structures, rubbish and objectionable material shall be removed to the following depths:

1. In areas to receive 6 inches (150 mm) or more embankment, a minimum of 12 inches (300 mm) below natural ground.

2. In areas to receive embankment less than 6 inches (150 mm), a minimum of 18 inches (450 mm) below the lower elevation of embankment, structure or excavation.

3. In areas to be excavated a minimum of 18 inches (450 mm) below the lower elevation of the embankment, structure or excavation.

4. In all other areas a minimum of 12 inches (300 mm) below natural ground.

When abandoned storm drains, sewers or other drainage systems are encountered they shall be removed as required to clear the new structure and plugged in a manner approved by the Engineer or designated representative.

Holes remaining after removal of all obstructions, objectionable material, trees, stumps, etc. shall be backfilled with select embankment material and compacted by approved methods. All cleared and grubbed material shall be disposed of in a manner satisfactory to the Engineer or designated representative. Unless otherwise provided, all materials as described above shall become the property of the Contractor and removed from the site and disposed of at a permitted disposal site.

Burning materials at the site shall conform to Standard Contract Document Section 01550, "Public Safety and Convenience".

B. Excavation

1. Excavation shall be done in accordance with the lines and depths indicated on the Drawings or as established by the Engineer or designated representative. Unless otherwise indicated on the Drawings or permitted by the Engineer or designated representative no excavation shall be made outside a vertical plane 3 feet (0.9 meter) from the footing lines and parallel thereto.

   When structures are installed in streets, highways or other paved areas, the pavement and base shall be cut to neat lines. After completion of the excavation and backfilling, the pavement structure shall be restored to the satisfaction of the Engineer or designated representative.

2. Slopes, benching, sheeting, bracing, pumping and bailing shall be provided as necessary to maintain the stability and safety of excavations up to 5 feet (1.5 meters) deep. Excavation protection for excavations deeper than 5 feet (1.5 meters) shall be governed by Standard Specification Item No. 509S, "Excavation Safety Systems".

3. Excavation shall conform to elevations indicated on the Drawing or raised or lowered by written order of the Engineer or designated representative, when such alterations are judged proper. When it is deemed necessary to increase or decrease the plan depth of footings, the alterations in the details of the structure shall be as directed by the Engineer or designated representative. The Engineer or designated representative shall have the right to substitute revised details resulting from consideration of changes in the design conditions.

4. When a structure is to rest on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation and the final excavation to grade shall not be performed until just before the footing is placed. Equipment selected and used by the Contractor for excavation which results in disturbance of what was otherwise stable subgrade material, as shown by laboratory tests, will not be used as a justification for payment for excavating to extra depth or for payment for stabilizing materials which may be ordered by the Engineer or designated representative.

5. Excavated material required to be used for backfill may be deposited by the Contractor in storage piles as indicated on the Drawing or at points convenient for its rehandling during the backfilling operations, subject to the approval of the Engineer or designated representative, who may require that the survey center line of the structure and the transverse or hub line of any unit of the structure be kept free of any obstruction. The Contractor shall adjust any stockpiles, to facilitate surveying and the work of other Contractors working in the immediate proximity, as directed by the Engineer or designated representative.

6. Excavated material required to be wasted shall be disposed of as directed by the Engineer or designated representative, in a manner which will not obstruct the stream or otherwise impair the efficiency or appearance of the structure or other part of the work.

7. For all single and multiple box culverts, pipe culverts, pipe arch culverts and box sewers of all types, where the soil encountered at established footing grade is a quicksand, muck or similar unstable material, the following procedure shall be used unless other methods are indicated:

   a) The depth to which unstable material is removed will be determined by the Engineer or designated representative. It will not exceed 2 feet (0.6 meter) below the footing of culverts that are 2 feet (0.6 meter) or more in height and will not exceed the height of culverts for those less than 2 feet (0.6 meter) high. Excavation shall be carried at least 1 foot (0.3 meter) horizontally beyond the limits of the structure on all sides. All unstable soil removed shall be replaced with suitable stable material, in uniform layers of suitable depth for compaction as directed by the Engineer or designated representative. Each layer shall be wetted, if necessary and compacted by rolling or tamping as required to provide a stable foundation for the structure. Soil, which has sufficient stability to properly sustain the adjacent sections of the roadway embankment, will be considered a suitable foundation material.

   b) When, in the opinion of the Engineer or designated representative, it is not feasible to construct a stable footing as outlined above, the Contractor shall construct it by the use of special materials, such as flexible base, cement stabilized base, cement stabilized rockfill or other material, as directed by the Engineer or designated representative. This work will be paid for as provided in Section 401S.9, " Payment".

8. When the material encountered at footing grade of a culvert is found to be partially rock or incompressible material and partially a compressible soil which is satisfactory for the foundation, the incompressible material shall be removed for a depth of 6 inches (150 mm) below the footing grade and backfilled with a compressible material similar to that used for the rest of the structure.

9. When the material encountered at footing grade of a 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 Engineer

or designated representative has inspected the footing and authorized such changes found necessary to provide an adequate foundation.

401S.5 Bridge Foundations and Retaining Walls

The material below the bottom of the footing grade shall not be disturbed. Backfill material shall not be used to compensate for excavation that is extended below the proposed footing grade. When excavation is carried below the proposed footing grade, the over excavated area shall be filled with concrete at the time the footing is placed. The additional concrete placement shall be at the Contractor's sole expense.

When required by the Engineer or designated representative, cores shall be taken to determine the character of the supporting material(s). The cores shall be taken when the excavation is nearing completion and shall be an intact sample adequate to judge the character of the founding material. The cores shall be acquired at a minimum depth of 5 feet (1.5 meters) below the proposed footing founding grade.

When the founding stratum is rock or other hard material, all loose material shall be removed and the founding grade cleaned and cut to a firm surface that is level, stepped or serrated as directed by the Engineer or designated representative. All soft seams shall be cleaned and filled with concrete at the time the footing is placed.

When the material at the footing grade of a retaining wall, bridge bent or pier is a mixture of compressible and incompressible material, the foundation shall not be placed until the Engineer or designated representative has inspected the excavation and authorized changes to provide a uniform bearing condition.

401S.6 Cofferdams

The term cofferdams, whenever used in this specification, 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 earth, timber, steel, concrete or a combination of these. It includes earthen dikes, timber cribs, any type of sheet piling, removable steel shells and the like and all necessary bracing and it shall be understood also to include the use of pumping wells or well points for de-watering. The cost of cofferdams, when required, shall be included as a part of the bid price for excavation.

It is the intent of this specification to require that a suitable cofferdam be provided, when necessary, to insure that the foundation may be placed in a dry condition, as to preclude sliding and caving of the walls of the excavation. The cofferdam shall conform with the requirements of Standard Specification Item No. 509S, "Excavation Safety Systems" and shall provide a safe work area with sufficient clearance for the construction, inspection and removal of required forms and, if necessary, sufficient room to allow pumping outside the forms. Where no ground or surface water is encountered, the cofferdam need be sufficient only to protect the workmen and to avoid cave-ins or slides beyond the excavation limits.

Unless otherwise indicated on the Drawings, cofferdams shall be removed by the Contractor after the completion of the substructure without disturbing or marring the structure.

401S.7 De-Watering

Structures shall not be constructed or placed in the presence of water unless otherwise approved by the Engineer or designated representative. Precast members, pipe and concrete shall only be placed on a dry, firm surface. Water shall be removed by bailing, pumping, well-point installation, deep wells, underdrains or other approved method.

When structures are approved for placement in the presence of water, standing water shall be removed in a manner that shall preclude the possibility of the movement of water through or alongside any concrete being placed. Pumping or bailing will not be permitted during the placing of concrete or for a period of at least 36 hours thereafter, unless from a suitable sump separated from the concrete work by a water-tight wall.

Pumping or bailing during placement of seal concrete shall only be allowed to the extent necessary to maintain a static head of water within the cofferdam. De-watering inside a sealed cofferdam shall not commence until the seal has aged a minimum of 36 hours.

When the bottom of an excavation cannot be de-watered to the point that the subgrade is free of mud or it is difficult to keep the reinforcing steel clean a stabilizing material (e.g. flexible base, cement-stabilized-backfill or lean concrete) shall be placed in the bottom of the excavation. When a lean concrete is used, the concrete shall include a minimum of 275 Pounds of cement per cubic yard (163 kilograms of cement per cubic meter) and be placed to a minimum depth of 3 inches (75 mm). Stabilizing material that is placed for the convenience of the Contractor will be at the Contractor's own expense.

401S.8 Backfilling

A. General

As soon as practicable, all portions of excavation not occupied by the permanent structure shall be backfilled. Back-fill material shall be free from stones large enough to interfere with compaction, large or frozen lumps that will not break down readily under compaction, wood or other extraneous material. Backfill material shall be approved by the Engineer or designated representative.

That portion of backfill which will support any portion of completed roadbed, retaining wall or embankment shall be placed in layers not more than 8 inches (200 mm) in depth (loose measurement) and shall be compacted to meet the density requirements of the roadbed, retaining wall, embankment material, or as indicated on the Drawings.

That portion of backfill which will not support any portion of completed roadbed or embankment shall be placed in layers not more than 10 inches (250 mm) in depth (loose measurement) and shall be compacted to a minimum of 95 percent of

maximum density as determined by TxDoT Test Method Tex-114-E and the re-excavated to the proper grade and dimensions.

If the excavation has been made through a hard material resistant to erosion, the backfill around piers and in front of abutments and wings may be ordered by the Engineer or designated representative to be of stone or lean concrete. Unless otherwise indicated on the Drawings, such backfill shall be paid for as extra work.

That portion of the backfill which will support any portion of the roadbed, retaining wall or embankment shall be placed in uniform layers not more than 8 inches (200 mm) in depth (loose measurement) and shall be compacted to a minimum of 95 percent of maximum density, as determined by TxDoT Test Method Tex-114-E and then re-excavated to the proper grade and wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to that density by means of mechanical tampers or rammers, except that the use of rolling equipment of the type generally used in compaction embankments will be permitted on portions which are accessible to such equipment.

All portions of embankment too close to any portion of 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 with mechanical tamps and rammers to avoid damage to the structure.

These provisions require mechanical compaction by means of either rolling equipment or mechanical tampers or rammers, of all backfill and embankment adjoining the barrels and wingwalls or culverts and adjoining all sides of bridge abutments and retaining walls, regardless of whether or not such embankment or backfill is above or below the original surface of the ground and regardless of whether the excavation at structure site was performed conforming to Standard Specification Item No.111S, "Excavation", this item 401S, "Structural Excavation", Standard Specification Item No. 110S, "Street Excavation" or Standard Specification Item No. 120S, "Channel Excavation". Unless otherwise indicated on the Drawings, hand tamping will not be accepted as an alternate for mechanical compaction.

As a general rule, material used in filling or backfilling the portions described in this paragraph shall be an earth, free of any appreciable amount of gravel or stone particles larger than 4 inches (100 mm) in greater dimension and of a gradation that permits thorough compaction. When, in the opinion of the Engineer or designated representative, such material is not readily available, the use of rock or gravel mixed with earth will be permitted, provided that no particles larger than 12 inches (300 mm) or smaller than 6 inches (150 mm) 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. When required by the Drawings or by written order of the Engineer or designated representative, cement-stabilized-backfill material shall be used for backfilling.

All portions of fill and backfill described in the preceding paragraph shall be compacted to the same density requirements specified for the adjoining sections of embankment in accordance with the governing specifications. Where no embankment is involved on the project and no relevant specifications are included in the contract, all backfill shall be compacted to a density comparable with the adjacent undisturbed material.

No backfill shall be placed against any abutment or retaining wall until such structure has been in place at least 7 days. No backfill shall be placed adjacent to or over single and multiple boxes until the top slab has attained 500 psi (3450 kPa) flexural strength. Backfill placed around abutments and piers shall be deposited on both sides to approximately the same elevation at the same time.

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 shall be uniformly placed around bridge foundations.

B. Pipe Culverts

The following requirements shall apply to the backfilling of pipe culverts in addition to the pertinent portions of the general requirements given in the preceding section.

Selected materials from excavation, borrow or other approved material shall be wetted, if required and placed along both sides of the pipe equally, in uniform layers not exceeding 8 inches (200 mm) in depth (loose measurement) and thoroughly compacted so that there shall be a berm of thoroughly compacted material on each side of the pipe. The method and degree of compaction shall be the same as specified above for portions of backfill within the limits of embankment or roadbed.

Filling and/or backfilling shall be continued in this manner to the elevation of the top of the pipe. Special care shall be taken to secure thorough compaction of the material placed under the haunches of the pipe to prevent damage or displacement of the pipe. All fill or backfill below the top of pipe shall be compacted mechanically in the manner and to the density prescribed above, regardless of whether or not such material is placed within the limits of the embankment or roadbed. In the case of pipe placed in trenches, that portion of the backfill above the top of the pipe which supports embankment or the roadbed shall receive mechanical compaction as specified above and the portion which will not support any portion of embankment or roadbed shall be placed in layers not more than 8 inches (200 mm) in depth (loose measurement) and shall be compacted by whatever means the Contractor chooses, to a density comparable with the adjacent, undisturbed material. Embankments above the top of pipe shall be placed conforming to Item No. 132S, "Embankment". During construction adequate cover must be provided to protect the structure from damage.

The Engineer or designated representative may reject backfill material that contains more than 20% by weight of material retained on a 3-in (75 mm) sieve, with large lumps not easily broken down, or that cannot be spread in loose layers. Material excavated by a trenching machine will generally meet the requirements of this Section as long as large stones are not present.

Where pipe extends 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 until the minimum cover has been provided.

Whenever excavation is made for installing pipe culverts or box sewers across private property or beyond the limits of the embankment, the top soil removed in

excavating the trench shall be kept separate and replaced as nearly as feasible in its original position and the entire area involved in the construction operations shall be restored to a presentable condition.

C. Cement Stabilized Backfill

When indicated on the Drawings, trenches shall be backfilled to the elevations shown with cement stabilized backfill. The cement-stabilized backfill shall be placed equally along the sides of structures to prevent strain on or displacement of the structure.

Cement stabilized backfill below the spring line of pipe culverts shall be sufficiently plastic to completely fill all voids in the trench. Hand operated tampers may be used if necessary to fill the voids. The pipe shall be held in alignment by jacks or other suitable means to prevent the mortared joints from cracking due to displacement caused by placing the backfill material.

Cement stabilized backfill above the spring line of pipe culverts may be dry enough to be transported without special mixing equipment.

On structures other than pipe culverts, special mixing equipment will not be required to transport the cement stabilized backfill unless otherwise indicated on the Drawings.

D. Controlled Low Strength Material (CLSM)

When indicated on the Drawings the excavation shall be backfilled with CLSM to the elevations shown. The structure shall be prevented from being displaced or "floated out" during the placement of CLSM. The CLSM shall be prevented from entering culverts and drainage structures.

401S.9 Measurement

Unless otherwise indicated on the Drawings, structural excavation for pipe headwalls, inlets, manholes, culvert widening (extensions), bridge abutments and side road and private entrance pipe culverts will not be measured in the field but shall be included in the Plan Quantity unit price bid by the cubic yard (cubic meters: 1 cubic meter is equal to 1.308 cubic yards). Determination of plan quantities for structural excavation shall be made by the method of average end-areas using the following limits to establish templates for measurement.

A. For all structures requiring measurement, except the barrels of pipe culverts, no material outside of vertical planes 1 foot (300 mm) beyond the edges of the footings and parallel thereto will be included.

B. For the barrels of pipe culverts of 42 inches (1.09 meters) or less nominal or equivalent diameter, no material outside of vertical planes 1 foot (300 mm) beyond the horizontal projection of the outside surfaces of the pipe and parallel thereto will be included. For the barrels of pipe culverts more than 42 inches (1.09 meters) in nominal or equivalent diameter, no material outside of vertical planes located 2 feet

(600 mm) beyond the horizontal projection of the outside surfaces of the pipe and parallel thereto will be included.

C. If a cofferdam, as herein defined, is used, the limitations indicated above shall apply just as if no cofferdams were used.

D. 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, measurements for such additional excavation will be limited laterally by vertical planes 1 foot (300 mm) beyond the face of the member and parallel thereto and vertically to a depth of 1 foot (300 mm) below the bottom of such member.

E. Except as allowed by the above conditions, no account will be taken of any excavation necessary for placing forms or falsework.

F. Except at side road culverts, all street excavation called for on the contract drawings at all structure sites shall be assumed to be completed before starting the structural excavation and the measurement of structural excavation will include only material below or outside the limits of the completed street excavation. Excavation for side road and private entrance pipe culverts will not be measured for payment but shall be included in the unit price bid for this specification item.

G. On all structures of bridge classification where the contract drawings call for channel excavation at the structure site, it shall be assumed to have been completed before starting the structural excavation and the measurement of structural excavation will include only material below or outside the limits of the completed channel section. The method of measurement for payment will be in accordance with this procedure regardless of the actual construction methods followed.

H. Where excavation diagrams are indicated on the Drawings, they shall take precedence over these provisions.

I. Measurement will not include materials removed below footing grades to compensate for anticipated swellage due to pile driving and it will not include material required to be removed due to swellage beyond the specified limits during pile driving operations.

J. Measurement will not include additional yardage caused by slips, slides, cave-ins, siltings or fillings due to the action of the elements or the carelessness of the Contractor. Water will not be classed as excavated material.

K. Where rock, other incompressible or unstable material is undercut to provide suitable foundation for pipe or box culverts, such material below grade, ordered by the Engineer or designated representative to be removed, will be measured for payment.

L. Except for any required undercut, quantities for "Structural Excavation", as indicated on the Drawings, shall be considered as final quantities and no further measurement will be required, unless the alignment, grades or structure locations

are revised by the Engineer or designated representative during construction. Final determination of quantities for individual structures will be made, if in the opinion of the Engineer or designated representative or upon evidence furnished by the Contractor, substantial variations exist between quantities indicated on the Drawings and actual quantities due to changes in cross sections or apparent errors. Excavation quantities for foundations indicated on the Drawings where cofferdams are required shall be considered as final quantities and no further measurement will be made.

M. For any footing, foundation or other structure unit within the scope of this specification, 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 Engineer or designated representative. Measurement will be made by the addition to or the deduction from, the original quantities for the volume of excavation involved in the authorized grade change.

N. Cement stabilized backfill shall be measured by the backfill diagram as indicated on the Drawings. The quantity of "Cement Stabilized Backfill" as indicated on the Drawings shall be considered as final quantities and no further measurement will be required, unless alignment or grade elevations as indicated are revised by the Engineer or designated representative. If such revisions result in an increase or decrease in this quantity, the final quantity will be revised by the amount represented by the changes in alignment or grade elevations.

401S.10 Payment

Payment for all work prescribed under this item and measured as provided above will be made at the unit bid price per cubic yard for the particular class of excavation specified on the Drawings in the amount shown on the Drawings and in the proposal. Payment for revised quantities will be made as specified above and for the removal of unstable and incompressible material as noted below.

Payment for removal and replacement of unstable or incompressible material below the footing grades of culverts and box sewers as indicated above will be made as follows:

When indicated on the Drawings or the Engineer or designated representative directs the use of special materials such as flexible base, concretebase, cement stabilized backfill, controlled low strength material or other special material, payment for excavation below the footing grades shall be made at the unit bid price for "Unclassified Structural Excavation", "Common Structural Excavation" or "Rock Structural Excavation", as the case may be. Payment for furnishing, hauling, placing and compacting the flexible base, concretebase, cement stabilized backfill, controlled low strength material or other special material will be made at the unit bid price for these items in the bid or in accordance with pertinent provisions for extra work.

Where special materials are not required or specified, the removal and replacement of the unstable material will be performed as described above. Payment therefore will be made at a price equal to 200 percent of the unit bid price per cubic yard for "Unclassified

Structural Excavation", "Common Structural Excavation" or "Rock Structural Excavation", as the case may be. The unit bid price shall include full compensation for removing the unstable or incompressible material, for furnishing, hauling, placing and compacting suitable material required to replace it and for all labor, equipment, tools and incidentals necessary to complete the work.

Payment for "Concrete Base", "Cement Stabilized Backfill" and “Controlled Low Strength Material” measured as prescribed above shall be made at the unit bid price per cubic yard. The unit bid price shall include full compensation for furnishing all materials, tools, labor, equipment, sheathing and incidentals required to perform the applicable work prescribed herein.

When the Engineer or designated representative judges it necessary to lower the structure footings to an elevation below the grade indicated on the Drawings, payment for the "Unclassified Structural Excavation", "Common Structural Excavation" or "Rock Structural Excavation" as the case may be, required below plan grade down to and including an elevation 5 feet (1.5 meters) below drawing grade for any individual footing will be made at a unit price equal to 115 percent of the contract unit bid price. Payment for the excavation from an elevation over 5 feet (1.5 meters) below plan grade down to and including an elevation 10 feet (3.05 meters) below plan grade will be made at a unit price equal to 125 percent of the contract unit bid price for "Unclassified Structural Excavation", "Common Structural Excavation" or "Rock Structural Excavation" as the case may be. No increase in unit price will be allowed for other bid items of the contract and no additional compensation will be allowed for any required cofferdam adjustments made necessary by such lowering of footings. These provisions shall not apply to the lowering of culverts, except when the flow line grade is lowered 1 foot (300 mm) or more below plan grade.

In cases where the extra depths required for any footing or footings exceeds 10 feet (3.05 meters), a supplemental agreement shall be made covering the quantities removed from depths in excess of 10 feet (3.05 meters) below plan grade.

No direct payment will be made for filling or backfilling around structures. Payment for the backfilling and compacting of areas, which were removed as structural excavation shall be included in the unit bid prices for the various classes of structural excavation.

At the end of each estimate period, the Engineer or designated representative shall determine the completed portion of the total work under Standard Specification Item No. 401S "Structural Excavation and Backfill" and payment shall be made accordingly.

Filling or backfilling of areas above the natural ground level or above the limits of street excavation or channel excavation sections shall be considered as Standard Specification Item No. 132S, "Embankment" and payment therefore shall be included in the unit prices bid for the various classes of Standard Specification Item No. 110S, "Street Excavation", Standard Specification Item No. 120S, "Channel Excavation" or Standard Specification Item No. 130S, "Borrow".

Where no channel excavation is provided for at culvert sites and where it is necessary to excavate beyond the limits of structural excavation, as herein described in order that the

culvert may function properly, such excavation shall be included with structural excavation as may be indicated on the Drawings.

Payment for all work prescribed under this item shall include full compensation for all excavation and backfill including compaction, all soundings, construction of all cofferdams, all dewatering and for furnishing all materials, labor, equipment, tools, sheathing, bracing, cofferdams, pumps, drills, explosives and incidentals necessary to complete the work, except for specific allowances stated above.

Special materials used or additional excavation made for the Contractor's convenience to expedite the work will not be paid for directly, but shall be included in the unit price bid for this specification item. In addition, if the Contractor's construction methods and equipment creates conditions necessitating usage of special materials or additional excavation, the work and materials will not be paid for directly, but shall be included in the unit price bid for this specification item.

When specified in the contract bid form as separate pay item(s), the item(s) will be paid for at the contract unit price(s) for "Flexible Base", "Lime Stabilized Base" and "Controlled Low Strength Material". The bid prices shall include full compensation for all Work herein, specified, including the disposal of all material not required in the Work, the furnishing of all material, equipment, tools, labor and incidentals necessary to complete the Work.

Payment will be made under one of the following:

Pay Item No. 401S-A:	Unclassified Structural Excavation, Plan Quantity.	Per Cubic Yard.
Pay Item No. 401S-B:	Common Structural Excavation	Per Cubic Yard.
Pay Item No. 401S-C:	Rock Structural Excavation	Per Cubic Yard.
Pay Item No. 401S-D:	Concrete Base	Per Cubic Yard.
Pay Item No. 401S-E:	Cement Stabilized Backfill	Per Cubic Yard.
Pay Item No. 401S-F:	Flexible Base	Per Cubic Yard.
Pay Item No. 401S-G:	Lime Stabilized Base	Per Square Yard.
Pay Item No. 401S-H:	Controlled Low Strength Material	Per Cubic Yard.
Pay Item No. 401S-I:	Cofferdams, type _____	Per Cubic Yard.
Pay Item No. 401S-J:	Dewatering	Per Cubic Yard.

End

SPECIFIC **CROSS REFERENCE MATERIALS**
Standard Specification Item 401S, "Structural Excavation and Backfill"

City of Austin Standard Contract Documents

Designation	Description
Section 00700	General Conditions
Section 01550	Public Safety and Convenience

City of Austin Utilities Criteria Manual

Designation	Description
Section 5.2.0	Permit Information and Format

City of Austin Standard Specification Items

Designation	Description
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 120S	Channel Excavation
Item No. 130S	Borrow
Item No. 132S	Embankment
Item No. 202S	Hydrated Lime and Lime Slurry
Item No. 203S	Lime Treatment for Materials in Place
Item No. 210S	Flexible Base
Item No. 302S	Aggregates for Surface Treatments

Item No. 402S	Controlled Low Strength Material
Item No. 403S	Concrete for Structures
Item No.509S	Excavation Safety Systems
Item No. 610S	Preservation of Trees and Other Vegetation

Texas Department of Transportation: Departmental Material Specifications

Designation	Description
DMS-4640	Chemical Admixtures for Concrete

American Society for Testing and Materials, ASTM

Designation	Description
ASTM C 33	Specification For Concrete Aggregates

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-114-E	Laboratory Compaction Characteristics & Moisture-Density Relationship of Subgrade & Embankment Soil
Tex-120-E	Soil-Cement Testing

RELATED **CROSS REFERENCE MATERIALS**
Standard Specification Item 401S, "Structural Excavation and Backfill"

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description

Item 110	Excavation
Item 132	Embankment
Item 400	Excavation and Backfill for Structures
Item 401	Flowable Backfill
Item 402	Trench Excavation Protection
Item 403	Temporary Special Shoring
Item 421	Hydraulic Cement Concrete

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Item No. 402S
Controlled Low Strength Material

402S.1 Description

This item governs Controlled Low Strength Material (CLSM) used for trench backfill and for filling abandoned culverts, pipes, other enclosures, and for other uses as indicated on the drawings, Standard Details or as approved by the Engineer or designated representative. CLSM is a low strength, self-compacting, flowable, cementitious material used in lieu of soil backfill. It is intentionally prepared at low strength to allow for future removal using conventional excavation equipment.

The CLSM shall be composed of Portland cement or fly ash, or both, filler aggregate and water. The CLSM, specified for use in filling abandoned culverts, pipes, or other enclosures, shall contain a settlement compensator, in addition to the other ingredients, to minimize settlement of the CLSM within the enclosure.

Normal Set CLSM shall be specified whenever the material will remain uncovered or will not be subjected to traffic or other loads within 24 hours after placement. Fast Set CLSM shall be specified whenever the material will be covered, subjected to traffic or other loads within 24 hours, or needed to expedite construction.

CLSM can be used for permanent subgrade repairs below the base layer, but shall not be used for permanent pavement repairs. For temporary traffic applications, a minimum 2 inch (50 mm) cap composed of Hot Mix-Cold Laid Asphaltic Concrete (TxDoT Standard Specification Item 334) shall be placed on the CLSM.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

402S.2 Submittals

The submittal requirements of this specification item include:

A. A mix design submittal including the results of unconfined compressive strength tests, air entrainment (if applicable), flow consistency, hardened unit weight, and timed Ball Drop and corresponding Penetrometer tests.

B. Certifications and test results for the cement fly ash, and admixtures.

C. Particle-size gradation and specific gravity tests on the filler aggregate.

402S.3 Materials

A. Cement.

Portland cement shall conform to ASTM C 150, Type I (General Purpose).

Portland cement manufactured in a cement kiln fueled by hazardous waste shall be considered as an approved product if the production facility is authorized to operate under regulation of the Texas Natural Resource Conservation Commission

(TNRCC) and the U. S. Environmental Protection Agency (EPA). Supplier shall provide current TNRCC and EPA authorizations to operate the facility.

B. Fly Ash

Fly ash shall conform to the requirements of Standard Specification Item No. 405, "Concrete Admixtures" and TxDOT Specification Item 437.

C. Filler Aggregate.

Filler aggregate shall consist of sand, stone screenings, pavement milling cuttings or other granular material that is compatible with the other mixture components. The filler aggregate shall be fine enough to stay in suspension to the extent required for proper flow without segregation, and, in the case of filling of enclosures, for minimal settlement. Filler aggregate shall have a Plasticity Index (TxDOT Test Method Tex-106-E) less than 15 and shall conform to the following gradation:

Sieve Designation US	(SI)	Percent Passing
No. 200	(75μm)	0 - 10

D. Mixing Water.

Mixing water shall conform to the requirements of Standard Specification Item No. 403, "Concrete for Structures".

E. Settlement Compensator

An air entraining admixture with a higher than usual dosage, which meets the requirements of Standard Specification Item No. 405, "Concrete Admixtures", shall be used as a settlement compensator. The settlement compensator may be introduced to the CLSM at the job site by placement of prepackaged admixture in capsules or bags in the mixing drum in accordance with the admixture manufacturer's recommendations.

402S.4 Mix Design

The proportioning of CLSM shall be the responsibility of the Contractor. The Contractor shall furnish a mix design conforming to the requirements herein, for review and approval by the Engineer or designated representative. The mix design shall be prepared by a qualified commercial laboratory and then reviewed and signed by a registered Professional Engineer licensed in the State of Texas.

The Mix Design submittal must include:

A. Test results for unconfined compressive strength, air entrainment (if applicable), flow consistency, hardened unit weight, and timed Ball Drop (ASTM C-360) and corresponding Penetrometer tests (with a concrete pocket penetrometer),

B. Certifications and test results for the cement, fly ash, and admixtures, and

C. Results of particle-size gradation and specific gravity tests on the filler aggregate. The submittal shall include Penetrometer tests performed every thirty minutes

until the Ball Drop test shows a 2-inch (50 mm) indentation, as well as the predicted Penetrometer reading that corresponds to a 3-inch (75 mm) Ball Drop indentation. Particle-size gradation shall be determined using a series of sieves that gives no fewer than five uniformly spaced points for graphing the entire range of particle sizes larger than a No. 200 sieve (75-µm).

The Contractor shall perform the work required to substantiate the design at no cost to the City, including all testing. Approved mix designs shall be valid for one year, provided there are no changes in the type, source, or characteristics of the materials during that year.

At the end of one year, the mix design may be submitted for renewal, provided that:

A. field tests of the CLSM during the year have been satisfactory,
B. there have been no changes in type or source of the materials of the mix, and
C. the characteristics of the materials have not changed significantly since the original submittal.

The Contractor shall also submit certifications and test results for the cement, fly ash and admixtures, and particle-size gradation and specific gravity test results for the filler aggregate. The Contractor shall compare results of tests made on the filler aggregate at the end of the year to the results of tests reported in the original submittal. Gradation changes less than ten percent in percent passing any sieve and specific gravity changes less than five percent shall not be considered significant.

402S.5 Strength

The CLSM mix designs shall meet the unconfined compressive strength requirements outlined in the table below. The compression tests shall be conducted in accordance with TxDOT Method Tex-418-A, using approved unbonded caps on specimens with four-inch (100 mm) diameter and eight-inch (200 mm) height [or three-inch (75 mm) diameter by six-inch (150 mm) high specimens if a smaller capacity loading device gives more accurate results].

Unconfined Compressive Strength, psi (mPa)		
Age	Normal Set CLSM	Fast Set CLSM
3 hours	—	35 (0.24) minimum
24 hours	35 (0.24) minimum	—
28 days	300 (2.1) maximum	300 (2.1) maximum

402S.6 Flow Consistency

Flow consistency shall be established in tests involving the use of a six-inch (150 mm) length by three-inch (75 mm) diameter open-ended straight tubing made of steel, plastic or other non-absorbent material that is non-reactive with cement or fly ash. The tube shall be placed with one end on a horizontal flat surface and held in a vertical position. The tube shall then be filled to the top with CLSM. The top surface shall be struck off with a suitable straight edge and any spillage shall be removed from the base of the tube. Within five seconds thereafter the tube shall be raised carefully, using a steady

upward lift with no lateral or torsional motion. The entire test, from the start of filling until removal of the tube, shall be completed within 1½ minutes without interruption.

After removal of the tube, the spread of the CLSM shall be measured immediately along two diameters that are perpendicular to one another. The average of those two measurements is defined as the flow consistency of the mix. The flow consistency of the CLSM shall be considered satisfactory if a circular-type spread of the mix occurs without segregation and a flow consistency (average diameter of spread) of 8 inches (200 mm) or more is achieved.

402S.7 Air Entrainment

Air entraining admixture shall be added as a settlement compensator, whenever the CLSM will be used to fill an enclosure (Section 402S-1). The dosage shall be sufficient to result in an air content of 15 to 25 percent (as determined by TxDOT Method Tex-416-A) at the time of placement of the CLSM.

402S.8 Field Strength Tests

Ball Drop or Penetrometer tests shall be used to determine, when the CLSM has developed sufficient strength to be covered or subjected to traffic or other loads as approved by the Engineer or designated representative.

The Ball Drop test shall be performed according to the latest version of ASTM C-360. An indentation diameter of three inches (75 mm) or less, and the absence of a sheen or any visible surface water in the indentation area shall indicate that the CLSM has achieved the desired strength. Because trench width and depth may affect the test results, the Contractor may perform this test on a control sample of CLSM in a two-foot (600 mm) square by six-inch (150 mm) deep container.

Penetrometer tests using a hand-held, spring reaction-type device commonly called a concrete pocket penetrometer, shall be performed on the surface of the CLMS. A Penetrometer reading, equal to or greater than the value established in the mix design (Section 402S.4) for a Ball Drop test indentation of 3-inches (75 mm), shall indicate that the CLSM has achieved the desired strength.

402S.9 Construction Methods

A. General

The height of free fall placement of the CLSM shall not exceed four feet (1.2 meters). Since CLSM is considered to be self-compacting, a vibrator shall not be allowed. The CLSM shall not be covered with any overlying materials or subjected to traffic or other loads until the Ball Drop test or the Penetrometer test shows acceptable results (Section 402S.8) or until the CLSM has been in place a minimum of 24 hours for Normal Set CLSM and a minimum of 3 hours for Fast Set CLSM. Curing of the CLSM will not be required.

B. Utility Line Backfill

After the utility pipe has been placed and the proper bedding material placed in accordance with the details on the drawings, the trench may be immediately backfilled with the CLSM to the subgrade level shown on the drawings, Standard Details 1100S-6A, B, C & D, 430S-4, 511S-13A and 511S-13B or as directed by the Engineer or designated representative.

C. Culvert Backfill

Care shall be taken to prevent movement of the structure. If the pipe or structure moves either horizontally or vertically, the CLSM and the structure shall be immediately removed and the pipe or structure re-laid to proper line and grade.

D. Other Backfill

CLSM may be used for backfill material in lieu of soil as shown on the drawings, Standard Details or as approved by the Engineer or designated representative.

E. Filling Abandoned Culverts, Pipe, or other Enclosures

The CLSM shall be placed in a manner that allows all air or water, or both, to be displaced readily as the CLSM fills the enclosure.

402S.10 Acceptance Testing During Construction

The Engineer or designated representative may perform flow consistency, air entrainment, and unconfined compressive strength tests to determine if the CLSM meets the specification requirements. The number and frequency of acceptance tests will be determined by the Engineer or designated representative.

402S.11 Measurement and Payment

The work and materials presented herein will generally not be paid for directly, but shall be included in the unit price bid for the item of construction in which this item is used.

When specified in the contract bid form as a separate pay item, the item will be paid for at the contract unit bid price(s) for "Controlled Low Strength Material". The bid prices shall include full compensation for all Work herein specified, including the furnishing of all materials, equipment, tools, labor and incidentals necessary to complete the Work.

Payment will be made under the following:

Pay Item No. 402S-A: Controlled Low Strength Material Per Cubic Yard.

End

SPECIFIC CROSS REFERENCE MATERIALS
Standard Specification Item 402S, “Controlled Low Strength Material”

City of Austin Standard Details

Designation	Description
430S-4	Concrete Backfill Under Curb & Gutter
506S-14	Control or Mini Manhole
511S-13A	Water Valve Box Adjustment to Grade W/ Full Depth Concrete
511S-13B	Water Valve Box Adjustment to Grade W/ Concrete and H.M.A.C.

1100S-6A	Narrow Excavation Next to C&G - Trench Width 0.3 M (12") & Less
1100S-6B	Narrow Excavations - Trench Width 0.3 M (12") & Less
1100S-6C	Excavation Next to C&G - Trench Width Greater than 0.3 M (12")
1100S-6D	Excavations - Trench Width Greater than 0.3 M (12")

City of Austin Standard Specification Items

Designation	Description
Item No 403S	Concrete for Structures
Item No 405S	Concrete Admixtures

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 334	Hot Mix-Cold Laid Asphaltic Concrete Pavement
Item No. 420	Concrete Structures
Item No. 421	Portland Cement Concrete
Item No. 437	Concrete Admixtures

RELATED CROSS REFERENCE MATERIALS
Standard Specification Item 402S, “Controlled Low Strength Material”

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-106-E	Method Of Calculating the Plasticity Index of Soils
Tex-416-A	Air Content of Freshly Mixed Concrete By The Pressure Method
Tex-418-A	Compressive Strength of Cylindrical Concrete

American Society for Testing and Materials (ASTM)

Designation	Description
ASTM C 150	Portland Cement
ASTM C 360	Ball Penetration in Fresh Portland Cement Concrete
ASTM C 403	Time of Setting of Concrete Mixtures by Penetration Resistance

City of Austin Standard Specification Items

Designation	Description
Item No. 504S	Adjusting Structures
Item No. 506S	Manholes
Item No. 508S	Miscellaneous Structures and Appurtenances
Item No. 510	Pipe

Item No. 403S
Concrete for Structures

403S.1 Description

This item shall govern quality, storage, handling, proportioning and mixing of materials for hydraulic cement concrete construction of buildings, bridges, culverts, slabs, prestressed concrete and incidental appurtenances.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

403S.2 Submittals

The submittal requirements of this specification item may include:

Mix design option(s) of the class of concrete required on the project,

The supplier of the concrete mix design(s) and type of mixing equipment, and

Type of admixtures to be used with the concrete mixes.

403S.3 Materials

Concrete shall be composed of hydraulic cement or hydraulic cement and supplementary cementing materials, water, aggregates (fine and coarse), and admixtures proportioned and mixed as hereinafter provided to achieve specified results.

A. Cementitious Materials

Hydraulic cement shall conform to ASTM C 150, Type I (General Purpose), Type II (General Purpose with Moderate Sulfate Resistance) and Type III (High Early Strength). Type I shall be used when none is specified or indicated on the drawings. Type I and Type III cements shall not be used when a Type II cement is specified or indicated on the drawings. Type III cement may be used in lieu of a Type I cement, when the anticipated air temperature for the succeeding 12 hours will not exceed 60oF (15.6oC). A Type III cement shall only be used in precast concrete or when otherwise specified or allowed. All cement shall be of the same type and from the same source for a monolithic placement.

Unless otherwise specified the cementitious material content shall be limited to no more than 700 lbs. per cubic yard (417 kg per cubic meter). When supplementary cementing materials are used, cement is defined as “cement plus supplementary cementing material.” Supplementary cementing materials include fly ash (DMS 4610), ultra-fine fly ash (DMS-4610), ground granulated blast furnace slag grade 100 or 120 (DMS-4620), silica fume (DMS-4630) and metakaolin (DMS-4635).

Supplementary cementing materials shall not be used when white hydraulic cement is specified.

Class C flyash shall not be used in sulfate-resistant concrete.

Hydraulic cement manufactured in a cement kiln fueled by hazardous waste shall be considered as an approved product if the production facility is authorized to operate under regulation of the Texas Commission on Environmental Quality (TCEQ) and the U. S. Environmental Protection Agency (EPA). Supplier shall provide current TNRCC and EPA authorizations to operate the facility.

When sulfate-resistant concrete is required for a project, mix design options 1, 2, 3 or 4 presented in Section 403S.8, "Mix Design Options" shall be used to develop appropriate mix design utilizing Type I/II, II, V, IP or IS cement.

B. Mixing Water

Water for use in concrete and for curing shall be potable water free of oils, acids, organic matter or other deleterious substances and shall not contain more than 1,000 parts per million of chlorides as Cl or sulfates as SO4.

Water from the City of Austin will not require testing. Contractor may request approval of water from other sources. Contractor shall arrange for samples to be taken from the source and tested at the Contractor's expense. When water from other sources is proposed, test reports shall be provided that indicates compliance with Table 1 before use.

Table 1: Chemical Limits for Mix Water

Contaminant	Test Method	Maximum Concentration (ppm)
Chloride (CL) Prestressed concrete Bridge decks & superstructure All other concrete	ASTM D-512	 500 500 1,000
Sulfate (SO4)	ASTM D-516	1,000
Alkalies (NA2O + 0.658 K2O)	ASTM D-4191 & D-4192	600
Total Solids	AASHTO T-26	50,000

Water that has an adverse effect on the air-entraining agent or any other chemical admixture or on strength or time of set of the concrete shall not be used. Water used in white Portland cement concrete shall be free from iron and other impurities, which may cause staining, or discoloration.

C. Coarse Aggregate

Coarse aggregate shall consist of durable particles of crushed or uncrushed gravel, crushed blast furnace slag, crushed stone or combinations thereof; free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material either free or as an adherent coating. When white hydraulic

cement is specified, the coarse aggregates used in the concrete shall be light colored. Quality shall be reasonably uniform throughout.

The coarse aggregate from each source shall not contain more than 0.25 percent by weight of clay lumps, nor more than 1.0 percent by weight of shale nor more than 5 percent by weight of laminated and/or friable particles when tested in accordance with TXDOT Test Method TEX-413-A. The coarse aggregate from each source shall have a wear of not more than 40 percent when tested in accordance with TXDOT Test Method TEX-410-A.

Unless otherwise indicated on the drawings, the coarse aggregate from each source shall be subjected to 5 cycles of the soundness test conforming to TXDOT Test Method TEX-411-A. The loss shall not be greater than 12 percent when sodium sulfate is used or 18 percent when magnesium sulfate is used.

Coarse aggregate shall be washed. The Loss by Decantation (TXDOT Test Method TEX-406-A), plus allowable weight of clay lumps, shall not exceed 1 percent or the value indicated on the drawings or in the project manual, whichever is less. If material finer than the # 200 (75 micrometer) sieve is definitely established to be dust of fracture of aggregates made primarily from crushing of stone, essentially free from clay or shale as established by Part III of TXDOT Test Method TEX-406-A, the percent may be increased to 1.5. When crushed limestone coarse aggregate is used in concrete pavements, the decant may exceed 1% but not more than 3% if the material finer than the # 200 (75 micrometer) sieve is determined to be at least 67% calcium carbonate in accordance with TxDoT Test Method Tex-406-A, Part III.

The coarse aggregate factor may not be more than 0.82; however, when voids in the coarse aggregate exceed 48 percent of the total rodded volume, the coarse aggregate factor shall not exceed 0.85. The coarse aggregate factor may not be less than 0.68 except for a Class I machine extruded mix that shall not have a coarse aggregate factor lower than 0.61.

When exposed aggregate surfaces are required, the coarse aggregate shall consist of particles with at least 40 percent crushed faces. Uncrushed gravel, polished aggregates and clear resilient coatings are not acceptable for exposed aggregate finishes.

When tested by approved methods, the coarse aggregate including combinations of aggregates when used, shall conform to the grading requirements shown in Table 2.

Table 2: Coarse Aggregate Gradation Chart (Percent Passing)

Grade	Nom. Size	2-1/2" (62.5 mm)	2" (50 mm)	1 ½" (37.5 mm)	1" (25 mm)	3/4" (19 mm)	1/2" (12.5 mm)	3/8" (9.5 mm)	No. 4 (4.75 mm)	No. 8 (2.36 mm)
1	2" (50 mm)	100	80-100	50-85		20-40			0-5	
2 (467)*	1 1/2" (37.5 mm)		100	95-100		35-70		10-30	0-5	
3	1" (50 mm)		100	95-100		60-90	25-60		0-5	

4 (57)*	1” (50 mm)			100	95-100		25-60		0-10	0-5
5 (67)*	3/4” (19 mm)				100	90-100		20-55	0-10	0-5
6 (7)*	½" (12.5 mm)					100	90-100	40-70	0-15	0-5
7	3/8" (9.5 mm)						100	70-95	0-25	
8	3/8" (9.5 mm)						100	95-100	20-65	0-10

Notes:

1. Recycled crushed concrete fine aggregate shall be limited to a maximum of 20% of the fine aggregate.

2. The use of recycled crushed hydraulic cement concrete as a coarse aggregate shall be limited to Concrete Classes A, B and D (see Table 5).

D. 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 hydraulic cement is specified, the fine aggregates used in the concrete shall be light colored. Quality shall be reasonably uniform throughout 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 in accordance with TEX-413-A. When subjected to color test for organic impurities per TXDOT Test Method TEX-408-A, it shall not show a color darker than standard.

Unless indicated otherwise on the drawings the acid insoluble residue of fine aggregate used in slab concrete subject to direct traffic shall not be less than 60 percent by weight (mass) when tested conforming to TXDOT Test Method TEX-612-J.

Unless indicated otherwise on the Drawings, fine aggregate shall be blended, when necessary, to meet the acid insoluble residue requirement.

When blending the following equation shall be used:

Acid Insoluble (%) = $\{(A1)(P1)+(A2)(P2)\}/100$

Where:

A1 = acid insoluble (%) of aggregate 1,

A2 = acid insoluble (%) of aggregate 2,

P1 = % by weight of A1 of the fine aggregate blend, and

P2 = % by weight of A2 of the fine aggregate blend.

When tested in accordance with TxDoT Test Method Tex-401-A, the fine aggregate, including mineral filler and combinations of aggregates, when used, shall conform to the grading requirements shown in Table 3.

Table 3: Fine Aggregate Gradation Chart1 (Grade 1 - Percent Passing)

3/8 (9.5 mm)	No. 4 (4.75 mm)	No. 8 (2.36 mm)	No. 16 (1.18 mm)	No. 30 (600 µm)	No. 50 (300 µm)	No. 100 (150 µm)	No. 200 (75 µm)
100	95-100	80-100	50-85	25-65	10-351	0-10	0-32

Notes:

1. Recycled crushed concrete fine aggregate shall be limited to a maximum of 20% of the fine aggregate.

2. The use of recycled crushed hydraulic cement concrete as a fine aggregate shall be limited to Concrete Classes A, B and D (see Table 5).

3. 6 to 35 when sand equivalent value is greater than 85.

4. 0 to 6 for manufactured sand.

   Sand equivalent per TXDOT Test Method TEX-203-F shall not be less than 80 nor less than otherwise indicated on the drawings, whichever is greater.

   The fineness modulus will be determined by adding the percentages by weight retained on sieve Nos. 4, 8, 16, 30, 50 and 100 (4.75 mm, 2.36 mm, 1.18mm, 600 µm, 300 µm, and 150 µm) and dividing the sum of the six sieves by 100. For all classes of concrete except K (see Table 5), the fineness modulus shall be between 2.30 and 3.10. For Class K concrete, the fineness modulus shall be between 2.40 and 2.90, unless indicated otherwise on the Drawings.

E. Mineral Filler

Mineral filler shall consist of stone dust, clean crushed sand or other approved inert material. When tested in accordance with TxDoT Test Method Tex-401-A, it shall conform to the following gradation:

Passing the No. 30 (600 µm) Sieve 100 percent

Passing the No. 200 (75 µm) Sieve 65 to 100 percent

F. Mortar and Grout

Unless otherwise specified, indicated on the drawings or approved by the Engineer or designated representative mortar and grout shall consist of 1 part hydraulic cement, 2 parts finely graded sand and enough water to make the mixture plastic. When required to prevent color difference, white cement shall be added to produce color required. When required by the Engineer or designated representative, approved latex adhesive may be added to the mortar. Mortar shall be provided with a consistency such that the mortar can be easily handled and spread by trowel.

Grout shall be provided of a consistency that will flow into and completely fill all voids.

G. Admixtures

All chemical admixtures including water reducing, placticizers and air entrainment shall conform to TxDoT DMS-4640, “Chemical Admixtures for Concrete”. Calcium chloride-based admixtures shall not be approved. Admixtures shall be included in the prequalified concrete admixtures list maintained by TxDot’s Construction Division. High-range water-reducing admixtures (TxDoT Type F or G) and accelerating admixtures (TxDoT Type C or E) shall not be used in bridge deck concrete.

H. Air Entrainment

Unless indicated otherwise on the drawings, all concrete classes with the exception of Class B shall be air;entained in accordance with Table 8. If the air content is more than 1-1/2 percentage points below or 3 percentage points above the required air, the load of concrete will be rejected. If the air content is more than 1-1/2 but less than 3 percentage points above the required air, the concrete may be accepted based on strength test results.

403S.4 Storage of Materials

A. Cement, Supplementary Cementing Materials and Mineral Filler

All cement, supplementary cementing materials and mineral filler shall be stored in separate and well ventilated, weatherproof buildings or approved bins, which will protect the material from dampness or absorption of moisture. Storage facilities shall be easily accessible and each shipment of packaged cement shall be kept separated to provide for identification and inspection. The Engineer or designated representative may permit small quantities of sacked cement to be stored in the open for a maximum of 48 hours on a raised platform and under waterproof covering.

B. 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. Aggregates shall be stockpiled in sizes to facilitate blending. If the aggregate is not stockpiled on a hard, non-contaminant base, the bottom 6-inch (150 mm) layer of the stockpile shall not be used without recleaning the aggregate.

When conditions require the use of 2 or more grades of coarse aggregates, separate stockpiles shall be maintained to prevent intermixing. Where space is limited, stockpiles shall be separated by walls or other appropriate barriers.

Aggregate shall be stockpiled and protected from the weather a minimum of 24 hours prior to use to minimize free moisture content. When stockpiles are too large to protect from the weather, accurate and continuous means acceptable to the Engineer or designated representative shall be provided to monitor aggregate

temperature and moisture. Aggregates shall be stockpiled and handled such that segregation and contamination are minimized.

The stockpiles shall be sprinkled to control moisture and temperature as necessary. A reasonably uniform moisture content shall be maintained in aggregate stockpiles.

C. Admixtures

Admixtures shall be stored in accordance with manufacturer's recommendations and shall be protected against freezing.

D. Hot Weather Concrete Mixes

Ice may be used during hot weather concrete placement (Section 13 of Standard Specification Item No. 410S, "Concrete Structures") to lower the concrete temperature; however, the Contractor shall furnish a mix design acceptable to the Engineer or designated representative for class of concrete specified. The addition of ice shall not exceed 50% of the total mix water weight.

403S.5 Measurement of Materials

Water shall be accurately metered. Fine and coarse aggregates, mineral filler, bulk cement and fly ash shall be weighed separately. Allowances shall be made in the water volume and aggregate weights during batching for moisture content of aggregates and admixtures. Volumetric and weight measuring devices shall be acceptable to the Engineer or designated representative. Measurement of materials in non-volumetric and volumetric mixers shall conform to Section 421.4.D of TxDot Specification Item 421, "Hydraulic Cement Concrete".

Batch weighing of sacked cement is not required; however, bags, individually and entire shipments, may not vary by more than 3 percent from the specified weight of 94 pounds (42.6 kilograms) per bag. The average bag weight of a shipment shall be determined by weighing 50 bags taken at random.

403S.6 Mix Design

The Contractor shall furnish a mix design acceptable to the Engineer or designated representative for the class of concrete required in accordance with Table 5. The mix shall be designed by a qualified commercial laboratory and signed/sealed by a registered Professional Engineer, licensed in the state of Texas to conform with requirements contained herein, to ACI 211.1 or TXDOT Bulletin C-11 (and supplements thereto). The maximum water-to-cementitious material ratio identified in Table 5 for specific classes of concrete shall not be exceeded.

A higher-strength class of concrete with equal or lower water-to-cementituous-material ratio may be substituted for the specified class of concrete.

The mix design shall be over-designed in accordance with Table 5 in order to account for production variability and to ensure minimum compressive strength requirements are met.

Allowable mix design options are presented in Section 403S.8.

The Contractor shall perform, at the Contractor's expense, the work required to substantiate the design, including testing of strength specimens. Complete concrete design data shall be submitted to the Engineer or designated representative for approval. The mix design will be valid for a period of one (1) year provided that there are no changes to the component materials.

When there are changes in aggregates or in type, brand or source of cement, supplementary cementing material or chemical admixtures, the mix shall be evaluated as n new mix design. A change in vendor does not necessarily constitute a change in materials or source. When only the brand or source of cement is changed and there is a prior record of satisfactory performance of the cement with the ingredients, the submittal of new trial batches may be waived by the Engineer or designated representative.

At the end of one (1) year, a previously approved mix may be resubmitted for approval if it can be shown that no substantial change in the component materials has occurred and that test results confirming the adequacy of the mix designs have been acquired during the previous year. The resubmittal analysis must be reviewed, signed and sealed by a registered Professional Engineer, licensed in the state of Texas. This resubmittal shall include a reanalysis of specific gravity, absorption, fineness modulus, sand equivalent, soundness, wear and unit weights of the aggregates. Provided that the fineness modulus did not deviate by more than 0.20 or that the re-proportioned total mixing water, aggregate and cement (or cement plus fly ash) are within 1, 2, and 3 percent, respectively, of pre-approved quantities, a one-year extension on the approval of the mix may be granted by the Engineer or designated representative. Updated cement, fly ash, and admixture certifications shall accompany the resubmittal.

Approved admixtures that are included in the prequalified concrete admixtures list maintained by TxDot's Construction Division may be used with all classes of concrete at the option of the Contractor provided that specific requirements of the governing concrete structure specification are met. Water reducing and retarding agents shall be required for hot weather, large mass, and continuous slab placements. Air entraining agents may be used in all mixes but must be used in the classes indicated on Table 5. Unless approved by the Engineer or designated representative, mix designs shall not exceed air contents for extreme exposure conditions as recommended by ACI 211.1 for the various aggregate grades.

403S.7 Consistency and Quality of Concrete

Concrete shall be workable, cohesive, possess satisfactory finishing qualities and of stiffest consistency that can be placed and vibrated into a homogeneous mass within slump requirements specified in Table 4 without the development of segregation or honeycombing. No concrete will be permitted with a slump in excess of the maximums

shown unless water-reducing admixtures have been previously approved. Concrete that exceeds the maximum acceptable placement slump at time of delivery will be rejected. Slump values shall be conducted in accordance with TXDOT Test Method TEX-415-A.

Consistency and quality of concrete should allow efficient placement and completion of finishing operations before initial set. Re-tempering (i.e. addition of water and reworking concrete after initial set) shall not be allowed. When field conditions are such that additional moisture is needed for final concrete surface finishing operation, the required water shall be applied to surface by fog spray only and shall be held to a minimum. Excessive bleeding shall be avoided and in no case will it be permissible to expedite finishing and drying by sprinkling the surface with cement powder.

Table 4: Slump Requirements

	Slump1, inches (mm)	
Type of Construction	Maximum	Minimum
Cased Drilled Shafts	4 (100)	3 (75)
Reinforced Foundation Caissons and Footings	3 (75)	1 (25)
Reinforced Footings and Substructure Walls	3 (75)	1 (25)
Uncased Drilled Shafts	6 (150)	5 (125)
Thin-walled Sections; 9 inches (225 mm) or less	6 ½ (165)	4 (100)
Prestressed Concrete Members1	6 ½ (165)	4 (100)
Precast Drainage Structures	6 (150)	4 (100)
Wall Sections over 9 inches (225 mm)	5 (125)	3 (75)
Reinforced Building Slabs, Beams, Columns and Walls	4 (100)	1 (25)
Bridge Decks	4 (100)	2 (50)
Pavements, Fixed-form	6 ½ (165)	4 (100)
Pavements, Slip-form	3 (75)	1-½ (37.5)
Sidewalks, Driveways and Slabs on Ground	4 (100)	2 (50)
Curb & Gutter, Hand-vibrated	3 (75)	1 (25)
Curb & Gutter, Hand-tamped or spaded	4 (100)	2 (50)
Curb & Gutter, Slip-form/extrusion machine	2 (50)	½ (12.5)
Heavy Mass Construction	2 (50)	1 (25)
High Strength Concrete	4 (100)	3 (75)
Riprap and Other Miscellaneous Concrete	6 (150)	1 (25)
Under Water or Seal Concrete	8 ½ (213)	6 (150)

1. Slump values when a high range water reducer (HRWR) is not used.

2. When a high range water reducer (HRWR) is used, maximum acceptable placement slump will be 9 in (225 mm)

During progress of the work, the Engineer or designated representative shall cast test cylinders as a check on compressive strength of concrete actually placed. The Engineer or designated representative may also perform slump tests, entrained air tests and temperature checks to ensure compliance with specifications.

Proportioning of all material components shall be checked prior to discharging. Excluding mortar material for pre-coating of the mixer drum [see section 403S.8.B and adjustment for moisture content of admixtures and aggregates, material components shall fall within the range of + 1% for water, + 2% for aggregates, + 3% for cement, +2% for fly ash and within manufacturer recommended dosage rates for admixtures except that air entrainment shall be within + 1-1/2 percentage points of the mix design requirements.

Unless otherwise specified or indicated on the drawings, concrete mix temperature shall not exceed 90°F (32oC) except in mixes with high range water reducers where a maximum mix temperature of 100°F (38oC) will be allowed. Cooling an otherwise acceptable mix by addition of water or ice during agitation will not be allowed.

Test cylinders will be required for small placements such as manholes, inlets, culverts, wing walls, etc. The Engineer or designated representative may vary the number of tests to a minimum of 1 for each 25 cubic yards (1 for each 19 cubic meters) placed over a several day period.

Test cylinders shall be required for each monolithic placement of bridge decks or superstructures, top slabs of direct traffic culverts, cased drilled shafts, structural beams and as otherwise directed by Engineer or designated representative for design strength confirmation or early form removal. Test cylinders made for early form removal or for consideration of use of structure will be at Contractor's expense, except when required by Engineer or designated representative.

A strength test shall be defined as the average breaking strength of 2 cylinders. A minimum of four test cylinders shall be prepared; two each to be tested at 7 and 28 days. Specimens will be tested conforming to TXDOT Test Method TEX-418-A. If required strength or consistency of class of concrete being produced cannot be secured with minimum cementitious material specified or without exceeding maximum water/cementitious material ratio, 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.

Slump tests will be performed in accordance with TxDoT Test Method Tex-415-A. Entrained air tests will be performed in accordance with TxDoT Test Method Tex-416-A.

Test specimens shall be cured using the same methods and under the same conditions as the concrete represented. Design strength cylinders shall be cured conforming to TXDOT Bulletin C-11 (and supplements thereto).

When control of concrete quality is by 28-day compressive tests, job control testing will be by 7-day compressive strength tests. The minimum strength requirement for seven (7) day test will be 70 percent of the specified minimum 28-day compressive strength. If the required 7-day strength is not secured with the quantity of cement specified in Table 4, changes in the mix design shall be made and resubmitted for approval. For an occasional failure of the seven-day compressive test, the concrete may be tested at 28 days for final evaluation.

Table 5: Classes of Concrete						
Class	Cement Sks Per CY	Minimum Strength, psi (MPa)		Maximum W/C Ratio1	Coarse Aggr. Grade 2,3,4	Air Entrain.
		28 Days	7 Days			
A	5.0 (280 kg/m3)	3000 (20.6)	2100 (14.5)	0.6	1,2,3,4, 8	Yes
B	4.0 (225 kg/m^3)	2000 (13.8)	1400 (9.7)	0.6	2,3,4,5,6,7	No
C5	6.0 (335 kg/m^3)	3600(24.8)	2520 (17.4)	0.45	1,2,3,4,5,6	Yes
D	4.5 (252 kg/m^3)	2500 (17.2)	1750 (12.1)	0.6	2,3,4,5,6,7	No
H5	6.0 (335 kg/m^3)	As indicated	As Indicated	0.45	3,4,5,6	Yes
I	5.5 (308 kg/m^3)	3500 (24.1)	2450 (16.9)	0.45	2,3,4,5	Yes
J	2.0 (112 kg/m^3)	800 (5.5)	560 (3.9)	N/A	2,3,4,5	No
S5	6.0 (335 kg/m^3)	4000 (27.6)	2800 (19.3)	0.45	2,3,4,5	Yes

Notes:

1. Maximum water-cement or water-cementitious ratio by weight

2 Unless otherwise allowed, Grade 1 coarse aggregate shall only be used in massive foundations with 4-in (100-mm) minimum clear spacing between reinforcing steel bars.

3. Grade 1 coarse aggregate grading shall not be used in drilled shafts.

4. Unless otherwise allowed, Grade 8 coarse aggregate shall be used in extruded curbs.

5. Structural concrete classes.

6. When Type II cement is used in Class C, S or A concrete, the 7-day compressive strength requirement will be 2310 psi (15.9 MPa) for Class C, 2570 psi (17.7 MPa) for Class S and 1925 psi (13.3 MPa) for Class A minimum.

Table 6: Over Design Required to Meet Compressive Strength Requirements$_1$					
Number Of Tests $_{2,3}$	Standard Deviation, psi (MPa)				
	300 (2.06)	400 (2.75)	500 (3.44)	600 (4.13)	700 (4.82)
15	470 (3.24)	620 (4.27)	850 (5.85)	1,120	1,390

				(7.71)	(9.57)
20	430 (2.96)	580 (3.99)	760 (5.23)	1,010 (6.95)	1,260 (8.67)
30 or more	400 (2.75)	530 (3.65)	670 (4.61)	900 (6.20)	1,130 (7.78)

Notes:

1. When designing the mix, add the tabulated amounts to the minimum design strength in Table 5.Maximum water-cement or water-cementitious ratio by weight

2. Number of tests of a concrete mixture used to estimate the standard deviation of a concrete production facility. Test of another mix within 1,000 psi (6.88 MPa) of the specified strength may be used.

3. If less than 15 prior tests are available, the overdesign should be 1,000 psi (6.88 MPa) for specified strength less than 3,000 psi (20.65 MPa), 1,200 psi (8.26 MPa) for specified strengths from 3,000 to 5,000 psi (20.65 to 34.42 MPa) and 1,400 psi (9.64 MPa) for specified strengths greater than 5,000 psi (34.42 MPa).

Table 7: Expected Usage of Concrete Classes

Class	General Usage
A	Inlets, manholes, curb, gutter, curb & gutter, concrete retards, sidewalks, driveways, backup walls and anchors
B	Riprap, small roadside signs and anchors
C5	Drilled shafts, bridge substructure, bridge railing, culverts except top slab of direct traffic culverts, headwalls, wing walls, approach slabs, and cast-in-place concrete traffic barrier
D	Riprap
H5	Prestressed concrete beams, boxes, piling and precast concrete traffic barrier
J	Utility trench repair
S5	Bridge slabs and top slabs of direct traffic culverts

Table 8: Air Entrainment[1]

Nominal Maximum Aggregate Size In (mm)	% Air Entrainment	
	Moderate Exposure	Severe Exposure
3/8 (9.5)- Grades 7 & 8	6	7-1/2
1/2 (12.5)- Grades 6	5-1/2	7
3/4 (19)- Grades 5	5	6
1 (25)- Grades 4	4-1/2	6
1-1/2 (37.5)- Grades 2 & 3	4-1/2	5-1/2
2 (50)- Grades 2	4	5

1. For specified concrete strengths above 5,000 psi (34.42 MPa) a reduction of 1 percentage point is allowed.

403S.8 Mix Design Options

For the structural concretes identified in Table 5 (Classes C, H and S) and any other class of concrete designed using more than 520 lbs. of cementitious material per cubic yard (310 kgs per cubic meter), one of the mix design options presented below shall be used.

For the non-structural concretes identified in Table 5 (Classes A, B, D and I) and any other class of concrete designed using less than 520 lbs. of cementitious material per cubic yard (310 kgs per cubic meter), one of the mix design options presented below will be used, except that Class C fly ash may be used instead of Class F fly ash for Options 1, 3 and 4 unless a sulfate-resistant concrete is required.

A. Option 1: Twenty (20) to thirty-five (35) percent of the cement may be replaced with Class F fly ash.

B. Option 2: Thirty-five (35) to fifty (50) percent of the cement may be replaced with ground granulated blast-furnace slag.

C. Option 3: Thirty-five (35) to fifty (50) percent of the cement may be replaced with a combination of Class F fly ash, ground granulated blast-furnace slag or silica fume. The combination may not include more than thirty-five (35) percent fly ash and no more than ten (10) percent silica fume.

D. Option 4: Type IP or Type IS will be used and up to ten (10) percent of the cement may be replaced with Class F fly ash, ground granulated blast-furnace slag or silica fume.

E. Option 5: Thirty-five (35) to fifty (50) percent of the cement may be replaced with a combination of Class C fly ash and at least six (6) percent of silica fume, ultra fine fly ash or metakaolin. The combination may not include more than thirty-five (35) percent fly ash and no more than ten (10) percent silica fume.

F. Option 6: A lithium nitrate admixture will be added at a minimum dosage of 0.55 gal. Of thirty (30) percent lithium nitrate solution per pound of alkalis present in the hydraulic cement.

G. Option 7: When hydraulic cement only is used in the design, the total alkali contribution from the cement in the concrete does not exceed 4.0 lbs. Per cubic yard, when calculated as follows:

alkali (lbs. per CY) = .01 (lbs cement/CY) (% Na_2O equivalent in cement)

where (% Na_2O equivalent in cement) is assumed to be the maximum cement alkali content reported on the cement mill certificate.

H. Option 8: When there are deviations from Options 1 through 7, the following shall be performed:

1. Conduct tests on both coarse and fine aggregate separately in accordance with ASTM C-1260, using 440 g of the proposed cementitious in the same proportions of hydraulic cement to supplementary cementing material to be used in the mix.

2. Prior to use of the mix, a certified test report signed and sealed by a Professional Engineer, licensed in the state of Texas shall be submitted that demonstrates that ASTM C 1260 test results for each aggregate do not exceed 0.10 percent expansion.

403S.9 Mixing and Mixing Equipment

All equipment, tools and machinery used for hauling materials and performing any part of the work shall be maintained in such condition to insure completion of the work without excessive delays for repairs and replacement. Mixing shall be done in a mixer of approved type and size that will produce uniform distribution of material throughout the mass and shall be capable of producing concrete meeting requirements of ASTM C 94, Ready-mixed Concrete and these specifications. Mixing equipment shall be capable of producing sufficient concrete to provide required quantities. Entire contents of the drum shall be discharged before any materials are placed therein for a succeeding batch. Improperly mixed concrete shall not be placed in a structure. For all mixers an adequate water supply and an accurate method of measuring the water shall be provided.

The mixer may be batched by either volumetric or weight sensing equipment and shall be equipped with a suitable timing device that will lock the discharging mechanism and signal when specified time of mixing has elapsed.

A. Proportioning and Mixing Equipment

For all miscellaneous concrete placements, a mobile, continuous, volumetric mixer or a volumetric or weight batch mixer of the rotating paddle type may be used.

When approved by Engineer or designated representative in writing or when specified for use in other items, these mixers may be used for other types of concrete construction, including structural concrete, if the number of mixers furnished will supply the amount of concrete required for the particular operation in question.

These mixers shall be designed to receive all the concrete ingredients, including admixtures, required by the mix design in a continuous uniform rate and mix them to the required consistency before discharging.

For continuous volumetric mixers, the materials delivered during a revolution of the driving mechanism or in a selected interval, will be considered a batch and the proportion of each ingredient will be calculated in the same manner as for a batch type plant.

Mixing time shall conform to recommendations of manufacturer of mixer unless otherwise directed by Engineer or designated representative.

B. Ready-mixed Concrete

Use of ready-mixed concrete will be permitted provided the batching plant and mixer trucks meet quality requirements specified herein. When ready-mixed concrete is used, additional mortar (1 sack cement, 3 parts sand and sufficient water) shall be added to each batch to coat the mixer drum. Ready-mixed concrete, batching plant and mixer truck operation shall include the following:

1. A ticket system will be used that includes a copy for the Inspector. Ticket will have machine stamped time/date of concrete batch, a mix design designation, weight of cement, fly ash, sand and aggregates; exact nomenclature and written quantities of admixtures and water. Any item missing or incomplete on ticket may be cause for rejection of concrete.

2. Sufficient trucks will be available to support continuous placements. The Contractor will satisfy the Engineer or designated representative that adequate standby trucks are available to support monolithic concrete placement requirements.

3. A portion of mixing water required by the mix design to produce the specified slump may be withheld and added at the job site, but only with permission of the Engineer or designated representative and under the Inspector's observation. When water is added under these conditions, the concrete batch will be thoroughly mixed before any slump or strength samples are taken. Additional cement shall not be added at the job site to otherwise unacceptable mixes.

4. A metal plate(s) shall be attached in a prominent place on each truck mixer plainly showing the various uses for which it was designed. The data shall include the drum's speed of rotation for mixing and for agitating and the capacity for complete mixing and/or agitating only. A copy of the manufacturer's design, showing dimensions of blades, shall be available for inspection at the plant at all times. Accumulations of hardened concrete shall be removed to the satisfaction of the Engineer or designated representative.

5. The loading of the transit mixers shall not exceed capacity as shown on the manufacturer's plate attached to the mixer or 63 percent of the drum volume, whichever is the lesser volume. The loading of transit mixers to the extent of causing spill-out enroute to delivery will not be acceptable. Consistent spillage will be cause for disqualification of a supplier.

6. Excess concrete remaining in the drum after delivery and wash water after delivery shall not be dumped on the project site unless approval of the dump location is first secured from the Engineer or designated representative.

C. Volumetric Batching

Use of volumetric batched concrete will be permitted provided the batching and continuous mixing operations conform to ASTM C 685, “Concrete Made By Volumetric Batching and Continuous Mixing”. This type concrete shall be made from materials continuously batched by volume, mixed in a continuous mixer and delivered to the site in a freshly mixed and unhardened state. Tests and criteria for batching accuracy and mixing efficiency shall be as specified in ASTM C 685.

A ticket system will be used that includes a copy for the Inspector. The ticket will have machine stamped time/date of concrete batch, a mix design designation, weight of cement, fly ash, sand and aggregates; exact nomenclature and written quantities of admixtures and water. Any item missing or incomplete on ticket may be cause for rejection of concrete.

Each batching or mixing unit, or both, shall carry in a prominent place a metal plate or plates on which are plainly marked the gross volume of the unit in terms of mixed concrete, discharge speed and the weight-calibrated constant of the machine in terms of a revolution counter or other output indicator. The mixer shall produce a thoroughly mixed and uniform concrete.

The batcher-mixer unit shall contain in separate compartments all the necessary ingredients needed for the manufacture of concrete. The unit shall be equipped with calibrated proportioning devices to vary the mix proportions and it shall produce concrete as required by the Work and ASTM C 685.

D. Truck-mixed Concrete

The concrete shall be mixed in a truck mixer from 70 to 100 revolutions at the mixing speed designated by the manufacturer that will produce a uniform concrete mix. The concrete shall be delivered to the project in a thoroughly mixed and uniform mass and shall be discharged with a satisfactory degree of uniformity. Additional mixing at the job site, at the mixing speed designated by the manufacturer, may be allowed by the Engineer or designated representative as long as the concrete is discharged before the drum has revolved a total of 300 revolutions after the introduction of the mixing water to the cement and the aggregates.

Re-tempering or adding concrete chemical admixtures is only permitted at the job site when concrete is delivered in a truck mixer. Water shall not be added after introduction of mixing water at the batch plant except on arrival at the job site with approval of the Engineer or designated representative, in order to adjust the slump of the concrete. When this water is added, the mix design water-cementitious-material ratio shall not be exceeded. The drum or blades shall be turned at least 30 additional revolutions at mixing speed to ensure thorough and uniform mixing of the concrete. Water or chemical admixtures shall not be added to the batch after any concrete has been discharged.

When the concrete contains silica fume, mixing times and batching operations shall be adjusted as necessary to ensure that the material is completely and uniformly dispersed in the mix. The dispersion of the silica fume within the mix shall be verified in trial batches.

E. Hand-mixed Concrete

Hand mixing of concrete may be permitted for small placements or in case of an emergency and then only on authorization of the Engineer or designated representative. Hand-mixed batches shall not exceed a 4 cubic foot (0.113 cubic meters) batch in volume. Material volume ratios shall not be leaner than 1 part cement, 2 parts large aggregate, 1 part fine aggregate and enough water to produce a consistent mix with a slump not to exceed 4 inches (100 mm). Admixtures shall not be used unless specifically approved by the Engineer or designated representative.

403S.10 Excavation, Placing of Concrete, Finishing, Curing and Backfill

Excavation, placing of concrete, finishing, curing and backfill shall conform to Standard Specification Item No. 401S, "Structural Excavation and Backfill", Standard Specification Item No. 410S, "Concrete Structures" and Standard Specification Item No. 411S, "Surface Finishes for Concrete".

403S.11 Measurement

Where measurement of concrete for a structure is not provided by another governing pay item, measurement shall be made under this specification in accordance with the following.

The quantities of concrete of the various classifications which constitute the completed and accepted structure or structures in place will be measured by the cubic yard (cubic meters:1 cubic meter is equal to 1.308 cubic yards), each, square yard (square meter: 1 square yard equals 0.836 square meters) or linear foot as indicated in the Contract Documents. Measurement will be as follows:

A. General

1. Measurement based on dimensions shall be for the completed structure as measured in place. However, field-measured dimensions shall not exceed those indicated on the drawings or as may have been directed by the Engineer or designated representative in writing.

2. No deductions shall be made for chamfers less than 2 inches (50 mm) in depth, embedded portions of structural steel, reinforcing steel, nuts, bolts, conduits less than 5 inches (125 mm) in diameter, pre/post tensioning tendons, keys, water stops, weep holes and expansion joints 2 inches (50 mm) or less in width.

3. No measurement shall be made for concrete keys between adjoining beams or prestressed concrete planks.

4. No measurement shall be made for fill concrete between the ends or adjoining prestressed concrete planks/box beams at bent caps or between the ends of prestressed concrete planks/box beams and abutment end walls.

5. No measurement shall be made for inlet and junction box invert concrete.

6. No measurement shall be made for any additional concrete required above the normal slab thickness for camber or crown.

B. Plan Quantity. For those items measured for plan quantity payment, adequate calculations have been made. If no adjustment is required by Article 403S.12, additional measurements or calculations will not be required or made.

C. Measured in Place. For those items not measured for Plan Quantity payment, measurement will be made in place, subject to the requirements of Article 403S.10.A.1 above.

403S.12 Payment

The work performed and materials furnished as prescribed by this item and measured in accordance with the applicable provisions of "Measurement" above will be paid for as follows.

The quantity to be paid for will be that quantity indicated in the contract documents and/or shown on the drawings, regardless of errors in calculations, except as may be modified by the following.

Plan Quantities will be adjusted:

A. When a complete structure element has been erroneously included or omitted from the drawings, the quantity shown on the drawings 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 drawings. Quantities revised in this manner will not be subject to the provisions of the "General Conditions", Article 11.

B. When the plan quantity for a complete structure element is in error by 5 percent or more, a recalculation will be made and the corrected quantity included for payment. Quantities revised in this manner will not be subject to the provisions of the "General Conditions", Article 11

C. When quantities are revised by a change in design, the "plan quantity" will be increased or decreased by the amount involved in the design change. Quantities revised in this manner will be subject to the provisions of the "General Conditions", Article 11.

The party to the contract requesting the adjustment shall present to the other, a 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 Engineer or designated representative, it will become the revised plan quantity.

Payment for increased or decreased costs due to a change in design on those items measured as "Cubic Yard", "Each", "Square Foot", "Square Yard" or "Linear

Foot" will be determined by Change Order. Quantities revised in this manner will be subject to the provisions of the "General Conditions", Article 11.

The unit prices bid for the various classes of concrete shown shall include full compensation for furnishing, hauling, and mixing all concrete material; placing, finishing and curing all concrete; all grouting, pointing and finishing; furnishing and placing drains; furnishing and placing metal flashing strips; furnishing and placing expansion joint material required by this item; and for all forms and false work, labor, tools, equipment and incidentals necessary to complete the work.

Pay Item No. 403S-CY: (Structure or Structural Component) - Per Cubic Yard.

Pay Item No. 403S-EA: (Structure or Structural Component) - Per Each.

Pay Item No. 403S-SY: (Structure or Structural Component) - Per Square Yard.

Pay Item No. 403S-LF: (Structure or Structural Component) - Per Lineal Foot.

End

SPECIFIC CROSS REFERENCE MATERIALS
Standard Specification Item 403S, "Concrete For Structures"

City of Austin Standard Specification Items

Designation	Description
Item No. 401S	Structural Excavation and Backfill
Item No. 410S	Concrete Structures
Item No. 411S	Surface Finishes for Concrete

Texas Department of Transportation: Departmental Material Specifications

Designation	Description
DMS-4640	Chemical Admixtures for Concrete
DMS-4610	Fly Ash
DMS-4620	Ground Granulated Blast-Furnace Slag
DMS-4630	Silica Fume
DMS-4635	Metakaolin

American Association of State Highway & Transportation Officials,
AASHTO Standard Method of Test for

Designation	Description
Method T 26	Quality of Water to be Used in Concrete

American Concrete Institute, ACI

Designation	Description
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

American Society for Testing and Materials, ASTM

Designation	Description
ASTM C 94	Specification For Ready-Mixed Concrete
ASTM C 150	Specification For Portland Cement
ASTM C 685	Concrete Made By Volumetric Batching and Continuous Mixing
ASTM C-1260	Standard Test Method for Potential Alkali Reactivity of Aggregates
ASTM D-512	Test Methods for Chloride Ion in Water
ASTM D-516	Test Methods for Sulfate Ion in Water
ASTM D-4191	Test Method for Sodium in Water by Atomic Absorption
ASTM D-4192	Test Method for Potassium Water by Atomic Absorption

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
TEX-203-F	Sand Equivalent Test
TEX-401-A	Sieve Analysis of Fine and Coarse Aggregate
TEX-406-A	Mineral Finer than 75 µm (No. 200) Sieve in Mineral Aggregates (Decantation Test for Concrete Aggregates)
TEX-408-A	Organic Impurities in Fine Aggregate for Concrete
TEX-410-A	Abrasion of Coarse Aggregate Using The Los Angeles Machine

TEX-411-A	Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
TEX-413-A	Determination of Deleterious Materials in Mineral Aggregate
TEX-415-A	Slump of Portland Cement Concrete
TEX-416-A	Air Content of Freshly-Mixed Concrete by the Pressure Method
TEX-418-A	Compressive Strength of Cylindrical Concrete Specimens
TEX-612-J	Acid Insoluble Residue

SPECIFIC CROSS REFERENCE MATERIALS (Continued)
Standard Specification Item 403S, "Concrete For Structures"

Texas Department of Transportation: Publications

Designation	Description
Bulletin C-11	Construction Bulletin

RELATED CROSS REFERENCE MATERIALS
Standard Specification Item 403S, "Concrete For Structures"

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item 360	Concrete Pavement
Item 420	Concrete Structures
Item 421	Hydraulic Cement Concrete
Item 427	Surface Finishes for Concrete
Item 431	Pneumatically Placed Concrete

Item 520 Weighing and Measuring Equipment

Texas Department of Transportation: Departmental Material Specifications

Designation	Description
DMS-4650	Hydraulic Cement Concrete Curing Materials and Evaporation Retardants”
DMS-6100	Epoxy and Adhesives
DMS 8900	Fly Ash

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Item No. 405S
Concrete Admixtures

405S.1 Description

This item shall govern material requirements of admixtures for Portland cement concrete.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

405S.2 Submittals

The submittal requirements of this specification item include:

A. Type and manufacturer of any proposed admixture.

B. Certification that proposed admixture meet the requirements of this specification, ASTM C260 and ASTM C494.

C. For a specific mix design, a statement of compatibility of products shall be submitted when admixtures from multiple manufacturers are proposed.

405S.3 Materials

All admixture submittals must be approved by the Engineer or designated representative. No admixture shall be chloride-based or have chloride(s) added in the manufacturing process. Admixtures must be pretested by the Texas Department of Transportation (TXDOT) Materials and Tests Engineer and be included in the State's current approved admixture list. All admixtures must retain an approved status through the duration of a mix design's one-year approval period.

(1) Air Entraining Admixture:

An "Air Entraining Admixture" is defined as a material which, when added to a concrete mixture in the proper quantity, will entrain uniformly dispersed microscopic air bubbles in the concrete mix. The admixture shall meet the requirements of ASTM Designation: C 260 modified as follows:

(a) The cement used in any series of test shall be either the cement proposed for the specific work or a "reference" Type I cement from one mill.

(b) The air entraining admixture used in the reference concrete shall be Neutralized Vinsol Resin.

(2) Water-reducing Admixture:

A "Water-reducing Admixture" is defined as a material which, when added to a concrete mixture in the correct quantity, will reduce the quantity of mixing water required to produce concrete of a given consistency and required strength. This admixture shall conform to ASTM C 494, Type A.

(3) Accelerating Admixture:

An "Accelerating Admixture" is defined as an admixture that accelerates the setting time and the early strength development of concrete. This admixture shall conform to ASTM C 494, Type C. The accelerating admixture will contain no chlorides.

(4) Water-reducing, Retarding Admixture:

A "Water-reducing, Retarding Admixture" is defined as a material which, when added to a concrete mixture in the correct quantity, will reduce the quantity of mixing water required to produce concrete of a given consistency and retard the initial set of the concrete. This admixture shall conform to ASTM C 494, Type D.

(5) High-range Water Reducing Admixtures:

A "High-range Water Reducing Admixture", referred to as a superplasticizer, is defined as a synthetic polymer material which, when added to a low slump concrete mixture increases the slump without adversely affecting segregation, impermeability or durability of the mix. This admixture shall conform to ASTM C 494, Type F or G.

(6) Fly Ash:

Fly ash used in Portland cement concrete as a substitute for Portland cement or as a mineral filler shall comply with TXDOT Materials Specification D-9-8900 and be listed on TXDOT's current list of approved fly ash sources. Fly ash obtained from a source using a process fueled by hazardous waste (30 Texas Administrative Code, Section 335.1) shall be prohibited. This applies to any other specification concerning the use of fly ash. Contractor shall maintain a record of source for each batch. Supplier shall certify that no hazardous waste is used in the fuel mix or raw materials.

405S.4 Certification and Product Information

The Contractor shall submit the name of the admixture proposed and manufacturer's certification that the selected admixtures meet the requirements of this item and of ASTM C 260 and C 494 as applicable. Admixtures for a mix design shall be of the same brand. If more than one admixture is proposed in the concrete mix, a statement of compatibility of components shall accompany certification. Manufacturer's product literature shall specify when in the batching/mixing operation the admixture must be added.

The Engineer or designated representative may request additional information such as infrared spectrophotometry scan, solids content, pH value, etc., for further consideration. Any unreported changes in formulation discovered by any of the tests prescribed herein may be cause to permanently bar the manufacturer from furnishing admixtures for Owner's work.

405S.5 Construction Use of Admixtures

All admixtures used shall be liquid except high-range water reducers which may be a powder. Liquid admixtures shall be agitated as needed to prevent separation or sedimentation of solids; however, air agitation of Neutralized Vinsol Resin will not be allowed.

No admixture shall be dispensed on dry aggregates. Admixtures shall be dispensed at the batching site separately, but at the same time as the mixing water. Only high range water reducers may be introduced into the mix at the job site.

When other admixtures are used with fly ash, the amount of the other admixture to be used shall be based on the amount of Portland cement only and not the amount of Portland cement and fly ash.

When high-range water reducers are to be added at the job site, transit mixers shall be used. Admixture manufacturer literature shall indicate recommended mixing methods and time for the specific equipment and mix design used. The transit mix equipment shall not be loaded in excess of 63 percent of its rated capacity to ensure proper mixing of the admixture at the site. If during discharging of concrete a change in slump in excess of 30% is noted, the remaining concrete shall be rejected unless prior approval was given by the Engineer or designated representative to retemper a load with a second charge of admixture. Retempering with water shall not be allowed.

Accelerating admixtures will not be permitted in combination with Type II cement.

All mixes with air entrainment shall have a minimum relative durability factor of 80 in accordance with ASTM C 260. Dosage of air entrainment admixtures may be adjusted by the Contractor to stay within the specified tolerances for air entrainment of Standard Specification Item No. 403S, "Concrete for Structures".

405S.6 Measurement and Payment

The requirements of this specifications shall not be measured and paid for directly, but shall be included in the unit price bid for the item of construction in which this item is used.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 405S, "Concrete Admixtures"

City of Austin Standard Specifications

Designation	*Description*
Item No. 403S	*Concrete for Structures*

American Society for Testing and Materials, ASTM

Designation	*Description*
ASTM C260	*Air-Entraining Admixtures for Concrete*
ASTM C495	*Chemical Admixtures for Concrete*

Texas Department of Transportation: Department Material Specification

Designation	*Description*
DMS-8900	*Fly Ash*

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 405S, "Concrete Admixtures"

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item 360	Concrete Pavement
Item 420	Concrete Structures
Item 421	Portland Cement Concrete
Item 427	Surface Finishes for Concrete
Item 431	Pneumatically Placed Concrete
Item 437	Concrete Admixtures
Item 520	Weighing and Measuring Equipment
Item 522	Portland Cement Concrete Plants
Item 524	Hydraulic Cement

Item No. 406S
Reinforcing Steel

406S.1 Description

This item shall govern furnishing and placement of reinforcing steel, deformed and smooth, of the size and quantity indicated on the drawings and in accordance with these specifications.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

406S.2 Submittals

The submittal requirements of this specification item may include:

A. Evidence that the steel reinforcement producer is included on the TxDoT list of approved producing mills

B. Listing of the size, grade, type and quantity of reinforcing steel proposed for the project.

C. If welding of reinforcing steel is proposed, evidence that carbon equivalent (C.E.) of the proposed steel is at least 0.55% with a report of chemical analysis showing the percentages of elements necessary to establish C.E.

D. If epoxy coated steel is proposed, evidence that the steel reinforcement producer is included on the TxDoT list of approved epoxy coating applicators

E. If epoxy coated steel is proposed, written certification that the epoxy-coated reinforcing steel meets the requirements of this Item with a copy of the manufacturer's control tests.

F. When mechanical splices are proposed, the types of couplers proposed for use.

406S.3 Materials

A. Approved Mills

Prior to furnishing reinforcing steel, the producing mills must be included on the list of approved producing mills that is maintained by the Construction Division of the State of Texas Department of Transportation

B. Deformed Bars and Wire Reinforcement

Unless indicated otherwise on the drawings, Bar reinforcement shall be Grade 60 and deformed. Reinforcing steel must conform to one of the following:

ASTM A615/ 615M, Grades 40 or 60 (300 or 420)

ASTM A996/ 996M, Type A, Grades 40 or 60 (300 or 420)

ASTM A996/996M, Type R, Grade 60 (420), permitted in concrete pavement only (furnished as straight bars only without bends. Bend tests are not required)

ASTM A706/706M

In cases where the provisions of this item are in conflict with the provisions of the ASTM Designation to which reference is made, the provisions of this item shall govern.

The nominal size, area and weight (mass) of reinforcing steel bars covered by these specifications are as follows:

Bar Size Number 1/8th ins (mm)	Nominal Diameter, inches (mm)	Nominal Area, Sq. ins. (mm2)	Weight/Linear Foot Lbs. (kg)
2 (6)	0.250 (6.6)	0.05 (32)	0.167 (.075)
3 (10)	0.375 (9.5)	0.11 (71)	0.376 (.171)
4 (13)	0.500 (12.5)	0.20 (127)	0.668 (.303)
5 (16)	0.625 (15.5)	0.31 (198)	1.043 (.473)
6 (19)	0.750 (19.0)	0.44 (285)	1.502 (.681)
7 (22)	0.875 (22.0)	0.60 (388)	2.044 (.927)
8 (25)	1.000 (25.5)	0.79 (507)	2.670 (2.211)
9 (29)	1.128 (28.5)	1.00 (641)	3.400 (1.542)
10 (32)	1.270 (32.0)	1.27 (792)	4.303 (1.952)
11 (36)	1.410 (36.0)	1.56 (958)	5.313 (2.410)
14 (43)	1.693 (43.0)	2.25 (1552)	7.65 (3.470)

18 (57)	2.257 (57.5)	4.00 (2565)	13.60 (6.169)

Smooth, round bars shall be designated by size number through a No. 4. Smooth bars above No. 4 shall be designated by diameter in inches.

C. Smooth Bar and Spiral Reinforcement

Smooth bars and dowels for concrete pavement must have a minimum yield strength of 60 ksi (414 MPa) and meet ASTM A615/615M. Smooth bars that are greater in diameter than a No. 3 (10 mm) designation shall conform to ASTM A615 or meet the physical requirements of ASTM A36.

Spiral reinforcement shall be either smooth or deformed bars or wire of the minimum size or gauge indicated on the drawings. Bars for spiral reinforcement shall comply with ASTM A615 Grade 40(300), ASTM A996, Type A, Grade 40 (300); or ASTM A675, Grade 80(550), meeting dimensional requirements of ASTM A615. Smooth wire shall comply with ASTM A82, and deformed wire shall comply with ASTM A496.

D. Weldable Reinforcing Steel

Reinforcing steel to be welded must comply with ASTM A706 or have a carbon equivalent (C.E.) of at most 0.55%. A report of chemical analysis showing the percentages of elements necessary to establish C.E. is required for reinforcing steel that does not meet ASTM A706 to be structurally welded. No tack welding will be allowed. All welding shall conform to the requirements of AWS D1.1/D1.1M.

The requirements above do not apply to the following miscellaneous welding applications:

Splicing reinforcing steel to extend bars in the bottom of a drilled shaft;

Attaching chairs to the reinforcing steel cage of a drilled shaft;

Armor joints and their supports;

Screed rail and form hanger supports where permitted on steel units;

Reinforcing steel to R-bars for lateral stability between prestressed beams, spirals, or bands of reinforcing bars in drilled shaft cages;

Permanent bridge deck forms;

Steel added in railing when slip-form construction is used; and

Other similar miscellaneous members that have no load carrying capacity in the completed structure.

E. Welded Wire Fabric

Wire shall conform to the requirements of the Standard Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement, ASTM A 82 or A 496. Wire fabric, when used as reinforcement, shall conform to ASTM A 185 or A 497.

When wire is ordered by size numbers, the following relation between size number, diameter in inches and area shall apply unless otherwise indicated on the drawings:

Size, W Number 1/100 in^2 (mm2)	Nominal Diameter inch (mm)	Nominal Area, sq. inches (mm^2)
31 (200)	0.628 (16.0)	0.310 (200)
30 (194)	0.618 (15.7)	0.300 (194)
28 (181)	0.597 (15.2)	0.280 (181)
26 (168)	0.575 (14.6)	0.260 (168)
24 (155)	0.553 (14.0)	0.240 (155)
22 (142)	0.529 (13.4)	0.220 (142)
20 (129)	0.505 (12.8)	0.200 (129)
18 (116)	0.479 (12.2)	0.180 (116)
16 (103)	0.451 (11.5)	0.160 (103)
14 (90)	0.422 (10.7)	0.140 (90)
12 (77)	0.391 (9.9)	0.120 (77)
10 (65)	0.357 (9.1)	0.100 (65)
8 (52)	0.319 (8.1)	0.080 (52)
7 (45)	0.299 (7.6)	0.070 (45)
6 (39)	0.276 (7.0)	0.060 (39)
5.5 (35)	0.265 (6.7)	0.055 (35)
5 (32)	0.252 (6.4)	0.050 (32)
4.5 (29)	0.239 (6.1)	0.045 (29)

4 (26)	0.226 (5.7)	0.040 (26)
3.5 (23)	0.211 (5.4)	0.035 (23)
3 (19)	0.195 (5.0)	0.030 (19)
2.5 (16)	0.178 (4.5)	0.025 (16)
2 (13)	0.160 (4.1)	0.020 (13)
1.5 (9)	0.138 (3.5)	0.015 (9.7)
1.2 (8)	0.124 (3.1)	0.012 (7.7)
1 (6)	0.113 (2.9)	0.010 (6.5)
0.5 (3)	0.080 (2.0)	0.005 (3.2)

Where deformed wire is required, the size number shall be preceded by D and for smooth wire the prefix W shall be shown.

Welded wire fabric shall be designated as follows: 6 x 12 – W16 x W8, which indicates a 6 in. (150 mm) longitudinal wire spacing and 12-in (300 mm) transverse wire spacing with smooth No. 16 (103) wire longitudinally and smooth no. 8 (52) wire transversely.

F. Epoxy Coating

Epoxy coating shall be required as indicated on the drawings. Prior to furnishing epoxy-coated reinforcing steel, the epoxy applicator must be included on the list of approved applicators that is maintained by the Construction Division of the State of Texas Department of Transportation.

The reinforcing steel shall be epoxy coated in accordance with the following.

Epoxy Coating Requirements for Reinforcing Steel

Material	Specification
Bar	ASTM A775 or A934
Wire or Fabric	ASTM A884 Class A or B
Mechanical Coupler	As indicated on the drawings

Hardware	As indicated on the drawings

The epoxy coating material and coating repair material shall comply with TxDoT's DMS-8130, "Epoxy Powder Coating for Reinforcing Steel". The applicator shall not patch more than ¼ inch total length in any foot (20 mm total length in any meter) at the applicator's plant.

The epoxy-coated reinforcing steel shall be sampled and tested in accordance with TxDoT Test Method Tex-739-I, "Sampling and Testing Epoxy Coated Reinforcing Steel".

The identification of all reinforcing steel shall be maintained throughout the epoxy coating and fabrication and until delivery to the project site.

Written certification that the epoxy-coated reinforcing steel meets the requirements of this Item shall be provided along with a copy of the manufacturer's control tests.

G. Mechanical Couplers

When mechanical splices in reinforcing steel bars are indicated on the drawings, the following types of couplers may be used:

Sleeve-filler

Sleeve-threaded

Sleeve-swaged, or

Sleeve-wedge.

H. Chairs and Supports

Chairs and Supports shall be steel, precast mortar or concrete blocks cast in molds meeting the approval of the Engineer or designated representative of sufficient strength to position the reinforcement as indicated on the drawings when supporting the dead load of the reinforcement, the weight of the workers placing concrete and the weight of the concrete bearing on the steel. Chairs shall be plastic coated when indicated on the drawings.

Chair Types and Applicable Uses	
Structural or Architectural Elements (columns, beams, walls, slabs) exposed to weather, not subjected to sand blasting, water blasting or grinding.	Galvanized steel or steel chairs with plastic coated feet.

Structural or Architectural Elements exposed to weather and subject to sand blasting, water blasting or grinding.	Stainless steel chairs.
Structural or Architectural Elements not exposed to weather or corrosive conditions.	Uncoated steel chairs
Slabs and grade beams cast on grade.	Steel chairs with a base with 9 inch^2 (58 cm^2) minimum area or sufficient area to prevent the chair from sinking into fill or subgrade. Precast mortar or concrete blocks meeting the requirements of this item may be used.

406S.4 Bending

The reinforcement shall be bent cold, true to the shapes indicated on the drawings. Bending shall preferably be done in the shop. Irregularities in bending shall be cause for rejection. Improperly fabricated, damaged or broken bars shall be replaced at no additional expense to the City. Damaged or broken bars embedded in a previous concrete placement shall be repaired using a method approved by the Engineer or designated representative.

Unless otherwise indicated on the drawings, the inside diameter of bar bends, in terms of the nominal bar diameter (d), shall be as follows:

Bends of 90 degrees and greater in stirrups, ties and other secondary bars that enclose another bar in the bend.

Bar Number in 1/8th inches (mm)	Diameter
3, 4, 5 (10, 13, 16)	4d
6, 7, 8	6d

All bends in main bars and in secondary bars not covered above.

Bar Number in 1/8th inches (mm)	Diameter
3 thru 8 (10 thru 25)	6d
9, 10, 11 (29, 32, 36)	8d
14, 18 (43, 57)	10d

406S.5 Tolerances

Fabricating tolerances for bars shall not be greater than shown on Standard (Detail) 406S-1.

406S.6 Storing

Steel reinforcement shall be stored above the surface of the ground upon platforms, skids or other supports and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, paint, grease, oil or other foreign materials. Reinforcement shall be free from injurious defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum dimensions, cross sectional area and tensile properties of a hand wire brushed specimen meets the physical requirements for the size and grade of steel indicated on the drawings.

406S.7 Splices

Splicing of bars, except when indicated on the drawings or specified herein, will not be permitted without written approval of the Engineer or designated representative. No substitution of bars will be allowed without the approval of the Engineer or designated representative. Any splicing of substituted bars shall conform to the requirements in the Table below.

Splices not indicated on the drawings will be permitted in slabs not more than 15 inches (380 mm) in thickness, columns, walls and parapets.

Splices will not be permitted in bars 30 feet (9.1 meters) or less in plan length unless otherwise approved. For bars exceeding 30 feet (9.1 meters) in plan length, the distance center to center of splices shall not be less than 30 feet (9.1 meters) minus 1 splice length, with no more than 1 individual bar length less than 10 feet (3 meters). Splices not indicated on the drawings, but permitted hereby, shall conform to the Table

below. The specified concrete cover shall be maintained at such splices and the bars placed in contact and securely tied together.

Minimum Lap Requirements		
Bar Number in 1/8th inches (mm)	Uncoated Lap Length	Coated Lap Length
3 (10)	1 foot 4 inches (0.4 meters)	2 foot 0 inches (0.610 meters)
4 (13)	1 foot 9 inches (0.533 meters)	2 foot 8 inches (0.813 meters)
5 (16)	2 foot 2 inches (0.660 meters)	3 feet 3 inches (0.991meters)
6 (19)	2 foot 7 inches (0.787 meters)	3 feet 11 inches (1.194 meters)
7 (22)	3 feet 5 inches (1.041 meters)	5 feet 2 inches (1.575 meters)
No. 8 (25)	4 feet 6 inches (1.372 meters)	6 feet 9 inches (2.057 meters)
No. 9 (29)	5 feet 8 inches (1.727 meters)	8 feet 6 inches (2.591 meters)
No. 10 (32)	7 feet 3 inches (2.210 meters)	10 feet 11 inches (3.327 meters)
No. 11 (36)	8 feet 11 inches (2.718 meters)	13 feet 5 inches (4.089 meters)

Spiral steel shall be lapped a minimum of 1 turn. Bar No. 14 and No. 18 may not be lapped.

Welded wire fabric shall be spliced using a lap length that includes an overlap of at least 2 cross wires plus 2 inches (50 mm) on each sheet or roll.

Splices using bars that develop equivalent strength and are lapped in accordance with the table above are permitted.

Welding of reinforcing bars may be used only where indicated on the drawings or as permitted herein. All welding operations, processes, equipment, materials, quality of work and inspection shall conform to the requirements indicated on the drawings. All

splices shall be of such dimension and character as to develop the full strength of the bar being spliced.

End preparation for butt-welding reinforcing bars shall be done in the field, except Bar No. 6 and larger shall be done in the shop. Delivered bars shall be of sufficient length to permit this practice.

For box culvert extensions with less than 1 foot (0.3 meters) of fill, the existing longitudinal bars shall have a lap with the new bars as shown in the table above. For box culvert extensions with more than 1 foot (0.3 meters) of fill, a minimum lap of 12 inches (300 mm) will be required.

Unless otherwise indicated on the drawings, dowel bars transferring tensile stresses shall have a minimum embedment equal to the minimum lap requirements shown in the table above. Shear transfer dowels shall have a minimum embedment of 12 inches (300 mm).

406S.8 Placement

Reinforcement shall be placed as near as possible in the position indicated on the drawings. Unless otherwise indicated on the drawings, dimensions shown for reinforcement are to the centers of the bars. In the plane of the steel parallel to the nearest surface of concrete, bars shall not vary from plan placement by more than 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 (6 mm). Cover of concrete to the nearest surface of steel shall be as follows:

	Minimum Cover, Inches (mm)
(a) Concrete cast against and permanently exposed to earth	3 (76 mm)
(b) Concrete exposed to earth or weather:	
Bar No. 6 (19) through No. 18 bars (57)	2 (51 mm)
Bar No. 5 (16), W31 (W200) or D31 (D200) wire and smaller	1 ½ (38 mm)
(c) Concrete not exposed to weather or in contact with ground:	

Slabs, walls, joists:	
Bar No. 14 (43) and 18 (57)	1 ½ (38mm)
Bar No. 11 (36) and smaller	1 (25 mm)
Beams, columns:	
Primary reinforcement, ties, stirrups, spirals	1 ½ (38 mm)
Shells, folded plate members:	
Bar No. 6 (19) and larger	1 (25 mm)
Bar No. 5 (16), W31 (W200) or D31 (D200) wire, and smaller	1 (25 mm)

Vertical stirrups shall always pass around the main tension members and be attached securely thereto.

The reinforcing steel shall be located accurately in the forms and held firmly in place before and during concrete placement by means of bar supports that are adequate in strength and number to prevent displacement and to keep the steel at the required distance from the form surface. Bars shall be supported by means of approved galvanized metal spacers, metal spacers with plastic coated tips, stainless steel spacers, plastic spacers or approved precast mortar or concrete blocks when supports are in contact with removable or stay-in-place forms. Bright basic bar supports shall be used to support reinforcing steel placed in slab overlays on concrete panels or on existing concrete slabs. Bar supports in contact with soil or subgrade shall be approved.

For bar supports with plastic tips, the plastic protection must be at least 3/32 in. (2.4 mm) thick and extend upward on the wire to a point at least ½ in. (12.5 mm) above the formwork.

For approval of plastic spacers on a project, representative samples of the plastic shall show no visible indications of deterioration after immersion in a 5 percent solution of sodium hydroxide for 120 hours.

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. When approved by the Engineer or designated representative, plastic supports may also be used with epoxy-coated reinforcement.

All reinforcing steel shall be tied at all intersections, except that where spacing is less than 1 foot (300 mm) in each direction, alternate intersections only need be tied. For reinforcing steel cages for other structural members, the steel shall be tied at enough intersections to provide a rigid cage of steel. Mats of wire fabric shall overlap each other 1 full space as a minimum to maintain a uniform strength and shall be tied at the ends and edges.

Where prefabricated deformed wire mats are specified or if the Contractor requests, welded wire fabric may be substituted for a comparable area of steel reinforcing bar plan, subject to the approval of the Engineer or designated representative.

Mortar or concrete blocks shall be cast to uniform dimensions with adequate bearing area. A suitable tie wire shall be provided in each block, to be used for anchoring to the steel. Except in unusual cases and when specifically authorized by the Engineer, the size of the surface to be placed adjacent to the forms shall not exceed 2 1/2 inches (63.5 mm) square or the equivalent thereof in cases where circular or rectangular areas are provided. Blocks shall be cast accurately to the thickness required and the surface to be placed adjacent to the forms shall be a true plane, free of surface imperfections. The blocks shall be cured by covering them with wet burlap or mats for a period of 72 hours. Mortar for blocks should contain approximately 1 part hydraulic cement to three parts sand. Concrete for blocks should contain 850 pounds of hydraulic cement per cubic yard (500 kilograms per cubic meter) of concrete

Individual bar supports shall be placed in rows at 4-ft (1.22 meters) maximum spacing in each direction. Continuous type bar supports shall be placed at 4-ft (1.22 meters) maximum spacing. Continuous bar supports shall be used with permanent metal deck forms.

The exposure of the ends of longitudinals, stirrups and spacers used to position the reinforcement in concrete pipe and in precast box culverts or storm drains is not a cause for rejection.

Reinforcing steel for bridge slabs, top slabs of direct traffic culverts, and top slabs of prestressed box beams at all intersections, except tie only alternate intersections where spacing is less than 1 ft. (300 mm) in each direction.

For steel reinforcing cages for other structural members, reinforcement shall be supported and tied in such a manner that a sufficiently rigid cage of steel is provided. Fasten mats of wire fabric securely at the ends and edges. If the cage is not adequately supported to resist settlement or floating upward of the steel, overturning of truss bars or movement in any direction during concrete placement, permission to continue concrete placement will be withheld until corrective measures are taken. Sufficient measurements shall be made during concrete placement to insure compliance with the above.

No concrete shall be deposited until the Engineer or designated representative has reviewed the placement of the reinforcing steel and all mortar, mud, dirt, etc, shall be cleaned from the reinforcement, forms, workers' boots and tools. Do not place concrete until authorized by the Engineer or designated representative

406S.9 Handling, Placement and Repair of Epoxy-coated Reinforcement Steel

A. Handling

Systems for handling coated-reinforcement with padded contact areas shall be provided. Handling bands shall be padded to prevent damage to the coating. Bundles of coated reinforcement shall be lifted with a strongback, spreader bar, multiple supports or a platform bridge. The bundled reinforcement shall be carefully transported and stored on protective cribbing. The coated reinforcement should not be dropped or drug during handling.

B. Construction Methods

Coated reinforcement shall not be flame-cut but shall be sawn or shear-cut only when approved. Cut ends shall be coated as specified in Section C, “Repair of Coating”.

Coated reinforcement steel shall not be welded or mechanically coupled except where specifically indicated on the drawings. When welding or coupling is indicated on the drawing, the epoxy coating shall be removed at least 6 in. (150 mm) beyond the weld limits before welding and 2 in. (50 mm) beyond the limits of the mechanical coupler before assembly. After the welding or coupling operation is completed the steel shall be cleaned of oil, grease, moisture, dirt, welding contamination (slag or acid residue) and rust to a near-white finish. The existing epoxy coating shall be examined for damage and any damaged or loose epoxy shall be removed to expose sound epoxy coating.

After cleaning the coated-steel, the splice area shall be coated with epoxy repair material to a thickness of 7 to 17 mils (0.18 to 0.43 mm) after curing. A second application of the repair material shall be applied to the bar and coupler interface to ensure complete sealing of the joint.

C. Repair of Coating

The material used for coating repair shall comply with the requirements of this Item and ASTM D3963/D3963M, “Specification for Fabrication and Jobsite Handling of Epoxy-coated Reinforcing Steel Bars”. Repairs shall be made in accordance with procedures recommended by the manufacturer of the epoxy coating powder. For areas to be patched, a minimum coating thickness as required for the original coating shall be applied. All visible damage to the coating shall be repaired.

Sawed and sheared ends, cuts, breaks and other damage shall be promptly repaired before additional oxidation occurs. The areas to be repaired shall be cleaned to ensure that they free from surface contaminants. Repairs shall be made in the shop or in the field as required.

406S.10 Measurement

The measurement of quantities of reinforcement furnished and placed will be based on the calculated weight of the steel actually placed as indicated on the drawings, with no allowance made for added bar lengths for splices requested by the Contractor nor for

extra steel used when bars larger than those indicated on the drawings are used or for a higher grade of steel that is substituted with the permission of the Engineer or designated representative. Tie wires and supporting devices will not be included in the calculated weights. The calculated weight of bar reinforcement will be determined using the theoretical bar weight set forth in this item.

Measurement required by a change in design will be computed as described above for the actual steel required to complete the work.

406S.11 Payment

Reinforcing steel will generally not be paid for directly, but shall be included in the unit price bid for the items of construction in which the reinforcing steel is used.

When specified in the contract bid form as a separate pay item, this item shall be paid for at the contract unit price bid per pound of "Reinforcing Steel". The unit bid price shall include full compensation for all work specified herein including furnishing, bending, fabricating, welding and placing reinforcement, for all clips, blocks, metal spacers, ties, chairs, wire or other materials used for fastening reinforcement in place and for all tools, labor, equipment and incidentals necessary to complete the work.

Payment, when included as a contract pay item, will be made under:

Pay Item No. 406S-RC:	Reinforcing Steel -	Per Pound.
Pay Item No. 406S-ERC:	Epoxy-Coated Reinforcing Steel -	Per Pound.

END

SPECIFIC CROSS REFERENCE MATERIALS
Standard Specification Item 406S, "Reinforcing Steel"

American Society for Testing and Materials, ASTM

Designation	Description
ASTM A 36/A 36M	Carbon Structural Steel
ASTM A 82	Steel Wire, Plain, for Concrete Reinforcement
ASTM A 185	Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 496	Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497	Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A 615/A 615M	Deformed and Plain Billet-steel Bars for Concrete Reinforcement
ASTM A 675/A 675M	Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASTM A 706/A 706M	Low- Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 775/A 775M	Epoxy-Coated Reinforcing Steel Bars
ASTM A 884/A 884M	Epoxy-Coated Steel Wire and Welded Wire Fabric For Reinforcement
ASTM A 934/A 934M	Epoxy-Coated Prefabricated Reinforcing Steel Bars
ASTM A 996/A 996M	Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM D3963/D3963M	Fabrication and Jobsite Handling of Epoxy-coated Reinforcing Steel Bars

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-739-I	Sampling and Testing Epoxy Coated Reinforcing Steel

City of Austin Standard (Details)

Designation	Description
Standard 406S-1	Reinforced Steel Tolerances

Texas Department of Transportation: Departmental Material Specifications

Designation	Description
DMS 8130	Epoxy Powder Coating for Reinforcing Steel

American Welding Society

Designation	Description
AWS D1.1/D1.1M	Structural Welding Code

RELATED CROSS REFERENCE MATERIALS
Standard Specification Item 406S, "Reinforcing Steel"

City of Austin Standard Specification Items

Designation	Description
Item No. 360	Concrete Pavement
Item No. 403S	Concrete for Structures
Item No. 410S	Concrete Structures
Item No. 414S	Concrete Retaining Walls

Item No. 420S	Drilled Shaft Foundations
Item No. 830S	Traffic Signal Controller Foundation
Item No. 831S	Traffic Signal Drilled Shaft Foundation

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 360	Concrete Pavement
Item No. 420	Concrete Structures
Item No. 421	Hydraulic Cement Concrete
Item No. 422	Reinforced Concrete Slab
Item No. 423	Retaining Walls
Item No. 440	Reinforcing Steel

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Item No. 408S
Concrete Joint Materials

408S.1 Description

This item shall govern the furnishing and placing of all longitudinal, transverse contraction and expansion joint material in concrete work as herein specified in the various items of these specifications as indicated or as directed by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

408S.2 Submittals

The submittal requirements of this specification item include:

A. Type and manufacturer of all joint materials proposed for use.

B. Technical data indicating that proposed products meet the requirements specified herein.

408S.3 Materials

(1) Preformed Asphalt Board

Preformed asphalt board formed from cane or other suitable fibers of a cellular nature securely bound together and uniformly impregnated with a suitable asphaltic binder and meeting the requirements of the Standard Specifications for Preformed Expansion Joint Filler for Concrete (Bituminous Type), ASTM D 994.

(2) Preformed Nonbituminous Fiber Material

Preformed nonbituminous fiber material shall meet the requirements of the Standard Specifications for the Preformed Expansion Joint Filler for Concrete Paving and Structural Construction, ASTM D 1751, except that the requirements pertaining to bitumen content, density and water absorption shall be voided.

(3) Boards

Boards obtained from Redwood timber, of sound heartwood, free from sapwood, knots, clustered birdseye, checks and splits. Occasional sound or hollow birdseye, 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.

(4) Joint Sealer (Concrete Pavement)

This material shall be a one part low modulus silicone especially designed to cure at ambient temperatures by reacting with moisture in the air and shall have the following properties:

As Supplied	
Color	Gray
Flow, MIL-2-8802D Sec. 4.8.4	0.2 maximum

Working Time, minutes	10
Tack-Free Time at 77°F ± 2F (25°C ± -1.66°C) Min. MIL-2-8802D Sec.4.8.7	60
Cure time, at 77°F (25°C), days	7-14
Full Adhesion, days	14-21
As Cured---after 7 days at 77°F (25°C) and 40% RH	
Elongation, percent minimum	1200
Durometer Hardness, Shore A, points ASTM 2240	15
Joint Movement Capability, percent	+100/-50
Tensile Strength, maximum elongation,psi (kPa)	100 (689)
Peel Strength, psi (kPa)	25 (172)

The joint sealer shall adhere to the sides of the concrete joint or crack and shall be an effective seal against infiltration of water and incompressibles. The material shall not crack or break when exposed to low temperature.

(5) Backer Rod

Backer Rod shall be expanded closed cell polyethylene foam compatible with sealant. No bond or reaction shall occur between rod and sealant. Backer Rod shall be of sufficient width to be in compression after placement and shall be used with joint sealer.

(6) Joint Sealing Material

Joint Sealing Material for other than pavement use may be a two-component, synthetic polymer or cold-pourable, self leveling type meeting the following requirements:

The material shall adhere to the sides of the concrete joint or crack and shall form an effective seal against infiltration of water and incompressibles. The material shall not crack or break when exposed to low temperatures. Curing is to be by polymerization and not by evaporation of solvent or fluxing of harder particles. It shall cure sufficiently at an average temperature of 77°F± 3°F (25°C ± -1.66°C) so as not to pick up under wheels of traffic in a maximum of 3 hours.

Performance Requirements:

When tested in accordance with Test Method Tex-525-C, the joint sealing material shall meet the above curing times and the requirements as follows:

It shall be of such consistency that it can be mixed and poured or mixed and extruded into joints at temperatures above 60°F (1.66°C).

Penetration 77°F (25°C), 150 gm. Cone, 5 sec., max.-cm	0.90
Bond and Extension 75%, 0F, 5 cycles:	
Dry Concrete Blocks	Pass
Wet Concrete Blocks	Pass
Steel Blocks (Primed if specified by manufacturer)	Pass
Flow at 200 °F (93°C)	None
Water content % by weight, max.	5.0

Resilience:	
Original sample min. % (cured)	50
Oven-aged at 158°F (70°C) min. %	50
For Class 1-a material only, Cold Flow (10 minute)	None

(7) Rebonded Recycled Tire Rubber

This material consists of granular particles of rubber, made by grinding automobile and truck tires, securely bound together by a synthetic resin or plastic binder. The filler must be molded into sheets of the required dimensions, which meet the testing requirements of both ASTM D 1751 and ASTM D 1752, except that the requirements for asphalt content and expansion are waived. The density of the material must be at least 30 lb/ft ^{3} (440kg/m^3).

408S.4 Construction Methods

The Contractor shall install "Concrete Joint Materials" which will function as a compatible system. Joint sealer shall not be placed where a bond braker is present.

Asphalt, Redwood board or other materials used shall extend the full depth of the concrete and shall be perpendicular to the exposed face. All joints shall be shaped to conform to the contour of the finished section in which they are installed. All material shall be a minimum of 1/2 inch (12.5 mm) thick or as indicated. Wood materials shall be anchored to the adjacent concrete to permanently hold them in place. Joint sealer shall be installed in accordance with the manufacturer's recommendations.

The material used for side walk expansion joints shall conform to No. 3 above, unless otherwise indicated.

The material used for curb and gutter expansion joints filler shall conform to any of the above, except when placed adjacent to concrete pavement, the joint material shall match the pavement joint material.

408S.5 Measurement and Payment

No additional compensation will be made for materials, equipment or labor required by this item, but shall be included in the unit price bid for the item of construction in which this item is used.

End

SPECIFIC Cross Reference Materials
Standard Specification Item No. 408S, " Concrete Joint Materials"

American Society for Testing and Materials (ASTM)

Designation	Description
D 994	Specification for Preformed Expansion Joint Filler for Concrete

	(Bituminous Type)
D 1751	Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
D 1752	Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
D 2240	Standard Test Method for Rubber Property-Durameter Hardness

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-525-C	Tests for Asphalt and Concrete Joint Sealers

Item No. 409S
Membrane Curing

409S.1 Description

This item shall govern curing concrete pavement, concrete base, pavement, curbs, gutters, retards, sidewalks, driveways, medians, islands, concrete riprap, cement stabilized riprap, concrete structures and other concrete as indicated by applying an impervious liquid membrane forming material.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

409S.2 Submittals

The submittal requirements of this specification item include:

A. Type and manufacturer for all membrane curing materials proposed.

B. Proposed curing procedures.

409S.3 Material

The liquid forming membrane curing compound shall comply with the "Standard Specification for Liquid Membrane-forming Compounds for Curing Concrete", ASTM C 309, Type 1-D clear or translucent, with fugitive dye or Type 2 white pigmented. The material shall have a minimum flash point of 80°F (26.7°C) when tested by the "Pensky-Martin Closed Cup Tester", ASTM D 93.

It shall be of such consistency that it can be satisfactorily applied as a fine mist through an atomizing nozzle by means of approved pressure spraying equipment at atmospheric temperatures above 40° F (4.4°C).

It shall be of such nature that it will not produce permanent discoloration of concrete surfaces nor react deleteriously with the concrete or its components. Type 1 compound shall contain a fugitive dye that will be distinctly visible not less than 4 hours nor more than 7 days after application.

Type 2 compound shall not settle out excessively or cake in the container and shall be capable of being mixed to a uniform consistency by moderate stirring and shall exhibit a daylight reflectance of not less than 60 percent of that of magnesium oxide when tested as indicated.

The compound shall produce a firm, continuous, uniform moisture impermeable film, free from pinholes and shall adhere satisfactorily to the surfaces of damp concrete. When applied to the damp concrete surface at the rate of coverage indicated, the compound shall dry to the touch in not more than 4 hours and shall not be tacky or track off concrete after 12 hours.

It shall adhere to horizontal and vertical surfaces in a tenacious film and shall not run off or show an appreciable sag, disintegrate, check, peel or crack during the required curing period.

Under traffic, the compound shall not pick up or peel and shall gradually disintegrate from the surface.

The compound shall be delivered to the job only in the manufacturer's original containers, which shall be clearly labeled with the manufacturer's name, the trade name of the material and a batch number or symbol with which test samples may be correlated.

The water retention test shall be in accordance with the following:

Percentage loss shall be defined as the water lost after the application of the curing material was applied. The permissible percentage moisture loss (at the rate of coverage specified herein) shall not exceed the following:

24 hours after application	2 percent
72 hours after application	4 percent

409S.4 Construction Methods

The membrane curing compound shall be applied after the surface finishing has been completed and immediately after the free surface moisture has disappeared. The surface shall be sealed with a single uniform coating of the specified type of curing compound applied at the rate of coverage recommended by the manufacturer and directed by the Engineer or designated representative, but not less than 1 gallon per 180 square feet (3.8 liters per 16.7 square meters) of area. The Contractor shall provide satisfactory means and facilities to properly control and check the rate of application of the compound.

The compounds shall not be applied before the surface has become dry, but shall be applied just after free moisture has disappeared.

The compound shall be thoroughly agitated during its use and shall be applied by means of approved mechanical power pressure sprayers for street and bridge applications. The sprayers used to apply the membrane to concrete exposed surfaces shall travel at a uniform speed along the forms and be mechanically driven. The equipment shall be of such design that it will insure uniform and even application of the membrane material. The sprayers shall be equipped with satisfactory atomizing nozzles. On small miscellaneous items or on interim bridge deck curing will the Contractor be permitted to use hand-powered spray equipment. For all spraying equipment, the Contractor shall provide facilities to prevent the loss of the compound between the nozzle and the concrete surface during the spraying operations.

At locations where the coating shows discontinuities, pinholes or other defects or if rain falls on the newly coated surface before the film has dried sufficiently to resist damage, an additional coat of the compound shall be applied immediately at the same rate of coverage specified herein.

To insure proper coverage, the Engineer or designated representative shall inspect all treated areas after application of the compound for the period of time designated in the specification for curing, either for membrane curing or for other methods. Dry areas are identifiable because of the lighter color of dry concrete as compared to damp concrete. All suspected areas shall be tested by placing a few drops of water on the suspected areas. If the water stands in rounded beads or small pools which can be blown along the surface of the concrete without wetting the surface, the water impervious film is present. If the water wets the surface of the concrete as determined by obvious darkening of the surface or by visible soaking into the surface, no water-impervious film is present. Should the foregoing test indicate that any area during the curing period is not protected by the required water-impervious film an additional coat or coats of the compound shall be applied immediately and the rate of application of the membrane compound shall be increased until all areas are uniformly covered by the required water-impervious film.

The compounds shall not be applied to a dry surface and if the surface of the concrete has become dry, it shall be thoroughly moistened prior to the application of the membrane by fogging or mist application. Sprinkling or coarse spraying will not be allowed.

When temperatures are such as to warrant protection against freezing, curing by this method shall be supplemented with an approved insulating material capable of protecting the concrete for the specified curing period.

If at any time there is reason to believe that this method of curing is unsatisfactory or is detrimental to the work, the Contractor, when notified, shall immediately cease the use of this method and shall change to curing by one of the other methods specified under this contract.

Curing compounds shall be compatible with the adhesion of toppings or overlays where curing has been applied to the concrete base surface in order to assure adequate bond.

When forms are stripped before the 4 minimum curing days have passed, curing shall continue by an approved method.

409S.5 Measurement and Payment

Membrane curing will not be measured for payment. The work and materials prescribed herein will not be paid for directly, but shall be included in the unit price bid for the item of construction in which these materials are used.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 409S, “Membrane Curing”

American Society for Testing and Materials (ASTM)

Designation	Description
C 309	Liquid Membrane-forming Compounds for Curing Concrete
D 93	Pensky-Martin Closed Cup Tester

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 409S, “Membrane Curing”

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item 360	Concrete Pavement
Item 420	Concrete Structures
Item 421	Portland Cement Concrete
Item 427	Surface Finishes for Concrete
Item 431	Pneumatically Placed Concrete
Item 437	Concrete Admixtures
Item 520	Weighing and Measuring Equipment
Item 522	Portland Cement Concrete Plants
Item 524	Hydraulic Cement

ITEM NO. 410S CONCRETE STRUCTURES 9-14-21

410S.1 Description

This item shall govern the construction of all types of structures involving the use of structural concrete, except where the requirements are waived or revised by other governing specifications.

All concrete structures shall be constructed in accordance with the design requirements and details indicated on the drawings, in conformity with the pertinent provisions of the items contracted for, the incidental items referred to and in conformity with the requirements herein.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

410S.2 Submittals

The submittal requirements of this specification item may include:

Appropriate mix designs for class of concrete for each type of structure or unit;

Appropriate mortar and grout mix designs;

Product name, description, technical information and supplier of any acrylic-polymer latex admixture;

Type, supplier and certified test results for expansion joint materials;

Type of waterstop and confirmation that the product conforms to TxDoT DMS-6160;

Type and manufacturer of proposed evaporation retardant and confirmation that it meets the requirements of test results for TxDoT DMS-4650;

Type and manufacturer of proposed chemical admixtures and confirmation that it meets the requirements of test results for TxDoT DMS-4640;

Type and manufacturer of proposed curing admixtures and confirmation that it meets the requirements of test results for TxDoT DMS-4640;

Type and manufacturer of proposed chemical admixtures and confirmation that it meets the requirements of test results for TxDoT DMS-4640;

Type and manufacturer of proposed epoxy and/or adhesives and confirmation that it meets the requirements of test results for TxDoT DMS-6100;

Reinforcing steel shall conform to Standard Specification Item No. 406S, "Reinforcing Steel";

Contractors formwork plan for placing and consolidating concrete around wall penetrations and at locations designated as having congested reinforcing steel.

410S.3 Materials

A. Concrete

Concrete shall conform to Item No. 403S, "Concrete for Structures".

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

B. Grout or Mortar

When required or shown on the drawings, mortar and grout consisting of 1 part hydraulic cement and 2 parts sand with sufficient water to provide the desired consistency shall be provided. Mortar shall be provided with a consistency that can be handled easily and spread by a trowel. Grout shall be provided with a consistency that will flow into and completely fill all voids.

C. Latex

When required an acrylic-polymer latex admixture (acrylic resin emulsion in accordance with TxDoT DMS-4640, "Chemical Admixtures for Concrete") suitable for producing polymer-modified concrete or mortar shall be provided. The latex shall not be allowed to freeze.

The following information shall be submitted for latex:

Name and information of company contact personnel,

Product name and polymer description, and

The latex shall meet the following requirements.

Table 1: LATEX ADDITIVE REQUIREMENTS	
Property	Value
Total Solids, minimum, percent	47
PH	9.0 to 11.0
Brookfield viscosity (# 1 spindle @ 10 rpm), mPas, maximum	60
Butadiene Content, percent	30 to 40
Freeze-thaw stability, 2 cycles, maximum	0.1

Specification targets and production tolerances shall also be provided for the following properties.

1. viscosity (including test method and temperature reference),
2. percent solids,
3. pH,
4. specific gravity, and
5. styrene/butadiene ratio.

D. Reinforcing Steel

Reinforcing steel shall conform to Standard Specification Item No. 406S, "Reinforcing Steel".

E. Expansion Joint Material

The expansion joint material shall conform to the requirements of TxDoT DMS-6310, "Joint Materials and Fillers".

1. Preformed Fiber Sheets

Unless otherwise indicated on the drawings preformed bituminous fiber material shall be provided. The preformed fiber material shall conform to the dimensions indicated on the drawings. Preformed fiber sheets shall meet the requirements of ASTM D-1751, "Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types). The requirements related to bitumen content, density and water absorption shall not apply to nonbituminous materials.

2. Joint Sealing Material

Unless otherwise indicated on the drawings a Class 4, 5 or 7 low-modulus silicone sealant shall be provided that conforms to the requirements of TxDoT DMS-6310, "Joint Sealants and Fillers".

3. Timber Boards

Timber boards shall be made from redwood or cypress and must be free from sapwood, knots, clustered bird's eye, checks and splits. When oven dried at 230°F (110°C) to a constant weight (mass), the density of the board shall be between 20 and 35 lbs. Per cubic foot (between 320 and 560 kgs per cubic meter)

4. Asphalt Board

Asphalt Board shall conform to the dimensions indicated on the drawings and shall meet the description, general requirements and distortion testing of ASTM D-994, "Preformed Expansion Joint Filler for Concrete (bituminous Type)".

5. Rebonded Neoprene Filler Sheet

Rebonded neoprene filler shall consist of ground closed cell neoprene particles, rebonded and molded into sheets of uniform thickness of the dimensions indicated on the drawings. These sheets shall meet the requirements of ASTM D-1752, Type I.

The manufacturer shall furnish the Engineer or designated representative with certified test results as to the compliance with the above requirements.

F. Waterstop

Unless otherwise indicated on the drawings, rubber waterstops or Polyvinyl Chloride (PVC) waterstops that conform to TxDoT DMS-6160, "Waterstops, Nylon Reinforced Neoprene Sheet, and Elastomeric Pads" shall be provided.

G. Evaporation Retardants

Evaporation retardants shall conform to the requirements of TxDoT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants". The evaporation retardant must be a commercially available monomolecular film compound. The evaporation retardant shall have no adverse effect on the cement hydration process or the concrete and shall reduce surface moisture evaporation from the concrete when performing concrete operations in direct sun, wind, high temperatures, or low relative humidity. The producer of the evaporation retardant shall certify that it meets these specified requirements.

H. Curing Materials

1. Liquid Membrane Forming compounds

Liquid Membrane Forming compounds shall conform to the requirements of TxDoT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants". The compound shall be applied to damp concrete as a fine mist through atomizing nozzles at a wet film thickness of 8 to 9 mils (200 to 230 µm). The liquid membrane-forming compound must not react deleteriously with concrete or its components. It must produce a firm, continuous, uniform moisture-impermeable film that is free of pinholes, cracks, or other film defects. It must also exhibit satisfactory adhesion.

The consistency must be such that the compound can be applied satisfactorily by conventional or airless spray at atmospheric and material temperatures above 40°F (5°C) without thinning. When applied at the manufacturer's recommended thickness, not less than 8 mils (200 µm) wet, to vertical surfaces of damp concrete, the compound must not run off or appreciably sag. The liquid membrane-forming compound must not disintegrate, check, peel, or crack during the required curing period. It

must not peel or pick up under traffic, and must disappear from the surface of the cured concrete by gradual disintegration.

2. Cotton Mats

Cotton mats shall consist of a filling material of cotton "bat" or "bats" [at least 12 oz. Per square yard (400 grams per square meter)] completely covered with unsized cloth [at least 6 oz. Per square yard (200 grams per square meter)] stitched longitudinally with continuous parallel rows of stitching spaced at less than 4 in. (100 mm), or tuft both longitudinally and transversely at intervals less than 3 in. (75 mm).

The cotton mats shall be free from tears and in good general condition. A flap at least 6 in. (150 mm) wide with two (2) thicknesses of the covering that extends along one side of the mat shall be provided.

3. Polyethylene Sheeting

The polyethylene sheeting shall be at least 4 mils thick (0.1 mm) and free from visible defects. Clear or opaque white sheeting shall be provided when the ambient temperature during curing exceeds 60°F (15°C) or when applicable to control temperature during mass pours.

4. Burlap-Polyethylene Mats

The burlap-polyethylene mats shall be made from burlap impregnated on 1 side with a film of opaque white-pigmented polyethylene, free from visible defects. The laminated mats shall have at least 1 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.

I. Chemical Admixtures

Chemical admixtures including water reducing, placticizers and air entrainment shall conform to TxDoT DMS-4640, "Chemical Admixtures for Concrete" Calcium chloride shall not be used. Admixtures shall be included in the prequalified concrete admixtures list maintained by TxDot's Construction Division.

J. City of Austin Survey Monuments

The Public Works Department may furnish permanent survey monuments to be cast in concrete as indicated on the drawings or as directed by the Engineer or designated representative.

K. Epoxy

Unless indicated otherwise on the drawings, epoxy materials shall conform to TxDoT DMS-6100, "Epoxy and Adhesives".

410S.4 General Requirements

Before starting work, the Contractor shall inform the Engineer or designated representative fully of the construction methods the Contractor proposes to use, the adequacy of which shall be subject to the review by the Engineer or designated representative. Drawings for forms and falsework for piers and superstructure spans over 20 feet (6 meters) long, bracing systems for girders when the overhang exceeds 3 ft. 6 in. (1 meter) and for all bridge widening details shall be submitted to the Engineer or designated representative for review, if requested. Similar drawings shall be submitted for other units of the structure, if requested by the Engineer or designated representative. The drawings shall be prepared on standard 22 inch by 36-inch (550mm by 900 mm) sheets and shall show all essential details of the proposed forms, falsework and bracing to permit a structural analysis. Four sets of such drawings will be required.

Concurrence on the part of the Engineer or designated representative in any proposed construction methods, approval of equipment or of form and falsework drawings does not relieve the Contractor of the responsibility for

the safety or correctness of the Contractor's methods, adequacy of equipment or from carrying out the work in full accordance with the contract.

Unless otherwise indicated on the drawings, the requirements in the succeeding paragraphs shall govern the time sequence in which construction operations may be carried on and for the opening of completed structures to traffic:

Superstructure members, forms, falsework or erection equipment shall not be placed on the substructure before the concrete therein has attained a 3000 psi (20.7 MPa) compressive strength.

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

No forms shall be erected on concrete footings supported by piling or drilled shafts until the concrete therein has attained a minimum compressive strength of 2500 psi (17.2 MPa). Such work may begin on spread footings after the therein has aged at least 2 curing days. Concrete may be placed as soon as the forms and reinforcing steel are approved by the Engineer or designated representative.

The support of tie beam and/or forms by falsework placed on previously placed tie beams is permissible provided such beams have attained 3000 psi (20.7 MPa) compressive strength, curing requirements are completed and the beams are properly supported to eliminate stresses not provided for in the design.

Bridges and direct traffic culverts shall not be opened to construction traffic or to the traveling public until authorized by the Engineer or designated representative in accordance with the following:

Authorization may be given after the last slab concrete has been in place at least 14 days for light construction traffic not to exceed a ¾-ton (0.68 Mg) vehicle. Authorization to place embankments to allow normal construction traffic and when necessary to the traveling public, may be given after the last slab concrete has been in place 30 days or when the minimum compressive strength (fc') has reached the 28 day strength conforming to Item No. 403S, "Concrete for Structures" or as indicated on the drawings.

410S.5 Drains

Weep holes and roadway drains shall be installed and constructed as indicated on the drawings.

410S.6 Expansion Joints

Joints and devices shall be used to provide for expansion and contraction of concrete slabs and shall be constructed as indicated on the drawings.

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 on the drawings. The material used to separate expansion surfaces shall be as indicated on the drawings and placed so that concrete or mortar cannot be subsequently worked around or under it. The bridging of concrete or mortar around expansion joint material in bearings and expansion joints shall be prevented.

Concrete adjacent to armor joints and finger joints shall be placed carefully to avoid defective anchorage and porous or honeycombed concrete in such areas.

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.

Preformed fiber joint material or other material indicated shall be used in the vertical joints of the roadway slab, curb, median or sidewalk. The top 1-inch (25 mm) thereof shall be filled with joint sealing material, as specified

herein. The sealer shall be installed in accordance with Standard Specification Item No. 413S, "Cleaning and/or Sealing Joints and Cracks (PC Concrete)" and the manufacturer's recommendations.

Prior to placing the sealing material, the vertical faces of the joint shall be cleaned of all laitance by sandblasting or by mechanical routing. Cracked or spalled edges shall be repaired. The joint shall be blown clean of all foreign material and sealed.

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 to prevent the material from falling out.

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

Soon after form removal and where necessary after surface finishing, all projecting concrete shall be removed along exposed edges to secure full effectiveness of the expansion joints.

410S.7 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 construction joints.

Construction joints shall be of the type and at the locations indicated on the drawings. Additional joints will not be permitted without written authorization from the Engineer or designated representative and when authorized, shall have details equivalent to those indicated 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 joints, except when horizontal. All vertical construction joints shall be chamfered. All horizontal construction joints shall be routed or grooved.

Construction joints requiring the use of joint sealing material shall be as indicated on the drawings or as directed by the Engineer or designated representative. The material will be indicated on the drawings without reference to joint type.

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 surfaces at bulkheads shall be roughened as soon as the forms are removed.

The hardened concrete surface shall be thoroughly cleaned of all loose material, laitance, dirt or foreign matter and saturated with water so it is moist when placing fresh concrete against it. Remove all free water and moisten the surface before concrete or bonding grout is placed against it. Forms shall be drawn tight against the existing concrete and the joint surface flushed with grout just prior to placing the fresh concrete.

The joint surface shall be coated with bonding mortar, grout, epoxy or other material as indicated on the drawings or other items. A Type V epoxy shall be provided in accordance with TxDoT DMS-6100, "Epoxies and Adhesives" for bonding fresh concrete to hardened concrete. The epoxy shall be placed on a clean dry surface and the fresh concrete shall be placed while the epoxy is still tacky. Bonding mortar or grout shall be placed on a surface that is saturated surface dry and the concrete shall be placed before the bonding mortar or grout dries. Other bonding agents shall be placed in accordance with the manufacturer's recommendations.

410S.8 Foundation and Substructure

Excavation for foundations and substructure shall conform to Standard Specification Item No. 401S, "Structural Excavation and Backfill".

Concrete for foundation seals, unless otherwise indicated on the drawings, shall be Class C Concrete with a coarse aggregate grade of 2, 3, 4 or 5 and placed in accordance with the requirements herein. The top of the completed seal shall not vary from plan grade or the grade established by the Engineer or designated representative.

Where a concrete seal is indicated on the Drawings, the design will be based on the normal water elevation as indicated on the Drawings. If the foundation concrete can be placed in the dry at the time of construction, the seal will not be required. If additional seal is necessary for the conditions existing during the time of construction, its thickness shall be increased as deemed necessary by the Contractor and at the Contractor's expense. If the conditions existing at the time of construction require a seal for placing the foundation concrete in the dry and none is indicated on the Drawings, the Contractor shall place an adequate seal at the Contractor's expense.

The seal shall be allowed to set for at least 36 hours before the caisson or cofferdam is dewatered, after which the top of the seal shall be cleaned of all laitance or other soft material and all high spots exceeding the above limitation shall be cut off and removed.

410S.9 Falsework

The Contractor is totally responsible for all falsework. The Contractor shall design and construct it to safely carry the maximum anticipated loads and to provide the necessary rigidity. Details of falsework construction shall be subject to review by the Engineer or designated representative, but Engineer's review shall in no way relieve the Contractor of responsibility of the adequacy and safety of the falsework design.

All timber used in falsework centering shall be sound, in good condition and free from defects which will impair its strength. When wedges are used to adjust falsework to desired elevations, they shall be used in pairs to insure even bearing.

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 driven to a bearing capacity sufficient to support the superimposed load without settlement. The safe bearing capacity of piling shall be determined by test loads or by such other methods that may be required or acceptable to the Engineer or designated representative.

In general, each falsework bent shall be capped transversely by a member of proper size. A short cap section forming a T-head may be substituted to permit the removal of portions of the forms without disturbing the falsework. Caps shall be securely fastened to each pile or column in the bent and set at the proper elevation to produce, in conjunction with the use of approved wedges or jacks, permanent camber indicated on the Drawings, plus a construction camber covering allowance for deformation of the forms and falsework. The use of wedges to compensate for incorrectly cut bearing surfaces will not be permitted. Each falsework bent shall be securely braced to provide the stiffness required with the bracing securely fastened to each pile or column it crosses.

In setting falsework for arches, allowances shall be made for settlement of falsework, deflection of the arch and permanent camber. Provision shall be made by suitable wedges, sand jacks or other acceptable devices for the controlled lowering of falsework when the arch is swung. Falsework may be required to be placed on jacks to provide for settlement correction during concrete placement.

When the falsework is no longer required, it shall be removed. Falsework piling shall be pulled or cut off not less than 2 feet (0.6 meter) below finished ground level. Falsework and piling in a stream, lake or bay shall be completely removed to a point specified by the Engineer or designated representative to prevent any obstruction to the waterway.

410S.10 Forms

Forms for precast prestressed concrete members and for prestressed piling shall be constructed conforming to Item No. 425S, "Prestressed Concrete Structures".

A. General

Except where otherwise indicated on the drawings, 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 Engineer or designated representative.

Forming plans shall be submitted for approval by the Engineer or designated representative. Forms shall be designed for the pressure exerted by a liquid weighing 150 pounds per cubic foot (2.4 Mega grams per cubic meter). The rate of placing the concrete shall be taken into consideration in determining the depth of the equivalent liquid. For job-fabricated forms an additional live load of 50 pounds per square foot (1.675 MPa) shall be allowed on horizontal surfaces. The maximum unit stresses shall not exceed 125 percent of the allowable stresses used by the Engineer or designated representative for the design of structures.

Formwork for wall and/or column pours equal or exceeding 8 feet (2.44 meters) shall be designed in accordance with ACI 347, "Guide to Formwork for Concrete" and sealed by a Registered Civil Engineer Licensed in the State of Texas, who is experienced in formwork design.

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 (1.175 MPa) of horizontal form surface and sufficient details and data shall be submitted for use in checking formwork details for approval.

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

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 of such work is complete to the satisfaction of the Engineer or designated representative.

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

B. 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. The lumber used for facing or sheathing shall be finished on at least 1 side and 2 edges and shall be sized to uniform thickness.

Form or form lumber that will be reused shall be maintained clean and in good condition. Lumber that is split, warped, bulged, or marred or that has defects that will produce inferior forms shall not be used but shall be 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.

Forms may be constructed of plywood not less than ¾ inch (19 mm) in thickness, with no form lining required. 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 II Exterior of the U.S. Department of Commerce Voluntary Product Standard, PS 1.

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 4 feet (1.22 meters) 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 specified 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 indicated otherwise on the drawings, forms shall be filleted at all sharp corners and edges with triangular chamfer strips measuring ¾ inch (19 mm) on the sides.

Forms for railings and ornamental work shall be constructed to standards equivalent to first class millwork. All moldings, panel work and bevel strips shall be straight and true with neatly mitered joints designed so the finish work is true, sharp and clean cut. 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 ½ inch (13 mm) from the concrete surface. They shall be made so the metal may be removed without undue chipping or spalling 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 ½ inch (13 mm) from the face of the concrete and properly patched.

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.

Prior to placing concrete, the facing of all forms shall be treated with oil or other bond breaking coating of such composition that it will not discolor or otherwise injuriously affect the concrete surface. Care shall be exercised to prevent coating of the reinforcing steel.

C. Metal Forms

The foregoing requirements for timber forms as regards 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 indicated on the drawings.

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 line up properly, shall not be used. Metal shall be kept free from rust, grease or other foreign materials.

D. 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, but shall not be used unless a structural analysis has been made of the affect on the girder or beam and approval is granted by the Engineer or designated representative.

In normal or skewed spans with standard overhangs not exceeding 3 feet, 1 ½ inches (0.95 meter), beam bracing as shown in the drawings shall be used.

Spans in which the overhang width exceeds 3 feet, 1½ inches (0.95 meter) will require additional support for the outside beams to resist torsion. Details of the Contractor's proposed method of providing additional support shall be included with the slab forming plans submitted to the Engineer or designated representative for review and approval.

Holes in steel members for support of overhang brackets may be punched or drilled full size or may be torch cut to ¼ inch (6 mm) under size and reamed full size. In no case shall the holes be burned full size. The hole shall be left open unless indicated to be filled with a button head bolt. They shall never be filled by welding.

410S.11 Placing Reinforcement

Reinforcement in concrete structures shall be placed carefully and accurately and rigidly supported as provided in Standard Specification Item No. 406S, "Reinforcing Steel". Reinforcing steel supports shall not be welded to I-beams or girders or stirrups of prestressed concrete beams.

410S.12 Placing Concrete

A. General

Concrete shall not be placed 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 the potential for shrinkage cracking, the concrete should be placed in early morning, at night or on a schedule with more favorable weather. When mixing, placing and finishing concrete is scheduled during non-daylight hours; the entire placement site should be illuminated to the satisfaction of the Engineer or designated representative.

If changes in weather conditions require protective measures after work starts, adequate shelter shall be provided to protect the concrete against damage from rainfall or from freezing temperatures as outlined in this Item. Operations during rainfall shall only be continued if approved by the Engineer or designated representative. Aggregate stockpiles shall be covered to the extent necessary to control the moisture conditions in the aggregates.

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 they have aged at least 4 full curing days or timber planking placed on top of the slab for the carts to traverse along. Carts shall be equipped with pneumatic tires. Curing operations shall not be interrupted for the purpose of wheeling concrete over finished slabs.

Exposed concrete surfaces, while still plastic, shall be stamped with an impression having the Contractor's name, the month and year. The stamp shall be of an approved design.

At least 1 day of curing shall be allowed after the concrete has achieved initial set before placing strain on projecting reinforcement to prevent damage to the concrete.

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.

B. Preparation of Surfaces

All forms, prestressed concrete panels, T-beams and concrete box beams on which concrete will be placed shall be thoroughly wetted before the placement of concrete. Puddles of excess water shall be removed before placing the concrete. The various surfaces shall be in a moist, saturated surface dry condition when concrete is placed on or against them.

The subgrade or foundation shall be moist before placing concrete for bridge approach slabs or other concrete placed on grade. If dry the subgrade shall be lightly sprinkled.

C. Placing Temperature

The minimum temperature of all concrete at the time of placement shall not be less than 50°F (10°C). The maximum temperature of any concrete, unless otherwise indicated on the drawings, shall not exceed 95°F (35°C) when placed. The maximum temperature of cast-in-place concrete in bridge superstructures, diaphragms, parapets, concrete portions of railing, curbs and sidewalks and direct traffic box culverts shall not exceed 85°F (30°C) when placed. Other portions of structures, when indicated on the drawings, shall require the temperature control specified.

For continuous placement of the deck on continuous steel units, the initial set of the concrete shall be retarded sufficiently to insure that it remains plastic in not less than 3 spans immediately preceding the one being placed. For simple spans, retardation shall be required only if necessary to complete finishing operations.

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When conditions are such that additional moisture is needed for finishing, the required water shall be applied to the surface by fog spray only and shall be held to a minimum amount. Fog spray for this purpose may be applied with hand operated fogging equipment.

The height of free fall of concrete shall be limited to 5 feet (1.575 meters) to prevent segregation.

D. Transporting Time

The maximum time interval between the addition of cement to the batch and the placing of concrete in the forms shall not exceed the following:

Table 2: Allowable Transportation Times

Air or Concrete Temperature whichever is higher	Maximum Time w/o Retarder	Maximum Time with Retarder	
		*Specific Applications	All others
Non-agitated Concrete			
35°F to 79°F (2°C to 26°C)	45 minutes	45 minutes	45 minutes
Over 80°F (Over 25°C)	30 minutes	45 minutes	45 minutes
Agitated Concrete			
90°F (32°C) or above	45 minutes	75 minutes	105 minutes

75°F to 89°F (24°C to 32°C)	60 minutes	90 minutes	120 minutes
35°F to 74°F (2°C to 23°C)	90 minutes	120 minutes	150 minutes

* Specific applications include Bridge decks, cased drilled shafts and slabs of direct traffic culverts

The use of an approved retarding agent in the concrete will permit the extension of each of the above temperature-time maximums by 30 minutes for bridge decks, top slabs of direct traffic culverts and cased drilled shafts and 1 hour for all other concrete except that the maximum time shall not exceed 45 minutes for non-agitated concrete.

E. Handling and Placing

The Contractor shall give the Engineer or designated representative sufficient advance notice before placing concrete in any unit of the structure to permit the review of forms, reinforcing steel placement and other preparations. Concrete shall not be placed in any unit prior to the completion of formwork and placement of reinforcement therein.

The sequence for placing concrete shall be as indicated on the drawings or as required herein. The placing shall be regulated so the pressures caused by the plastic concrete shall not exceed the loads used in the form design.

The method of handling, placing and consolidation of concrete shall minimize segregation and displacement of the reinforcement and produce a uniformly dense and compact mass. Concrete shall not have a free fall of more than 5 feet (1.5 meters), except in the case of drilled shafts, thin wall sections such as in culverts, or as allowed by other Items. Any hardened concrete spatter 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. The coarse aggregate shall be worked back from the face and the concrete forced under and around the reinforcement bars without displacing them. Depositing large quantities at one point and running or working it 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 (0.9 meter) in thickness, unless otherwise directed by the Engineer or designated representative.

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 without a cold joint. Not more than 1 hour (1 ½ hours if a normal dosage of retarding admixture is used) shall elapse between adjacent or successive placements of concrete. Unauthorized construction joints shall be avoided by placing all concrete between the authorized joints in one continuous operation.

An approved retarding agent shall be used to control stress cracks and/or authorized cold joints in mass placements where differential settlement and/or setting time may induce stress cracking, such as on false work, in deep girder stems, etc.

Openings in forms shall be provided, if needed, for the removal of laitance or foreign matter of any kind.

All forms shall be wetted thoroughly before the concrete is placed therein.

F. Consolidation

All concrete shall be carefully consolidated and the mortar flushed to the form surfaces by continuous working with immersion type vibrators. Vibrators which operate by attachment to forms or reinforcement will not be permitted, except on steel forms. At least 1 standby vibrator shall be provided for emergency use

in addition to the ones required for placement. For lightweight concrete, vibrators of the high frequency type, which produce a minimum of 7000 impulses per minute, will be required.

The concrete shall be vibrated immediately after deposition. Prior to the beginning of work, 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. Immersion type vibrators shall be inserted vertically, at points 18 to 30 inches (450 to 750 mm) apart and slowly withdrawn. The vibrator may only 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 (several cms) into the preceding lift. The vibrator shall not be used to move the concrete to other locations. In addition the vibrator shall not be dragged through the concrete. 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.

G. Finishing

From the time of initial strike off until final finish is completed and required interim curing is in place, the unformed surfaces of slab concrete in bridge decks and top slab of direct traffic culverts and concrete slabs, shall be kept damp, not wet, to offset the effects of rapid evaporation of mixing water from the concrete due to wind, temperature, low humidity or combinations thereof. Fogging equipment capable of applying water in the form of a fine fog mist, not a spray, will be required. Fogging will be applied at the times and in the manner directed by the Engineer or designated representative.

Fogging equipment may be either water pumped under high pressure or a combination of air and water, either system in combination with a proper atomizing nozzle. The equipment shall be sufficiently portable for use in the direction of any prevailing winds. The equipment shall be adapted for intermittent use to prevent excessive wetting of the surfaces.

Upon completion of the final finish, interim curing will be required for slab concrete in bridge decks and top slabs of direct traffic culverts as follows:

(1) Required water curing shall begin as soon as it can be done without damaging the concrete finish.

(2) Unless otherwise indicated on the Drawings, Type 1-D membrane curing compound that conforms to TxDoT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants" shall be applied to the slab surface.

H. Installation of Dowels and Anchor Bolts

Dowels and anchor bolts shall be installed by casting them in place or by grouting with grout, epoxy, or epoxy mortar unless indicated otherwise on the drawings.

Holes for grouting shall be formed or drilled. Holes for anchor bolts shall be drilled to accommodate the bolt embedment required on the drawings. Holes for dowels shall be made at least 12 in. (300 mm) deep unless indicated otherwise on the drawings. When grout or epoxy mortar is specified the diameter of the hole shall be at least twice the dowel or bolt diameter but shall not exceed the dowel or bolt diameter plus 1 ½ in (38 mm). When epoxy is specified the hole diameter should be 1/16to ¼ in. (1.6 to 6.35 mm) greater than the dowel or bolt diameter.

Holes for anchor bolts in piers, abutments, bents or pedestals may be drilled or formed by the insertion of oiled wooden plugs or metal sleeves in the plastic concrete. Formed holes shall be large enough to permit horizontal adjustments of the bolts. The bolts shall be carefully set in mortar. In lieu of the above, anchor bolts may be set to exact locations when the concrete is placed.

The holes shall be thoroughly cleaned of all loose material, oil, grease or other bond-breaking substance and blow them clean with filtered compressed air. When an epoxy type material is used the holes shall be in a surface dry condition. When hydraulic cement grout is used the holes shall be in a surface moist condition. The void space between the hole and the dowel or bolt shall be completely filled with grouting material. The requirements for cleaning outlined in the product specification for prepackaged systems shall be followed exactly.

The following should be used as a guide in selection of an appropriate grout, mortar, epoxy or epoxy grout.

Table 3: Guide for Selection of Epoxy, Epoxy Mortar, Grout and Epoxy Grout

Material Type	Recommendation
Epoxy, Epoxy Mortar or other prepackaged Mortar	As Approved
Cast-in-place or Grouted system	1 part hydraulic cement, 2 parts sand and sufficient water for desired consistency
Neat Epoxy	Type III epoxy per TxDoT DMS-6100, "Epoxies and Adhesives"
Epoxy Grout	Type III epoxy per TxDoT DMS-6100, "Epoxies and Adhesives"Provide grout, epoxy or epoxy mortar as the binding agent unless otherwise indicated on the drawings

410S.13 Placing Concrete in Cold Weather

A. General

The Contractor is responsible for the protection of concrete placed under any and all weather conditions and is responsible for producing concrete equal in quality to that placed under normal conditions. Permission given by the Engineer or designated representative to allow placement of the concrete during cold weather does not relieve the Contractor of the responsibility for producing concrete equal in quality to that placed under normal conditions. Concrete placed under adverse weather conditions that proves to be unsatisfactory shall be removed and replaced at Contractor' expense.

B. Cast-in-Place Concrete

Concrete may be placed when the ambient temperature is not less than 35°F (2°C) in the shade and rising or above 40°F (4°C). Concrete shall not be placed when the ambient temperature in the shade is below 40°F (4°C) and falling unless approved by the Engineer or designated representative. Concrete shall not be placed in contact with any material coated with frost or having a temperature less than 32°F (0°C).

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(82°C) and/or the aggregate temperature shall not exceed 150°F(66°C). The heating apparatus shall heat the mass of aggregate uniformly. The temperature of the mixture of aggregates and water shall be between 50°F(10°C) and 85°F(29°C) before introduction of the cement.

All concrete shall be effectively protected as follows:

1. The temperature of slab concrete of all unformed surfaces shall be maintained at 50°F(10°C) or above for a period of 72 hours from time of placement and above 40°F(4°C) for an additional 72 hours.

2. The temperature at the surface of all concrete in bents, piers, culvert walls, retaining walls, parapets, wingwalls, bottom of slabs and other similar forms shall be maintained at 40°F(4°C) or above for a period of 72 hours from time of placement.

3. The temperature of all concrete, including the bottom slabs of culverts placed on or in the ground, shall be maintained above 32°F(0°C) for a period of 72 hours from time of placement.

   Protection shall consist of providing additional covering, insulated forms or other means and if necessary, supplementing such covering with artificial heating. Avoid applying heat directly to concrete surfaces. Curing 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 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 prior to form removal and acceptance.

C. Precast Concrete

   A fabricating plant for precast products which has adequate protection from cold weather in the form of permanent or portable framework and covering, which protects the concrete when placed the forms and is equipped with approved steam curing facilities may place concrete under any low temperature conditions provided:

   1. The framework and covering are placed and heat is provided for the concrete and the forms within 1 hour after the concrete is placed. This shall not be construed to be 1 hour after the last concrete is placed, but that no concrete shall remain unprotected longer than 1 hour.

   2. Steam heat shall keep the air surrounding the concrete between 50°F (10°C) and 85°F(29°C) for a minimum of 3 hours prior to beginning the temperature rise, which is required for steam curing.

410S.14 Placing Concrete in Hot Weather

When the temperature of the air is above 85°F (29°C), an approved retarding agent will be required in all exposed concrete, concrete used in superstructures, top slabs of direct traffic culverts and all cased drilled shafts regardless of temperatures. Concrete mix temperatures shall not exceed 90°F (32°C) except for mixes that include high range water reducers where a maximum mix temperature of 100°F (38°C) will be allowed.

If the concrete mix temperature is expected to exceed 90°F (32°C) (or 100°F (38°C) in mixes with high range water reducers) ice may be utilized to lower the concrete mix temperature. Ice may be added to the concrete mix as a portion by weight of the mix water. However the addition of ice shall not exceed 50% of the total mix water weight.

When weather conditions are such that the addition of ice at 50% of the mix water is not sufficient to reduce the concrete mix temperature to an acceptable temperature, concrete work shall not be allowed.

When ice is to be used in hot weather concrete placement, the Contractor shall furnish a mix design (Section 4.4 of Standard Specification Item 360S, "Concrete Pavement" and Section 6 of Standard Specification Item No. 403S, "Concrete for Structures") acceptable to the Engineer or designated representative for class of concrete specified on the drawings.

410S.15 Placing Concrete in Water

Concrete shall be deposited in water only when indicated on the drawings or with written permission of the Engineer or designated representative. The forms, cofferdams or caissons shall be sufficiently tight to prevent any water current passing through the space in which the concrete is being deposited. Pumping 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, pump or other approved method and shall not be permitted to fall freely through the water nor shall it be disturbed after it has been placed. Its surface shall be kept approximately level during placement.

The tremie shall be supported or the pump operated 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 or pump hose shall be submerged in the concrete at all times.

The placing operations shall be continuous until the work is complete.

For concrete to be placed under water, the concrete mix shall be designed in accordance with Standard Specification Item No. 403S, "Concrete For Structures" with a minimum cement content of 650 lb. Per cubic yard (10.4 Mg per cubic meter). An anti-wash admixture may be included in the mix design as necessary to produce a satisfactory finished product.

410S.16 Placing Concrete in Superstructure

A. General

Unless otherwise indicated on the drawings, simple span roadway slabs shall be placed without transverse construction joints by using a mechanical longitudinal screed or a self-propelled transverse finishing machine or a mechanical longitudinal screed. For small placements or unusual conditions such as narrow widening, variable cross-slopes, or transitions, manually operated screeding equipment may be used if approved by the Engineer or designated representative.

B. Transverse Screeding

Unless otherwise indicated on the drawings, slabs on continuous units shall be placed in one continuous operation without transverse construction joints using a longitudinal screed or a self-propelled transverse finishing machine. Rails for transverse finishing machines supported from the beams or girders shall be installed so they may be removed without damage to the slab. Bond between removable supports and the concrete shall be prevented in a manner acceptable to the Engineer or designated representative. 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 "General Requirements" stated above. Unless indicated otherwise on the drawings, the minimum rate of concrete placement is 30 lineal feet (9.144 lineal meters) of bridge slab per hour. The concrete shall be deposited parallel to the skew of the bridge so that all girders are loaded uniformly along their length. Slab concrete shall be deposited between the exterior beam and the adjacent beam before placing concrete in the overhang portion of the slab. Personnel and equipment shall be furnished that is capable of placing, finishing and curing the slab at an acceptable rate to ensure compliance with this Item. Concrete shall be placed in transverse strips. On profile grades greater than 1.5 %, placement shall be started at the lower end.

C. Longitudinal Screeding

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 indicated on the drawings, temporary intermediate headers will be permitted for placements exceeding 50 feet (15.24 meters) in length for the

longitudinal screed, provided the rate of placement is rapid enough to prevent a cold joint and these headers are designed for early removal to permit satisfactory consolidation and finish of the concrete at their locations. The slab concrete shall be deposited between the exterior beam and the adjacent beam before placing concrete in the overhang portion of the slab.

For longitudinal screeding, concrete shall be placed in longitudinal strips starting at a point in the center of the segment adjacent to one 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 1.5 percent or more, placing shall start at the lower 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.

D. Placements on Continuous Steel Units

Unless otherwise indicated on the drawings, slabs on continuous steel units shall be placed in a single continuous operation without transverse construction joints using a mechanical longitudinal screed or a self-propelled transverse finishing machine. The initial set of the concrete shall be retarded sufficiently to ensure that concrete remains plastic in at least 3 spans immediately preceding the slab being placed. Construction joints shall be used, when required for slab placements on steel beams or girders, as shown on the drawings. When staged placement of a slab is specified in the drawings, it shall be necessary to ensure that the previously placed concrete attains a compressive strength of 3000 psi (20.7 MPa) before placing the next stage concrete. Multiple stages may be placed in a single day if approved by the Engineer or designated representative. When drawings permit staged concrete placement without specifying a particular order of placement, a placing sequence that will not overstress any of the supporting members shall be submitted for the approval of the Engineer or designated representative.

E. Slab and Girder Units

Unless indicated otherwise on the drawings, girders, slab and curbs of slab and girder spans shall be placed monolithically. Concrete girders shall be filled first, and the slab concrete placed within the time limits specified in this Item. If a transverse screed is used, the concrete shall be placed in the stem for a short distance and then the concrete placed in transverse strips. If a longitudinal screed is used, the concrete shall be placed in the outside girder stem first beginning at the low end or side, and then continue the concrete placed in longitudinal strips.

410S.17 Placing Concrete in Concrete Arches

Concrete shall be placed in arch rings so the loading is kept symmetrical on the falsework. The arch rings and ribs shall be placed in one continuous operation unless otherwise indicated on the drawings or permitted by the Engineer or designated representative. The spandrel walls or columns and the beams shall not be placed until the arch is swung. Floor slab, railing, parapet walls, etc., shall not be placed until all spandrels are complete. Slab placement shall be symmetrical about the transverse centerline so the loading of the arch is kept approximately symmetrical.

The placing sequence shall be as indicated on the drawings.

410S.18 Placing Concrete in Box Culverts

In general, construction joints will be permitted only where indicated on the drawings.

Where the top slab and walls are placed monolithically in culverts more than 4 feet (1.22 meters) in clear height, an interval of not less than 1 nor more than 2 hours shall elapse before placing the top slab to allow for settlement and shrinkage in the concrete wall.

The base slab shall be trowel finished accurately at the proper time to provide a smooth uniform surface. Top slabs, which carry traffic, shall be finished as specified for roadway slabs in "Finish of Roadway Slabs", below. Top slabs of fill type culverts shall be given a reasonably smooth float finish.

410S.19 Placing Concrete in Foundations and Substructure

Concrete shall not be placed in footings until the depth and character of the foundation has been inspected by the Engineer or designated representative and permission has been given to proceed.

Placing of concrete footings upon seal courses will be permitted after the caissons or cofferdams are free from water and the seal course cleaned. Any necessary pumping or bailing during the concrete placement shall be done from a suitable sump located outside the forms.

All temporary wales or braces inside cofferdams or caissons shall be constructed or adjusted as the work proceeds to prevent unauthorized construction joints in footings or shafts.

When footings can be placed in a dry excavation without the use of cofferdams or caissons, forms may be omitted if desired by the Contractor and approved by the Engineer or designated representative and the entire excavation filled with concrete to the elevation of the top of footing.

Concrete in columns shall be placed monolithically unless otherwise indicated on the drawings. Columns and caps and/or tie beams supported thereon may be placed in the same operation or separately. To allow for settlement and shrinkage of the column concrete, it shall be placed o the lower level of the cap or tie beam and placement delayed for not less than 1 hour nor more than 2 before proceeding with the cap or tie beam placement.

410S.20 Treatment and Finishing of Horizontal Surfaces Except Bridge 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 Engineer or designated representative.

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 back wall to the edge, as directed by the Engineer or designated representative, so that water will drain from the surface. The concrete shall be given a smooth trowel finish. Bearing areas for steel units shall be constructed in such a manner to have a full and even bearing upon the concrete. When the concrete is placed below grade, bearing areas may be raised to grade on beds of Portland cement mortar consisting of 1 part cement, 2 parts sand and a minimum amount of water.

Bearing seat buildups or pedestals for concrete units shall be cast integrally with the cap or with a construction joint. The construction joint area under the bearing shall have the surface roughened thoroughly as soon as practical after initial set is obtained. The bearing seat buildups shall be placed using a latex based grout, an epoxy grout, or an approved proprietary bearing mortar, mixed in accordance with the manufacturer's recommendation. Pedestals shall be placed using Class C concrete, reinforced as indicated on the drawings.

The bearing area under the expansion end of concrete slabs and slab and girder spans shall be given a steel-trowel finish to the exact grades required on the drawings. Bearing areas under elastomeric bearing pads or nonreinforced bearing seat buildups shall be given a textured wood float finish. The bearing area shall not vary from a level plane more than 1/16in. (1.6 mm) in all directions.

410S.21 Finish of Bridge Slabs

In all roadway slab-finishing operations, camber for specified vertical curvature and transverse slopes shall be provided.

For concrete flat slab and concrete slab and 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 indicated in the drawings. For concrete slab and girder spans using pan forms, a camber of approximately 3/8 in. for 30 ft. (9.5 mm for 9.14 meter) spans and ½ in. for 40 ft. (12.7 mm for 12.19 meter) spans shall be provided to offset initial and final deflections unless otherwise directed by the Engineer or designated representative. When dead load deflection requirements for concrete flat slab and concrete slab and girder spans not using pan forms is not indicated on the drawings, the additional amount of camber shall be ⅛ inch per 10 foot (3.2 mm per 3 meter) of span length but not to exceed ½ inch (12.7 mm).

Bridge slabs supported on prestressed concrete beams, steel beams or girders shall receive no additional camber, except that for slabs without vertical curvature, the longitudinal camber shall be approximately ¼ inch (6.35 mm).

Work bridges or other suitable facilities shall be provided from which to perform all finishing operations and to provide access, if necessary, for the Engineer or designated representative to 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 struck off, leveled and screeded, carrying a slight excess of concrete ahead of the screed to insure filling of all low spots. The screed shall be designed rigid enough to hold true to shape and shall have sufficient adjustments to provide for the required camber. A vibrating screed shall be used in all slabs more than 20 feet (6.1 meters) in width. A vibrating screed may be used if heavy enough to prevent undue distortion. The screeds shall be provided with a metal edge.

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 transverse screeds shall be moved longitudinally approximately 1/5 of the drum length for each complete out-and-back pass of the carriage.

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 of the proper size or hand floated from bridges over the slab. Floating may not be necessary if the pan float attached to a transverse screed produces an acceptable finish. Overworking the concrete surface and overuse of finish water shall be avoided.

The Contractor shall perform in the presence of the Engineer or designated representative sufficient checks with a long handled 16-foot (5 meter) straightedge on the plastic concrete to insure that the final surface will be within the specified tolerances. 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 1/16inch (1.6 mm) 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.

Screed-rail support holes shall be filled with concrete and finished to match the top of the slab.

The concrete surface shall be finished to a uniform texture using a carpet drag, burlap drag or broom finish. The surface shall be finished to a smooth sandy texture without blemishes, marks or scratches deeper than 1/16inch (1.6 mm). The surface texturing shall be applied using a work bridge or platform immediately after completing the straightedge checks. The carpet or burlap drag shall be drug longitudinally along the concrete surface, adjusting the surface contact area or pressure to provide a satisfactory coarsely textured surface. A broom finish may be performed using a fine bristle broom transversely.

The concrete surface shall be coated immediately after the carpet or burlay drag, or broom finish with a single application of evaporation retardant at a rate recommended by the manufacturer. The time between the texturing at any location and subsequent application of evaporation retardant shall not exceed 10 minutes. The evaporation retardant may be applied using the same workbridge used for surface texturing. The concrete surface shall not be worked once the evaporation retardant has been applied.

Interim and final curing shall be applied in accordance with Section P410S.23, "Curing Concrete".

The Contractor is responsible for the ride quality of the finished bridge slab. The Engineer or designated representative will use a 10-ft. (3.05 meter) straightedge to verify ride quality [⅛ in. or less in 10 ft (3.2 mm or less in 3.05 meters)] and to determine locations where corrections are needed. If the Engineer or designated representative determines that the ride quality is unacceptable, then the Contractor shall submit to the Engineer or designated representative for approval a plan to produce a ride of acceptable quality. All corrections for ride-quality shall be made before saw-cutting grooves.

At the option of the Contractor or when indicated on the drawings, the hardened concrete surface of bridge slabs, bridge approach slabs and direct-traffic culverts shall be given its final texture by saw grooving to meet the above requirements after completion of the required curing period. Grooves shall be cut perpendicular to the structure centerline. The grooves shall be cut continuously across the slab to within 18 in. (450 mm) of the barrier rail, curb or median divider. At skewed metal expansion joints in bridge slabs, groove cutting shall be adjusted by using narrow-width cutting heads so that all grooves end within 6 in. (150 mm) of the joint, measured perpendicular to the centerline of the metal joint. There should not be any ungrooved surface wider than 6 in. (150 mm) adjacent to either side of the joint. The minimum distance to the first groove, measured perpendicular to the edge of the concrete joint or from the junction between the concrete and the metal leg of the joint shall be 1 in. (25 mm), Grooves shall be continuously cut across construction joints or other joints in the concrete that are less than ½ in. (13 mm) wide. The same procedure described above shall be used where barrier rails, curbs or median dividers are not parallel to the structure centerline in order to maintain the 18-in. (450-mm) maximum dimension from the end of the grooves to the gutter line. The grooves shall be cut continuously across formed concrete joints.

When the plans require that a concrete overlay be placed on the slab (new construction) or on prestressed concrete box beams or other precast elements, a carpet drag, burlap drag or broom finish shall be given to all concrete surfaces to be overlaid. Saw grooving is not necessary in this case. An average texture depth for the finish of approximately 0.035 in. (0.9 mm) shall be provided with no individual test falling below 0.020 in. (0.5 mm), unless otherwise indicated on the drawings, when tested in accordance with TxDoT's Tex-436-A, "Measurement of Texture Depth by the Sand Patch Method". If the texture depth falls below what is specified, the finishing procedure shall be revised to produce the desired texture.

When the drawings require an asphalt seal with or without overlay on the slab (new construction), on prestressed concrete box beams or on other precast elements, all concrete surfaces to be covered shall be given a lightly textured broom or carpet drag finish, similar to a sidewalk finish having an average texture depth of approximately 0.025 inch (0.635 mm), when tested in accordance with TxDoT's Tex-436-A, ".

410S.22 Placing Survey Monuments

The Contractor shall obtain City Survey Monuments, for a fee of 10 dollars, from the Department of Public Works, Construction Inspection Division. Monuments shall be embedded in freshly poured concrete at locations indicated on the drawings and accessible to survey equipment at the completion of the project. The monuments shall be installed flush with the adjacent concrete.

410S.23 Curing Concrete

The Contractor shall inform the Engineer or designated representative fully of the methods and procedures proposed for curing, shall provide the proper equipment and material in adequate amounts and shall have the

proposed method, equipment and material approved by the Engineer or designated representative prior to placing concrete.

Inadequate curing and/or facilities therefore shall be cause for the Engineer or designated representative to notify the Contractor, in writing, that the work is unsatisfactory and the concrete will have to be removed and replaced.

All concrete shall be cured for a period of 4 curing days except as noted herein. A curing day is a calendar day when the temperature, taken in the shade away from artificial heat is above 50°F (10°C) for at least 19 hours or on colder days if the temperature of all surfaces of the concrete is maintained above 40°F (4°C) for the entire 24 hours. The required curing shall begin when all concrete has attained its initial set. TxDoT's Tex-440-A, "Initial Time-of-Set of Fresh Concrete" may be used to establish when the concrete has attained its initial set.

Table 4: Exceptions to 4-Day Curing

Description	Type of Cement	Required Curing Days
Upper Surfaces of Bridge Slabs, Top Slabs of Direct Traffic Culverts and Concrete Overlays	I or II	8
	II or I/II	10
	All types with supplementary cementing materials	10
Concrete Piling buildups		6

For upper surfaces of bridge slabs, bridge support slabs, median and sidewalk slabs and culvert top slabs constructed using Class S Concrete (Standard Specification Item No. 403S, "Concrete for Structures") interim curing using a Type 1-D curing compound shall be applied as soon as possible after application of the evaporation retardant and after the water sheen has disappeared, but no more than 45 minutes after application of the evaporation retardant. Membrane interim curing shall be applied using a work bridge or other approved apparatus to ensure a uniform application. Final curing with water cure in accordance with this section shall start as soon as possible without damaging the surface finish. Water curing shall be maintained for the duration noted in the table above. Polyethylene sheeting, burlap-polyethylene blankets, laminated mats or insulating curing mats shall be placed in direct contact with the slab when the ambient temperature is expected to drop below 40°F (4°C) during the first 72 hours of the curing period. The curing materials will be weighed 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 wet weather if the insulating cotton mats become wet or if the concrete temperature drops below the specified curing temperature. Application of heat directly to concrete surfaces shall be avoided.

For the top surface of any concrete unit upon which concrete is to be placed and bonded at a later date (i.e. stub walls, risers, etc.), only water-cure in accordance with this Section shall be used.

All other concrete shall be cured as specified in pertinent Items.

The following methods are permitted for curing concrete subject to the restrictions of this Item .

A. Form Curing

When forms are left in intimate contact with the concrete, other curing methods will not be required except for exposed surfaces and for cold weather protection.

When forms are striped before the 4-day minimum curing time has elapsed, curing shall continue by an approved method.

B. 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 indicated in Item No. 403S,

"Concrete for Structures". Seawater will not be permitted. Water, which stains or leaves an unsightly residue, shall not be used.

1. Wet Mats

   Wet cotton mats placed in direct contact with the slab shall be maintained for the required curing time. If needed damp burlap blankets made from 9-ounce (255 gm) stock may be placed on the damp concrete surface for temporary protection prior to the application of the cotton mats, which may be placed dry and wetted down after placement.

   The mats shall be weighted down adequately to provide continuous contact with all concrete surfaces where possible. The surfaces of the concrete shall be kept wet for the required curing time. Surfaces, which cannot be cured by contact, shall be enclosed with mats, anchored positively to the forms or to the 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.

2. Water Spray

   This method shall consist of overlapping sprays or sprinklers that keep all unformed surfaces continuously wet.

3. Ponding

   This method requires the covering of the surfaces with a minimum of 2 inches (50 mm) of clean granular material, kept wet at all times or a minimum of 1 inch (25 mm) depth of water. Satisfactory provisions shall be made to provide a dam to retain the water or saturated granular material.

C. Membrane Curing

Unless otherwise indicated on the drawings, either Type 1-D or Type 2 membrane curing compound may be used where permitted except that Type 1-D (Resin Base Only) will be permitted for slab concrete in bridge decks and top slabs of direct traffic culverts and all other surfaces that require a higher grade of surface finish. For substructure concrete, only one Type of curing compound will be permitted on any one structure.

TABLE 5

	REQUIRED		**PERMITTED**	
STRUCTURE UNIT DESCRIPTION	**Water for Complete Curing**	**Membrane for Interim Curing**	**Water for Complete Curing**	**Membrane for Complete Curing**
1. Upper surfaces of Bridge Roadway, Median and Side walk Slabs, Top Slabs of Direct Traffic, and Culverts.	X	X (resin base)		
2.Top Surface of any Concrete Unit upon which Concrete is to be placed and bonded at a later interval (Stub Walls, Risers, etc.). Other Super-structure Concrete (curbs, wing- walls, Parapet Walls, etc.).	X		*X	*X
3. Top Surface of Precast and/or Pre-stressed Piling.	X	X		
4. All Substructure Concrete Culverts. Box Sewers, Inlets, Manholes, Retaining Walls, Riprap.			*X	*X

* 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 items under 4.

The membrane curing shall be applied just after free moisture has disappeared in a single, uniform coating at the rate of coverage recommended by the manufacturer and as approved by the Engineer or designated representative, but not less than 1 gallon per 180 square feet (1 liter per 4.4 square meters) of area. Tests for acceptance shall be at this specified rate.

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 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. Polyethylene sheeting, burlap-polyethylene mats or laminated mats in close intimate contact with the concrete surfaces, will be considered equivalent to membrane curing. Unless otherwise indicated on the drawing, the choice of membrane type shall be at the option of the Contractor, except that the Engineer or designated representative may require the same curing method for like portions of a single structure.

410S.24 Removal of Forms and Falsework

Unless otherwise indicated on the drawing, forms for vertical surfaces may be removed when the concrete has aged 12 hours after initial set, provided it can be done without damage to the concrete. Forms for mass concrete placements shall be maintained in place for 4-days following concrete placement. Mass placements are defined as concrete placements with a least dimension greater than equal to 5 ft. (1.575 meters), or those designated as such on the drawings.

Forms for inside curb faces may be removed in approximately 3 hours provided it can be done without damage to the curb.

Unless indicated otherwise on the drawings weight supporting forms and falsework spanning more than 1 ft. (300 mm) for structures, bridge components and culvert slabs shall remain in place until the concrete has attained a minimum compressive strength of 2500 psi (17.25 MPa). Forms for other structural components may be removed as specified by the Engineer or designated representative.

Inside forms (walls and top slabs) for inlets, box culverts and sewers may be removed after the concrete has attained a minimum compressive strength of 1800 psi (12.4 MPa), provided an overhead support system, approved by the Engineer or designated representative, is used to transfer the weight (mass) of the top slab to the walls of the box culvert or sewer before the support provided by the forms is removed.

If all test cylinders 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.

Remove all metal appliances used inside forms for alignment shall be removed to a depth of at least ½ in. (13 mm) from the concrete surface. The appliances shall be manufactured to allow the removal without undue chipping or spalling of the concrete, and so that it leaves a smooth opening in the concrete surface when removed. Rods, bolts and ties shall not be burned-off.

Backfilling against walls of Type I or Type II cement shall not take place for a minimum of 7 days. Backfilling against walls of Type III cement shall not take place until the cylinder compressive strength has reached 3000 psi (20.7 MPa) or the wall has cured for 5 days.

All forms and falsework shall be removed unless indicated otherwise on the drawings.

410S.25 Defective Work

Any defective work discovered after the forms have been removed shall be repaired as soon as possible in accordance with "Finishing Exposed Surfaces", below.

If the surface of the concrete is bulged, uneven or shows excess honeycombing or form marks, which in the opinion of the Engineer or designated representative, cannot be repaired satisfactorily, the entire section shall be removed and replaced at the expense of the Contractor.

410S.26 Finishing Exposed Surfaces

A. Ordinary Surface Finish

An Ordinary Surface Finish shall be applied to all concrete surfaces either as a final finish or preparatory to a higher grade or class of finish. Higher grades and classes of finish shall conform to Item No. 411S, "Surface Finishes for Concrete". Where neither a grade or class of finish is specified, an Ordinary Surface Finish only, will be required.

Ordinary Surface Finish shall be provided as follows:

1. After formal removal, all porous, honeycombed areas and spalled areas shall be corrected by chipping away all loose or broken material to sound concrete.
2. Featheredges shall be eliminated by saw-cutting and chipping spalled areas to a depth at least ½ in. (13 mm) deep perpendicular to the surface. Shallow cavities shall be repaired using a latex adhesive grout, cement mortar or epoxy grout approved by the Engineer or designated representative. If judged repairable by the Engineer or designated representative, large defective areas shall be corrected using concrete or other material approved by the Engineer or designated representative.
3. Holes and spalls caused by removal of form ties, etc., shall be cleaned and filled with latex adhesive grout, cement mortar or epoxy grout approved by the Engineer or designated representative. Only the holes shall be filled. The patch shall not be blended with the surrounding concrete. On surfaces to receive a rub finish in accordance with Standard Specification Item No. 411S, "Surface Finishes for Concrete" the exposed parts of metal chairs shall be chipped out to a depth of ½ inch (13 mm) and the surface repaired.
4. All fins, runs, drips or mortar that will be exposed shall be removed from surfaces. Form marks and chamfer edges shall be smoothed by grinding and/or dry rubbing.
5. Grease, oil, dirt, curing compound, etc., shall be removed from surfaces requiring a higher grade of finish. Discolorations resulting from spillage or splashing of asphalt, paint or other similar material shall be removed.
6. Repairs shall be dense, well bonded and properly cured and when made on surfaces, which remain exposed and do not require a higher finish, shall be finished to blend with the surrounding concrete.

Unless otherwise indicated on the drawings Ordinary Surface Finish shall be the final finish for the following exposed surfaces:

1. inside and top of inlets,
2. inside and top of manholes,
3. inside of sewer appurtenances,

4. inside of culvert barrels,
5. bottom of bridge decks between beams or girders,
6. vertical and bottom surfaces of interior concrete beams or girders.

B. Rubbed Finish

In general, the following areas shall require a rubbed finish and shall receive a first and second rubbing:

1. The top, exterior and roadway facia of curbs and parapet walls.
2. All concrete surfaces of railing.
3. The exterior vertical facia of slab spans, rigid frames, arches and box girders.
4. The outside and bottom surfaces of facia beams or girders (except precast concrete beams).
5. The underside of overhanging slabs to the point of juncture of the supporting beams.
6. All vertical surfaces of piers, columns, bent caps, abutments, wing walls and retaining walls which are exposed to view after all backfill and embankments is placed.
7. Exposed formed surfaces of inlet and outlet structures on culverts, transition structures, headwalls and inlets.
8. Such other surfaces specified elsewhere to receive a rubbed finish and such additional surfaces required by the Engineer or designated representative to receive a rubbed finish.

After removal of forms and as soon as the mortar used in pointing has set sufficiently, surfaces to be rubbed shall be wet with a brush and given a first surface rubbing with a medium coarse carborundum stone. This rubbing shall be done before the concrete has cured more than 48 hours.

The second rubbing shall present a cleaned uniform appearance free from drip marks and discoloration. It shall be given with a No. 30 carborundum stone or an abrasive of equal quality.

If the Contractor elects to use epoxy paint in lieu of the second rubbings the Contractor may do so upon approval of the Engineer or designated representative.

C. Special Surface Finishes

Striated, exposed aggregate and other special surface finishes shall conform to Standard Specification Item No. 411S, "Surface Finishes for Concrete" and/or with the requirements indicated on the drawings.

410S.27 Repair of Existing Structures

Assessment, repair and rehabilitation of structural concrete in existing structures shall be in accordance with current version of ACI 562 Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures.

Source: Rule No. R161-21.17 , 9-14-2021.

410S.28 Measurement and Payment

No direct measurement or payment will be made for the work to be done or the equipment to be furnished under this item, but shall be included in the unit price bid for the item of construction in which this item is used.

Source: Rule No. R161-21.17 , 9-14-2021.

End

SPECIFIC CROSS REFERENCE MATERIALS	
Standard Specification Item 410S, "Concrete Structures"	
City of Austin Standard Specification Items	
Designation	Description
Item No. 360S	Concrete Pavement
Item No. 401S	Structural Excavation and Backfill
Item No. 403S	Concrete for Structures
Item No. 406S	Reinforcing Steel
Item No. 411S	Surface Finishes for Concrete
Item No. 413S	Cleaning and/or Sealing Joints and Cracks (PC Concrete)
Item No. 425S	Prestressed Concrete Structures
U.S. Department of Commerce Voluntary Product Standard, PS 1 American Concrete Institute	
Designation	Description
ACI 347	Guide to Formwork for Concrete
American Society for Testing and Materials (ASTM)	
Designation	Description
ASTM D-994	Preformed Expansion Joint Filler for Concrete (bituminous Type)
ASTM D-1751	Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D-1752	Prefprmed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
Texas Department of Transportation: Departmental Material Specifications	
Designation	Description
DMS-4640	Chemical Admixtures for Concrete
DMS-4650	Hydraulic Cement Concrete Curing Materials and Evaporation Retardants"
DMS-6100	Epoxy and Adhesives
DMS-6160	Waterstops, Nylon Reinforced Neoprene Sheet, and Elastomeric Pads
DMS-6310	Joint Materials and Fillers
Texas Department of Transportation: Manual of Testing Procedures	
Designation	Description
Tex-436-A	Measurement of Texture Depth by the Sand Patch Method
Tex-440-A	Initial Time-of-Set of Fresh Concrete

RELATED CROSS REFERENCE MATERIALS	
Standard Specification Item 410S, "Concrete Structures"	
American Society for Testing and Materials, ASTM	
Designation	Description
A 36/A 36M	Carbon Structural Steel
A 82	Steel Wire, Plain, for Concrete Reinforcement
A 185	Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
A 496	Steel Wire, Deformed, for Concrete Reinforcement

A 497	Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
A 615/A 615M	Deformed and Plain Billet-steel Bars for Concrete Reinforcement
A 675/A 675M	Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
A 706/A 706M	Low- Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
A 775/A 775M	Epoxy-Coated Reinforcing Steel Bars
A 884/A 884M	Epoxy-Coated Steel Wire and Welded Wire Fabric For Reinforcement
A 934/A 934M	Epoxy-Coated Prefabricated Reinforcing Steel Bars
A 996/A 996M	Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
D3963/D3963M	Fabrication and Jobsite Handling of Epoxy-coated Reinforcing Steel Bars
Texas Department of Transportation: Manual of Testing Procedures	
Designation	Description
Tex-739-I	Sampling and Testing Epoxy Coated Reinforcing Steel
City of Austin Standard (Details)	
Designation	Description
Standard 406S-1	Reinforced Steel Tolerances
Texas Department of Transportation: Departmental Material Specifications	
Designation	Description
DMS 8130	Epoxy Powder Coating for Reinforcing Steel
City of Austin Standard Specification Items	
Designation	Description
Item No. 404S	Pneumatically Placed Concrete
Item No. 407S	Fibrous Concrete
Item No. 414S	Concrete Retaining Walls
Item No. 420S	Drilled Shaft Foundations
Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges	
Designation	Description
Item No. 360	Concrete Pavement
Item No. 420	Concrete Structures
Item No. 421	Hydraulic Cement Concrete
Item No. 422	Reinforced Concrete Slab
Item No. 423	Retaining Walls
Item No. 440	Reinforcing Steels

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Item No. 411S
Surface Finishes for Concrete

411S.1 Description

This item shall govern the furnishing of all materials and the application by the methods of construction indicated on the Drawings for the application of a surface finish to concrete.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

411S.2 Submittals

The submittal requirements of this specification item include:

A. Type and manufacturer of cement(s).

B. Type and manufacturer of membrane curing compound.

C. Type and manufacturer of adhesive grout.

D. Type and manufacturer of resin paint.

E. Samples as requested.

F. Locations of proposed grade/class of finishes.

411S.3 Materials

(1) Masonry Sand

Masonry sand shall conform to ASTM C 144.

(2) White Cement

White cement shall conform to ASTM C 150.

(3) Portland Cement

All cement unless otherwise indicated shall be Portland cement conforming to ASTM C 150.

Portland cement manufactured in a cement kiln fueled by hazardous waste shall be considered as an approved product if the production facility is authorized to operate under regulation of the Texas Natural Resource Conservation Commission (TNRCC) and the U. S. Environmental Protection Agency (EPA). Supplier shall provide current TNRCC and EPA authorizations to operate the facility.

(4) Membrane Curing

Membrane curing shall conform to Item No. 409S, "Membrane Curing".

(5) Adhesive Grout

This subsection sets forth the requirements for three epoxy adhesives with different viscosities designed to bond fresh Portland Cement concrete to existing Portland Cement concrete, hardened concrete to hardened concrete and steel to fresh or hardened concrete. These adhesives are as follows:

Type V: Standard (medium viscosity) for applying to horizontal and vertical surfaces. This material is suitable for surface sealing of fine cracks in concrete.

Type VI: Low viscosity for application with spray equipment to horizontal surfaces.

Type VII: Paste consistency for overhead application and where a high buildup is required. This material is suitable for surface sealing of cracks in concrete, which are veed out prior to sealing, and for grouting of dowel bars where clearance is 1/16 inch (1.6 mm) or less.

(a) Mixing Ratio: The ratio of resin and hardener components to be mixed together to form the finished adhesive shall be either 1 to 1 or 2 to 1 by volume.

Any specific coloring of resin and/or hardener components desired will be stated by the Engineer or designated representative.

Fillers, pigments and thixotropic agents. All fillers, pigments and/or thixotropic agents in either the epoxy resin or hardener component must be of sufficiently fine particle size and dispersed so that no appreciable separation or settling will occur during storage.

Any fillers present in the low viscosity version must be of such a nature that they will not interfere with application by spray equipment or abrade or damage such equipment.

The concrete adhesive shall contain no volatile solvents.

(b) Consistency: The adhesives shall comply with the following:

	Type V	Type VI	Type VII
Viscosity of mixed adhesive 77° ± 1°F, (25° ± -17°C) Poises	400 Maximum	150 Maximum	must be sufficiently fluid to apply by trowel or spatula without difficulty
Pot Life at 77°F (25°C), minutes minimum - 30			
Set Time at 77°F (25°C) (Time required to attain 180 psi (1.3 mPa), hours maximum - 12			

Thixotropy test shall be performed at both 77° and 120° F (25° and 49° C). Average thickness of cured adhesive remaining on test panel, mils minimum.

Type V	Type VII
30	45

Samples of the individual components in sealed containers shall be maintained at 115° + 3° F (46° + -16° C) for 2 weeks. The mixed adhesive prepared from these samples must still comply with the minimum thixotropy requirements.

The viscosity of the Type V and Type VI versions must not show an increase of more than 20 percent compared with the viscosity prior to the stability test. The

Type VII adhesive must still be sufficiently fluid to apply by trowel or spatula without difficulty.

(c) Physical Properties of the Cured Adhesive

Property	Requirements
Adhesive Shear Strength, psi, (mPa), minimum	2200 (15)
Water Gain, percent by weight, maximum	0.20
Ability to bond fresh Portland cement concrete to cured Portland cement concrete psi, (mPa), minimum (7 days cure time)	400 (2.8)

(6) Synthetic Resin Paint

Type X Epoxy: This is a high solids epoxy coating designed for application by brush or roller. The materials can also be applied by airless spray by addition of a maximum of 5 percent toluene solvent at the direction of the Engineer or designated representative.

Raw Materials: The basic raw materials to be incorporated into this coating are listed below, along with the specific requirements for each material. The final decision as to the quality of materials shall be made by the Engineer or designated representative. After the Engineer or designated representative has approved the brand names of raw materials proposed by the Contractor, no substitution will be allowed during the manufacture without prior approval of the Engineer or designated representative.

Epoxy Resin: The basic epoxy resin used in the formulation shall be an unmodified liquid resin conforming to the following chemical and physical requirements:

Viscosity at 25.0 + 0.1 C, cps	7,000 to 10,000
Weight per epoxy equivalent, gms per gm - mole	175 to 195
Color (Gardner Number), maximum	5
Hydrolyzable chlorine, maximum % by weight	0.2
Specific gravity, 25/25 degrees	1.14. to 1.18

Test methods to be used in determining these qualities are listed below:

(a) Viscosity - Test for Kinematic Viscosity (ASTM Designation: D 445).

(b) Weight per Epoxy Equivalent - Test for Epoxy Content of Epoxy Resins (ASTM Designation: D 1652).

(c) Color - Test for Color of Transparent Liquids (Gardner Color Scale) (ASTM Designation: D 1544).

(d) Hydrolyzable Chlorine - Test for Hydrolyzable Chlorine Content of Liquid Epoxy Resins (ASTM Designation D: 1726).

(e) Specific Gravity - Method of Test for Density of Paint, Varnish, Lacquer and Related Products (ASTM Designation: D 1475).

Pigment

Titanium Dioxide: The titanium dioxide used in this formulation shall be equivalent to DuPont R-900. This shall be a pure, chalk-resistant, rutile titanium dioxide meeting the requirements of ASTM D 476, Type III.

Extender: The extender used in this formulation shall be Nyad 400, manufactured by Interpace Pigments. Specific requirements are as follows:

Particle size distribution	Minimum	Maximum
Minus 20 microns, percent by weight	95	
Minus 10 microns, percent by weight	70	80
Minus 5 microns, percent by weight	40	50
Minus 3 microns, percent by weight	30	40
Minus 1 micron, percent by weight	14	20
Oil Absorption (rub out, lbs/100 lbs)		25 maximum
Brightness (G.E.)	92.5 minimum	

411S.4 Grade of Finish

(1) General

The grade and/or class of finish shall be as described herein and as indicated.

"Grade" of finish designates the areas to which a higher finish is to be applied beyond the requirements of an Ordinary Surface Finish. Four grades of finish are included herein.

"Class" of finish designates the materials or the process to be used in providing the grade of finish. Three classes of finish are included herein.

For structures and surfaces not described herein under grade of finish, a class of finish only may be indicated. Where neither a grade nor class is specified, an Ordinary Surface Finish only will be required as specified in Item No. 410S, "Concrete Structures".

Where the plans specify a grade and class of finish, i.e., Grade II, Class C, only that type of finish shall be furnished.

Where the plans specify a grade of finish only, i.e., Grade I Finish, any of the classes of finish may be furnished. Only one class of finish shall be furnished on any individual structure, twin structures or on structures in close proximity to each other, except as specified for prestressed concrete members below.

(2) Grade I

The following areas shall receive a Class A, B or C (two rub) Finish, except that prestressed members shall receive either a Class A or B Finish only.

All concrete surfaces of railing, including the parapet types; exterior vertical faces of slabs, slab spans, arches and box girders; the outside and bottom surfaces of fascia beams or girders (including prestressed members); the underside of overhanging slabs to the point of juncture of the supporting beam; all exposed vertical surfaces of

bents and piers and bottom surfaces of bent caps; all exposed surfaces of tie beams, abutments, bridge wingwalls, culvert headwalls and wingwalls and retaining walls exposed to view after all backfill and is placed.

Unless otherwise indicated, the underside of the slab of slab spans shall be finished its entire width.

Unless otherwise indicated, exposed surfaces of pump houses and other miscellaneous concrete surfaces shall receive a Class A, B or C (one rub) Finish.

(3) Grade II

All concrete surfaces of railing, including the parapet types, all exposed surfaces of bridge wingwalls and the exterior vertical faces of slabs and slab spans shall receive a Class A, B or C (two rub) Finish. All other surfaces described under Grade I Finish shall receive a Class A or B finish only. The underside of slab spans shall receive an Ordinary Surface Finish only.

(4) Grade III

All concrete surfaces of railing, including the parapet types, all exposed surfaces of bridge wingwalls and the exterior vertical faces of slabs shall receive a Class A, B or C (two rub) Finish. All other surfaces described under Grade I Finish shall receive an Ordinary Surface Finish.

(5) Grade IV

The top and roadway faces only of all concrete railing, including the parapet types and bridge wingwalls shall receive a Class A, B or C (one rub) Finish. All other surfaces described under Grade I shall receive an Ordinary Surface Finish.

411S.5 Class of Finish

The Class of Finish designates either an adhesive grout material, a paint-type material or a rubbing process applied to surfaces specified in "Grade of Finish", as required above and/or as indicated.

Unless otherwise indicated the color shall be concrete gray.

(1) Class A

This finish shall consist of an adhesive grout textured coating with a minimum 1/16 inch thickness, composed of 1 part white cement, 1 part natural (gray) cement, 2 parts masonry sand, 1 part (latex) emulsion and enough water to form a viscous slurry of a consistency that may be applied by spray gun, brush or roller without appreciable running or sagging. The proportions of white and gray cement may be varied slightly to obtain the desired color.

Gradation of the masonry sand shall be as required to produce a texture satisfactory to the Engineer or designated representative.

Prepackaged materials meeting these requirements and acceptable to the Engineer or designated representative as to color, texture and appearance will be permitted.

(2) Class B

The finish shall be a paint-type material, consisting of a synthetic resin, containing fibrous as well as texturing pigments, which when applied by a 1 coat spray application at the rate of 45 + 5 square feet per gallon (15.9 + 1.9 square meters per liter) will yield an acceptable textured coating. Certification by the manufacturer of the above materials will be required.

(3) Class C

This finish shall consist of a one rub or two rub system, as the case may be, meeting the requirements set forth below under "Construction Methods".

411S.6 Approval of Surface Finishing Materials

The material to be furnished shall meet the requirements of TxDoT Specification DMS-8110, Structural Coatings, latest revision.

In addition to the above, the manufacturer shall furnish the following:

(1) At the time of original request for approval of the surface furnishing material, the manufacturer shall supply a 1-gallon (3.8 L) sample of the material to the Engineer or designated representative, if requested.

(2) Each 6 months after approval of the material, the manufacturer shall furnish a notarized certification indicating that the material originally approved has not been changed or altered in any way. Any change in formulation of a surface finish shall require retesting prior to use.

The Engineer or designated representative may request additional information to be submitted such as infrared spectophotometry scan, solids content, etc., for further identification. A change in formula discovered by any of the tests prescribed herein or by other means and not reported and retested, may be cause to permanently bar the manufacturer from furnishing surface finish materials for City work.

The City reserves the right to perform any or all of the tests required by this specification as a check on the tests reported by the manufacturer. In case of any variance the City tests will govern.

411S.7 Construction Methods

Prior to application of any of the finishes required herein, concrete surfaces shall be given an Ordinary Surface Finish. For Class A and B materials, concrete surfaces shall be clean and free of dirt, grease, curing compound or any other bond breaking substance. Class A shall be applied on moistened surfaces but Class B requires a dry surface. The temperature of the atmosphere, concrete and compound shall be above 50°F (10°C) for Classes A and B at the time of application. The finished surfaces shall be protected against rain or freezing for a period of 24 hours after application.

Class A materials shall be applied by spraying, by roller or by brush. Class B materials shall be applied by spraying only. All applications shall provide an acceptable texture of the proper coverage.

The Class A and B material shall be applied after all preparation work required by Ordinary Surface Finish has been completed.

The Class C Finish shall be performed with a carborundum stone as follows, after all preparatory work required by Ordinary Surface Finish has been completed:

For a two-rub system, the first rubbing shall bring the wetted concrete face to a paste and produce a smooth dense surface without pits, form marks or other irregularities. The use of cement or grout to form the paste will not be permitted. Striping with a brush and washing after the first rubbing will not be required. Chamfer lines shall be finished during the second rubbing.

The first rubbing shall be done soon after form removal. Membrane curing, if used, shall be applied after the first rub is complete. Prior to the second rubbing, any remaining curing membrane shall be removed from the surface by brushing, buffing or other satisfactory methods.

The second rubbing shall be performed when conditioning the structure for final acceptance. The specified surfaces shall be cleaned of drip marks and discolorations and given a final rubbing. The surface shall be striped neatly with a brush and the paste allowed to take a reset, after which the surfaces shall be washed with clean water leaving them with a neat and uniform appearance and texture.

For a one rub system, the rubbing requirements shall be the same as for the first rub above, except chamfer lines shall be finished and the paste spread uniformly, striped with a brush and allowed to take a reset after which the surfaces shall be washed with clean water leaving them with a neat and uniform appearance and texture.

411S.8 Special Surfaces Finishes

(1) General

When special surface finishes are required for retaining walls, panels, copings or similar construction, the Contractor shall prepare sample panels for approval of the finish and the method of application. Unless otherwise indicated, panel or pattern arrangement and dimensions may be varied to achieve a more pleasing appearance or to utilize forming material more efficiently when approved by the Engineer or designated representative. Aggregates, materials, variation of panel or pattern arrangement, dimensions and other features affecting the work shall be approved prior to start of the work.

(2) Striated Finish

The striated (grooved) pattern shall be as indicated or as approved by the Engineer or designated representative.

The finish shall be made by lining the forms with striated sheets of plywood, plastic, fiberglass, metal or other material acceptable to the Engineer or designated representative. The striations on the panels shall be of a smooth, wide pattern, not sharp or angular.

A chamfer groove shall be used along all edges of each panel. All ties, bolts or other forming accessories shall be located along the chamfer grooves or panel edges.

(3) Exposed Aggregate Finish

(a) Structural Concrete

Exposed aggregate panels may be either raised, recessed or as indicated with the sides of each panel chamfered as directed by the Engineer or designated representative.

The aggregate used for this finish shall be approved by the Engineer or designated representative. Unless otherwise indicated, aggregate shall conform to the grading requirements of Grade 2 aggregate except that a minimum of 50 percent shall be retained on the ¾-inch (19 mm) sieve. Gravel of predominately rounded particles shall be used, except that when indicated or approved by the Engineer or designated representative in writing, crushed stone may be used. The aggregate shall be large enough to remain firmly anchored in the face of the final product. The depth shall be 1/4-inch (6.4 mm) minimum to 1/2-inch (12.7 mm), unless otherwise indicated or directed by the Engineer or designated representative.

A surface retarder that penetrates the concrete approximately 1/4 inch (6.4 mm) shall be applied to the forms or concrete surface as an aid in achieving the desired finish. Wood forms may require 2 or 3 coatings to compensate for absorption. Form joints shall be taped or caulked to prevent escape of the retarder during placing operations.

Treated form surfaces shall be protected from sun and rain while exposed to the atmosphere. In case of high humidity or if rain has dampened the forms prior to placing concrete, a reapplication of the surface retarder may be required to provide uniform coverage of the retarder on the forms.

Adjacent areas of fresh concrete not requiring exposed aggregate finish shall be protected when the retarder is applied.

The finish shall be obtained by sandblasting, bush hammering, water blasting or other methods, as approved by the Engineer or designated representative. Horizontal surfaces may be finished by a combination of brushing and washing, but only after the concrete has set sufficiently to prevent loosening of the aggregate.

Unless otherwise directed by the Engineer or designated representative, forms for surface requiring exposed aggregate finish shall be removed 12 to 15 hours after concrete placement. The exposed aggregate operation shall be accomplished immediately after form removal. Except for the time required for obtaining the exposed aggregate finish, curing of all surfaces shall be maintained for the minimum 4 day curing time. All surfaces shall be either water cured or may be cured with an approved clean membrane compound. If water curing is used, it shall be followed by a clear membrane curing compound conforming to Item No. 409S, "Membrane Curing".

Care shall be taken to ensure proper vibration at all points of concrete placement to prevent honeycomb or segregation of the materials. Vibration shall be done in such a manner as to provide adequate penetration of previously placed concrete lifts. Care shall be taken to prevent contact of the vibrator with the face form.

(b) Sidewalks

When exposed aggregate surfaces are required for sidewalks, driveways and/or medians, the coarse aggregate shall consist of particles with at least 40 percent crushed faces. Uncrushed gravel, polished aggregates and clear resilient

coatings are not acceptable. Grade 5 coarse aggregates shall be used for exposed aggregate finishes for sidewalks, driveways and/or medians.

411S.9 Measurement and Payment

No direct measurement or payment will be made for the work to be done, the equipment or materials to be furnished under this item, but shall be included in the unit price bid for the item of construction in which this item is used.

End

SPECIFIC Cross Reference Materials
Standard Specification Item No. 411S, " Surface Finishes for Concrete"

City of Austin Standard Specification Items

Designation	Description
Item No. 410S	Concrete Structures

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
DMS-8110	Coatings for Concrete

American Society for Testing and Materials (ASTM)

Designation	Description
C 144	Aggregate for Masonry Mortar
C 150	Portland Cement
D 445	Kinematic Viscosity of Transparent and Opaque Liquids
D 476	Standard Classification for Dry Pigmentary Titanium Dioxide Products
D 1475	Standard Test Method for Density of Liquid Coatings, Inks and Related Products
D 1544	Standard Test Method for Color of Transparent Liquids (Gardner Color Scale)
D 1652	Standard Test Method for Epoxy Content of Epoxy Resins
D 1726	Standard Test Method for Hydrolyzable Chloride Content of Liquid Epoxy Resins

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 411S, " Surface Finishes for Concrete"

City of Austin Standard Specification Items

Designation	Description
Item No. 403S	Concrete for Structures
Item No. 410S	Concrete Structures
Item No. 411S	Surface Finished for Concrete

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Item No. 414S
Concrete Retaining Walls

414S.1 Description

This item shall govern reinforced Portland cement concrete precast or cast-in-place retaining walls constructed in conformity with the lines, grades and details indicated on the Drawings or as directed by the Engineer or designated representative.

When indicated on the drawings or directed by the Engineer or designated representative, this item shall also govern any requirements for pumping, bailing, drainage and/or protection of workers in trenches in compliance with Standard Specification Item No. 509S, "Excavation Safety Systems".

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

414S.2 Submittals

The submittal requirements of this specification item may include:

A. Type of concrete
B. Reinforcing steel type, size, area, lengths
C. Joint sealants and fillers type, manufacturer, fact sheets and application recommendations.
D. Curing compound: manufacturer, type compound material, batch number or symbol and appropriate fact sheets
E. Filter fabric manufacturer, fact sheets and test results.
F. Select Backfill source, gradation and test results.
G. Type and manufacturer of waterstops

414S.3 Materials

A. Concrete

Cast-in-place Portland cement concrete shall conform to the requirements of a Class C Concrete, as specified in Standard Specification Item No. 403S, "Concrete For Structures". Precast Portland cement concrete shall conform to the requirements of Standard Specification Item No. 403S, "Concrete for Structures" but shall have a minimum 28 day compressive strength of 4500 psi (31027 kPa).

B. Reinforcing Steel

Reinforcing steel shall conform to Standard Specification Item No. 406S, "Reinforcing Steel".

C. Joint Sealants and Fillers

Preformed Bituminous Fiber Material shall meet the requirements of ASTM D 1751. Joint sealant shall be a non-sag low-modulus silicone.

D. Membrane Curing Compound

Membrane curing compound shall conform to Standard Specification Item No. 409S, "Membrane Curing".

E. Filter Fabric

Filter fabric shall conform to Standard Specification Item No. 620S, "Filter Fabric".

F. Select Backfill

Select backfill shall conform to Standard Specification Item No. 210S, "Flexible Base".

G. Waterstops

Waterstops, if shown on the Drawings, shall conform to Standard Specification Item 416S, “Waterstops”.

H. Pipe Underdrains

Pipe Underdrains, if shown on the Drawings, shall conform to Standard Specification Item 551, “Pipe Underdrains”.

414S.4 Construction Methods

A. General

All excavation shall be done in accordance with Standard Specification Item No. 401S, "Structural Excavation and Backfill".

All forms and forming, placement of reinforcement, placement of Portland cement concrete, form removal, finishing and curing shall conform to Standard Specification Item No. 410S, "Concrete Structures". Cast-in-place Portland cement concrete retaining walls shall be constructed in one continuous vertical pour from the top of the footing to the top of the wall unless intermediate horizontal construction joints are shown on the Drawings.

The height of the retaining wall will be determined by established grades or as directed by the Engineer or designated representative but and shall be such that water will not be trapped or ponded on private or public property.

Reinforcement for the wall shall be as indicated on the Drawings. The Contractor shall provide dowel bars of the proper size, shape and spacing, as indicated on the drawings.

Devices to release the hydrostatic head shall be installed as indicated on the drawings.

All exposed corners and edges shall be filleted with triangular chamfer strips measuring 3/4 inch (19 mm) on each side. Exposed horizontal surfaces shall be level and flat, and exposed vertical surfaces shall be plumb and flat, unless indicated otherwise on the Drawings.

B. Vertical Control Joints

Unless indicated otherwise on the Drawings, vertical control joints shall be constructed in the retaining wall stem (the vertical portion of the wall) to create planes of weakness to control cracking. Horizontal wall reinforcement shall extend through the vertical control joints. These joints shall be constructed at abrupt

changes in wall height and at a spacing not to exceed 20 feet (6 meters) in wall sections of uniform. The joints shall be formed by placing triangular chamfer strips to create grooves in both faces of the wall to a depth of at least ten percent of the wall thickness. Control joints shall be sealed, on the backfilled side of the retaining wall, with a non-sag low-modulus silicone sealant, or, alternatively, the joint may be covered with a waterproofing material consisting of an 18-inch (450-mm) wide strip of self-adhering polyethylene having a rubberized asphalt mastic, as approved by the Engineer or designated representative.

C. Vertical Expansion Joints

Vertical expansion joints shall conform to the applicable section of Standard Specification Item 410S, "Concrete Structures". These joints shall be constructed at a spacing not to exceed 60 feet (15 meters), unless indicated otherwise on the Drawings. They shall extend the full height and width of the wall, including the wall footing, and shall consist of sleeved dowels and 1/2-inch (13 mm) thick preformed bituminous fiber material. The edges and corners of the joints shall be formed by triangular chamfer strips measuring 3/4 inch (19 mm) on each side. The concrete on the two sides of an expansion joint shall be placed in two separate pours unless approved otherwise by the Engineer or designated representative.

D. Construction Joints

Construction joints shall conform to the applicable section of Standard Specification Item 410S, "Concrete Structures". Wall reinforcement shall extend through the construction joint unless indicated otherwise on the Drawings,

E. Waterstops

Waterstops shall be provided in construction and expansion joints in retaining walls where water-tightness is essential to the function of the structure, as in detention, retention, or water quality ponds or flood walls.

414S.5 Measurement

Accepted cast in place or precast Portland cement concrete work as prescribed by this item will be measured by the cubic yard for reinforced concrete retaining wall, complete in place.

All concrete quantities will be based on the dimensions indicated on the drawings.

414S.6 Payment

The cast-in-place or precast Portland cement concrete work performed as prescribed by this item will be paid for at the unit bid price per cubic yard for "Concrete Retaining Wall". The unit bid price shall include full compensation for all excavation, forms, concrete, curing, finishing, backfilling, sloping that is not part of an excavation safety system covered by Item No. 509S, and for all labor, tools, materials, equipment and incidentals necessary to complete the work.

Payment will be made under one of the following:

Pay Item No. 414S-C: Cast-in-place Portland Cement Concrete Retaining Wall, Including Reinforcement - Per Cubic Yard.

Pay Item No. 414S-P: Precast Concrete Retaining Wall - Per Cubic Yard.

End

SPECIFIC CROSS REFERENCE MATERIALS
Standard Specification Item 414S, "Concrete Retaining Walls"

City of Austin Standard Specification Items

Designation	Description
Item No. 210S	Flexible Base
Item No. 401S	Structural Excavation and Backfill
Item No, 403S	Concrete for Structures
Item No. 406S	Reinforcing Steel
Item No, 409S	Membrane Curing
Item No. 410S	Concrete Structures
Item No. 416S	Waterstops
Item No. 509S	Excavation Safety Systens
Item No, 551	Pipe Underdrains
Item No. 620S	Filter Fabric

American Society for Testing and Materials, ASTM

Designation	Description
ASTM D 1751	Preformed Expansion Joint Filler for Concrete Paving and Structural Construction

RELATED CROSS REFERENCE MATERIALS
Standard Specification Item 414S, "Concrete Retaining Walls"

City of Austin Standard Specification Items

Designation	Description
Item No. 404S	Pneumatically Placed Concrete
Item No. 405S	Concrete Admixtures
Item No, 408S	Concrete Joint Materials
Item No. 411S	Surface Finishes for Concrete

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 360	Concrete Pavement
Item No. 420	Concrete Structures
Item No. 421	Portland Cement Concrete
Item No. 427	Surface Finishes for Concrete
Item No. 431	Pneumatically Placed Concrete
Item No. 437	Concrete Admixtures
Item No. 520	Weighing and Measuring Equipment
Item No. 522	Portland Cement Concrete Plants
Item No. 524	Hydraulic Cement

Texas Department of Transportation: Departmental Material Specifications

Designation	Description
DMS 8900	Fly Ash

Item No. 416S
Waterstops

416S.1 Description

This item shall govern the furnishing and installation of waterstops in accordance with the details shown on the Drawings and the requirements of this item.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

416S.2 Submittals

The submittal requirements of this specification item include:

A. Type and manufacturer of proposed waterstop.

B. Certification that waterstops meet the requirements of this section.

C. Proposed method of performing splices.

416S.3 Materials

(1) General: Except where otherwise shown on the Drawings, waterstops may be manufactured from either natural or synthetic rubber or from polyvinyl chloride (PVC) as specified below.

(a) Natural Rubber. Natural rubber waterstops shall be manufactured from a stock composed of a high-grade compound made exclusively from new plantation rubber, reinforcing carbon black, zinc oxide, accelerators, anti-oxidants and softeners. This compound shall contain not less that 72 percent by volume of new plantation rubber.

Physical properties of the natural rubber for waterstops shall be as shown in Table A below.

(b) Synthetic Rubber. Synthetic rubber water stops shall be manufactured from a compound made exclusively from neoprene or butadiene styrene rubber (GRS), reinforcing carbon black, zinc oxide, polymerization agents and softeners. This compound shall contain not less than 70 percent by volume of neoprene or GRS.

Physical properties of the synthetic rubber for waterstops shall be as shown in Table A below.

(c) Polyvinyl Chloride. Polyvinyl chloride (PVC) waterstop material shall conform to the Corps of Engineers Specification Number CRD-C-572.

(2) Manufacturer's Certification: The manufacturer shall furnish test reports certified by a nationally known testing laboratory for each batch or lot of waterstops furnished under this contract, indicating compliance with this specification.

(3) Manufacturing Requirements: Natural and/or synthetic rubber waterstops shall be manufactured with an integral cross section which shall be uniform within plus or minus 1/8 inch (3.2 mm) in width. The web thickness or bulb diameter cross section shall be within plus 1/16 (1.6 mm) and minus 1/32 inch (0.8 mm). No splices will be permitted in straight strips. Strips and special connection pieces shall be well cured so that any cross section shall be dense, homogeneous and free from all porosity. All junctions in the special connections shall be full-molded.

Requirements for PVC waterstops shall be the same as for natural or synthetic rubber waterstops except that splicing of PVC shall be done by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. A thermostatically controlled electric source of heat shall be used to make all splices. The heat shall be sufficient to melt but not to char the plastic.

416S.4 Construction Methods

Waterstops shall be of the size and shape shown on the Drawings. They shall be installed in the locations as shown on the Drawings.

The waterstops shall be accurately located in the forms and firmly held in place, both before and during concrete placement, to prevent displacement.

No field splices shall be permitted unless otherwise indicated on the Drawings. Field splices shall be either vulcanized; mechanical, using stainless steel parts; or made with a rubber splicing union of the same stock as the waterstop. All finished splices shall have a tensile strength not less than 50 percent of the unspliced material.

TABLE A: Physical Properties for Rubber for Waterstops

Original Physical Properties:	Natural (Plain) Rubber	Synthetic (Neoprene or GRS) Rubber
Hardness, ASTM D676 (Durometer)	60 ± 5	55 ± 5
Tensile Strength, Min. psi (mPa), ASTM D412	3500 (24)	2500 (17)
Elongation at Break, Min. percent	550	425
Accelerated Tests to Determine Aging Characteristics (Alternate tests):		
(1) After 7 days in air at 158° ± 2° F (70° ± -17° C), ASTM D573, or;		
(2) After 48 hours in oxygen at 158° ± 2° F (70° ± -17° C) and 300 psi (2 mPa) pressure, ASTM D572:		
Tensile Strength, percent change, max.	35	35
Maximum Elongation, percent change, max.	35	-

416S.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 shall be included in the unit price bid for the item of construction in which this item is used.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 416S, “Waterstops”

Corps of Engineers Specifications

Designation	Description
CRD-C-572	Polyvinylchloride Waterstop

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 416S, “Waterstops”

City of Austin Standard Specifications

Designation	Description
Item No. 403S	Concrete for Structures
Item No. 410S	Concrete Structures
Item No. 414S	Concrete Retaining Walls
Item No. 425S	Prestressed Concrete Structures

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Item No. 430S
P.C. Concrete Curb and Gutter

430S.1 Description

This item shall govern Portland Cement (p.c.) concrete curb, p.c. concrete curb and gutter with reinforcing steel or p.c. concrete laydown curb as required, that is constructed in accordance with this specification on an approved subgrade and base in conformity with Standard Detail Series 430S and the lines, grades, section indicated on the Drawings or as established by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

430S.2 Submittals

The submittal requirements of this specification item include:

A. Class A p.c. concrete mix design,

B. Type of Installation (i.e. P.C. Concrete Curb and Gutter or P.C. Concrete Curb or P.C. Concrete Laydown Curb) and construction details (i.e. base, reinforcing steel, joints, curing membrane),

C. Identification of the type, source, mixture, Pure Live Seed (PLS) and rate of application of the seeding.

430S.3 Materials

A. Concrete

The Portland cement (p.c.) concrete shall conform to Class A Concrete, Section 403S.7 (Table 4) of Standard Specification Item No. 403S, "Concrete for Structures" or Sections 360S.4 and 360S.6 of Standard Specification Item No. 360S, "Concrete Pavement" when curb and gutter is to be constructed integral with the pavement.

B. Reinforcing Steel

Reinforcing steel shall conform to Standard Specification Item No. 406S, "Reinforcing Steel".

C. Expansion Joint Materials

Expansion joint materials shall conform to Standard Specification Item No. 408S, "Expansion Joint Materials".

D. Membrane Curing Compound

Membrane curing compound shall conform to Standard Specification Item No. 409S, "Membrane Curing".

E. Flexible Base

Aggregate shall conform to Standard Specification Item No. 210S, "Flexible Base".

430S.4 Construction Methods

A. Subgrade and Base Preparation

Subgrade for curb and gutter shall be excavated and prepared to depth and width requirements indicated on the Drawings, including a minimum of 12 inches (300 mm) behind the curb, unless a greater width is indicated on the Drawings. The subgrade shall be shaped to the line, grades, cross section and dimensions indicated on the Drawings. A minimum of 4 inches (100 mm) of flexible base shall be spread, wetted and thoroughly compacted under curb and gutter as specified in Standard Specification Item No. 210S, "Flexible Base". If dry, the base shall be sprinkled lightly with water before p.c. concrete is deposited thereon.

B. C & G Forms

Forms shall be of metal, well-seasoned wood or other approved material. The length of the forms shall be a minimum of 10 feet (3 meters). Flexible or curved forms shall be used for curves of 100-foot (30 meter) radius or less. Wood forms for straight sections shall be not less than 2 inches (50 mm) in thickness. Forms shall be a section, that is satisfactory to the Engineer or designated representative, of the depth required and clean, straight, free from warp and, if required, oiled with a light form oil. All forms shall be securely staked to line and grade and maintained in a true position during the placement of p.c. concrete.

C. Reinforcing Steel

The reinforcing steel, if required, shall be placed as shown on the typical section of the Drawings. Care shall be exercised to keep all steel in its proper location during p.c. concrete placement.

D. Joints

Joints shall be of the type and spacing shown on the Drawings. Expansion joint material, 3/4 inch (19 mm) in thickness, shall be provided at intervals not to exceed 40 feet (12 meters) and shall extend the full width and depth of the p.c. concrete. Weakened plane joints shall be made 3/4 inch (19 mm) deep at 10-foot (3 meters) intervals. All joint headers shall be braced perpendicular and at right angles to the curb.

Two round smooth dowel bars, 1/2 inch (12.5 mm) in diameter and 24 inches (600 mm) in length, shall be installed at each expansion joint. Sixteen inches (400 mm) of one end of each dowel shall be thoroughly coated with hot oil, asphalt or red lead, so that it will not bond to the concrete. The dowels shall be installed with a dowel sleeve on the coated end as indicated on the Drawings or equivalent method as directed by the Engineer or designated representative.

E. P.C. Concrete Placement and Form Removal

Concrete shall be placed in the forms and properly consolidated. Within 1 hour after p.c. concrete placement, a thin coating, that is no more than 1/2 inch (12.5 mm) nor less than 1/4 inch (6.25 mm) thick of finish mortar, composed of 1 part Portland Cement to 2 parts fine aggregate, shall be worked into the exposed faces of the curb and gutter by means of a "mule". After the p.c. concrete has become sufficiently set, the exposed edges shall be rounded by the use of an edging tool to the radii indicated on Standard Detail 430S-1. The entire exposed surface of the curb and gutter shall be floated to a uniform smooth surface, and then finished with

a camel hairbrush to a gritty texture. The forms shall remain in place a minimum of 24 hours unless approved otherwise by the Engineer or designated representative.

After removal of the forms, any minor honeycombed surfaces shall be plastered with a mortar mix as described above. Excessively honeycombed curb and gutter, as determined by the Engineer or designated representative, shall be completely removed and replaced when directed.

F. Curing

Immediately after finishing the curb, concrete shall be protected by a membrane curing conforming to Standard Specification Item No. 409S, "Membrane Curing".

After a minimum of 3 days curing and before placement of the final lift of the base course, the curb shall be backfilled to the full height of the p.c. concrete, tamped and sloped as directed by the Engineer or designated representative. The upper 4 inches (100-mm) of backfill shall be of clean topsoil that conforms to Standard Specification Item No. 130S, "Borrow" and is free of stones and debris.

G. Seeding in Turf Areas

When turf is to be established, preparation of the seedbed shall conform to Item No. 604S, "Seeding for Erosion Control".

430S.5 Measurement

Accepted work as prescribed by this item will be measured by the lineal foot (lineal meter: 1 lineal meter equals 3.281 lineal feet) of p.c. concrete curb and gutter, p.c. concrete curb and/or p.c. concrete laydown curb, complete in place.

430S.6 Payment

The work performed as prescribed by this item will be paid for at the unit bid price per lineal foot for "P.C. Concrete Curb and Gutter" or P.C. Concrete Curb. The price shall include full compensation for all work as set forth and described under payment Method A and/or B.

A. Method A (Pay Item No. 430S-A)

This payment method shall include all the work performed for "P.C. Concrete Curb and Gutter" complete, at the unit bid price. The unit bid price shall include full compensation for excavation, preparation of the subgrade, furnishing and placing all concrete and base material, reinforcing steel, dowels, expansion joint material, curing material, backfill and for all other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

B. Method B (Pay Item No. 430S-B)

This payment method includes all the work performed for "P.C. Concrete Curb and Gutter", complete, at the unit bid price. The unit bid price shall include full compensation for fine grading, furnishing and placing concrete and reinforcing steel, dowels, expansion joint material, curing material, backfill and for all other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

C. Method C (Pay Item No. 430S-C)

This payment method includes all the work performed for " P.C. Concrete Curb" complete, at the unit bid price. The unit bid price shall include full compensation for excavation, furnishing and placing all concrete and base material, reinforcing steel, dowels, expansion joint material, curing material, backfill and for all other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

D. Method D (Pay Item No. 430S-D)

This payment method includes all the work performed for "P.C. Concrete Curb" complete, at the unit bid price. The unit bid price shall include full compensation for fine grading, furnishing and placing concrete and reinforcing steel, dowels, expansion joint material, curing material, backfill and for other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

E. Method E (Pay Item No. 430S-E)

This payment method shall include all the work performed for "P.C. Concrete Laydown Curb" complete, at the unit bid price. The unit bid price shall include full compensation for excavation, preparation of the subgrade, furnishing and placing all concrete and base material, reinforcing steel, dowels, expansion joint material, curing material, backfill and for all other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work

F. Method F (Pay Item No. 430S-F)

This payment method includes all the work performed for "P.C. Concrete Laydown Curb" complete, at the unit bid price. The unit bid price shall include full compensation for fine grading, furnishing and placing concrete and reinforcing steel, dowels, expansion joint material, curing material, backfill and for other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under one of the following:

Pay Item No. 430S-A:	P.C. Concrete Curb and Gutter (Excavation)	Per Lineal Foot.
Pay Item No. 430S-B:	P.C. Concrete Curb and Gutter (Fine Grading)	Per Lineal Foot.
Pay Item No. 430S-C:	P.C. Concrete Curb (Excavation)	Per Lineal Foot.
Pay Item No. 430S-D:	P.C. Concrete Curb (Fine Grading)	Per Lineal Foot.
Pay Item No. 430S-E:	P.C. Concrete Laydown Curb (Excavation)	Per Lineal Foot.
Pay Item No. 430S-F:	P.C. Concrete Laydown Curb (Fine Grading)	Per Lineal Foot.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 430S, “P.C. Concrete Curb and Gutter”

City of Austin Standard Specifications

Designation	*Description*

Item No 130S	Borrow
Item No 210S	Flexible Base
Item No. 360S	Concrete Pavement
Section 360S.4 of Item 360S	Proportioning of Concrete
Section 360S.6 of Item 360S	Concrete Mixing and Placing
Item No. 403S	Concrete for Structures
Section 403S.7 of Item No. 403S	(Table 4)
Item No. 406S	Reinforcing Steel
Item No. 408S	Expansion Joint Materials
Item No. 409S	Membrane Curing
Item No. 604S	Seeding for Erosion Control

City of Austin Standard Details

Designation	*Description*
430S-1	Curb and Gutter Section
430S-3	Curb Expansion Joint Dowel Detail
430S-4	Concrete Backfill Under Curb & Gutter
430S-5	Reinforcing Bar Detail at Existing Curb and Gutter

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 430S, “P.C. Concrete Curb and Gutter”

City of Austin Standard Specifications

Designation	*Description*
Item No. 301S	Asphalts, Oils and Emulsions
Item No. 302S	Aggregates for Surface Treatments
Item No. 340S	Hot Mix Asphaltic Concrete Pavement
Item No. 431S	Machine Laid PCC Curb and Gutters
Item No. 433S	P.C. Concrete Driveways
Item No. 434S	P.C. Concrete Medians and Islands
Item No. 436S	P.C. Concrete Valley Gutters
Item No. 606S	Fertilizer

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Item No. 432S
Portland Cement Concrete Sidewalks

432S.1 Description

This item shall govern the construction of Portland cement concrete sidewalks (Standard Detail No. 432S-1), as herein specified, on an approved subgrade and in conformance with the lines, grades and details indicated on the Drawings or as established by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text inch-pound units are given preference followed by SI units shown within parentheses.

432S.2 Submittals

The submittal requirements of this specification item include:

A. Class A portland cement (p.c). concrete mix design,
B. Type of Installation (i.e. Type I, Type II, etc.) and construction details (i.e. cushion layer, base, reinforcing steel, joints, curing membrane),
C. Identification of the type, source, mixture, Pure Live Seed (PLS) and rate of application of the seeding.
D. Number, manufacturer, model, construction, finish and installation details of streetscape appurtenances of bicycle racks, benches, chairs, trash receptacles, streetlights, tree wells and above grade tree planters [for sidewalks, 12 feet (3.66 meters) or wider].

432S.3 Materials

A. Portland Cement Concrete

Portland cement concrete shall be Class A conforming to Specification Item No. 403S, "Concrete for Structures" or Specification Item No. 407S, "Fibrous Concrete".

B. Reinforcement

Reinforcement shall conform to Specification Item No. 406S, "Reinforcing Steel" or Specification Item No. 407S, "Fibrous Concrete".

C. Expansion Joint Materials

Expansion joint materials shall conform to Specification Item No. 408S, "Expansion Joint Materials".

D. Membrane Curing Compound

Membrane curing compound shall conform to Specification Item No. 409S, "Membrane Curing".

432S.4 Construction Methods

The subgrade shall be excavated in accordance with Specification Item No. 111S, “Excavation”, prepared in accordance with Specification Item No. 201S, “Subgrade Preparation”, shaped to the lines, grades and cross section as indicated on the Drawings or as directed by the Engineer or designated representative and thoroughly compacted in accordance with Specification Item No. 201S. A granular cushion of a minimum thickness of 2 inches (50 mm) but maximum thickness of 5 inches (125 mm), composed of crusher screenings, gravel and sand, crushed rock or coarse sand,

shall be spread, wetted thoroughly, tamped and leveled. The granular cushion shall be moist at the time the Portland cement concrete is placed.

If the subgrade is undercut by more than 4 inches (100 mm) or the elevation of the natural ground is more than 4 inches (100 mm) below "top of subgrade", then a necessary backfill/embankment layer of an approved material shall be placed and compacted with a mechanical tamper. Hand tamping will not be permitted.

Where the subgrade is rock or gravel, 70 percent of which is rock; the 2-inch (50 mm) cushion need not be used. The Engineer or designated representative will determine if the subgrade meets the above requirements.

Sidewalk forms shall be constructed of metal or well-seasoned wood not less than 2 inches (50 mm) in thickness, with a section satisfactory to the Engineer or designated representative. The forms shall be clean, straight, and free from warp with a depth equal to the thickness of the finished work. All forms shall be securely staked to line and grade and maintained in a true position during the deposition of Portland cement concrete. Before p.c. concrete is placed, the forms shall be thoroughly oiled with a light form oil.

Expansion joint material 3/4 inch (19 mm) thick, shall be provided where the new construction abuts an existing structure, sidewalk or driveway. Similar expansion material shall be placed around all obstructions protruding through the sidewalk. The expansion joint material shall be placed vertically and shall extend the full depth of the p.c. concrete. Maximum spacing of expansion joints shall be 40 feet (12 meters) as indicated on the Drawings or as directed by the Engineer or designated representative. Weakened plane joints shall be spaced at 5 feet (1.5 meters) on center. Normal dimensions of the weakened plane joints shall be 1/4 inch wide and 3/4 inch deep (6 mm wide and 19 mm deep). All joints shall be constructed perpendicular (90 degrees) to the centerline of walk and shall match any previously placed concrete joints. For sidewalks with widths exceeding 6 feet (1.83 meters) longitudinal weakened-plane tooled joints shall be provided as indicated on the Drawings or as directed by the Engineer or designated representative.

Reinforcement for sidewalks shall consist either of polypropylene fibrillated fibers or 6” x 6” x W1.4 x W1.4 (150mm x 150mm x MW9 x MW9) welded wire fabric or one layer #3 (10M) reinforcing bars, placed no more than 18 inches (450 mm) on center both directions. All reinforcement shall be accurately placed at slab mid-depth, equidistant from the top and bottom of the p.c. concrete and held firmly in place by means of bar supports of adequate strength and number that will prevent displacement and keep the steel at its proper position during the placement of the p.c concrete. In no instance shall the steel be placed directly on the subgrade or sand cushion layer.

Prior to placement of the concrete, the reinforcement installation shall be inspected by the Engineer or designated representative to insure conformance with the drawings, specifications and this item. In addition care shall be exercised to keep all steel in its proper position during placement of the p.c. concrete. If during placement of the concrete, the reinforcement is observed to loose bar support, float upward or move in any direction, the placement shall be stopped until corrective action is taken.

Splices in wire fabric shall overlap sufficiently to allow two pairs of transverse wires to be tied together and no splice of less than 6 inches (150 mm) will be permitted. Splices in the #3 (10M) bars shall have a minimum lap of 12 inches (300 mm).

Where driveways cross sidewalks, additional reinforcing shall be placed in the sidewalk as indicated on the Drawings.

Portland cement concrete shall be placed in the forms and spaded, tamped and thoroughly consolidated until it covers the entire surface with a monolithic finish. The top surface shall be floated and troweled to a uniform smooth surface; then finished with a broom or wood float to a gritty texture unless indicated otherwise on the Drawings or as directed by the Engineer or designated representative. The outer edges and joints shall be rounded with approved tools to a

1/4-inch (6 mm) radius. Care will be exercised to prevent loss of dummy joints or rounded edges when applying the brush finish.

Portland cement concrete sidewalk ramps shall be formed to produce a finished surface with detectable warnings (Standard Detail 432S-2A) in accordance with the requirements of the American Disabilities Act and Texas Accessibility Standards (TAS), including Sections 4.29.2 and A4.29.2. The p.c. concrete sidewalk ramps shall be constructed in accordance with appropriate City of Austin Standard Details (Standard Details 432S-3, 432S-3A through 432S-3H, 432S-5, 432S-5A, 432S-5B, etc.).

Detectable warning for the ramps shall consist of raised truncated domes with a diameter of nominal 0.9 inch (23 mm), a height of nominal 0.2 inch (5 mm) and center-to-center spacing of nominal 2.35 inches (60 mm) and shall contrast visually with adjoining surfaces, either light on dark or dark-on-light. The material used to provide contrast shall be an integral part of the walking surface.

When indicated on the Drawings or as directed by the Engineer or designated representative, the construction of the sidewalk ramp shall include the installation of interlocking concrete paving units (Standard Specification Item No. 480S, "Concrete Paving Units"). The concrete paving units shall be constructed in accordance in accordance with Standard Specification Item No. 485S, "Concrete Paving Units for Sidewalk Ramps) and appropriate City of Austin Standard Details (Standard Details 432S-2A, 432S-3, 432S-3A through 432S-3H, 432S-5, 432S-5A and 432S-5B).

At the proper time after finishing, the surface shall be protected by a membrane, compound curing agent or by wetted cotton or burlap mats, conforming to Item No.409S, "Membrane Curing". The sides of the p.c. concrete shall be cured in the forms. If the forms are removed during the curing process, the curing shall be continued by the placement of fill against the exposed concrete edges or by other procedures conforming to Item No. 410S, "Concrete Structures". The top 4 inches (100 mm) of fill shall be clean topsoil conforming to Item No. 604S, "Seeding for Erosion Control".

Existing sidewalk that is scheduled for removal and replacement shall be removed and the underlying material shaped to the lines, grades and cross section as indicated in the drawings or as directed by the Engineer or designated representative. The removal and/or relocation of obstructions, including but not limited to signs, trash cans and benches on concrete pads, abandoned manholes, sprinkler control valves and landscaping, shall be performed, as indicated on the drawings, in a manner acceptable to the Engineer or designated representative. Removal and/or relocation of obstructions will be considered incidental work to this item and will not be paid for directly.

Existing PVC pipe drains in and behind curb shall be removed and replaced as required in new sidewalk and/or curb and gutter. In areas of proposed sidewalk construction, where curb and gutter is to remain in place, existing PVC pipe shall be cut far enough behind the back of curb to allow sufficient room for joint fittings to connect to new or salvaged PVC pipe.

The Contractor shall be responsible for removing and replacing mailboxes that are located in the construction area, while assuring that mail delivery will not be interrupted as a result of the construction activities. Mailboxes shall not be laid on the ground.

All necessary excavation, filling and grading of the slopes adjacent to the completed concrete sidewalks will be considered incidental work pertaining to this item and will not be paid for directly. The adjacent excavation and grading of the slopes shall be done in a manner acceptable to the Engineer or designated representative.

432S.5 Streetscape Furniture Installation Requirements

A. General General

Bicycle racks, benches and chairs, trash receptacles, tree wells and above grade tree wells and planters shall only be installed in sidewalks that are 12 feet (3.66 meters) or wider. When installation is indicated on the Drawings or directed by the Engineer or designated representative, these items shall be permanently installed as indicated in Standard Details 710S-4 and 710S-5; 432S-9B; 432S-7C, and 432S-7F; and 432S-8B. Above grade tree wells shall be installed in conformance with Standard Detail 432S-7E, while above grade tree planters shall be installed in conformance with Standard Detail Nos. 432S-7D and 432S-7G.

B. Location Requirements

1. Benches.

   Benches shall be placed either perpendicular to the curb with the center of the bench on line with trees and light poles and facing toward the building entry, or parallel to the building and within 6” (150 mm) of the building wall, facing out to the street.

   Bench siting shall be in conformance with Standard Detail No. 432S-9C in 12’ (3.6 M) or wider sidewalks and Standard Detail No. 432S-9D in sidewalks of width between 12’ (3.6 M) and 18’ (5.4 M).

2. Bike Racks.

   Bike racks are to be placed perpendicular to the curb with the centerline of the rack on line with trees and light poles.

   Bike rack siting shall be in conformance with Standard Detail No. 710S-6A in 12’ (3.6 M) or wider sidewalks and Standard Detail No. 710S-6B in sidewalks of width between 12’ (3.6 M) and 18’ (5.4 M).

3. Trash Receptacles.

   Trash receptacles shall either be placed along the curb, with the center line of the receptacle on line with the trees and light poles, or shall be located at the building entry in alignment with the structural bay system of the building. If located at the entry there shall be no more than 1 foot (300 mm) clearance between the receptacle and the building wall.

   Trash receptacle siting adjacent to curb ramps within an intersection shall be in conformance with Standard Detail No. 432S-8C in 12’ (3.6 M) or wider sidewalks.

P432S.6 Pedestrian Railing

When a pedestrian railing installation is required along sidewalks for pedestrian protection as indicated on the Drawings or directed by the Engineer or designated representative, this type of pedestrian railing shall be permanently installed in conformance with one of the following designated Standard Details: 707S-1, 707S-2, 707S-3 or 707S-4.

When a pedestrian railing installation is required along portions of sidewalks identified as ‘ramps’ for ADA accessibility purposes as indicated on the Drawings or directed by the Engineer or designated representative, this type of pedestrian railing shall be permanently installed in conformance with one of the following designated Standard Details: 707S-2, 707S-3 or 707S-4.

432S.7 Measurement

Accepted work performed as prescribed by this item will be measured by the square foot (square meter: 1 square meter is equal to 10.764 square feet) of surface area of "Concrete Sidewalk".

Accepted work performed as prescribed by "Sidewalk Ramps" will be measured per each for the type of ramp indicated on the Drawings.

Accepted work performed as prescribed by "Streetscape Appurtenances" will be measured per each for the type of appurtenance indicated on the Drawings.

Accepted work performed as prescribed by "Pedestrian Railing" will be measured per lineal foot of the type of railing indicated on the Drawings.

432S.8 Payment

The work performed as prescribed by this item for concrete sidewalk will be paid for at the unit bid price per square foot for "Concrete Sidewalk" and/or "Sidewalks Reconstruction"; per each for "Concrete Sidewalk Ramps" and "Streetscape Appurtenances" or per lineal foot for "Pedestrian Railing".

The unit bid price for new sidewalk shall include full compensation for excavating and/or removal and/or relocating obstructions, vegetating adjacent areas disturbed by sidewalk construction, preparing the subgrade; for furnishing and placing all materials including cushion material, all reinforcement, bar supports, joints, expansion joint materials, and for any other materials, manipulations, labor, tools, equipment, finishing, curing and incidentals necessary to complete the work.

The unit bid price for sidewalk reconstruction shall include full compensation for excavating and/or removal of existing sidewalk and other obstructions, relocating obstructions, replacing PVC drain pipe, re-vegetating adjacent areas disturbed by sidewalk construction, preparing the subgrade; for furnishing and placing all materials including cushion material, all reinforcement, bar supports, joints, expansion joint materials, and for any other materials, manipulations, labor, tools, equipment, finishing, curing and incidentals necessary to complete the work.

The unit bid price for ramps shall include full compensation for preparing the subgrade when not included as a separate item; for furnishing and placing all materials, manipulation, labor, tools, equipment and incidentals necessary to complete the work. All necessary excavation, filling and grading of the slopes adjacent to the completed concrete paver units will be included in the unit price bid for the item of construction in which this item is used, unless included as a separate pay item in the Contract bid form.

The unit bid price for streetscape appurtenances shall include full compensation for the individual item (i.e. bench, chair, bicycle rack, trash receptacle, street light or above grade tree planter), as well as the removal of existing sidewalk, preparation of footings, furnishing and placing all materials, manipulation and finishing, labor, tools, equipment and incidentals necessary to complete the work.

The unit bid price for pedestrian railing shall include full compensation for the complete installation of the specific pedestrian railing including but not limited to preparation of footings or curb, furnishing and placing all materials, manipulation and finishing, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under one of the following:

New Sidewalks

Pay Item 432S-4: New P.C. Concrete Sidewalks, 4 Inch thickness Per Square Foot.
Pay Item 432S-5: New P.C. Concrete Sidewalks, 5 Inch thickness Per Square Foot.
Pay Item 432S-6: New P.C. Concrete Sidewalks, 6 Inch thickness Per Square Foot.
Pay Item 432S-7: New P.C. Concrete Sidewalks, 7 Inch thickness Per Square Foot.

Sidewalks Reconstruction

Pay Item 432SR-4: Reconstruct Concrete Sidewalks to 4 Inch thickness, including removal of existing sidewalk Per Square Foot.
Pay Item 432SR-5: Reconstruct Concrete Sidewalks to 5 Inch thickness, including removal of existing sidewalk Per Square Foot.
Pay Item 432SR-6: Reconstruct Concrete Sidewalks to 6 Inch thickness, including removal of existing sidewalk Per Square Foot.
Pay Item 432SR-7: Reconstruct Concrete Sidewalks to 7 Inch thickness, including removal of existing sidewalk Per Square Foot.

Ramps

Pay Item 432S - RP-1: P.C. Sidewalk Curb Ramp with Pavers (Type I) Per Each.
Pay Item 432S-RP-1A: P.C. Sidewalk Curb Ramp with Pavers (Type IA) Per Each.
Pay Item 432S-RP-1B: P.C. Sidewalk Curb Ramp with Pavers (Type IB) Per Each.

Streetscape Appurtenances

Pay Item 432S-SAC-1 Streetscape Bench (____ inches in length) Per Each.
Pay Item 432S-SAC-2 Streetscape Chair Per Each.
Pay Item 432S-SAC-3 Streetscape Bicycle Rack Per Each.
Pay Item 432S-SAC-4 Streetscape Trash Receptacle Per Each.
Pay Item 432S-SAC-5 Streetscape Street Light Per Each.
Pay Item 432S-SAC-7C Streetscape Tree Well for Concrete Sidewalks Per Each.
Pay Item 432S-SAC-7D Streetscape Above Grade Tree Planters with Bench Per Each.
Pay Item 432S-SAC-7E Streetscape Above Grade Tree Well with Seat Per Each.
Pay Item 432S-SAC-7F Streetscape Tree Well without Grate Per Each.
Pay Item 432S-SAC-7G Streetscape Above Grade Galvanized Steel Tree Planters Per Each

Pedestrian Railing

Pay Item 432S-PRC-1 Pedestrian Railing (Standard 707S-1) Per LF.
Pay Item 432S-PRC-2 Pedestrian ADA Railing – Option 1 (Standard 707S-2) Per LF.
Pay Item 432S-PRC-3 Pedestrian ADA Railing – Option 2 (Standard 707S-3) Per LF.
Pay Item 432S-PRC-4 Pedestrian ADA Railing – Option 3 (Standard 707S-4) Per LF.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification 432S, “P. C. Concrete Sidewalks”

City of Austin Standard Specifications

Designation	Description
Item No. 111S	Excavation
Item No. 201S	Subgrade Preparation
Item No. 403S	Concrete for Structures
Item No. 406S	Reinforcing Steel
Item No. 407S	Fibrous Concrete
Item No. 408S	Expansion Joint Materials
Item No. 409S	Membrane Curing
Item No. 410S	Concrete Structures
Item No. 480S	Concrete Paving Unit
Item No. 485S	Concrete Paving Units for Sidewalk Ramps
Item No. 604S	Seeding for Erosion Control

City of Austin Standard Details

Designation	Description
432S-1	Sidewalk
432S-2A	Detectable Warning-Paver
432S-3	Type I Curb Ramps-Full Intersection
432S-3A	Type I Curb Ramps-T Intersection
432S-3B	Type IA/IB Curb Ramps-Full Intersection
432S-3C	Type IA/IB Curb Ramps-T Intersection
432S-3D	Combined Curb Ramps-Full Intersection
432S-3E	Combined Curb Ramps-T Intersection
432S-3F	Combined Sidewalk Curb Ramp with Pavers
432S-3G	Combined Sidewalk Curb Ramp with Pavers within Limited ROW
432S-3H	Type I Curb Ramps within PC/PT of Curb and Gutter
432S-5	Type I Sidewalk Curb Ramp
432S-5A	Type IA Sidewalk Curb Ramp
432S-7C	Tree Well for New Trees Planted Within Concrete Sidewalk 3.6 M (12') or Greater
432S-7D	Above Grade Tree Planters
432S-7E	Above Grade Tree Well with Bench
432S-7F	Tree Well Without Grate
432S-7G	Above Grade Galvanized Steel Tree Planters
432S-8B	Trash Receptacle Installation in Concrete Sidewalk
432A-8C	Furnishing Location in 12' (3.6 M) or greater Trash Receptacle Siting
432S-9B	Bench/Chair Installation in Sidewalks
432S-9C	Furnishing Location in 12' (3.6 M) or greater Sidewalks-Bench Siting
432S-9D	Furnishing Location in Greater than 12' (3.6 M) or Less than 18' (5.4 M) Sidewalks-Bench Siting
707S-1	Pedestrian Railing
707S-2	Pedestrian ADA Railing – Option 1
707S-3	Pedestrian ADA Railing – Option 2
707S-4	Pedestrian ADA Railing – Option 3
710S-4	Bicycle Rack Installation in Concrete Sidewalks (Alternate 1)
710S-5	Bicycle Rack Installation in Concrete Sidewalks (Alternate 2)

710S-6A	Furnishing Location in 12' (3.6 M) or greater Sidewalks-Bicycle Rack Siting
710S-6B	Furnishing Location in Greater than 12' (3.6 M) or Less than 18' (5.4 M) Sidewalks-Bicycle Rack Siting

American Disabilities Act, Federal Register; Volume 56, No. 144; July 26, 1991
ADA Accessibility Guidelines For Building And Facilities

Designation	Description
Section 4.29	Detectable Warnings on Walking Surfaces
Section A4.29.2	Detectable Warnings on Walking Surfaces

Architectural Barriers; Texas Civil Statutes, Article 9102; June 14, 1995
Texas Accessibility Standards (TAS)

Designation	Description
Section 4.29	Detectable Warnings on Walking Surfaces
Section A4.29.2	Detectable Warnings on Walking Surfaces

RELATED CROSS REFERENCE MATERIALS

City of Austin Standard Contract Documents

Designation	Description
00700	General Conditions
01500	Temporary Facilities
01550	Public Safety and Convenience

City of Austin Utilities Criteria Manual

Designation	Description
Section 5.2.3	Utility Adjustments For Roadway Construction Projects

City of Austin Standard Specifications

Designation	Description
Item No. 102S	Clearing and Grubbing
Item No. 104S	Removing Portland Cement Concrete
Item No. 110S	Street Excavation
Item No. 132S	Embankment
Item No. 203S	Lime Treatment for Materials In Place
Item No. 204S	Portland Cement Treatment for Materials In Place
Item No. 230S	Rolling (Flat Wheel)
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 234S	Rolling (Tamping)
Item No. 236S	Rolling (Proof)
Item No. 360S	Concrete Pavement
Item No. 402S	Controlled Low Strength Material
Item No. 404S	Pneumatically Placed Concrete
Item No. 405S	Concrete Admixtures
Item No. 411S	Surface Finishes for Concrete

Item No. 433S
P. C. Concrete Driveways

433S.1 Description

This item shall govern construction of Portland Cement (p.c.) concrete driveways, as herein specified, on an approved subgrade, in conformity with the lines, grades and cross section indicated on the Drawings, identified in Standard Detail Series 433S, or as established by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

433S.2 Submittals

The submittal requirements of this specification item include:

A. Class A and/or Item 360S p.c. concrete mix design,

B. Type of Installation (i.e. Type I, Flared Type I, Type II, etc.) and construction details (i.e. cushion layer, base, reinforcing steel, joints, curing membrane),

C. Identification of the type, source, mixture, Pure Live Seed (PLS) and rate of application of the seeding.

433S.3 Materials

A. Concrete

The Portland Cement Concrete for a Type I driveway (Standards 433S-1 and 433S-1A shall conform to Class A, Section 403S.7 (Table 4) of Standard Specification Item No. 403S, "Concrete for Structures." The Portland Cement Concrete for a Type II driveway (Standard 433S-2) shall conform to a normal concrete mix design for concrete pavement, Section 360S.4(2) of Standard Specification Item No. 360S, "Concrete Pavement".

B. Reinforcing Steel

Reinforcing steel and welded wire fabric shall conform to Standard Specification Item No. 406S, "Reinforcing Steel".

C. Expansion Joint Materials

Expansion joint materials shall conform to Standard Specification Item No. 408S, "Expansion Joint Materials".

D. Membrane Curing Compound

Membrane curing compound shall conform to Standard Specification Item No. 409S, "Membrane Curing".

E. Cushion Layer

The Cushion layer shall consist of crusher screenings, gravel or coarse sand.

433S.4 Construction Methods

All forms and forming, placement of reinforcement, placement of concrete, form removal, finishing and curing shall conform to Standard Specification Item No. 410S, "Concrete Structures".

A. Subgrade Preparation

The subgrade shall be excavated, prepared and shaped to the lines, grades and cross sections indicated on the Drawings or as directed by the Engineer or designated representative. The subgrade shall be thoroughly compacted in accordance with Standard Specification Item No. 201S, "Subgrade Preparation". A 2-inch (50-mm) minimum compacted thickness cushion shall be spread, wetted thoroughly, tamped and leveled. The cushion shall be moist at the time the p.c. concrete is placed.

If the subgrade is undercut or natural ground is located below the top of subgrade, the necessary backfill material shall conform with Standard Specification Item 130S, "Borrow" and shall be compacted with a mechanical tamper. Hand tamping will not be permitted.

Where the subgrade material consists of gravel or includes 70 percent of rock, the 2-inch (50-mm) cushion layer may not be required. The Engineer or designated representative will determine if the subgrade meets the above requirements.

B. Forms

Forms shall be of metal, well-seasoned wood or other approved material of a section satisfactory to the Engineer or designated representative. Wood forms shall not be less than 2 inches (50 mm) nominal thickness for straight runs and 1-inch (25-mm) nominal thickness for curved runs. Forms shall be a section satisfactory to the Engineer or designated representative and clean, straight, free from warp and of a depth equal to the thickness of the finished work.

All forms shall be securely staked to line and grade and maintained in a true position during the placement of p.c. concrete.

C. Joints

Joints shall be of the type and spacing shown on the Drawings. Expansion joint material, 3/4 inch (19 mm) thick, shall be provided where the new construction abuts the existing sidewalks or driveways or as directed by the Engineer or designated representative. The expansion joint material shall be placed vertically and shall extend the full depth of the p.c. concrete. Similar expansion material shall be placed around all obstructions protruding through the driveway. Weakened plane joints shall be located on 10-foot (3-meter) centers or as directed by the Engineer or designated representative. Normal dimensions of the weakened plane groove joints shall be 1/4-inch (6.25-mm) wide and 3/4 inch (19 mm) deep.

D. Reinforcement

Reinforcement for Type I driveways shall consist of 1 layer of 6 x 6 by W 1.4 x W 1.4 (150 x 150 by MW9 x MW9) wire fabric or No. 3 (10 M) bars placed not more than 18 inches (450 mm) on center, both directions. Reinforcement for Type II driveways shall consist of 1 layer of layer of No. 4 (13M) bars placed no more than 18 inches (450 mm) on center, both directions.

All reinforcements shall be accurately placed equidistant from the top and bottom of the p.c. concrete slab and held firmly in place by means of bar supports of adequate strength and number that will prevent displacement and keep the steel at its proper position. In no instance shall the steel be placed directly on the subgrade or sand cushion layer.

Prior to placement of the concrete, the reinforcement installation shall be inspected by the Engineer or designated representative to insure conformance with the drawings, specifications and this item. In addition, care shall be exercised to keep all steel in its proper position during the placement of p.c. concrete. If during placement of the concrete, the reinforcement is observed to loose bar support, float upward or move in any direction, the placement shall be stopped until corrective action is taken.

Splices in wire fabric shall overlap sufficiently to allow two pairs of transverse wires to be tied together and no splice of less than 6 inches (150 mm) will be permitted. Splices in the No. 3 (10 M) and No. 4 (13M) bars shall have a minimum lap of 12 inches (300 mm).

E. P.C. Concrete Placement and Finishing

The p.c. concrete shall be placed in the forms and spaced, tamped and thoroughly compacted until it entirely covers the surface and has a monolithic finish. The top surface shall be floated and troweled to a uniform smooth surface, then finished with a broom or wood float to a gritty texture unless otherwise indicated on the Drawings. The outer edges and joints shall be rounded with approved tools to a 1/4-inch (6.3 mm) radius. Care shall be exercised to prevent loss of dummy joints or rounded edges when applying the broom finish.

F. Curing

At the proper time after finishing, the surface shall be protected by a membrane compound curing agent in conformance with Standard Specification Item No. 409S, "Membrane Curing" or by wetting cotton or burlap mats. Either method shall be subject to approval by the Engineer or designated representative.

Traffic shall be barricaded from using the driveway for a minimum of 4 days after initial placing and may be opened to traffic only with approval of the Engineer or designated representative.

G. Incidental Work

All necessary excavation, filling and grading of the slopes, adjacent to the completed pcc driveways, will be considered incidental work pertaining to this item and will not be paid for directly.

The adjacent excavation and grading of the slopes shall be done with topsoil conforming to Standard Specification Item No. 130S, "Borrow". When turf is to be established, the preparation of the seedbed shall conform to Standard Specification Item No. 604S, "Seeding for Erosion Control", in a manner acceptable to the Engineer or designated representative.

433S.5 Measurement

Accepted work performed as prescribed by this item will be measured by the square foot (square meters: 1 square meter equals 10.764 square feet) of surface area of the specific type of p.c. concrete driveway.

433S.6 Payment

The work performed as prescribed by this item will be paid for at the unit bid price per square foot for "Concrete Driveways". The unit bid price shall include full compensation for preparation of the subgrade; furnishing and placing all materials, including cushion layer, all reinforcing steel, bar supports and expansion joint materials; and any other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

Pay Item No. 433S-A:	Type I P.C. Concrete Driveway	Per Square Foot.
Pay Item No. 433S-B:	Flared Type I P.C. Concrete Driveway	Per Square Foot.
Pay Item No. 433S-C:	Type II P.C. Concrete Driveway	Per Square Foot.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 433S, "P.C. Concrete Driveways"

City of Austin Standard Specifications

Designation	Description
Item No. 130S	Borrow
Item No. 201S	Subgrade Preparation
Item No. 360S	Concrete Pavement
Item No. 403S	Concrete for Structures, Section 403S.7
Item No. 403S	Concrete for Structures, Table 4: Classes of Concrete
Item No. 406S	Reinforcing Steel
Item No. 408S	Expansion Joint Materials
Item No. 409S	Membrane Curing
Item No. 410S	Concrete Structures
Item No. 604S	Seeding for Erosion Control

City of Austin Standard Details

Designation	Description
No. 433S-1	Type I Driveway (1 & 2 Family Residential Use Only)
No. 433S-1A	Flared Type I Driveway (1 & 2 Family Residential Use Only)
No. 433S-2	Type II Driveway

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 433S, "P.C. Concrete Driveways"

City of Austin Standard Specifications

Designation	Description
Item No. 430S	P.C. Concrete Curb and Gutter
Item No. 431S	Machine Laid PCC Curb and Gutter
Item No. 432S	Concrete Sidewalks
Item No. 434S	P.C. Concrete Medians and Islands
Item No. 436S	P.C. Concrete Valley Gutters
Item No. 470S	Curb Cuts for Sidewalk Ramps and Driveways
Item No. 606S	Fertilizer

Item No. 436S
P.C. Concrete Valley Gutters

436S.1 Description

This item shall govern the construction of Portland cement (p. c.) concrete valley gutters on an approved subgrade in conformity to the lines, grades, Standard Detail No. 436S-2 and details indicated on the Drawings or as established by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

436S.2 Submittals

The submittal requirements of this specification item include:

A. Class A p. c. concrete mix design,

B. Construction details (i.e., reinforcing steel, curing membrane, etc.),

436S.3 Materials

A. Portland Cement Concrete

The Portland cement concrete shall be Class A Concrete, Section 403S.7 (Table 4) of Standard Specification Item No. 403S, "Concrete for Structures".

B. Reinforcing Steel

Reinforcing steel and welded wire fabric shall conform to Standard Specification Item No. 406S, "Reinforcing Steel".

C. Expansion Joint Materials

Expansion joint materials shall conform to Standard Specification Item No. 408S, "Expansion Joint Materials".

D. Membrane Curing Compound

Membrane curing compound shall conform to Standard Specification Item No. 409S, "Membrane Curing".

436S.4 Construction Methods

All forms and forming, placement of reinforcement, placement of concrete, form removal, finishing and curing shall conform to Standard Specification Item No. 410S, "Concrete Structures".

A. Subgrade Preparation

Where a stabilized subbase is not provided, the subgrade shall be excavated in accordance with Standard Specification Index No. 111S, "Excavation" to remove all unstable or otherwise objectionable material and all holes, ruts and depressions shall be filled with approved material.

Rolling shall be performed in accordance with Standard Specification Item No. 230S or 232S, to the extent indicated on the Drawings or directed by the Engineer or designated representative. The roadbed shall be completed to the plane of the typical sections indicated on the Drawings and the lines and/or grades established by the Engineer or designated representative. All work shall conform to Standard Specification Item No. 201S, "Subgrade Preparation".

If the subgrade is dry, the valley gutter area shall be sprinkled lightly immediately before the Portland cement concrete is placed.

Unless otherwise specified on the Drawings, all necessary excavation, filling and grading of the subgrade will be considered incidental work pertaining to this item, and will not be paid for directly.

B. Forms

Forms shall be of metal, well-seasoned wood or other approved material. Wood forms for straight sections shall be not less than 2 inches (50 mm) nominal thickness. Forms shall be a section satisfactory to the Engineer or designated representative and clean, straight, free from warp and of a depth equal to the thickness of the finished work. All forms shall be securely staked to line and grade and maintained in a true position during the placement of concrete and, if necessary, forms shall be oiled with a light form oil, prior to placement of p.c. concrete.

C. Reinforcing Steel

Reinforcement for Portland cement concrete valley gutters shall conform to Standard Detail No. 436S-2; details indicated on the Drawings or as directed by the Engineer or designated representative. Care shall be exercised to keep the reinforcement in its proper position during the placement of Portland cement concrete.

D. Joints

Joints shall be of the type and spacing shown on the Drawings. Expansion joint material 3/4 inch (19 mm) thick shall be provided as indicated on the Drawings or as directed by the Engineer or designated representative. The expansion joint material shall be placed vertically and shall extend the full depth of the Portland cement concrete. Weakened plane joints shall be provided on 10 foot (3 meter) centers or as directed by the Engineer or designated representative. Normal dimensions of the weakened plane joints shall be 1/4 inch (6.3 mm) wide and 3/4 inch (19 mm) deep.

E. Placement and Finishing

The Portland cement concrete shall be placed in the forms and properly consolidated until it entirely covers the surface and has a monolithic finish. The top surface shall be screeded and floated to a uniform smooth surface, then finished with a wood float to a gritty texture. The outer edges shall be rounded with approved tools to a 1/4-inch (6.3 mm) radius.

F. Curing

At the proper time after finishing, the surface shall be protected by a membrane-curing compound conforming to Standard Specification Item No. 409S, "Membrane Curing" or by wetting cotton or burlap mats. Either method shall be subject to approval by the Engineer or designated representative. Traffic shall be securely barricaded from using the Portland cement concrete valley gutter for a minimum of 4 days after initial placement and may be opened to traffic only with the approval of the Engineer or designated representative.

436S.5 Measurement

Accepted work performed as prescribed by this item will be measured by the square foot (square meter: 1 square meter equals 10.764 square feet) of surface area of Portland cement concrete placed. The square foot measurement shall include the reinforced monolithic curb placed at the ends of the valley gutter.

436S.6 Payment

The work performed as prescribed by this item will be paid for at the unit bid price per square foot for "P. C. Concrete Valley Gutters". The unit bid price shall include full compensation for preparation the subgrade; furnishing and placing all materials, including reinforcing steel and expansion joint materials; any other materials, manipulations, labor, tools, equipment, barricading and all incidentals necessary to complete the work.

Payment will be made under:

Pay Item No. 436S: P. C. Concrete Valley Gutters Per Square Foot.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 436S, "P.C. Concrete Valley Gutters"

City of Austin Standard Specifications

Designation	Description
Item No. 111S	Excavation
Item No. 201S	Subgrade Preparation
Item No. 230S	Rolling (Flat Wheel)
Item No. 232S	Rolling (Pneumatic)
Item No. 403S	Concrete for Structures
Section 403S.7; Item No. 403S	Table 4: Classes of Concrete
Item No. 406S	Reinforcing Steel
Item No. 408S	Expansion Joint Materials
Item No. 409S	Membrane Curing
Item No. 410S	Concrete Structures

City of Austin Standard Details

Designation	Description
436S-2	P. C. Concrete Valley Gutter

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 436S, "P.C. Concrete Valley Gutters"

City of Austin Standard Specifications

Designation	Description
Item No. 110S	Street Excavation
Item No. 130S	Borrow
Item No. 236S	Proof Rolling
Item No. 360	Concrete Pavement
Item No. 405S	Concrete Admixtures
Item No. 430S	P.C. Concrete Curb and Gutter
Item No. 431S	Machine Laid PCC Curb and Gutter

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Item No. 439S
Parking Lot Bumper Curbs

439S.1 Description

This item shall govern parking lot bumper curbs, composed of precast concrete and reinforcing steel for placement on gravel, asphalt and concrete surfaces as indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

439S.2 Submittals

The submittal requirements of this specification item include:

A. Type A Portland cement concrete design mix.

B. Reinforcing steel details.

439S.3 Materials

A. Concrete. All precast concrete shall be Class A Concrete conforming to Specification Item No. 403S, "Concrete for Structures".

B. Reinforcing Steel. All reinforcing steel shall be #3 (10M) bar conforming to Specification Item No. 406S, "Reinforcing Steel".

439S.4 Construction Methods

All forms and forming, placement of reinforcement, placement of concrete, form removal, finishing and curing shall conform to Specification Item No. 410S, "Concrete Structures".

Reinforcement shall conform to the details indicated on the Drawings. Care shall be exercised to keep reinforcement in its proper position during the depositing of concrete.

Concrete shall be placed in the forms to the depth indicated and vibrated until thoroughly compacted. Care shall be taken during vibration to insure that a vibrator is not held too long at one location that segregation is produced. The top surface of the concrete shall be floated and troweled to a uniform smooth surface, and then finished with a camel hair brush or wood float to a gritty texture. The outer edges shall be rounded with approved tools to the radii shown on the Drawings.

When the ambient air temperature is above 85^{o}F (30^{o}C), an approved retarding agent will be required in all concrete unless moist curing procedures are employed. The maximum temperature of all concrete placed shall not exceed 95^{o}F (35^{o}C).

439S.5 Measurement

Parking Lot Bumper Curbs shall be measured per each, complete and in place.

439S.6 Payment

The work performed as prescribed by this Specification Item will be paid for at the unit bid price per each. The unit bid price shall include full compensation for: all materials, including all reinforcing steel, placing and the concrete curb, and all labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

Pay Item No. 439S: Parking Lot Bumper Curbs - Per Each.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item 439S "Parking Lot Bumper Curbs"

City of Austin Technical Specifications

Designation	Description
Item No. 403S	Concrete for Structures
Item No. 406S	Reinforcing Steel
Item No. 410S	Concrete Structures

RELATED CROSS REFERENCE MATERIALS
Specification Item 439S "Parking Lot Bumper Curbs"

City of Austin Technical Specifications

Designation	Description
Item No. 405S	Concrete Admixtures
Item No. 409S	Membrane Curing
Item No. 411S	Surface Finishes for Concrete

City of Austin Standards

Designation	Description
Item No. 406S-1	Reinforced Steel Tolerances

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item 420	Concrete Structures
Item 421	Portland Cement Concrete
Item 427	Surface Finishes for Concrete
Item 437	Concrete Admixtures
Item 440	Reinforcing Steel

American Society for Testing and Materials

Designation	Description
A-496	Standard Specification for Steel Wire, Deformed for Concrete Reinforcement
A-615/615M	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

Item No. 501S
Jacking or Boring Pipe

501S.1 Description

This item shall govern furnishing and installing of encasement pipe by methods of jacking or boring as indicated on the Drawings and in conformity with this specification. This item shall also include, but not be limited to other constructions activities such as traffic control measures, excavation, removal of all materials encountered in jacking or boring pipe operations, disposal of all material not required in the work, grouting, end seal installation, backfilling and re-vegetation.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

501S.2 Submittals

The submittal requirements for this specification item shall include:

A. Shop drawings identifying proposed jacking or boring method complete in assembled position

B. Excavation Safety Plan including pits, trenches and sheeting or bracing if necessary,

C. Design for jacking or boring head,

D. Installation of jacking or boring supports or back stop,

E. Arrangement and position of jacks and pipe guides, and

F. Grouting plan,

501S.3 Materials

A. Pipe

Carrier pipe and encasement pipe shall conform to Standard Specification Item Nos. 505S, "Concrete Encasement and Encasement Pipe" and 510, "Pipe" and shall be size, type materials, thickness and class indicated on the Drawings, unless otherwise specified.

B. Grout

Grout for void areas shall consist of 1 part Portland cement and 4 parts fine, clean sand mixed with water.

501S.4 Construction Methods

A. General

The Contractor is responsible for:

1. Adequacy of jacking and boring operations,
2. Installation of support systems as indicated on the Drawings,
3. Provision of encasement and carrier pipe, and
4. Execution of work involving the jacking operation, the wet or dry method of boring and the installation of encasement pipe simultaneously.

The Contractor shall have sole responsibility for the safety of the jacking and boring operations and for persons engaged in the work. The Contractor's attention is directed to the Construction Industry Occupational Safety and Health Administration (OSHA) Standards (29 FR 1926/1920) as published in U.S. Department of Labor publication OSHA 2207, latest revision, with particular attention to Subpart S. The Contractor shall conform to the requirements in accordance with Standard Specification Item 509S, "Excavation Safety System" and shall provide an appropriate Trench Safety Plan.

When the grade of the pipe at the jacking or boring end is below the ground surface, suitable pits or trenches shall be excavated to provide sufficient room to conduct the jacking or boring operations and for placement of end joints of the pipe. In order to provide a safe and stable work area, the excavated area shall be securely sheeted and braced to prevent earth caving in accordance with the Trench Safety Plan.

The location of the work pit and associated traffic control measures required for the jacking or boring operations shall conform to the requirements of the City of Austin Transportation Criteria Manual and TxDoT Manual on Uniform Traffic Control Devices.

Where installation of pipe is required under railroad embankments, highways, streets, or other facilities by jacking or boring methods, construction shall be undertaken in such a manner that it will not interfere with operation of any railroad, street, highway, utility or other facility and shall not weaken or damage any embankment or structure. All appropriate permits shall be acquired prior to the initiation of the work.

During construction operations, and until the work pits are backfilled and fill material compacted, traffic barricades and warning lights to safeguard traffic and pedestrians shall be furnished and maintained by the Contractor. The Contractor shall submit the proposed pit location and traffic control plan for review by the Engineer or designated representative. The Review by the Engineer or designated representative, however, will not relieve the Contractor of the responsibility to obtain specified results in a safe, professional manner.

When grade of pipe at jacking or boring end is below ground surface, suitable pits or trenches shall be excavated for the purpose of conducting the jacking or boring operations and for joining pipe. Work shall be securely sheeted and braced as indicated on the Excavation Safety Plan to prevent earth caving and to provide a safe and stable work area.

The pipe shall be jacked or bored from the low or downstream end, if possible. Minor lateral or vertical variation in the final position of pipe from line and grade established by Engineer or designated representative will be permitted at the

discretion of Engineer or designated representative provided that such variation is regular and occurs only in one direction and that the final grade of the flow line conforms to the specified direction.

When conforming to details indicated on the drawings, but the bottom of the work pit is unstable or excessively wet or the installation of water and wastewater pipe will result in less than 30 inches (750 mm) of cover, the Contractor shall notify the Engineer or designated representative. The Engineer or designated representative may require the Contractor to install a concrete seal, cradle, cap or encasement or other appropriate action.

Immediately after jacking or boring is complete and the encasement pipe is accurately positioned and approved for line and grade, the clear space between the pipe and the surrounding excavated material shall be completely filled by pressure grouting for entire length of installation if the encasement pipe is 36 inches or larger in diameter.

After placement of the carrier pipe is complete, the ends of the encasement pipe shall be sealed with end seals meeting SPL WW-575A.

As soon as possible after the carrier pipe(s) and end seals are completed, the work pits or trenches, which are excavated to facilitate these operations, shall be backfilled. The backfill in the street ROW shall be compacted to not less than 95 percent of the maximum density conforming to TxDOT Test Method Tex-114-E, “Laboratory Compaction Characteristics & Moisture-Density Relationship of Subgrade & Embankment Soil”. Field density measurements will be made in accordance with TxDOT Test Method Tex-115-E, “Field Method for Determination of In-Place Density of Soils and Base Materials”.

Where the characteristics of soil, size or size of proposed pipe dictate that tunneling is more satisfactory than jacking or boring, a tunneling method may be submitted for acceptance by Engineer or designated representative

B. Jacking
Heavy duty jacks suitable for forcing the pipe through the embankment shall be provided. In operating the jacks, an even pressure shall be applied to all jacks used so that the pressure will be applied to the pipe uniformly around the ring of the pipe. A suitable jacking frame or back stop shall be provided. The pipe to be jacked shall be set on guides properly braced together, to support the section of the pipe and to direct it in the proper line and grade. The complete jacking assembly shall be placed in order to line up with the direction and grade of the pipe. In general, the embankment material shall be excavated just ahead of the pipe, the material removed through the pipe and the pipe forced through embankment by jacking, into the space thus provided.

The excavation for the underside of the pipe, for at least 1/3 of the circumference of the pipe, shall conform to the contour and grade of the pipe. A clearance of no more than 2 inches (50 mm) may be provided for the upper half of the pipe. This clearance shall be tapered to zero at the point where excavation conforms to contour of pipe.

The distance that excavation shall extend beyond the end of the pipe depends on the character of material encountered, but it shall not exceed 2 feet (0.6 meter) in any case. This distance shall be decreased, when directed by the Engineer or designated representative, if the character of the material being excavated makes it desirable to keep the advance closer to the end of the pipe.

The Contractor may use a cutting edge of steel plate around head end of the pipe extending a short distance beyond the end of pipe with inside angles or lugs to keep cutting edge from slipping back onto the pipe.

When jacking of the pipe is begun, all operations shall be carried on without interruption, insofar as practical, to prevent the pipe from becoming firmly set in the embankment.

Any pipe damaged in jacking operations shall be removed and replaced by the Contractor at its entire expense.

C. Boring

The boring shall proceed from a work pit provided for the boring equipment and workers. Excavation for the work pits and the installation of shoring shall be as outlined in the Trench Safety Plan. The location of the pit shall be approved by the Engineer or designated representative. The boring shall be done mechanically using either a pilot hole or the augur method.

In the pilot hole method an approximate 2 inch (50 mm) pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade on the opposite end of the bore from the work pit. This pilot hole shall serve as the centerline of the larger diameter hole to be bored.

When the augur method is used, a steel encasement pipe of the appropriate diameter equipped with a cutter head to mechanically perform the excavation shall be used. Augurs shall be of sufficient diameter to convey the excavated material to the work pit.

Excavated material will be removed from the working pit and disposed of properly. The use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings. Water jetting will not be permitted.

In unstable soil formations, a gel-forming colloidal drilling fluid, that consists of at least 10 percent of high grade carefully processed bentonite, may be used to consolidate the drill cuttings, seal the walls of the hole and furnish lubrication to facilitate removal of the cuttings from the bore.

D. Tunneling

Where the characteristics of the soil, the size of the proposed pipe, or the use of monolithic sewer would make the use of tunneling more satisfactory than jacking or boring; or when indicated on the drawings, a tunneling method may be used, with the approval of the Engineer or designated representative.

E. Joints
If reinforced concrete pipe is used, the joints shall be in accordance with TxDOT Specification Item 464, “Reinforced Concrete Pipe”.

501S.5 Measurement

Jacking or boring pipe will be measured by the linear foot (meter: 1 meter equals 3.281 feet) of pipe complete in place. Such measurement will be made between the ends of the pipe along the central axis as installed.

501S.6 Payment

The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit bid price per linear foot for "Jacking or Boring Pipe" as the case may be, of type, size and class of encasement pipe indicated on the Drawings. The price shall include full compensation for furnishing, preparing, hauling and installing required materials, encasement pipe, end seals, for grouting and for labor, tools, equipment and incidentals necessary to complete work, including excavation, backfilling and disposal of surplus material.

The Carrier pipe shall be paid at the unit price bid for Standard Specification Item 510, "Pipe".

Payment when included as a contract pay item, will be made under one of the following:

Pay Item No. 501S: Jacking or Boring __ In. Pipe, Class ___ Per Linear Foot.

End

SPECIFIC Cross Reference Materials
Specification Item 501S, "Jacking or Boring Pipe"

City of Austin Standard Specification Items

Designation	Description
Item No. 505S	Concrete Encasement and Encasement Pipe
Item No. 509S	Excavation Safety Systems
Item No. 510	Pipe

TxDOT Standard Specifications For Construction And Maintenance Of Highways, Streets, And Bridges

Designation	Description
Item 464	Reinforced Concrete Pipe

TxDOT Testing Procedures

Designation	Description
Tex-114-E	Laboratory Compaction Characteristics & Moisture Density Relationship of Subgrade & Embankment Soil

Tex-115-E	Field Method for Determination of In-Place Density of Soils and Base Materials

TxDOT Manual on Uniform Traffic Control Devices (MUTCD)

Designation	Description
MUTCD Part VI	Traffic Controls for Street and Highway Construction, Maintenance, Utility and Incident Management Operations
MUTCD Section 6C	Channelizing Devices
MUTCD Section 6C-8	Barricade Design
MUTCD Section 6C-9	Barricade Application
MUTCD Section 6E	Lighting Devices
MUTCD Section 6F	Control of Traffic Through Work Areas

City of Austin Transportation Criteria Manual

Designation	Description
Section 8	Traffic Control
Section 8.5.5.E	Typical Applications/Bore Pits

RELATED Cross Reference Materials
Specification Item 501S, "Jacking or Boring Pipe"

City of Austin Standard Details

Designation	Description
Detail 501S-1	Encasement Detail w/ Casing Spacers

TxDOT Standard Specifications

Designation	Description
Item 476	Jacking, Boring or Tunneling Pipe
Item 502	Barricades, Signs and Traffic Handling

Item No. 503S
Frames, Grates, Rings and Covers

503S.1 Description

This item shall govern furnishing and installation of frames, grates, rings and covers for inlets, manholes and other structures indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

503S.2 Submittals

The submittal requirements of this specification item include manufacturer, model number, description, painting requirements and characteristics of frames, grates, rings, covers, height adjustment insert and nuts and bolts required for completion of the work.

503S.3 Materials

The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation in the Work is the kind and quality that satisfies the specified functions and quality. The City of Austin Water and Wastewater Utility Standard Products Lists (SPLs) form a part of these Specifications. Contractors may, when appropriate, elect to use products from the SPLs; however, submittal to the Engineer or designated representative is still required. If the Contractor elects to use any materials from these lists, each product shall be completely and clearly identified by its corresponding SPL number when making the product submittal.

The purpose of the SPLs is to expedite the review by the Engineer or designated representative and, if necessary, the City of Austin Water and Wastewater Utility Standard Products Committee of Contractor product submittals. The SPL's should not be interpreted as being a pre-approved list of products necessarily meeting the requirements for a given construction Project. Items contained in the SPL cannot be substituted for items that are shown on the Drawings, called for in the specifications, or specified in the Bidding Requirements, Contract Forms and Conditions of Contract, unless approved by the Engineer or designated representative in conjunction with the Water and Wastewater Utility Standard Products Committee. The Standard Product List current at the time of plan approval will govern.

A. Welded Steel

Welded steel grates and frames shall conform to the number; size, dimensions and details indicated on the Drawings and shall be welded into an assembly in accordance with those details. Steel shall conform to the requirements of ASTM A 36/A 36M, "Specification for Structural Steel".

B. Castings

Castings, whether Carbon-Steel, Gray Cast Iron or Ductile Iron shall conform to the shape and dimensions indicated on the Drawings and shall be clean substantial castings, free from sand or blowholes or other defects. Surfaces of the castings shall be free from burnt on sand and shall be reasonably smooth. Runners, risers, fins and other cast on pieces shall be removed from the castings and such areas ground smooth. Bearing surfaces between manhole rings and covers or grates and frames shall be cast or machined with such precision that uniform bearing shall be provided throughout the perimeter area of contact. Pairs of machined castings shall be matchmarked to facilitate subsequent identification at installation with the exception of water and wastewater manhole and valve castings. These manhole and valve castings shall be fabricated with such draft, tolerances, bolt hole spacing, etc., that all rings and covers of a particular type or class are interchangeable and match-marking will not be required.

Steel castings shall conform to ASTM A 27/27M, “Specifications for Steel Castings, Carbon, for General Application”. Grade 70-36 (480-250) shall be furnished unless otherwise specified on the Drawings.

Cast iron castings shall conform to ASTM A 48, “Specification for Gray Iron Castings”, Class 30.

Ductile Iron castings shall conform to ASTM A 536, “Specification for Ductile Iron Castings”. Grade 60-40-18 (415-275-125) shall be used unless otherwise indicated on the Drawings.

C. Manhole Cover Riser Rings

Height-adjustment inserts for wastewater manhole rings, which are used for raising standard manhole covers, shall be those models listed in Water and Wastewater Standard Products List item QPL WW-330.

D. Nuts and Bolts

Nuts and bolts shall be hex head 5/8” x 2.5” (16 mm x 63.5 mm) #11 National Coarse Thread, Type 316 stainless steel. For bolted manhole covers, a thin film of an approved "Anti-freeze" compound, approved by the Engineer or designated representative, shall be applied to all bolts.

E. Mortar

Unless otherwise specified or approved by the Engineer or designated representative, the mortar for bedding castings shall consist of one (1) part Portland cement and three (3) parts sand and sufficient water to provide the desired consistency. The gradation of the fine aggregate shall meet the requirements for Grade No. 1, Item No. 403, "Concrete for Structures".

503S.4 Construction Methods

Frames, grates, rings and covers shall be constructed of the specified materials in accordance with the details indicated on the Drawings or in the City of Austin Standard

Details. The Frames, grates, rings and covers shall be placed carefully to the lines or grades indicated on the Drawings or as directed by the Engineer or designated representative.

All welding shall conform to the requirements of the ANSI/AWS Structural Welding Code D1.1. Welded frames, grates, rings and covers shall be given 1 coat of a commercial grade red lead oil paint and 2 coats of commercial grade aluminum paint. All coats shall be a minimum of 1.5 mils (0.4 mm), dry.

Painting of gray iron castings will not be required, except when used in conjunction with structural steel shapes.

503S.5 Measurement and Payment

Frames, grates, rings and covers will not be measured and payment for furnishing all materials, tools, equipment, labor and incidentals to complete the Work will be included in the Bid Items which constitute the complete structures.

End

SPECIFIED Cross Reference Materials
Standard Specification Item Number 503S, "Frames, Grates, Rings and Covers"

City of Austin Standard Specifications

Designation	Description
Item No. 403S	Concrete for Structures

City of Austin Water and Wastewater Standard Products List

Designation	Description
QPL WW-330	Manhole Cover Riser Rings for raising City of Austin Standard Manhole Covers

American Society for Testing Materials (ASTM)

Designation	Description
A36/A36M	Specification for Structural Steel
A27/A27M	Specification for Steel Castings, Carbon, for General Application
A48	Specification for Gray Iron Castings
A536	Specification for Ductile Iron Castings

ANSI/AWS

Designation	Description
Code D 1.1	Structural Welding Code

RELATED Cross Reference Materials
Standard Specification Item Number 503S, "Frames, Grates, Rings and Covers"

City of Austin Standard Specifications

Designation	Description
Item No. 504S	Adjusting Structures
Item No. 510	Pipe

City of Austin Standard Details

Designation	Description
No. 503S-1	457mm (18") Cover and Frame
No. 503S-2S	Storm Sewer Manhole Ring and 610 mm (24") Cover
No. 503S-2W	Sanitary Sewer Manhole Ring and 610 mm (24") Cover
No. 503S-3S	Bolted Storm Sewer Manhole Ring and 610 mm (24") Cover
No. 503S-3W	Bolted Sanitary Sewer Manhole Ring and 610 mm (24") Cover
No. 503S-4S	Storm Sewer Manhole Ring and 813 mm (32") Cover
No. 503S-4W	Sanitary Sewer Manhole Ring and 813 mm (32") Cover
No. 503S-5S	Bolted Storm Sewer Manhole Ring and 813 mm (32") Cover
No. 503S-5W	Watertight Manhole Ring and 813 mm (32") Cover
No. 506S-2	Major Manhole Adjustment
No. 506S-11	Storm Sewer Manhole Details

TxDOT Specifications

Designation	Description
Item 421	Portland Cement Concrete

Item No. 504S
Adjusting Structures

504S.1 Description

This item shall govern the removal and replacement of surfacing, furnishing of materials, adjusting and/or repositioning existing structures, valve boxes, pull boxes, survey monument boxes and water meters in accordance with these specifications to the locations or elevations indicated on the Drawings or as directed by the Engineer or designated representative. This item shall also govern any pumping, bailing and drainage required to complete the Work and Standard Specification Item No. 509S, "Excavation Safety Systems" for trench walls when indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text the inch-pound units are given preference followed by SI units shown within parentheses

504S.2 Submittals

The submittal requirements of this specification item include:

A. Aggregate type, gradations and physical characteristics for the Portland cement concrete mix.

B. Proposed proportioning of materials for the mortar mix.

C. Type structures and proposed adjustment technique (lowering, raising, lateral displacement).

D. Type structure, repair technique and materials to be furnished (new replacement or reuse of existing) Type of mixing plant and associated equipage including chart indicating the calibration of each cold bin

504S.3 Materials

Precast reinforced concrete rings and castings in good condition, which are removed from the structures to be adjusted, may be reused with the written approval of the Engineer or designated representative. Additional materials required shall conform to the details indicated on the Drawings.

A. Portland Cement Concrete

The Portland cement concrete shall be Class A conforming to Standard Specification Item No. 403S, "Concrete for Structures".

B. Mortar

Unless otherwise specified or approved by the Engineer or designated representative, the mortar for bedding castings shall consist of one (1) part Portland cement and three (3) parts sand, by volume based on dry materials. Sufficient water will be added to provide the desired consistency. The gradation of the fine aggregate shall meet the requirements for "Fine Aggregate" as given in Standard Specification Item No. 403S, "Concrete for Structures".

504S.4 Construction Methods

All adjustments shall be completed prior to the placement of the final surface.

Pull box and valve box components scheduled for reuse shall be carefully removed and the contact areas shall be cleaned of all mortar, concrete, grease and sealing compounds. Any items broken in the process of removal and cleaning shall be replaced in kind by the Contractor at its own expense.

If the adjustment involves slight lowering or raising a valve box or survey monument box, the outside shell of a slip or screw casing shall be excavated to its full length and adjusted to the proposed grade. Pipe castings shall be excavated to the depth required to cut from or weld a section to the casing as may be needed to adjust the ring to the proposed elevation. The ring shall be welded to the casing prior to pouring concrete around the casing.

If the adjustment involves a vertical (lowering or raising) or a horizontal reassignment of a water meter and the property owner's cut off valve, this work shall be completed in accordance with Standard Installation Details included in the City of Austin Standard Details Series (501S-1, 504S-3, 511S-13A, 511S-13B, etc.).

After the adjustments have been completed and cured, structures within the paved area shall be paved as indicated on the Drawings.

504S.5 Measurement

The work performed and materials furnished as prescribed by this item as indicated shall be measured per each.

504S.6 Payment

The work performed, materials furnished and measures as provided above, will be paid by the unit bid price per each. The price shall include full compensation for furnishing all materials, handling, placing, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under one of the following:

Pay Item No. 504S-1WM:	Adjusting Water Meters -	Per Each
Pay Item No. 504S-1RM:	Repositioning & Adjusting Water Meters -	Per Each
Pay Item No. 504S-3G:	Adjusting Gas Valve Boxes to Grade -	Per Each
Pay Item No. 504S-3S:	Adjusting Survey Monument Boxes to Grade -	Per Each
Pay Item No. 504S-3W:	Adjusting Water Valve Boxes to Grade -	Per Each
Pay Item No. 504S-4PB:	Adjusting Pull Boxes to Grade -	Per Each

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification 504S, “Adjusting Structures”

City of Austin Standard Specifications

Designation	Description
Item No. 403S	Concrete for Structures
Item No. 509S	Excavation Safety Systems

City of Austin Standard Details

Designation	Description
No. 501S-1	Encasement Detail W/ Casing Spacers
No. 504S-3	Gas Valve Casing Adjustment
No. 511S-13A	Water Valve Box Adjustment to Grade w/ Full Depth Concrete
No. 511S-13B	Water Valve Box Adjustment to Grade w/ Concrete and HMAC

RELATED CROSS REFERENCE MATERIALS
Specification 504S, “Adjusting Structures”

City of Austin Standard Specifications

Designation	Description
Item No. 501S	Jacking or Boring
Item No. 503S	Frames, Grates, Rings and Covers
Item No. 505S	Concrete Encasement and Encasement Pipe
Item No. 507S	Bulkheads
Item No. 508S	Miscellaneous Structures and Appurtenances
Item No. 511S	Water Valves

City of Austin Standard Details

Designation	Description
No. 1100S-1	Casting Adjustment
No. 725S-1	Monument, Type A Survey Identification Marker
No. 725S-2	Monument, Type B Survey Identification Marker
No. 725S-3	Monument, Type C Survey Identification Marker
No. 725S-7	Survey Identification Marker Non-Traffic Construction Detail
No. 725S-10	Survey Identification Marker Roadway Construction Detail
No. 725S-11	Adjustable Valve Box For Survey Monument

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No.421	Portland Cement Concrete

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Item No. 505S
Concrete Encasement and Encasement Pipe

505S.1 Description

This item shall govern the furnishing of materials and the methods of constructing a Portland cement concrete encasement or encasement pipe in a trench.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

505S.2 Submittals

The submittal requirements of this specification item include:

A. Type, of pipe, construction methods and sequence,

B. Aggregate types, gradations and physical characteristics for the Portland cement concrete mix,

C. Proposed proportioning of materials for the mortar mix.

505S.3 Materials

A. Portland Cement Concrete

The Portland cement concrete shall conform to Class D Concrete, Item No. 403S, "Concrete for Structures".

B. Pipe

Portland Cement concrete pipe shall conform to ASTM C-76, Class III or better.

Corrugated Metal Pipe (CMP) shall conform to Section 510.2 (8) (o) of the City of Austin Standard Specification Item No. 510, "Pipe".

Steel Pipe shall conform to ASTM A134 with a minimum thickness of 3/8 inch (9.5 mm) for pipe with a diameter of 16 inches (400 mm) and greater.

C. Grout

Grout shall consist of not less than 6 sacks Portland cement per cubic yard (335 kilograms Portland cement per cubic meter) and clean washed sand mixed with water. The grout shall have a consistency such that the grout will flow into and completely fill all voids. If allowed by the Engineer or designated representative, an air entraining admixture may be added to facilitate placement.

505S.4 Construction Methods

When indicated on the Drawings or acceptable to Engineer or designated representative, concrete encasement shall be placed to protect the pipe. Pipe or bedding shall not be placed where:

(a) the top of the pipe would have less than 30 inches (750 mm) of cover from finish grade,

(b) the ground water invades the trench, or

(c) the trench bottom is of unstable material.

If either of these conditions is encountered, the Engineer or designated representative shall be notified and may direct the Contractor to:

(a) encase the pipe with concrete,

(b) change pipe material, or

(c) use a higher strength class of pipe.

Concrete encasement shall extend from 6 inches (150 mm) below to 6 inches (150 mm) above the outer projections of the pipe over the entire width of the trench in accordance with the City of Austin Standard Detail 501S-1," Encasement Detail w/ Casing Spacers".

The ends of the encasement pipe shall be bulkheaded (Standard Specification Item No. 507S) with concrete blocks, bricks or stones, dry-stacked without mortar, sufficient to prevent the intrusion of trench backfill material into the encasement, but fitted loosely enough to facilitate the escape of water from the encasement should carrier pipe leakage or failure occur.

505S. 5 Measurement

Concrete encasement will be measured by the lineal foot (meter: 1 meter equals 3.281 feet), for size of pipe being encased, complete in place. The measurement will be made between ends of the encasement, along the central axis as installed.

Encasement pipe installed by open cut will be measured by size of encasement installed, complete in place. The measurement will be made between the ends of the pipe, along the central axis as installed.

505S.6 Payment

Work performed and materials furnished as prescribed by this item will be included in a unit price bid item from Standard Specification Item No. 510, "Pipe" unless included as a separate pay item in the contract.

When included for payment, it shall be measured as provided under "Measurement" and will be paid at the unit bid price per lineal foot for "Concrete Encasement" or "Encasement Pipe" of the size indicated on the Drawings. The unit bid price shall include full compensation for furnishing all materials, pipe for all preparation, hauling, installation and for all labor, tools, equipment and incidentals necessary to complete the work, including bench excavation and disposal of surplus material.

Payment, when included as a contract Pay Item, will be made under one of the following:

Pay Item No. 505*S*-A:	Concrete Encasement for ___ Dia. Pipe -	Per Lineal Foot.
Pay Item No. 505*S*-B:	Encasement Pipe ___ Dia., Type ___, -	Per Lineal Foot.

End

SPECIFIC Cross Reference Materials
Standard Specification Item No. 505S, “Encasement and Encasement Pipe"

City of Austin Standard Specification Items

Designation	Description
Item 403S	Concrete For Structures
Item 507S	Bulkheads
Item 510	Pipe
Section 510.2(8)(o)	Corrugated Metal Pipe (CMP)

City of Austin Standard Details

Designation	Description
Detail 501S-1	Encasement Detail w/ Casing Spacers

American Society for Testing and Materials (ASTM)

Designation	Description
A-134	Specification for Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS 16 and Over)
C-76/C-76M	Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

RELATED Cross Reference Materials
Standard Specification Item No. 505S, “Encasement and Encasement Pipe"

TxDOT Specifications

Designation	Description
Item 421	Portland Cement Concrete
Section 421.9	Quality of Concrete
Section 421.2(8)	Mortar and Grout

City of Austin Standard Specification Items

Designation	Description
Item No. 501S	Jacking or Boring Pipe
Item No. 506	Manholes
Section 510.2(8)(c)	Concrete pipe
Section 510.2(8)(m)	Steel Pipe
Item No. 593S	Concrete Retards

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ITEM NO. 506 MANHOLES 2-22-21

506.1 Description

This item governs construction of pre-cast and cast-in-place wastewater manholes, storm water manholes, storm water junction boxes and cast-in-place wastewater junction boxes, complete in place, including excavation, installation, backfilling and surface restoration; required items including rings, covers, coatings, and appurtenances; and incidental work such as pumping and drainage necessary to complete the work. Contractor-performed acceptance testing is required for wastewater manholes.

Source: Rule No. R161-21.08 , 2-22-2021.

506.2 Qualifications

Applicators of coatings to the interior surfaces of wastewater manholes, as specified in 506.4.R and 506.5.J, shall be listed on Austin Water (AW) Standard Products List (SPL) WW-511. Individual(s) setting up and operating equipment to core through the walls of existing manholes or junction boxes shall have experience in coring similar size holes through the walls of similar size and type structures on at least ten projects (or 15 manholes) in AW's jurisdiction.

Source: Rule No. R161-21.08 , 2-22-2021.

506.3 Project Submittals

A. Products and Materials

The Contractor shall submit descriptive information and evidence that the materials the Contractor proposes for incorporation in the Work are of the kind and quality that satisfy the requirements in the Contract Documents. AW shall be included in all submittal review. The AW SPLs are considered a part of the Specifications for the Work. The Contractor shall use products from the SPLs for all water and wastewater construction unless alternative products are shown on the Drawings; called for in the specifications; or specified in the Bidding Requirements, Contract Forms and Conditions of the Contract.

The products included in the SPLs current at the time of plan approval shall govern; unless a specific product or products on the lists have subsequently been removed from those SPLs because of quality or performance issues. Products and materials that are not covered by SPLs shall meet the requirements in the contract documents.

Submittals for the products and materials covered by this specification shall include manufacturer catalog sheets, technical data sheets, shop drawings, product or material test results, requirements listed below, and any other information needed to adequately describe the product or material. For products covered by SPLs, the submittal shall include a copy of the applicable SPL with the proposed product identified. An SPL by itself is not considered an adequate submittal.

The submittal requirements of this specification item include:

1. For pre-cast manholes and junction boxes: shop drawings for each structure showing, at a minimum, the Project and Contractor's name: manufacturer's name and plant location; applicable specifications; list of materials (such as adjusting rings, boots, gaskets, and pre-cast sections) by type and quantity; elevation view showing diameter or size, ring and cover size and elevation, ring type (bolted or unbolted, flared top or flared bottom) wall thickness, elevations of transitions from large diameter

sections to smaller diameter sections, base width and thickness, total depth, size of openings, reinforcement, and length of each pre-cast section; structure identification number and station location; pipe line identification; pipe material and size; pipe flowline elevations; plan view showing azimuthal orientation (based on 360 degrees clockwise) of the pipes relative to the outflow pipe; technical data sheets covering pipe-to-manhole or pipe-to-junction box connectors, and gaskets.

2. For cast-in-place manholes and junction boxes: formwork drawings sealed by a registered Professional Engineer licensed in the State of Texas with documented experience in formwork design for wall pours that exceed 4 feet in height and slabs that are not ground supported.

3. For hydraulic cement concrete; mix components and proportions, material sources, materials test results.

4. For mortar: mix components and proportions, material sources, materials test results.

5. For non-shrink grout: technical data sheet indicating ASTM type and containing instructions on surface preparation, mixing, placing, and curing procedures.

6. For wastewater manhole coatings and linings: technical data sheets that include instructions on surface preparation, mixing, placing, and curing procedures; technical data sheets for coating thickness measuring equipment and for holiday detection test equipment.

7. For connections to existing manholes or junction boxes: details showing the size, location, and method of removal of the wall section, including any temporary supports attached to the manhole or junction box wall; details showing the location of existing joints, other connecting pipes, and other features that penetrate or attach to the wall; and technical data sheets covering the pipe-to-manhole or pipe-to-junction box connectors.

B. Acceptance Test Records

Submittal of acceptance test records is required for wastewater manholes and shall include as a minimum the following items:

Name of the manhole manufacturer.

Interior surface coating type and application method.

Model and manufacturer of vacuum tester.

Date tested/date re-tested.

Indication of whether test passed or failed and statement of corrective action taken if test failed.

Test Method Used.

Location/station of manhole.

Type of base: Precast/cast-in-place.

Type of repairs made to the joints.

The test records shall also be included as part of the Project records turned in with the acceptance package.

C. Installation

The Contractor shall submit evidence that the individual(s) setting up the equipment and coring through the walls of manholes and junction boxes are experienced with the equipment and procedures and have successfully cored through the same types of materials using the same types of equipment.

Source: Rule No. R161-21.08 , 2-22-2021.

506.4 Materials

A. Concrete

All cast-in-place concrete shall conform to City of Austin (COA) Standard Specification Item No. 403S, "Concrete for Structures." Cast in place concrete shall be Class A or as specified on the Drawings. Concrete used in precast concrete manhole base sections, riser sections and appurtenances shall conform to the requirements of Texas Department of Transportation Item 421, Hydraulic Cement Concrete. Concrete for backfill of over-excavated areas shall be COA Class A, or Class J (COA Standard Specification Item 403S, Concrete For Structures) or Controlled Low Strength Material (COA Standard Specification Item 402S) as indicated on the Drawings.

B. Mortar

Mortar shall be composed of one part Portland cement, one part masonry cement (or ¼ part hydrated lime), and sand equal to 2½ to 3 times the sum of the volumes of the cements and lime used. The sand shall meet the requirements for "Fine Aggregate" as given in Standard Specification Item No. 403S "Concrete For Structures." Mortar shall not be used for any purpose on the inside of wastewater manholes.

C. Grout

Grout shall be the non-shrink type conforming to ASTM C 1107, Packaged, Dry, Hydraulic Cement Grout (Nonshrink), Grade C. Grout shall be used as packaged, with the mixed ingredients requiring only the addition of water.

D. Reinforcement

The reinforcing steel shall conform to the requirements of Standard Specification Item No. 406S, "Reinforcing Steel." Secondary, non-structural steel in cast-in-place stormwater manholes may be replaced by collated fibrillated polypropylene fibers, if approved by the Engineer or designated representative.

E. Brick

The brick for ring adjustment courses and for stormwater manholes shall be of first quality, sound, hard burned, perfectly shaped brick conforming to the requirements of ASTM C 62, Grade SW, or concrete brick meeting the requirements of ASTM C 55, Grade N-1. Use of brick to construct any part of wastewater manholes is prohibited.

F. Rings and Covers

Rings and covers shall conform to the requirements of COA Standard Specification Item No. 503, "Frames, Grates, Rings and Covers."

1. Replacement Rings and Covers, 24-inch Diameter Lids

   This ring and cover shall be used for the replacement of broken rings and covers, minor manhole adjustment, or as otherwise directed by the Engineer or designated representative.

2. Rings and Covers, 32-inch Diameter Lids

   This ring and cover shall be used for all new manhole construction, except as otherwise directed by the Engineer or designated representative.

G. Bulkheads

Bulkheads shall meet the requirements of COA Standard Specification Item No. 507 "Bulkheads."

H. Precast Base Sections, Riser Sections, Flat-top Slabs and Cones

Precast concrete base sections, riser sections, flat-top slabs, and cones shall conform to the requirements of ASTM C 478. The width of the invert shall be specifically sized for the connecting pipes. Inverts shall be "U" shaped channels. The channel depth at the point where a pipe connects to the manhole wall, for pipes 24 inches in diameter and smaller, shall be a minimum of three-fourths of the diameter of the pipe, with the top of the channel being a smooth transition between the inlet and outlet pipe connection points. For manholes connecting to pipes larger than 24 inches in diameter, the channel depth at the point where a pipe connects to the manhole wall shall be at least equal to the full pipe diameter. Changes in flow direction in the inverts of manholes shall be made by constructing smooth, long-radius sweeps to minimize splashing, turbulence, and eddies. The manhole invert grade shall 1) be a continuation of the inlet and outlet pipe grades carried through to the centerline of the manhole, or 2) have a minimum slope of 2.5 percent between the inlet and outlet pipe inverts, or 3) have a minimum difference of 0.10 feet between the inlet and outlet pipe inverts, whichever provides the maximum difference in invert elevation between the inlet and outlet pipes, 4) have a straight section of invert that is 4 to 6 inches in length to transition between the curved portion of the invert channel and the connecting pipes in order to accommodate the mandrel apparatus for up to 15-inch dimeter pipes. In all cases, the bottom(s) of the channel(s) shall provide a smooth transition between the inlet and outlet pipes. Where wastewater lines enter a manhole above the flowline of the outlet, the invert shall be filleted to prevent splashing and solids deposition.

Joints for wastewater base sections, riser sections, and cones shall conform to the requirements of ASTM C 443. Additionally, joint dimensions for 48-inch inside diameter wastewater manhole sections and cones shall comply with the "Wedge Seal Offset Joint Detail, Precast Manhole Section", located in SPL WW-146. Joint dimensions for wastewater manhole sections and cones larger than 48-inch inside diameter shall comply with COA Standard No. 506S-12, "O-Ring Joint Detail Precast Manhole Section" or "Wedge Seal Offset Joint Detail, Precast Manhole Section", located in SPL WW-146. Precast bases for 48-inch inside diameter manholes shall have preformed inverts. Inserts acceptable to the Engineer or designated representative shall be embedded in the concrete wall of the manhole sections to facilitate handling; however, through-wall holes for lifting will not be permitted.

I. Precast Junction Boxes

Precast junction boxes shall conform to the requirements of ASTM C913 and shall be allowed only where indicated on the Drawings or acceptable to the Engineer or designated representative.

J. Pipe-to-Manhole and Pipe-to-Junction-Box Connectors

Resilient connectors, ring waterstops, and seals at connections of wastewater pipes to pre-cast and cast-in-place manholes and junction boxes shall be watertight, flexible, resilient and non-corrosive, conforming to ASTM C 923. Metallic mechanical devices for securing the connectors, ring waterstops, and seals in place shall be Type 304 stainless steel.

K. Precast Flat-Slab Transition/Junction Box Lids

Precast slab transitions and lids shall be designed to safely resist pressures resulting from loads which might result from any combination of forces imposed by an HS-20 loading as defined by the American Association of State Highway and Transportation Officials (AASHTO). The joints of precast slab transitions and of lids for wastewater applications shall conform to the requirements of ASTM C443.

L. Precast-Prefabricated Tee Manholes

Tee manholes shall be allowed only where indicated on the Drawings or as directed by the Engineer or designated representative. The main pipe section shall conform to the requirements of COA Standard Specification Item No. 510, "Pipe." The vertical manhole portion (tee) above the main pipe shall conform to the requirements of the precast components.

The manhole tee shall have a minimum inside diameter of 48 inches and shall rise vertically centered or tangent to the main pipe, as indicated on the Drawings or as directed by the Engineer or designated

representative. An access hole less than 48 inches in diameter shall be cut into the main pipe to allow a ledge for support of access ladders. Unless otherwise specified on the Drawings, the main pipe portion of the tee manhole shall be included in the unit price bid for the unit tee manhole price.

M. Precast Grade Rings

Rings shall be reinforced Class A concrete

1. Precast Grade Rings, 24½ inches Inside Diameter

This adjustment ring shall be used only for adjusting existing manholes with 24-inch diameter lids and for Wastewater Access Device. Inside to outside diameter dimension of ring shall be 6 inches with a thickness of 3 to 6 inches.

2. Precast Grade Rings, 35 inches Inside Diameter

This adjustment ring shall be used for all new manhole construction with 32-inch diameter lids. Inside to outside diameter dimension of ring shall be 6 inches with a thickness of 2 to 6 inches.

N. High Density Polyethylene Grade Rings

Plastic grade (adjusting) rings shall be injection molded from high density polyethylene identified according to ASTM D4976. Reprocessable and recyclable ethylene plastic materials are allowed. Manufacturers of HDPE adjusting rings shall be listed on SPL WW-146G.

O. Controlled Low Strength Material

Controlled low strength material (CLSM) shall meet Standard Specification Item 402S, Controlled Low Strength Material.

P. Cement Stabilized Sand

Cement stabilized sand for bedding or backfilling shall contain 2 bags of Portland cement per cubic yard. The sand shall meet the requirements for "Fine Aggregate" in Standard Specification Item 403S, "Concrete for Structures."

Q. Waterproofing Joint Materials

O-rings and wedge seals for the joints of all wastewater manholes, and for stormwater manholes when indicated on the Drawings, shall conform to the requirements of ASTM C443. Cold applied preformed plastic gaskets for stormwater manholes shall be as specified in City of Austin Standard Specification Item No. 510, "Pipe." Plastic seals wrapped around manholes at joints, and hydrophillic waterstops installed in joints, shall be listed on SPL WW-146A. PVC waterstops installed in joints and waterproofing compounds applied to the exterior surfaces of manholes and junction boxes shall be as specified in the Contract Documents.

R. Interior Surface Coatings for Wastewater Manholes

Interior surface coatings for wastewater manholes shall be either: as specified on the Drawings, as designated in writing by the Engineer or designated representative, or as included on SPL WW-511, which lists acceptable products, uses and applicators.

S. Structural Lining Systems for Wastewater Manholes

Structural lining systems for wastewater manholes shall be either: as specified on the Drawings, as designated in writing by the Engineer or designated representative, or as included on SPL WW-511A.

Source: Rule No. R161-21.08 , 2-22-2021.

506.5 Construction

A. General

Pipe ends within the base section or junction box walls shall not be relied upon to support overlying manhole dead and live load weights. All wastewater branch connections to new or existing mains shall be made at manholes, with the branch pipe crown installed at an elevation no lower than the elevation of the effluent pipe crown. Changes in flow direction in the inverts shall be made by constructing smooth, long-radius sweeps to minimize splashing, turbulence, and eddies. Where wastewater lines enter the manhole up to 24 inches above the flowline of the outlet, the invert shall be sloped upward in a U-shaped channel three-fourths of the diameter of the incoming pipe to receive the flow, thus preventing splashing or solids deposition. A drop pipe shall be provided for a wastewater pipe entering a manhole whenever the invert cannot be constructed to prevent splashing and solids deposition. Construction of extensions to existing systems shall require placement of bulkheads at locations indicated or directed by the Engineer or designated representative.

Unless otherwise indicated on the Drawings, stormwater manholes shall have eccentric cones and wastewater manholes shall have concentric cones, except on manholes over large mains where an eccentric cone shall be situated to provide access to an invert ledge. Eccentric cones may be used where conflicts with other utilities dictate. Flat-slab tops may be used only where clearance problems are encountered or where specified on the Drawings. Cast-in-place wastewater junction boxes shall be allowed only where indicated on the Drawings or where accepted by the Engineer or designated representative.

B. Foundation Support

Manholes shall be founded at the established elevations on uniformly stable subgrade. Unstable subgrade shall be over-excavated a minimum of 12 inches and replaced with a material acceptable to the Engineer or designated representative. Precast base units shall be founded and leveled on a 6-inch thick layer of coarse aggregate bedding. A pipe section with a prefabricated tee manhole and half the length of the adjoining pipe sections on each side shall be founded on a minimum 6-inch thick layer of unreinforced Class A concrete (COA Standard Specification Item No. 403S, "Concrete For Structures"). The cast-in-place concrete cradle shall be placed against undisturbed trench walls up to the pipe's springline.

C. Cast-in-Place Concrete

Structural concrete work shall conform to Standard Specification Item No. 410S, "Concrete Structures." Forms shall be used for all slabs that are not ground supported and for all vertical surfaces above the foundation level. Formwork shall be designed according to American Concrete Institute ACI 347, Guide to Formwork for Concrete. Outside forms on vertical surfaces may be omitted where concrete can be cast against the surrounding earthen material that can be trimmed to a smooth vertical face.

D. Manhole Bases

Pre-cast bases shall conform to requirements in 506.4.H.

Cast-in-place bases shall have a minimum thickness of 12 inches at the invert flowline. The widths of all manhole inverts shall be specifically sized for the connecting pipes. Inverts shall be "U" shaped channels. The channel depth at the point where a pipe connects to the manhole wall, for pipes 24 inches in diameter and smaller, shall be a minimum of three-fourths of the pipe diameter, with the top of the channel being a smooth transition between the inlet and outlet pipe connection points. For manholes connecting to pipes greater than 24 inches in diameter, the channel depth at the point where a pipe connects to the manhole wall shall be equal to the full pipe diameter. The manhole invert grade shall 1) be a continuation of the inlet and outlet pipe grades carried through to the centerline of the manhole, or 2) have a minimum slope of 2.5 percent between the inlet and outlet pipe inverts, or 3) have a minimum difference of 0.10 feet between the

inlet and outlet pipe inverts, whichever provides the maximum difference in invert elevation between the inlet and outlet pipes, 4) have a straight section of invert that is 4 to 6 inches in length to transition between the curved portion of the invert channel and the connecting pipes in order to accommodate the mandrel apparatus for up to 15-inch dimeter pipes. In all cases, the bottom(s) of the channel(s) shall provide a smooth transition between the inlet and outlet pipes. Changes in flow direction in the inverts of manholes shall be made by constructing smooth, large-radius sweeps to prevent splashing, turbulence, and eddies. The lowermost riser section may be set in the Portland cement concrete, while still plastic, after which the base shall be cured a minimum of 24 hours prior to proceeding with construction of the manhole up to 12 feet in depth. The base shall be cured an additional 24 hours prior to continuing construction above the 12-foot level.

Wastewater manholes having cast-in-place bases may be constructed over existing wastewater pipes and the top half of the pipe removed to facilitate invert construction, except where the existing pipe is PVC, in which case, the entire pipe shall be removed from inside the manhole. The manhole floor shall rise outwardly from the springline elevation of the pipe, approximately one inch for each 12 inches of run (8 percent slope). The floors of stormwater manholes, also, shall rise outwardly from the springline elevation of the pipe, approximately one inch for each 12 inches of run (8 percent slope).

Wastewater manholes with lines larger than 18 inches shall require pre-cast bases; manholes constructed over in-service mains however, may be built on cast-in-place bases if the flow cannot be interrupted.

E. Pipe Connections to New Manholes and Junctions Boxes

Wastewater pipe connections to new manholes and junction boxes shall be made using flexible, resilient, and non-corrosive watertight boot connectors or ring waterstops acceptable to the Engineer and conforming to the requirements of ASTM C-923. Any voids in the annular space between the pipe and boot connector or ring waterstop and the inside of the manhole wall shall be filled with non-shrink grout to prevent solids collection. New precast manholes and manholes with cast-in-place bases shall have holes for pipe penetrations in the manhole wall separated by a minimum of 7 inches, designed by the manhole manufacturer and as measured from the inside diameter of the cored or formed holes on the inside wall of the manhole to ensure the structural integrity of the manhole wall.

F. Pipe Connections to Existing Manholes and Junction Boxes

Wastewater pipe connections to existing manholes and junction boxes shall be made by removing the wall section by coring; installing flexible, resilient, and non-corrosive boot connectors or ring waterstops acceptable to the Engineer and conforming to the requirements of ASTM C-923; filling any voids in the annular space between the pipe and boot connector or ring waterstop and the inside of the manhole or junction box wall with non-shrink grout; rebuilding the invert to conform to Section 506.5.D; rehabilitating the interior walls with structural lining material listed on SPL WW-511A, and coating the interior of the manhole with material listed on SPL WW-511. Connections to existing manholes and junction boxes shall be made at locations that allow the removal limits of the wall section to be no closer than 12 inches to the inside diameter of the nearest existing connecting pipe. Equipment used to remove the wall section shall be operated in a manner that does not damage the adjacent interior coating, substrate, or wall. This includes installation of anchors or other supports that are attached to the manhole or junction box wall for temporary support of the removal equipment.

G. Waterproofing

PVC waterstops, hydrophillic waterstops, joint wrapping, and waterproofing compounds shall be installed as specified. Material wrapped around manholes at joints shall be listed on SPL WW-146A regardless of whether installation of the material is required by the Contract for waterproofing or is volunteered by the Contractor for ensuring acceptance of the manhole joints.

H. Backfilling

Backfilling of manholes shall conform to the density requirements of COA Standard Specification Item No. 510, "Pipe." Manhole construction in roadways may be staged to facilitate pavement base construction. Manholes constructed to interim elevations to facilitate interim construction shall be covered with steel plates that conform to the requirements of COA Standard 804S-4, sheets 5, 6 and 7, Steel Plating. Steel plates on wastewater manholes shall be set in mortar to minimize inflow of storm water runoff. Manholes shall be completed to finish elevation prior to placement of the roadway's finish surface except on pavement reconstruction projects, where castings may be adjusted after paving is completed. The excavation for completion of manhole construction shall be backfilled in accordance with COA Standards for Trench Repair.

I. Height Adjustment of Manholes

1. General

All adjustments shall be completed prior to the placement of the final roadway surface except on pavement reconstruction projects, where castings may be adjusted after paving is completed.

Brick shall not be used in making height adjustments to wastewater manholes. Mortar shall not be used for any purpose on the inside of wastewater manholes.

Manhole components to be reused shall be carefully removed and the contact areas shall be cleaned of all mortar, concrete, grease and sealing compounds. Any items broken in the process of removal and cleaning shall be replaced in kind by the Contractor at its expense.

If the adjustment involves lowering the top of a manhole, a sufficient depth of pre-cast concrete rings or brick courses shall be removed to permit reconstruction. Existing mortar shall be cleaned from the top surface remaining in place and from all brick or concrete rings to be reused and the manhole rebuilt to the required elevation. The manhole ring and cover shall then be installed with the top surface conforming to the proposed grade.

If the adjustment involves raising the elevation of the top of the manhole in accordance with "Minor Manhole Height Adjustment," the top of brick or concrete ring shall be cleaned and built up vertically to the new elevation, using new or salvaged concrete rings or bricks and the ring and cover installed with the top surface conforming to the proposed grade.

After rings and covers are set to grade, the inside and outside of the precast concrete grade rings shall be wiped with non-shrink grout to form a durable surface and water-tight joints. The grouted surface shall be smooth and even with the manhole cone section. Grout shall not be placed when the atmospheric temperature is at or below 40°F. If a sudden drop in temperature below 40°F occurs or temperatures below 40°F are predicted, the grouted surfaces shall be protected against freezing for at least 24 hours.

2. Minor Manhole Height Adjustment (New and Existing Manholes)

Minor manhole height adjustments shall be performed as indicated on COA Standard 506S-4, "Minor Manhole Height Adjustment", and shall consist of adding precast reinforced concrete rings to adjust new and existing manholes to final grade. Brick shall not be used in making height adjustments to wastewater manholes.

If the adjustment involves raising the elevation of the top of the manhole, the top of brick or concrete ring shall be cleaned and built up vertically to the new elevation, using new or salvaged concrete rings or bricks and the ring and cover installed with the top surface conforming to the proposed grade.

For new manhole construction, the maximum allowable throat or chimney height, including the depth of the ring casting, shall be limited to 21 inches of vertical face on the interior surface. For adjustments of existing manholes that fall within the limits of overlay and street reconstruction projects, the maximum vertical allowable height, including the depth of the ring casting, shall be limited to 27 inches of vertical face on the interior surface. All other existing manholes shall have a maximum allowable

throat or chimney height adjustment, including the depth of the ring casting, of 12 inches of vertical face on the interior surface. Any adjustment that will exceed these requirements shall be accomplished as indicated on COA Standard 506S-2, "Major Manhole Height Adjustment" and as described below. Manholes not located in paved areas shall have bolted covers. Manholes located within paved areas (street right-of-way only) shall be standard non-bolted unless otherwise noted on the drawings.

3. Major Manhole Height Adjustment (Existing Manholes Only)

   Any adjustment that exceeds the requirements of Minor Manhole Adjustments, shall be accomplished as indicated on COA Standard 506S-2, "Major Manhole Height Adjustment," and shall consist of any combination of removing and replacing the concrete rings, and/or the manhole cone section, and/or the straight riser section of the manhole in order to bring the manhole to final grade. Major manhole adjustments shall apply only to existing manholes. Manholes not located in paved areas shall have bolted covers. Manholes located within paved areas (street right-of-way only) shall be standard non-bolted unless otherwise noted on the drawings.

J. Interior Coatings of Wastewater Manholes and Junction Boxes

The interior surfaces of all Portland cement concrete wastewater manholes and junction boxes shall be coated with products specified either on the Drawings, designated in writing by the Engineer or representative, or listed on SPL WW-511. Product selection shall conform to usage described in that SPL. Surface preparation shall follow the product manufacturer's recommended procedures contained in technical data sheets unless otherwise specified in the contract documents. The Contractor shall measure the coating thickness according to ASTM D 6132, Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Over Concrete Using an Ultrasonic Gage. Thickness measures shall be made at locations designated by the Engineer or designated representative. All thickness measurements shall be witnessed by the Engineer or designated representative.

The contractor shall test for discontinuities (holidays) in each new layer of interior organic coating applied to wastewater manholes and junction boxes. The test methods and equipment shall confirm to ASTM D4787, Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrate. Each new layer of applied coating shall be tested to detect pinholes, voids, cracks, thin spots, and foreign inclusions. All discontinuity testing shall be performed using high-voltage, pulse-type equipment and witnessed by the Engineer or designated representative. The test voltage shall depend on the coating thickness according to the tabulated values in ASTM D4787. Test voltages for common coating thicknesses are as follow:

Coating or Lining Thickness, Mils	Test Voltage
20	2700
40	5500
80	11500
120	16500

K. Structural Linings of Existing Wastewater Manholes

The interior surfaces of existing wastewater manholes and junction boxes at locations shown in the Drawings or as designated by the Engineer shall be strengthened by application of structural lining systems either as specified on the Drawings, directed in writing by the Engineer or designated representative, or listed on SPL WW-511A. Selection of products for coating the interior of existing manholes shall be based on the condition of the manholes. Surface preparation shall follow the product manufacturer's recommended procedures contained in technical data sheets unless otherwise specified in the contract documents.

L. Abandonment of Existing Manholes

Manholes designated on the Drawings for abandonment, shall be removed to a level not less than four feet below grade. Two-foot long sections of the inlet and outlet pipes shall be cut and removed on the outside of the manhole, the ends of the remaining pipe and the pipe sections penetrating the manhole wall shall be securely plugged, and the structure filled with material in accordance with COA Standard 506S-15 or as directed by the Engineer or designated representative.

Source: Rule No. R161-21.08 , 2-22-2021.

506.6 Acceptance Testing of Wastewater Manholes

Manholes shall be tested separately and independently of the wastewater lines.

A. Test by the Vacuum Method

A vacuum test shall be performed by the Contractor prior to backfilling those manholes that fall within the right-of-way that require detouring of vehicular traffic. A second vacuum test will not be required after backfilling and compaction is complete unless there is evidence that the manhole has been damaged or disturbed subsequent to the initial vacuum test.

For manhole installations which do not require detouring of vehicular traffic, the vacuum method is recommended and may be used by the Contractor prior to backfilling the manhole to insure proper installation so that defects may be located and repaired; however, a vacuum test shall be performed after backfilling, and compaction are complete. Testing after backfill and compaction are complete will be the basis for acceptance of the manhole.

1. Equipment

    a) The manhole vacuum tester shall be a device approved for use by the Engineer or designated representative.

    b) Pipe sealing plugs shall have a load resisting capacity equal to or greater than that required for the size of the connected pipe to be sealed.

    c) Gauges shall be calibrated and read in inches of mercury (inches Hg or in Hg) or pounds per square inch gauge (psig) or both.

2. Procedures applicable to new 48-inch diameter manholes

    a) Manhole section interiors shall be carefully inspected; units found to have through-wall lift holes, or any penetration of the interior surface by inserts provided to facilitate handling, will not be accepted. Coating shall be applied after the testing unless coating is applied before installation or unless it is applied at the factory. All lift holes and exterior joints shall be plugged with an acceptable non-shrink grout. No grout shall be placed in horizontal joints. Tests shall be performed before grouting the invert or around pipe penetrations and before coating the interior surfaces of the manhole or junction box.

    b) After cleaning the interior surfaces of the manhole, the Contractor shall place and inflate pneumatic plugs in all of the connecting pipes to isolate the manhole; sealing pressure within the plugs shall be as recommended by the plug manufacturer. Plugs and the ends of pipes connected by flexible boots shall be blocked to prevent their movement during the vacuum test.

    c) The vacuum test head shall be placed on the top of the cone section or, inside of the top of the manhole cone section, and the compression seal band inflated to the pressure recommended by its manufacturer. The vacuum pump shall be connected to the outlet port with the valve open. When a vacuum of 10 inches of mercury (-10" Hg) (-5 psig) has been attained, the valve shall be closed and the time noted. Tampering with the test equipment will not be allowed.

d) The manhole shall have passed the test if the vacuum does not drop below 9 inches of mercury (-9" Hg) (-4.5 psig) within 3 minutes of the time the valve was closed. The actual vacuum shall be recorded at the end of the 3 minutes during which the valve was closed.

e) When the standard vacuum test cannot be performed because of design or material constraints (examples: T-Type manholes, T-Lock Liners, or other reasons acceptable to the Engineer or designated representative), testing of individual joints shall be performed as directed by the Engineer or designated representative.

B. Test by the Exfiltration Method

At the discretion of the Engineer or designated representative, the Contractor may substitute the Exfiltration Method of testing for the Vacuum test described in Section 506.6.A. above. This method may only be used when ground water is not present. If ground water is present a Vacuum Test shall be used unless otherwise directed by the Engineer or designated representative. All backfilling and compaction shall be completed prior to the commencement of testing.

The procedures for the test shall include the following:

1. Manhole section interiors shall be carefully inspected; units found to have through-wall lift holes, or any penetration of the interior surface by inserts provided to facilitate handling, will not be accepted. Coating shall be applied after the testing unless coating is applied before field assembly, or at the factory. All lift holes and exterior joints shall be plugged with an acceptable non-shrink grout. No grout shall be placed in horizontal joints. Tests shall be performed before grouting the invert or around pipe penetrations and before coating the interior surfaces of the manhole or junction box.
2. After cleaning the interior surface of the manhole, the Contractor shall place and inflate pneumatic plugs in all of the connecting pipes to isolate the manhole; sealing pressure within the plugs shall be as recommended by the plug manufacturer.
3. Concrete manholes shall be filled with water or otherwise thoroughly wetted for a period of 24 hours prior to testing.
4. At the start of the test, the manhole shall be filled to the top with water. The test time shall be 1 hour. The Construction Inspector must be present for observation during the entire time of the test. Permissible loss of water in the 1-hour test time is 0.025 gallons per diameter foot, per foot of manhole depth. For a 4-foot diameter manhole, this quantity converts to a maximum permissible drop in the water level (from the top of the manhole cone) of 0.1 inches per foot of manhole depth or 1.0 inch for a 10-foot deep manhole.

C. Failure to Pass the Test - Records of Tests

If the manhole fails to pass the initial test method as described in (A) Test by the Vacuum Method and, if allowed, (B) Test by the Exfiltration Method, or if visible groundwater leakage into the manhole is observed, the Contractor shall locate the leak, if necessary by disassembly of the manhole. The Contractor shall check the gaskets and replace them if necessary. The Contractor may re-lubricate the joints and re-assemble the manhole, or the Contractor may install an acceptable exterior joint sealing product (see AW Standard Products List Item SPL WW-146A) on all joints and then retest the manhole. If any manhole fails the vacuum and/or exfiltration test twice, the Contractor shall consider replacing that manhole. If the Contractor chooses to attempt to repair that manhole, the manhole must be retested until it passes. In no case shall cold applied preformed plastic gaskets be used for repair. Records of all manhole testing shall be made available to the Engineer or designated representative at the close of each working day, or as otherwise directed by the Engineer or designated representative. Any damaged or visually defective products, or any products out of acceptable tolerance shall be removed from the site.

D. Inspection

The Engineer or designated representative shall make a visual inspection of each manhole after it has passed the testing requirements and is considered to be in its final condition. The inspection shall determine the completeness of the manhole; any defects shall be corrected to the satisfaction of Engineer or designated representative.

Source: Rule No. R161-21.08 , 2-22-2021.

506.7 Measurement

A "Junction Box" and "Box Manholes" will be measured by each structure of the indicated size regardless of depth.

A "Standard Pre-cast Manhole with Pre-cast Base", "Standard Pre-cast Manhole with Cast-in-Place (CIP) Base", "Special Manhole", "Drop Manhole with Pre-cast Base", "Drop Manhole with Cast-in-Place (CIP) Base", "Centered Tee Manhole", or "Tangent Tee Manhole" will be measured by each structure of the indicated size for the first 8 feet of depth.

An "Extra Depth Manhole" will be measured by linear vertical foot of Standard Pre-cast Manhole with Pre-cast Base, Standard Pre-cast Manhole with CIP Base, Drop Manhole with Pre-cast Base, Drop Manhole with CIP Base, Special Manhole, Centered Tee Manhole, or Tangent Tee Manhole of the indicated size in excess of eight feet of depth. Manhole depth will be measured from the invert flow line to the finished surface elevation.

"Minor Manhole Height Adjustment" and "Major Manhole Height Adjustment" will be measured by each unit for the indicated size. Only existing manholes will be measured for minor or major manhole height adjustment.

"Connection to Existing Manhole or Junction Box" will be measured per each for the indicated type of structure and location.

"Structural Lining" will be measured by the linear vertical foot for the indicated structure.

New manholes constructed to interim elevations to facilitate stage construction shall be measured as one unit regardless of the number of interim elevations constructed. All labor, materials and other expenses necessary for the stage construction shall be included in the unit price bid for the completed unit. Cost of abandonment of existing manholes shall be included in the unit price bid for the completed unit, unless Pay Item No. 506 AB is indicated on the Drawings and identified in Standard Contract Bid Form 00300U.

Source: Rule No. R161-21.08 , 2-22-2021.

506.8 Payment

Payment for completed junction boxes and manholes of the type indicated on the Drawings shall be made at the appropriate unit bid price. The unit bid price shall include all labor, equipment, materials, (including but not limited to frames and grates, rings and covers, adjusting rings, cone sections, riser sections, gaskets, drop piping and fittings, bases, pipe-to-manhole connectors, concrete, reinforcing steel, non-shrink grout, mortar, joint wrap where specified, and, for wastewater manholes, interior coatings), time and incidentals necessary to complete the work.

Payment for a "Junction Box" and "Box Manhole" will be made at the unit price bid for the indicated size, complete in place.

Payment for the first 8 feet of a "Standard Pre-cast Manhole with Pre-cast Base", "Standard Pre-cast Manhole with Cast-in-Place (CIP) Base", "Special Manhole", "Drop Manhole with Pre-cast Base", "Drop Manhole with Cast-in-Place (CIP) Base", "Centered Tee Manhole", or "Tangent Tee Manhole" will be made at the unit price bid for the indicated type and size, complete in place.

Payment for that portion of a Standard Pre-cast Manhole with Pre-cast Base, Standard Pre-cast Manhole with CIP Base, Drop Manhole with Pre-cast Base, Drop Manhole with CIP Base, Special Manhole, Centered Tee Manhole, or

Tangent Tee Manhole in excess of 8 feet in depth will be made at the unit price bid for "Extra Depth Manhole" of the indicated type and size, complete in place.

Payment for "Minor Manhole Height Adjustment" and "Major Manhole Height Adjustment" will be made at the unit bid price, complete in place.

Payment for "Structural Lining" will be made at the unit price per linear vertical foot, which will include surface preparation, environmental adjustments, lining application, and curing, as required.

Payment for "Connection to Existing Manhole or Junction Box" shall be made at the unit price per connection and will include removing the wall section by coring or alternative method approved by the Engineer or designated representative, rehabilitating the interior walls, rebuilding the invert, and preparing and coating the interior surfaces of the structure.

When indicated in the Drawings, abandonment of existing manholes shall be made at the unit price for abandonment.

The intended use of each item shall be designated by a two-letter code (Wastewater = WW; Stormwater = SW) in the spaces provided after the pay item number:

Pay Item No. 506 M___:	Standard Pre-cast Manhole w/Pre-cast Base, ___ Dia.	Per Each.
Pay Item No. 506 M1___:	Standard Pre-Cast Manhole w/CIP Base, ___ Dia.	Per Each.
Pay Item No. 506 S___:	Special Manhole, ___ Dia.	Per Each.
Pay Item No. 506 D___:	Drop Manhole w/Pre-cast Base, ___ Dia.	Per Each.
Pay Item No. 506 D1___:	Drop Manhole w/CIP Base, ___ Dia.	Per Each.
Pay Item No. 506 C___:	Centered Tee Manhole, ___ Dia. × ___ Dia.	Per Each.
Pay Item No. 506 T___:	Tangent Tee Manhole, ___ Dia. × ___ Dia.	Per Each.
Pay Item No. 506 J___:	Junction Box, ___ Ft. × ___ Ft.	Per Each.
Pay Item No. 506 B___:	Box Manhole ___ Ft. × ___ Ft.	Per Each.
Pay Item No. 506 2___:	Major Manhole Height Adjustment, ___ Dia.	Per Each.
Pay Item No. 506 4___:	Minor Manhole Height Adjustment, ___ Dia.	Per Each.
Pay Item No. 506 AB___:	Abandonment of existing Manholes:	Per Each.
Pay Item No. 506 EDM___	Extra Depth of Manhole, ___ Dia.	Per Linear Vert. Foot.
Pay Item No. 506 SL___:	Structural Lining of ___:	Per Linear Vert. Foot.
Pay Item No. 506 CN___:	Connection to Existing ___:	Per Each.

End

SPECIFIC CROSS REFERENCE MATERIALS	
Standard Specification Item No. 506, "Manholes"	
COA Standard Specifications Items	
Designation	Description
Item 402S	Controlled Low Strength Material
Item 403S	Concrete For Structures
Item 406S	Reinforcing Steel
Item 410S	Concrete Structures
Item 503	Frames, Grates, Rings and Covers
Item 504	Adjusting Structures
Item 507	Bulkheads
Item 510	Pipe
Texas Department of Transportation Standard Specifications For Construction and Maintenance of Highways, Streets and Bridges	
Designation	Description
Item 421	Hydraulic Cement Concrete
COA Utilities Criteria Manual	
Designation	Description
Section 2.8.0	Abandonment of Facilities
Subsection 2.9.4.D	Manholes
AW Standard Products Lists	
Designation	Description
SPL WW-146	Concrete Manhole Sections
SPL WW-146A	Manhole Seals
SPL WW-146G	Manhole Grade Rings, Plastic
SPL WW-511	Organic Lining for Wastewater Manholes
SPL WW-511A	Structural Lining for Wastewater Manholes
COA Standard Details	
Designation	Description
506S-2	Major Manhole Height Adjustment
506S-4	Minor Manhole Height Adjustment
506S-15	Abandoned Manhole
506S-12	O-Ring Joint Detail, Precast Manhole Section
506S-15	Abandoned Manhole
804S-4, 5, 6 and 7 of 9	Steel Plating
COA Standard Contract	
Designation	Description
00300U	Bid Form (Unit Prices)
American Society for Testing and Materials (ASTM)	
Designation	Description

ASTM C 55	Specification for Concrete Building Brick
Designation	Description
ASTM C 62	Specification for Building Brick Solid Masonry Units Made from Clay of Shale
ASTM C478/C478M	Standard Specification for Precast Concrete Manhole
ASTM C443/C443M	Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C923/C923M	Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures Pipes
ASTM C1107	Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D4787	Continuity Verification of Liquid or Sheet Lining Applied to Concrete Substrate
ASTM D4976	Specification for Polyethylene Plastics Molding and Extrusion Materials
ASTM D6132	Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coating Over Concrete Using an Ultrasonic Gage
American Concrete Institute	
Designation	Description
Item 347	Guide to Formwork for Concrete

RELATED CROSS REFERENCE MATERIALS	
Standard Specification Item No. 506, "Manholes"	
AW Standard Products Lists	
SPL WW-219	32 Inch Manhole Cover Casting Sets
COA Utilities Criteria Manual	
Designation	Description
Section 2	Water, Reclaimed Water and Wastewater Criteria
COA Standards	
Designation	Description
1100S-1	Casting Adjustments
503S-4S	Storm Sewer Manhole Ring and 32” Cover
503S-5S	Bolted Storm Sewer Manhole Ring and 32” Cover
506S-1	Manhole Invert Plan
506S-5	Typical Box Manhole 30” and Larger Pipe
506S-7	Precast Manhole with Drop Inlet on Cast in Place Foundation
506S-8	Precast Manhole with Drop Inlet on Precast Base
506S-9	Precast Manhole on Cast-In-Place Foundation
506S-10	Wastewater Manhole on Precast Base
506S-11	Storm Sewer Manhole Details
American Association of State Highway and Transportation Officials (AASHTO)	
Designation	Description
M306	Standard Specifications for Drainage Structure Castings

Source: Rule No. R161-21.08 , 2-22-2021.

Item No. 508S
Miscellaneous Structures and Appurtenances

508S.1 Description

This item governs the construction of miscellaneous structures and appurtenances, complete in place or to the stage detailed and/or indicated in the Drawings, using the materials specified herein, including the excavation, installation, backfilling, placement of the concrete and when required, the furnishing and installation of frames, grates, rings, covers, safety end treatment and any concrete curb and gutter indicated on the Drawings.

This specification is applicable for projects or work involving either SI or inch-pound units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses

508S.2 Submittals

The submittal requirements of this specification item include:

A. Type of structure and appurtenances (inlets, headwalls, frames, grates, energy dissipators, etc.), construction methods and sequence (precast, cast in place), materials (bolts, nuts, plates, angles, etc.)

B. Aggregate types, gradations and physical characteristics for the Portland cement concrete mix.

C. Proposed proportioning of materials for the mortar mix.

D. Analysis and thickness calculations for temporary steel covers.

508S.3 Types

The various types of structures and appurtenances such as inlets, headwalls, energy dissipators, etc., are designated on the Drawings by letter or by number for the particular design of structure to be constructed in accordance with the details indicated on the Drawings. Unless otherwise indicated on the Drawings, the Contractor may have the option of furnishing cast in place or precast structures.

508S.4 Materials

A. Portland Cement Concrete

The Portland cement concrete shall conform to Item No. 403S, "Concrete For Structures", with the following classes:

Cast in Place Concrete	Class A
Precast Concrete	Class C

B. Mortar

Mortar shall be composed of 1 part Portland cement and 2 parts clean, sharp mortar sand suitably graded for the purpose by conforming in other respects to the provisions

of Standard Specification Item No. 403S, "Concrete for Structures" for fine aggregate. Hydrated lime or lime putty may be added to the mix, but in no case shall it exceed 10 percent by weight (mass) of the total dry mix.

C. Reinforcement and Steel

Reinforcing Steel shall conform to Standard Specification Item No. 406S,"Reinforcing Steel".

Structural Steel shall conform to Standard Specification Item No. 720S, "Metal for Structures".

D. Frames, Grates, Rings and Covers

Frames, grates, rings and covers shall conform to City of Austin Standard Specification Item No. 503S, “Frames, Grates, Rings and Covers".

E. Safety End Treatment for Structures

The safety end treatment for structures shall conform to TxDOT Specification Item No. 467, “Safety End Treatment”.

1. Bolts and Nuts. All bolts, nuts and associated hardware shall meet the specifications of ASTM A 307.
2. Plates and Angles. All plates and similar angles and brackets shall meet the specifications of ASTM A 36.
3. Pipe Runners. Pipe Runners shall conform to the requirements of ASTM A53, Grade B.
4. Galvanizing. All hardware including nuts, bolts and plates listed above shall be galvanized conforming to ASTM A 123 or A 153.

F. Miscellaneous Items

Cast iron for supports, steps and inlet units shall conform to the shape and dimensions indicated on the Drawings. The casting shall be clean and perfect, free from sand or blowholes or other defects. Cast iron castings shall meet the requirements of ASTM A 48, Class 30. Steel for temporary covers when used with stage construction shall be adequate for the loads imposed.

508S.5 Construction Methods

All concrete work shall be performed in accordance with Standard Specification Item No.410S, "Concrete Structures". Forms will be required for all cast-in-place concrete walls, except where the nature of the surrounding material is such that it can be trimmed to a smooth vertical face (the outside form for concrete bases). Where cast in place concrete is used in wall construction of storm sewers, the steps shall be cast into the wall when the concrete is placed.

The construction inlets shall be completed, as soon as is practicable after installation is complete of the sewer lines in the inlet. All sewer line shall be cut neatly at the inside face of the walls of the inlet and pointed up with mortar.

Bases for cast in place inlets may be placed prior to or at the Contractor's option after the sewer is constructed.

Bases for box sewers shall be cast as an integral part of the sewer. The manholes may be constructed prior to backfilling or if the Contractor so elects, the manhole opening may be covered temporarily with a steel plate to facilitate the compaction of backfill for the sewer as a whole. Thereafter, required excavation for the inlet shall be made and the inlet constructed and backfilled.

The inverts passing out or through an inlet shall be shaped and grouted across the floor of the inlet as indicated on the Drawings. This shaping may be accomplished by adding shaping mortar or concrete after the base is cast or by placing the required additional material with the base.

All miscellaneous structures shall be completed in accordance with the details indicated on the Drawings. Backfilling to original ground elevation shall be in accordance with the provisions of the appropriate items and as directed by the Engineer or designated representative.

Energy dissipators and headwalls shall be constructed in accordance with City of Austin Standard Detail 508S-13.

508S.6 Measurement

All miscellaneous structures and safety end treatments satisfactorily completed as indicated on the Drawings will be measured as completed units per each.

Concrete removal, excavation and backfill, riprap, pipe, headwalls, wing walls, collars and apron slabs will not be measured under this item but will be included in the unit price bid for the item of construction in which this item is used.

Frames, grates, rings, covers, safety end treatment and any concrete curb and gutter indicated will not be measured and paid for but shall be included in the unit price bid of one of the pay items identified in the contract bid form.

508S.7 Payment

A . Inlets

Payment for Inlets of the type indicated in place in accordance with these specifications and measured as prescribed above will be made at the unit bid price for each Inlet, of the type specified.

B. Energy Dissipators and Headwalls

Payment for special complete structures will be made at the unit price bid per each.

C Safety End Treatment

Payment for Safety End Treatment, complete in place, will be made at the unit bid price for each unit of the type indicated on the Drawings.

Payment will be made under one of the following:

Pay Item No. 508S-E:	Energy Dissipators, _____ In. Dia. -	Per Each.
Pay Item No. 508S-H:	Headwalls, Type _____, ___ In. Dia. Pipe -	Per Each.
Pay Item No. 508S-IG:	Inlet, Grated -	Per Each.
Pay Item No. 508S-SET	Safety End Treatment, Type ___ Size ___	Per Each
Pay Item No. 508S-I5R:	Inlet, Recessed -	Per Each.
Pay Item No. 508S-I10R:	Inlet, Recessed -	Per Each.
Pay Item No. 508S-I15R:	Inlet, Recessed -	Per Each.
Pay Item No. 508S-I20R:	Inlet, Recessed -	Per Each.
Pay Item No. 508S-I5S:	Inlet, Recessed -	Per Each.
Pay Item No. 508S-I10S:	Inlet, Standard -	Per Each.
Pay Item No. 508S-I15S:	Inlet, Standard -	Per Each.
Pay Item No. 508S-I20S:	Inlet, Standard -	Per Each.

End

SPECIFIED Cross Reference Materials
Standard Specification Item No. 508S, "Miscellaneous Structures and Appurtenances"

City of Austin Standard Specification Items

Designation	Description
Item No. 403S	Concrete For Structures
Item No. 406	Reinforcing Steel
Item No. 410	Concrete Structures
Item No. 720	Structural Steel
Item No. 503S	Frames, Grates, Rings and Covers

TxDOT Standard Specifications For Construction And Maintenance Of Highways, Streets, And Bridges

Designation	Description
Item 467	Safety End Treatment

American Society for Testing and Materials (ASTM)

Designation	Description
ASTM A36/36M	Specification for Structural Steel
ASTM A48	Specification for Gray Iron Castings
ASTM A53	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
ASTM A123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	Specifications for Carbon Steel Externally Threaded Standard Fasteners
ASTM C913	Specifications for Precast Concrete Water and Wastewater Structures

RELATED Cross Reference Materials

City of Austin Drainage Criteria Manual

Designation	Description
Section 6.6.0	Energy Dissipators

City of Austin Standard Specification Items

Designation	Description
Item No. 501S	Jacking or Boring Pipe
Item No. 504S	Adjusting Structures
Item No. 506	Manholes
Item No. 507S	Bulkheads
Item No. 510	Pipe

City of Austin Standard Details

Designation	Description
508S-13	Standard Headwall and Energy Dissipators
510S-1	Concrete Trench Cap

TxDOT Specifications

Designation	Description
Item 420	Concrete Structures
Item 421	Portland Cement Concrete
Section 421.2(5)	Fine Aggregate
Item 424	Precast Concrete Structures (Fabrication)
Item 440	Reinforcing Steel
Item 466	Headwalls and Wingwalls
Item 467	Safety End Treatment
Item 471	Frames, Grates, Rings and Covers
Item 529	Concrete Curb, Gutter and Combined Curb and Gutter

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Item No. 509S
Excavation Safety Systems

509S.1 Description

This item shall govern the designing, furnishing, installing, maintaining and removing or abandoning of temporary Excavation Safety Systems consisting of trench shields, aluminum hydraulic shoring, timber shoring, trench jacks, tieback or braced sheeting, tieback slurry walls, soil nailing, rock bolting, tieback or braced soldier piles and lagging, and other systems for protecting workers in excavations. This item shall also govern the designing and constructing of sloping and benching systems for protecting workers in excavations.

At a minimum, the Excavation Safety Systems shall conform to United States Department of Labor Rules 29 CFR, Occupational Safety and Health Administration, Part 1926 Safety and Health Regulations for Construction, Subpart P, Excavation (hereinafter called OSHA).

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

509S.2 Definitions

"Competent Person" shall mean one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. The competent person shall be capable of interpreting the manufacturer’s data sheets and interpreting and implementing the Excavation Safety System Plan.

An "Excavation" shall mean any cut, cavity, trench, or depression in an earth surface, formed by earth removed by the Contractor. The Contractor shall provide an Excavation Safety System for all excavations except when 1) the excavation is in stable rock as determined by the Texas-licensed Professional Engineer who prepared the Contractor’s Excavation Safety System Plan or 2) the excavation is less than 5 feet (1.52 m) in depth and examination of the ground by the Contractor’s competent person provides no indication of a potential cave-in.

"Trench" (trench excavation) shall mean any narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth shall be greater than the width, but the width of a trench (measured at the bottom) shall not be greater than 15 feet (4.56 m). Excavation Safety Systems for such trenches shall be defined as "Trench Excavation Safety Protective Systems".

If the Contractor installs or constructs forms or other structures in an excavation such that the dimension measured from the forms or structures to the sides of the excavation is reduced to 15 feet (4.6 m) or less (measured at the bottom of the excavation), those excavations shall also be defined as a Trench if workers must enter it. Excavation Safety Systems for such trenches shall also be defined as "Trench Excavation Safety Protective Systems".

509S.3 Excavation Safety System Submittals

A. The Notice to Proceed with construction may be issued by the Owner before the Contractor has submitted the necessary Excavation Safety Plan(s); however, excavation shall not proceed until the Owner has received the Contractor's Excavation Safety Plan(s) for the Project.

B. Prior to Starting Excavation

Prior to starting any Excavation, the Contractor shall submit to the Owner:

1. A certificate indicating that the Contractor's Competent Person(s) has completed training in an excavation safety program based on OSHA regulations within the past 5 years.
2. Manufacturer's tabulated data or other tabulated data for Excavation Safety Systems consisting of pre-engineered protective systems such as trench shields, aluminum hydraulic shoring, timber shoring, pneumatic shoring, or trench jacks, or benching or sloping or other protective systems that are not designed specifically for the Project.

   Manufacturer's tabulated data shall meet the requirements in OSHA and shall describe the specific equipment to be used on the Project. Tabulated data must bear the seal of the licensed professional engineer who approved the data. Manufacturer's tabulated data shall be an attachment to the Contractor's Excavation Safety System Plan described below.

509S.4 Excavation Safety System Plan

The Contractor shall prepare an Excavation Safety System Plan (hereafter called the "Plan") specifically for the Project. The Contractor shall retain a Texas-licensed Professional Engineer to prepare the Plan. On City-funded projects, the Contractor must follow qualifications-based procedures to procure the required Professional Engineering services, according to Chapter 2254 of the Texas Government Code.

The Contractor shall be responsible for obtaining geotechnical information necessary for design of the Excavation Safety System. If geotechnical information for design of the Project has been acquired by the Owner or designated representative, it shall be provided to the Contractor for information purposes subject to the provisions of City of Austin Standard Contract Section 00220, "Geotechnical Data."

A. The Plan for Excavation Safety Systems consisting of pre-engineered protective systems such as trench shields, aluminum hydraulic shoring, timber shoring, pneumatic shoring, or trench jacks, or benching or sloping or other protective systems that are not designed specifically for the Project shall include:

   1. Detailed Drawings of the Excavation Safety System(s) that will provide worker protection conforming to OSHA. The Drawings shall note the required load carrying capacity, dimensions, materials, and other physical properties or characteristics in sufficient detail to describe thoroughly and completely the Excavation Safety System(s).
   2. Drawings, notes, or tables clearly detailing the specific areas of the Project in which each Excavation Safety System shall be used, the permissible size of the excavation, the length of time that the excavation shall remain open, the means of egress from the excavation, the location of material storage sites in relation to the excavation, the methods for placing/compacting bedding/backfill within the safety of the system, any excavation safety equipment restrictions and subsequent removal of the system.
   3. Recommendations and limitations for using the Excavation Safety Systems.
   4. A Certificate of Insurance of the Excavation Safety System Engineer's Professional Liability Insurance coverage. For City-funded projects, coverage meeting the requirements of Standard Contact Documents Section 00810 shall be provided. For privately funded projects the coverage shall be at least $1,000,000.

B. The Plan for Excavation Safety Systems consisting of tieback or braced sheeting, tieback or braced soldier piles and lagging, slurry walls, soil nailing, rock bolting or other protective systems that are designed specifically for the Project shall include:

1. Detailed Drawings of the Excavation Safety System(s) that will provide worker protection conforming to OSHA. The Drawings shall note the design assumptions, design criteria, factors of safety, applicable codes, dimensions, components, types of materials, and other physical properties or characteristics in sufficient detail to describe thoroughly and completely the Excavation Safety System(s).
2. Detailed technical specifications for the Excavation Safety System addressing the properties of the materials, construction means and methods, quality control and quality assurance testing, performance monitoring, and monitoring of adjacent features, as appropriate.
3. Drawings that clearly detail the specific areas of the Project in which each type of system shall be used and showing the plan and elevation (vertical profile) views.
4. Drawings, notes or tables clearly detailing the length of time that the excavation shall remain open, the means of egress from the excavation, the location of material storage sites in relation to the excavation, the methods for placing/compacting bedding/backfill within the safety of the system, any excavation safety equipment restrictions and subsequent removal or abandonment of the system or parts thereof.
5. Recommendations and limitations for using the Excavation Safety Systems.
6. A Certificate of Insurance of the Excavation Safety System Engineer's Professional Liability Insurance coverage. For City-funded projects, coverage meeting the requirements of Standard Contract Documents Section 00810 shall be provided. For privately funded projects the coverage shall be at least $1,000,000.

509S.5 Excavation Safety System Submittal Review

Review of the Excavation Safety System submittal conducted by the Owner or designated representative shall only relate to conformance with the requirements herein. The Owner's failure to note exceptions to the submittal shall not relieve the Contractor of any or all responsibility or liability for the adequacy of the Excavation Safety System. The Contractor shall remain solely and completely responsible for all Excavation Safety Systems and for the associated means, methods, procedures, and materials.

509S.6 Contractor’s Responsibility

The Contractor shall be responsible for implementing the Excavation Safety System Plan and for confirming that the Excavation Safety System(s) used on the Project meets the requirements of the Plan.

The Contractor’s Competent Person(s) shall be on the Project whenever workers are in an excavation meeting the definitions of a Trench given in 509S.2.

509S.7 Construction Methods

The Contractor's Competent Person(s) shall maintain a copy of appropriate OSHA regulations onsite and shall implement OSHA excavation safety regulations at the work site. The Contractor shall perform all excavation in a safe manner and shall maintain the Excavation Safety Systems to prevent death or injury to personnel or damage to structures, utilities or property in or near excavation.

If evidence of possible cave-ins or earthen slides is apparent or an installed Excavation Safety System is damaged, the Contractor shall immediately cease work in the excavation, evacuate

personnel from any potentially hazardous areas and notify the Owner. 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 replacement of damaged Excavation Safety System shall be at the Contractor's sole expense.

509S.8 Changed Conditions

When changed conditions require modifications to the Excavation Safety System, the Contractor shall provide to the Owner or designated representative a new design or an alternate Excavation Safety System Plan that is proposed by the Contractor's Excavation Safety System Engineer to address the changed conditions. Copies of the new design or alternate system shall be provided to the Owner or designated representative in accordance with the requirements of section 509S.3, "Excavation Safety System Plan Submittals". A copy of the most current Excavation Safety System Plan shall be maintained on site and made available to inspection and enforcement officials at all times.

Any changes to the Excavation Safety System Plan that are initiated by the Contractor for operational efficiency or as a result of changed conditions, that could be reasonably anticipated, will not be cause for contract time extension or cost adjustment. When changes to the Excavation Safety System Plan are necessitated by severe and uncharacteristic natural conditions or other conditions not reasonably within the control of the Contractor, the Contractor may make a written request to the Owner for a Change Order to address the anticipated work. The Contractor shall notify the Owner in writing within 24 hours of the occurrence of changed conditions that the Contractor anticipates the submittal of a claim for additional compensation. Under 'Changed Conditions" the work deemed immediately necessary by the Contractor to protect the safety of workers and public, equipment or materials may only be accomplished until the Owner or designated representative has a reasonable opportunity to investigate the Contractor's written request for a Change Order and respond in writing to the request.

509S.9 Measurement

Trench Excavation Safety Protective Systems will only be measured and paid for those trenches that workers would reasonably be expected to enter.

Trench Excavation Safety Protective Systems for Trenches excavated to a final width (measured at the bottom of the excavation) not exceeding 15 feet (4.56 m) shall be measured by the linear foot (meter: 1 meter equals 3.281 feet) through manholes, bore pits, receiving pits, and other appurtenances along the centerline of the trench. This method of measurement shall apply to any and all protective systems, including but not limited to tieback or braced sheeting, tieback or braced soldier piles and lagging, slurry walls, soil nails, rock bolts, shoring, trench boxes, and sloping or benching as used to provide a Trench Excavation Safety Protective System in accordance with the Excavation Safety System Plan.

Trench Excavation Safety Protective Systems for Trenches created by installation or construction of forms or other structures in an excavation whose width is greater than 15 feet (4.56 m) such that the dimension measured from the forms or structures to the sides of the excavation is reduced to 15 feet (4.56 m) or less (measured at the bottom of the excavation) shall be measured by the linear foot along the centerline of the Trench. Where forms or structures create multiple Trenches in one excavation, each Trench shall be measured separately. This method of measurement shall apply to any and all protective systems, including but not limited to tieback or braced sheeting, tieback or braced soldier piles and lagging, slurry walls, soil nails, rock bolts, shoring, trench boxes, and sloping or benching as used to provide a Trench Excavation Safety Protective System in accordance with the Excavation Safety System Plan.

509S.10 Payment

Payment for Trench Excavation Safety Protective Systems, measured as prescribed above, will be made at unit bid price per centerline linear foot of Trench. The unit bid price shall include full compensation for designing, furnishing, installing the system; for dewatering, and for maintaining, replacing, repairing and removing the Trench Excavation Safety Protective System and for sloping, special clearing, and excavation necessary to safely implement the Excavation Safety System Plan. No payment will be made for Trench Excavation Safety Protective Systems made necessary by the Contractor's selection of an optional design or sequence of work that creates the need for the Trench Excavation Safety Protective System.

Payment will be made under the following:

Pay Item No. 509S-1: Trench Excavation Safety Protective Systems, (all depths) Per Linear Foot.

END

SPECIFIC Cross Reference Materials
Standard Specification Item No. 509S, "Excavation Safety Systems"

City of Austin Standard Contract Documents

Designation	Description
Section 00020	Invitation for Bids
Section 00220	Geotechnical Data
Section 00650	Certificate of Insurance
Section 00700, Article 6.11	Safety and Protection
Section 810	Supplemental General Conditions

29 CFR, Occupational Safety and Health Administration, Part 1926 Safety and Health Regulations for Construction, Subpart P, Excavation
Texas Health and Safety Code Title 9 Chapter 756 Subchapter C
Texas Government Code Chapter 2254

RELATED Cross Reference Materials
Standard Specification Item No. 509S, "Excavation Safety Systems"

Texas Department of Transportation Standard Specifications
For Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item 104	Removing Concrete
Item 110	Excavation
Item 402	Trench Excavation Protection

City of Austin Standard Specification Items

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 130S	Borrow

Item No. 132S	Embankment
Item No. 201S	Subgrade Preparation
Item No. 402S	Controlled Low Strength Material
Item No. 501S	Jacking or Boring Pipe
Item No. 503S	Frames, Grates, Rings and Covers
Item No. 504S	Adjusting Structures
Item No. 505S	Concrete Encasement and Encasement Pipe
Item No. 506	Manholes
Item No. 507S	Bulkheads
Item No. 510	Pipe
Item No. 511S	Water Valves
Item No. 593S	Concrete Retards
Item No. 594S	Gabions and Revet Mattresses

ITEM NO. 510 PIPE 12-8-18

510.1 Description

This item governs the furnishing and installing all pipe and/or materials for constructing pipe mains, sewers, laterals, stubs, inlet leads, service connections, culverts, temporary service lines and temporary diversion lines, including all applicable Work such as excavating, bedding, jointing, backfilling materials, tests, concrete trench cap, concrete cap and encasement, etc., prescribed under this item in accordance with the provisions of the Edwards Aquifer Protection Ordinance, when applicable, and City of Austin Utility Criteria Manual, Section 5, "Working in Public Rights-of-Way." The pipe shall be of the sizes, types, class and dimensions indicated or as designated by the E/A and shall include all joints or connections to new or existing mains, pipes, sewers, manholes, inlets, structures, etc., as may be required to complete the Work in accordance with specifications and published standard practices of the trade associations for the material specified and to the lines and grades indicated. This item shall include any pumping, bailing, and drainage when indicated or applicable. Unless otherwise provided, this item shall consist of the removal and disposition of trees, stumps and other obstructions, old structures or portions thereof such as house foundations, old sewers, masonry or concrete walls, the plugging of the ends of abandoned piped utilities cut and left in place and the restoration of existing utilities damaged in the process of excavation, cutting and restoration of pavement and base courses, the furnishing and placing of select bedding, backfilling and cement or lime stabilized backfill, the hauling and disposition of surplus materials, bridging of trenches and other provisions for maintenance of traffic or access as indicated.

510.2 Materials

The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation into the Work are of the kind and quality that satisfies the specified functions and quality. Austin Water Utility Standard Products Lists (SPL) form a part of the Specifications. Contractors may, when appropriate, elect to use products from the SPL; however, submittal to the E/A is still required. Should the Contractor elect to use any materials from these lists, each product shall be completely and clearly identified by its corresponding SPL number when making the product submittal. This will expedite the review process in which the E/A, and, if necessary, the Austin Water Utility Standard Products Committee, decides whether the products meet the Contract requirements and the specific use foreseen by the E/A in the design of this engineered Project. The purpose of the SPL's is to expedite review, by the E/A and, if necessary, the Austin Water Utility Standard Products Committee, of Contractor product submittals. The SPL's shall not be considered as being a pre-approved list of products necessarily meeting the requirements of the Project. Items contained in the SPL cannot be substituted for items shown on the Drawings, or called for in the specifications, or specified in the Bidding Requirements, Contract Forms and Conditions of Contract, unless approved by the E/A in conjunction with the Austin Water Utility Standard Products Committee. The Standard Product List current at the time of plan approval will govern.

(1) Concrete

Concrete shall conform to Item No. 403S, "Concrete for Structures".

(2) Coarse Aggregate

Coarse aggregate shall conform to Item No. 403S, "Concrete for Structures" or one of the following:

(a) Pipe Bedding Stone

Pipe bedding stone shall be clean gravel, crushed gravel or crushed limestone, free of mud, clay, vegetation or other debris, conforming to ASTM C 33 for stone quality. Size gradation shall conform to ASTM C-33 No. 57 or No. 67 or the following Table:

SIEVE SIZE	% RETAINED BY WEIGHT
1½"	0
1"	0—10
½'	40—85
#4	90—100
#8	95—100

(b) Foundation Rock

Foundation rock shall be well graded coarse aggregate ranging in size from 2 to 8 inches.

(c) Flexible Base

Flexible base shall conform to Item No. 210S, "Flexible Base".

(3) Fine Aggregate

(a) Concrete and Mortar Sand

Fine aggregate shall conform to Item No. 403S, "Concrete for Structures".

(b) Bedding Sand

Sand for use as pipe bedding shall be clean, granular and homogeneous material composed mainly of mineral matter, free of mud, silt, clay lumps or clods, vegetation or debris. The material removed by decantation TxDOT Test Method Tex-406-A, plus the weight of any clay lumps, shall not exceed 4.5 percent by weight.

The resistivity shall not be less than 3000 ohms-cm as determined by TxDOT Test Method Tex-129-E. Size gradation of sand for bedding shall be as follows:

GRADATION TABLE	
SIEVE SIZE	% RETAINED BY WEIGHT
¼"	0
#60	75—100
#100	95—100

(c) Stone Screenings

Stone screenings shall be free of mud, clay, vegetation or other debris, and shall conform to the following Table:

SIEVE SIZE	% PASSING
⅜"	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

All screenings shall be the result of a rock crushing operation.

(4) Controlled Low Strength Material

Controlled Low Strength Material (CLSM) shall conform to Item 402S, "Controlled Low Strength Material.

(5) Pea Gravel

Pea gravel bedding shall be clean washed material, hard and insoluble in water, free of mud, clay, silt, vegetation or other debris. Stone quality shall meet ASTM C 33. Size gradation shall be as follows:

SIEVE SIZE	% RETAINED BY WEIGHT
¾″	0
½″	0—25
¼″	90—100

(6) Select Backfill or Borrow

This material shall consist of borrow or suitable material excavated from the trench. It shall be free of stones or rocks over 8 inches and shall have a plasticity index of less than 20. The moisture content at the time of compaction shall be within 2 percent of optimum as determined by TxDOT Test Method Tex-114-E. Sandy loam borrow will not be allowed unless shown on the Drawings or authorized by the E/A.

All suitable materials from excavation operations not required for backfilling the trench may be placed in embankments, if applicable. All unsuitable materials that cannot be made suitable shall be considered surplus excavated materials as described in 510.3(13). The Contractor may, if approved by the engineer, modify unsuitable materials to make them suitable for use. Modification may include drying, removal or crushing of over-size material, and lime or cement treatment.

(7) Cement Stabilized Backfill

When indicated or directed by the E/A, all backfill shall be with cement-stabilized backfill rather than the usual materials. Unless otherwise indicated, cement stabilized backfill material shall consist of a mixture of the dry constituents described for Class J Concrete. The cement and aggregates shall be thoroughly dry mixed with no water added to the mixture except as may be directed by the E/A.

(8) Pipe

General

Fire line leads and fire hydrant leads shall be ductile iron. Domestic water services shall not be supplied from fire service leads, unless the domestic and fire connections are on separately valved branches with an approved backflow prevention device in the fire service branch. All wastewater force mains shall be constructed of ductile iron pipe Pressure Class 250 minimum for pipe greater than 12-inch size and Pressure Class 350 for pipe 12-inch size and smaller. Wastewater pipe shall be in accordance with Austin Water Utility's Standard Products List SPL WW-534 and shall have a corrosion resistant interior lining acceptable to the Owner.

All water pipe within utility easements on private property shall be Ductile Iron Pipe, Pressure Class 350 minimum for pipe 12-inch size and smaller and Pressure Class 250 minimum for pipe greater than 12-inch size wrapped as indicated. For sizes over 24 inches, Concrete Pressure Pipe, steel cylinder type, conforming to the requirements of AWWA C-301 will be acceptable.

There may be no service connections to Concrete Pressure Pipe installed in utility easements on private property. Approved service clamps or saddles shall be used when tapping ductile iron pipe 12 inch size

and smaller. All service tubing (¾ inch thru 2 inches) installed in utility easements on private property shall be 150 psi annealed seamless Type K copper tubing with no sweat or soldered joints.

All reclaimed water mains shall be constructed of ductile iron pipe, Pressure Class 350 minimum for pipe 12-inch size and smaller and pressure class 250 for pipe greater than 12-inch size. For mains 12-inch size and smaller, PVC pipe, conforming to the requirements of AWWA C-900, DR 14 shall be acceptable. Reclaimed water pipe shall be manufactured purple, painted purple, or wrapped in purple polyethylene film wrap.

Manufacturers of concrete pipe and pipe larger than 24-inch diameter shall have a quality control program consisting of one or more of the following: 1) a quality management system certified by the American National Standards Institute (ANSI) or National Sanitation Foundation (NSF) to comply with ISO 9001:2000, 2) a quality management system certified by the QCast Program following the requirements of the ACPA Plant Certification Manual, 3) a quality management system certified by the National Precast Concrete Association 4) a quality control program approved by the OWNER prior to submittal of bids for the PROJECT, or 5) an independent, third party quality control testing and inspection firm for testing and inspecting pipe produced for the PROJECT and approved by the OWNER prior to submittal of bids for the PROJECT. All such quality control programs shall be paid for by the manufacturer. It is the intent of this requirement that the manufacturer will document all appropriate tests and inspections with sampling and inspection criteria, frequency of testing and inspection, date of testing and inspection and date on which every piece was manufactured. Required testing and inspection, including that by an independent, third party, shall be performed full-time during production of pipe for the PROJECT. When requested by the OWNER, the manufacturer will provide copies of test data and results and inspection reports with the shipment of pipe for the PROJECT. Test data and results and inspection reports shall be traceable to specific pipe lots or pieces. Owner approval of the manufacturer's quality control program will expire after three years, at which time the manufacturer must present a current quality control program for approval in order to retain listing on the applicable SPL. Owner approval of the Concrete Pipe manufacturer's quality control program will expire after three years, at which time the manufacturer must present a current quality control program for approval.

The quality of materials, the process of manufacture and the finished pipe shall be subject to inspection and approval by the E/A at the pipe manufacturing plant and at the project site prior to and during installation. Plant inspections shall be conducted at the discretion of the City Representative. Only manufacturers having a quality control program of the type described above will be considered as approved providers of concrete pipe and pipe products as listed in the Standard Products List (SPL).

All water distribution pipe and fittings shall be listed in the Fire Protection Equipment Directory published by the Underwriter's Laboratories, Inc., or shall be Factory Mutual approved for fire service. All water pipe and related products shall be registered by the National Sanitation Foundation as having been certified to meet NSF/ANSI Standard 61.

(a) Reserved

(b) Iron Pipe

Iron pipe shall be ductile iron pipe meeting all requirements of standards as follows:

-For push-on and mechanical joint pipe: AWWA C-151

-For flanged pipe: AWWA C-115

Barrels shall have a nominal thickness required by Table 1 of AWWA C-115, which thickness corresponds to Special Class 53 in sizes through 54 inch, and Class 350 in 60 and 64-inch sizes. Flanges shall be ductile iron (gray iron is not acceptable); they shall be as shown in ANSI/AWWA C115/A21.15 and shall conform to dimensions shown in Table 2 and Figure 1

of AWWA C115. These flanges are the same in all respects as flanges shown in ANSI/AWWA C110/A21.10 for fittings and are standard for all flanges used with pipe, valve, and equipment units in the City of Austin water distribution and wastewater force main systems. Flanges shall be fabricated and attached to the pipe barrels by U.S. fabricators using flanges and pipe barrels of U.S. manufacture. If fabrication is to be by other than the pipe barrel manufacturer, a complete product submittal and approval by the Austin Water Utility will be required. Additionally, such fabricator shall furnish certification that each fabricated joint has been satisfactorily tested hydrostatically at a minimum pressure of 300 psi.

-Linings and Coating:

Interior surfaces of all iron potable or reclaimed water pipe shall be cement-mortar lined and seal coated as required by AWWA C104. Interior surfaces of all iron wastewater line and force main pipe shall be coated with a non-corrosive lining material as indicated on Austin Water Utility's Standard Products List SPL WW-534. Pipe exteriors shall be coated as required by the applicable pipe specification. The type and brand of interior lining shall be clearly marked on the outside of the pipe and fittings. Except as authorized by the E/A, only one type and brand of pipe lining shall be used on a given project.

Except as described above for flanged pipe (Thickness Class 53) and where not otherwise indicated, ductile iron pipe shall be minimum Class 250 as defined by ANSI/AWWA C150/A21.50-current; all ductile iron pipe and flanges shall meet the following minimum physical requirements:

Grade 60-42-10:

-Minimum tensile strength: 60,000 psi (414 mPa).

-Minimum yield strength: 42,000 psi (290 mPa).

-Minimum elongation: 10 percent.

The flanges for AWWA C115 pipe may be also be made from:

Grade 70-50-05:

-Minimum tensile strength: 70,000 psi (483 mPa).

-Minimum yield strength: 50,000 psi (345 mPa).

-Minimum elongation: 5 percent.

1. Ductile Iron Fittings:

   Fittings shall be push-on, flanged or mechanical joint as indicated or approved and shall meet all requirements of standards as follows:

   -Sizes 4 inch through 24 inch: AWWA C-110 or AWWA C-153

   -Sizes larger than 24 inch: AWWA C-110.

   -Lining and Coating:

   Interior surfaces or all iron potable/reclaimed water pipe fittings shall be lined with cement- mortar and seal coated as required by AWWA C104. Interior surfaces of all iron wastewater and force main fittings shall be coated with a non-corrosive lining material acceptable to Owner. Fitting exteriors shall be coated as required by the applicable pipe specification.

2. Joint Materials

Gaskets for mechanical joints shall conform to ANSI/AWWA A21.11/C-111.

Joining of slip joint iron pipe shall, without exception, be accomplished with the natural or synthetic rubber gaskets of the manufacturer of that particular pipe being used. A joint lubricant shall be used and applicable recommendations of the manufacturer shall be followed.

Gaskets for flanged joints shall be continuous full face gaskets, of ⅛ inch minimum thickness of natural or synthetic rubber, cloth-reinforced rubber or neoprene material, preferably of deformed cross section design and shall meet all applicable requirements of ANSI/AWWA A21.11/C-111 for gaskets. They shall be manufactured by, or satisfy all recommendations of, the manufacturer of the pipe/fittings being used and be fabricated for use with Class 125 ANSI B16.1 flanges.

Tee-head bolts, nuts and washers for mechanical joints shall be high strength, low alloy, corrosion resistant steel stock equal to "COR-TEN A" having UNC Class 2 rolled threads or alloyed ductile iron conforming to ASTM A 536; either shall be fabricated in accordance with ANSI/AWWA A21.11/C-111.

Hex head bolts and nuts shall satisfy the chemical and mechanical requirements of ASTM A449 SAE Grade 5 plain, and shall be fabricated in accordance with ASTM B 18.2 with UNC Class 2 rolled threads.

Either Tee-Head or Hex-Head bolts, nuts and washers as required, shall be protected with bonded fluoro-polymer corrosion resistant coating where specifically required by the E/A.

All threaded fasteners shall be marked with a readily visible symbol cast, forged or stamped on each nut and bolt, which will identify the fastener material and grade. The producer and the supplier shall provide adequate literature to facilitate such identification; painted markings are not acceptable.

3. Polyethylene Film Wrap

   All iron pipe, fittings and accessories shall be wrapped with standard 8 mil (minimum) low density polyethylene film or 4-mil (minimum) cross laminated high-density polyethylene conforming to AWWA C-105, with all edges overlapped and taped securely with duct tape to provide a continuous wrap to prevent contact between the piping and the surrounding backfill. Repair all punctures of the polyethylene, including those caused in the placement of bedding aggregates, with duct tape to restore the continuous protective wrap before backfilling. Polyethylene film wrap for reclaimed water pipe shall be purple.

4. Marking

   Each pipe joint and fitting shall be marked as required by the applicable AWWA specification. This includes in all cases: Manufacturer's identification, Country where cast, year of casting, and "DUCTILE" or "DI". Barrels of flanged pipe shall show thickness class; others shall show pressure class. The flanges of pipe sections shall be stamped with the fabricators identification; fittings shall show pressure rating, the nominal diameter of openings and the number of degrees for bends. Painted markings are not acceptable.

5. Warning Tape

   Warning tape for identifying restrained joint pipe and fittings shall be yellow and shall have black lettering at least 2inches high that reads "Restrained Joint / Junta de Restriccion" at intervals not exceeding 24 inches. The warning tape shall be polypropylene having a minimum thickness of 2 mils, a minimum width of 3 inches, and adhesive backing on the side opposite the lettering.

(c) Concrete

1. General

Pipe shall conform to ASTM C 76 for Circular Pipe. Concrete pipe smaller than 12 inches in diameter shall conform to ASTM C 14, Extra Strength. All pipe shall be machine made or cast by a process which will provide uniform placement of the concrete in the form and compaction by mechanical devices, which will assure a dense concrete. Concrete shall be mixed in a central batch plant or other approved batching facility from which the quality and uniformity of the concrete can be assured. Transit mixed concrete shall not be acceptable for use in precast pipe. The pipe shall be Class III or the class indicated. Storm sewer pipe shall be of the tongue and groove or 0-ring joint design. Wastewater pipe shall be of the 0-ring joint design; it shall be acceptably lined for corrosion protection.

2. Marking

Each joint of pipe shall be marked with the pipe class, the date of manufacture, the manufacturer's name or trade mark, diameter of pipe and orientation, if required.

Pipe marking shall be waterproof and conform to ASTM C 76.

3. Minimum Age for Shipment

Pipe shall be considered ready for shipment when it conforms to the tests specified in ASTM C 76.

4. Joint Materials

When installing storm sewers (or storm drains), the Contractor shall have the option of using joints with preformed flexible joint sealants or with rubber gaskets. Preformed flexible joint sealants for storm drain joints shall comply with ASTM C990, and rubber gaskets for storm drain joints shall comply with ASTM C 1619. Mortar shall not be used to seal pre-fabricated joints. Pipe manufacturer shall be responsible for submitting to the Owner a detailed design of the joint upon request. The pipe manufacturer shall be responsible for submitting to the Owner a complete list of joint sizes showing the minimum size of material to be used with each size joint, along with complete instructions on recommended installation procedures. Quality control testing at the manufacturing plant shall be in accordance with Texas Department of Transportation (TxDOT) Departmental Materials Specifications (DMS) 7310, "Reinforced Concrete Pipe And Machine-Made Precast Concrete Box Culvert Fabrication And Plant Qualification". The pipe manufacturer shall be verified as compliant with TxDOT DMS 7310 at time of pipe delivery to the jobsite.

a. Mortar

Mortar for joints shall meet the requirements set forth below in "Mortar".

b. Cold Applied Preformed Plastic Gaskets

Cold Applied Plastic Gaskets shall be suitable for sealing joints of tongue and groove concrete pipe. The gasket sealing the joint shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents, irritating fumes or obnoxious odors. The gasket joint sealer shall not depend on oxidizing, evaporating or chemical action for its adhesive or cohesive strength and shall be supplied in extruded rope form of suitable cross section. The size of the plastic gasket joint sealer shall be in accordance with the manufacturer's recommendations and sufficient to obtain squeeze-out around the joint. The gasket joint sealer shall be protected by a suitable removable wrapper that

may be removed longitudinally without disturbing the joint sealer to facilitate application.

The chemical composition of the gasket joint sealing compound as shipped shall meet the following requirements:

Composition (% by weight)	Test Method	Typical Analysis
Bitumen (petroleum plastic content)	ASTM D 4	50-70
Ash-inert Mineral Water	Tex-526-C	30-50
Volatile Matter (at 325 F)	Tex-506-C	2.0 Maximum

The gasket joint sealing compound when immersed for 30 days at ambient room temperature separately in 5 percent solution of caustic potash, a mixture of 5 percent hydrochloric acid, a 5 percent solution of sulfuric acid and a saturated H2S solution shall show no visible deterioration.

The physical properties of the gasket joint sealing compound as shipped shall meet the following requirements:

Property	Test Method	Typical Analysis	
		Minimum	Maximum
Specific Gravity at 77 F	ASTM D 71	1.20	1.35
Ductility at 77F (cm) Minimum	Tex-503-C	5.0	
Softening point	Tex-505-C	275 F	
Penetration:			
32 F (300 g) 60 sec	Tex-502-C	75	
77 F (150 g) 5 sec	Tex-502-C	50	120
115 F (150 g) 5 sec	Tex-502-C		150
Flashpoint C.O.C. F	Tex-504-C	600 F	
Fire Point C.O.C. F	Tex-504-C	625 F	

When constructing wastewater lines, the Contractor shall use 0-ring gasket joints conforming to ASTM C 443. Just before making a joint, the ends of the pipe shall be clean, dry, free of blisters or foreign matter and shall be wire brushed. For O-ring joints, the gasket and the inside surface of the bell shall be lubricated with a light film of soft vegetable soap compound to facilitate assembly of the joint. The rubber O-ring gasket shall be stretched uniformly in the joint. Wedge seal type ("Forsheda" pre-lubricated) gaskets may be used if joint details submitted are approved; installation of such gaskets shall be in strict accordance with the manufacturer's recommendations, and shall be the sole element depended upon to make the joint flexible and watertight.

In wastewater lines no horizontal or vertical angles in the alignment of pipes shall be permitted unless indicated. The spigot shall be centered in the bell, the pipe pushed uniformly home and brought into true alignment. Bedding material shall be placed and tamped against pipe to secure the joint.

5. Bends

When horizontal or vertical angles in the alignment of storm sewers are indicated, the bend or angle shall be constructed by cutting on a bias one or both pipes as may be required for the alignment indicated. The pipe cut shall be sufficiently long to allow exposing the reinforcement, which shall be bent, welded and incorporated into the pipe bend and reinforced concrete collar to maintain the structural integrity. The collar shall be 6 inches minimum, reinforced with #4 bars on a 1 foot center both directions. Builder's hardware cloth may be used on the outside of the joint to aid in holding cementing materials in place. Plywood, fiberboard or other materials placed on the inside of the pipe as formwork shall be removed as soon as the joint materials have obtained initial set, after which the inside surface of the pipe joint shall be finished smooth and true to the line and grade established. The Contractor may use prefabricated bends meeting the specification requirements in lieu of field fabricated bends. All bends shall be watertight, have a smooth flow line and be equal or greater in strength to the adjacent pipe.

Horizontal or vertical changes in alignment in wastewater lines shall be accomplished by use of manholes. With the E/A's approval, horizontal changes in alignment may be made by the "Joint Deflection" method. Joint deflection is limited by regulations of the Texas Commission on Environmental Quality (TCEQ) to 80 percent of the maximum recommended by the manufacturer; such deflection may not exceed 5 degrees at any joint. Changes in alignment using pipe flexure shall not be allowed.

6. Sulfide and Corrosion Control

All concrete pipe used for wastewater installations shall be protected from sulfide and corrosion damage by using limestone aggregate.

(d) Concrete Steel Cylinder (CSC) Pipe

1. General Requirements

The Contractor shall submit to the E/A for approval along with other required data a tabulated layout schedule with reference to the stationing and grade lines to be used.

The manufacturer shall furnish all fittings and special pieces required for closures, bends, branches, manholes, air valves, blow offs and connections to main line valves and other fittings as indicated.

Each pipe length, fitting and special joint shall have plainly marked on the bell end of the pipe, the head condition for which it is designed. In addition, marking shall be required to indicate the location of each pipe length or special joint in the line and such markings will be referenced to the layout schedules and drawings and submitted for approval.

Concrete steel cylinder fittings shall be tested as required by the applicable AWWA Standards.

2. Design and Inspection

Where not otherwise indicated, concrete steel cylinder pipe shall be Class 150, designed to withstand a vacuum of not less than 28 feet of water. Valve reducers, tees and outlets from a pipe run shall be designed and fabricated so that all stresses are carried by the steel forming the fitting or outlet.

Concrete steel cylinder pipe shall meet one of the following specifications:

AWWA C-301 - Any Size

AWWA C-303 - 24-inch maximum size

All pipe flanges shall conform to AWWA C-207, requirements for standard steel flanges of pressure classes corresponding to the pipe class.

Pipe to be installed in a tunnel or encasement shall be manufactured with 1 inch thick by 24-inch wide skid bands of mechanically impacted mortar in addition to the normal coating.

All concrete steel cylinder fittings shall be constructed of steel plate of adequate strength to withstand both internal pressure and external loading. Rod reinforcing shall not be used to figure the required steel area. The fittings shall have a concrete lining and 1 inch minimum coating of cement mortar, except that centrifugally spun lining need not be reinforced.

Minimum lining thickness shall be ½ inch for 16-inch pipe and ¾ inch for sizes larger than 16-inch pipe. Where it is impractical to place such concrete protection on interior surfaces of small outlets, 2 coats of "Bitumastic Tank Solution" shall be applied.

No fitting shall be made by cutting of standard pipe, except that outlets of less than 75 percent of the pipe diameter may be placed in a standard pipe. Beveled spigots may be placed on standard pipe.

3. Joint Materials

Joints shall be of the rubber gasket type conforming to the applicable standards. The inside and outside recesses between the bell and spigot shall be completely filled with Cement Grout in accordance with the pipe manufacturer's recommendations. Grout materials for jointing such pipe, unless otherwise indicated, shall be as described herein.

(e) Reserved

(f) Polyethylene Tubing

1. General

All polyethylene (PE) tubing shall be high density, high molecular weight plastic tubing meeting ASTM D2737; it shall be pressure rated at 200 psi working pressure and must bear the National Sanitation Foundation seal of approval for potable water service. Pipe manufacturers shall be listed on SPL WW-65.

2. Materials

Polyethylene plastics shall be Designation PE3408 (Grade P34 with hydrostatic design stress of 800 psi).

3. Markings

Permanent marking on the tubing shall include the following at intervals of not more than 5 feet:

Nominal tubing size.

Type of plastic material, i.e., PE 3408.

Dimension Ratio (SDR) and pressure rating in psi for water at 73.4 F (e.g., SDR-9, 200 psi).

ASTM D 2737 designation.

Manufacturer's name or trademark, code and seal of approval (NSF mark) of the National Sanitation Foundation.

Polyethylene tubing for reclaimed service lines shall be purple.

4. Tube Size

PE tubing shall be standard copper tube size outside diameter, with Standard Dimension Ratio (SDR) of 9.

(g) Copper Tubing

All copper service tubing shall be annealed seamless Type K water tube meeting ASTM B88 and rated at 150 psi working pressure. The tubing shall be homogenous throughout and free from cracks, holes, crimping, foreign inclusions or other defects. It shall be uniform in density and other physical properties. Copper tubing for reclaimed water shall be wrapped in purple polyethylene film wrap. Pipe manufacturers shall be listed on SPL WW-613.

(h) Service Connection Fittings

All fittings used in customer service connection - tapping mains, connecting meters, etc. - must be currently listed on the applicable Water and Wastewater Standard Products List (SPL WW-68), or called for in the City of Austin Standard Details (520 - series).

(i) Brass Goods

All brass valves, couplings, bends, connections, nipples and miscellaneous brass pipe fittings and accessories used in meter connections, service lines, air release piping assemblies, and wherever needed in the water distribution system, shall conform to the City of Austin Standards, Austin Water Utility Standard Products Lists, and AWWA C-800, except as herein modified or supplemented.

Unless otherwise noted, the goods described herein shall be fabricated of standard Red Brass (Waterworks Brass) meeting ASTM B62 or B584, alloy 83600, consisting of 85 percent copper and 5 percent each of tin, lead and zinc.

Exposed threads shall be covered with plastic caps or sheeting to protect the threads.

Brass goods of each type and class shall be compatible with other fittings in common usage for similar purposes. Where not otherwise indicated, all such materials shall meet the following requirements:

Inlet threads of corporation valves shall be AWWA iron pipe (IP) thread (male); outlets of service saddles shall be tapped with AWWA IP thread (female). AWWA IP threads shall conform to ANSI/ASME B1.20.1 as required by AWWA C800 for "General Purpose (Inch) Pipe Threads". For ¾" and 1” sizes only, corporation valve inlet threads, and the internal threads of saddles may be the AWWA taper thread conforming to AWWA C800 Figure 1 and Table 6. External threads of corporation valve inlet must be compatible with internal threads of the service saddle.

Connections of all new tubing, and of tubing repairs wherever possible, shall be by compression fittings. Compression connections shall be designed to provide a seal and to retain the tubing, without slippage, at a working water pressure of 150 psig.

Flanges shall conform to ANSI B16.1, Class 125, as to dimensions, drillings, etc. Copper tubing, when used, shall be Type K tubing having dimensions and weights given in Table A.1 of AWWA C800.

Brass pipe shall conform to the weights and dimensions for Extra Strong pipe given in Table A.2 of AWWA C800.

All fittings shall be suitable for use at hydrostatic working pressures up to 150 psig (hydrostatic testing of installed systems is at 200 psig).

(j) Reserved

(k) Polyvinyl Chloride Potable/Reclaimed Water Pipe

1. General

All polyvinyl chloride (PVC) potable/reclaimed water pipe shall be of the rigid (UNPLASTICIZED) type and must bear the National Sanitation Foundation seal of approval for potable water pipe. Each joint of pipe shall consist of single continuous extrusion; bells or other components attached by solvent welding are not acceptable. Pipe shall be pressure rated at 200 psi (SDR-14).

Pipe shall have push-on, rubber gasket joints of the bell and spigot type with thickened integral bells with rubber gasket joints. The wall thickness of each pipe bell and joint coupling must be greater than the standard pipe barrel thickness. Clearance must be provided in every gasket joint for both lateral pipe deflection and for linear expansion and contraction. Concrete thrust blocking shall be placed behind bends and tees. Concrete support cradles or blocking shall be required for support of all fire hydrants, valves and AWWA C110 fittings; such support shall be provided for AWWA C153 fittings when required by the E/A.

2. Applicable Specifications

Except as modified or supplemented herein, PVC pipe shall meet the following standards:

AWWA C-900, or SDR 14 for PVC Pressure Pipe, in 4, 6, 8 and 12 inch nominal sizes, having Cast Iron Pipe size outside diameters.

Fittings used with PVC Pressure pipe shall be AWWA C-110 or AWWA C-153 compact ductile iron fittings.

All pipe 4 inches and larger must be approved Underwriter's Laboratories for use in buried water supply and fire protection systems.

3. Material Requirements

All pipe and fittings shall be made from clean, virgin, NSF certified, Class 12454B PVC. Clean reworked materials generated from the manufacturers own production may be used within the current limits of the referenced AWWA C-900.

4. Marking

PVC for reclaimed piping shall be purple or wrapped in purple polyethylene film wrap.

Permanent marking on each joint of pipe shall include the following at intervals of not more than 5 feet:

Nominal pipe size and OD base (e.g., 4 CIPS).

Type of plastic material (e.g., PVC 12454B).

Standard Dimension Ratio and the pressure rating in psi for water at 73 F (e.g., SDR 18, 150 psi).

AWWA designation with which the pipe complies (e.g., AWWA C-900).

Manufacturer's name or code and the National Sanitation Foundation (NSF) mark.

5. Tracer Tape

Inductive Tracer Detection Tape shall be placed directly above the centerline of all non-metallic pipe a minimum of 12 inches below subgrade or, in areas outside the limits of pavement, a minimum of 18 inches below finished grade. The tracer tape shall be encased

in a protective, inert, plastic jacket and color coded according to American Public Works Association Uniform Color Code. Except for minimum depth of cover, the tracer tape shall be placed according to manufacturer's recommendations. Manufacturers must be listed on SPL WW-597.

(l) Polyvinyl Chloride (PVC) Pipe (Nonpressure) and Fittings

1. General

PVC sewer and wastewater pipe and fittings 6 through 15 inch diameter shall conform to ASTM D 3034. Pipe shall have minimum cell classification of 12364 or 12454. Fittings shall have cell classification of 12454 or 13343. Pipe stiffness shall be at least 115 psi as determined by ASTM D 2412. Pipe manufacturers shall be on SPL WW-227, and fitting manufacturers shall be on SPL WW-227B.

PVC sewer and wastewater pipe and fittings 18 through 27 inch diameter shall conform to ASTM F 679. Pipe shall have minimum cell classification of 12364 or 12454. Pipe stiffness shall be at least 72 psi as determined by ASTM D 2412. Pipe manufacturers shall be on SPL WW-227A, and fitting manufacturers shall be on SPL WW-227B.

2. Joints

PVC pipe and fitting shall have elastomeric gasket joints conforming to ASTM D 3212. Gaskets shall conform to ASTM F 477.

3. Pipe Markings

Pipe meeting ASTM D 3034 shall have permanent marking on the pipe that includes the following at intervals of not more than 5 feet:

Manufacturer's name and/or trademark and code.

Nominal pipe size.

PVC cell classification per ASTM D 1784.

The legend "SDR-_ _ PVC Sewer Pipe" (SDR 26, 23.5. or less is required)

The designation "ASTM D 3034"

Pipe meeting ASTM F 679 shall have permanent marking that includes the following at intervals of not more than 5 feet:

Manufacturer's name or trademark and code

Nominal pipe size

PVC cell classification per ASTM D 1784

Pipe stiffness designation "PS _ _ PVC Sewer Pipe" (PS of at least 72 is required

The designation "ASTM F 679"

4. Fitting Markings

Fittings meeting ASTM D 3034 shall have permanent marking that includes the following:

Manufacturer's name or trademark

Nominal size

The material designation "PVC"

The designation, "ASTM F 679"

Fittings meeting ASTM F 679 shall have permanent marking that includes the following:

Manufacturer's name or trademark and code

Nominal size

The material designation "PVC"

The designation "ASTM F 679"

5. Tracer Tape

   Inductive Tracer Detection Tape shall be placed directly above the centerline of all non-metallic pipe a minimum of 12 inches below subgrade or, in areas outside the limits of pavement, a minimum of 18 inches below finished grade. The tracer tape shall be encased in a protective, inert, plastic jacket and color coded according to American Public Works Association Uniform Color Code. Except for minimum depth of cover, the tracer tape shall be placed according to manufacturer's recommendations. Manufacturers must be listed on SPL WW-597.

(m) Steel Pipe

1. Standard Weight

   ASTM A 53, Schedule 40.

2. Extra Heavy Weight

   Seamless ASTM A 53, Schedule 80.

3. Encasement Pipe

   a. For direct-bury installations, pipe shall conform to ASTM A134 with minimum thickness of 3/8 inch (9.5 mm).

   b. For jacked installations, pipe shall conform to requirements on drawings.

4. Fittings

   Nipples and fittings extra strong Federal Specification WW-N 351 or WW-P 521.

5. Coatings

   Black or galvanized as indicated.

(n) Welded Steel Pipe and Fittings for Water-Pipe

1. General Reference Standards Specification.

   Specifications of the American Water Works Association (AWWA) listed below shall apply to this Section.

   C-200 Steel Water Pipe 6 inches and larger.

   C-205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe, 4 inches and larger, Shop Applied.

   C-206 Field Welding of Steel Water Pipe.

   C-207 Steel Pipe Flanges for Waterworks Services, Sizes 4 inches through 144 inches.

   C-208 Dimensions for Steel Water Pipe Fittings.

C-602 Cement-Mortar Lining of Water Pipelines, 4 inches and larger in Place.

2. Submittals

Furnish Shop Drawings, product data, design calculations and test reports as described below:

a. Certified copies of mill tests confirming the type of materials used in steel plates, mill pipe flanges and bolts and nuts to show compliance with the requirements of the applicable standards.

b. Complete and dimensional working drawings of all pipe layouts. Shop Drawings shall include the grade of material, size, wall thickness of the pipe and fittings, type and location of fittings and the type and limits of the lining and coating systems of the pipe and fittings.

c. Product data to show compliance of all couplings, supports, fittings, coatings and related items.

3. Job Conditions

a. The internal design pressure of all steel pipe and fittings shall be as indicated.

b. The interior of all steel pipe for potable water, 4 inches and larger, shall be cement-mortar lined.

4. Manufacturing

a. Description

Pipe shall comply with AWWA C-200.

(1) Circumferential deflection of all pipe in-place shall not exceed 2.0 percent of pipe diameter.

(2) Diameter

Nominal pipe diameter shall be the inside diameter of lining or pipe barrel, unless otherwise designated in Job Conditions.

b. Wall Thickness

(1) Steel pipe wall thickness shall be designed for the internal and external loads specified in this section. The cylinder thickness needed to resist internal pressure shall be based on an allowable stress in the steel equal to ½ the minimum yield stress of the material used.

5. Fittings

a. Welded

Fabricated steel fittings shall be of the same material as pipe and shall comply with AWWA C-208.

6. Flanges

a. Flanges shall comply with the requirements of AWWA C-207, Class D or Class E. The class shall be based on operating conditions and mating flanges of valves and equipment.

b. Gaskets shall be cloth-inserted rubber, ⅛ inch thick.

c. Flanges shall be flat faced with a serrated finish.

7. Pipe Joints

a. Lap Joints for Field Welding

(1) Lap joints for field welding shall conform to AWWA C-206. This item applies only to pipes 72 inches in diameter and larger.

(2) The bell ends shall be formed by pressing on a hydraulic expander or a plug die. After forming, the minimum radius of curvature of the bell end at any point shall not be less than 15 times the thickness of the steel shell. Bell ends shall be formed in a manner to avoid impairment of the physical properties of the steel shell. Joints shall permit a lap at least 1 ½ inches when assembled. The longitudinal or spiral weld on the inside of the bell end and the outside of the spigot end on each section of pipe shall be ground flush with the plate surface. The inside edge of the bell and the outside edge of the spigot shall be scarfed or lightly ground to remove the sharp edges or burrs.

b. Bell and Spigot Joints with O-Ring Gasket

(1) Bell and spigot joints with rubber gasket shall conform to AWWA C-200.

(2) The bell and spigot ends shall be so designed that when the joint is assembled, it will be self-centered and the gasket will be confined to an annular space in such manner that movement of the pipe or hydrostatic pressure cannot displace it. Compression of the gasket when the joint is completed shall not be dependent upon water pressure in the pipe and shall be adequate to ensure a watertight seal when subjected to the specified conditions of service. Bell and spigot ends shall be welded on preformed shapes. The bell and spigot ends shall conform to the reviewed Shop Drawings.

8. Interior and Exterior Protective Surface Coatings

a. Exterior Surface to be mortar coated shall conform to AWWA C-205 for shop application and AWWA C-602 for field application. Pipe materials shall be the product of an organization, which has had not less than 5 years successful experience manufacturing pipe materials, and the design and manufacture of the pipe, including all materials, shall be the product of one company.

b. All surfaces except as noted in c and d below shall receive shop application of mortar lining and coating.

c. Field Welded Joints. After installation, clean, line and coat unlined or uncoated ends adjacent to welded field joints, including the weld proper, as specified for pipe adjacent to the weld. Potable water only shall be used in the preparation of any cement, mortar, or grout lining.

d. Machined Surfaces. Shop coat machined surfaces with a rust preventative compound. After jointing surfaces, remaining exposed surfaces shall be coated per a) and b) above.

(o) Corrugated Metal Pipe

1. General

Pipe shall be corrugated continuous lock or welded seam helically corrugated pipe. Corrugated metal pipe may be galvanized steel, aluminized steel or aluminum conforming to the following:

Galvanized Steel AASHTO M 218

Aluminized Steel AASHTO M 274

Aluminum AASHTO M 197

Where reference is made herein to gage of metal, the reference is to U.S. Standard Gage for uncoated sheets. Tables in AASHTO M 218 and AASHTO M 274 list thickness for coated sheets in inches. The Tables in AASHTO M 197 list thickness in inches for clad aluminum sheets.

Sampling and testing of metal sheets and coils used for corrugated metal pipe shall be in accordance with TXDOT Test Method Tex-708-I.

Damaged spelter coating shall be repaired by thoroughly wire brushing the damaged area and removing all loose, cracked or weld-burned spelter coating. The cleaned area shall be painted with a zinc dust-zinc oxide paint conforming to Federal Specifications TT-P 641b. Damaged pipe shall be rejected and removed from the project.

Damaged aluminized coating shall be repaired in accordance with the manufacturer's recommendations.

The following information shall be clearly marked on each section of pipe:

Thickness and corrugations

Trade Mark of the manufacturer

Specification compliance

2. Fabrication

a. Steel Pipe

Galvanized or aluminized steel pipe shall be full circle or arch pipe conforming to AASHTO M 36, Type I or Type II as indicated.

It may be fabricated with circumferential corrugations; lap joint construction with riveted or spot welded seams or it may be fabricated with helical corrugations with continuous helical lock seam or ultra high frequency resistance butt-welded seams.

b. Aluminum Pipe

Pipe shall conform to AASHTO M 196, Type I, circular pipe or Type II, pipe arch as indicated. It may be fabricated with circumferential corrugations; lap joint construction with riveted or spot welded seams or it may be fabricated with helical corrugations with a continuous helical lock seam.

Portions of aluminum pipe that are to be in contact with high chloride concrete or metal other than aluminum, shall be insulated from these materials by a coating of bituminous material. The coating applied to the pipe or pipe arch to provide insulation between the aluminum and other material shall extend a minimum distance of 1 foot beyond the area of contact.

3. Selection of Gages

The pipe diameter, permissible corrugations and required gauges for circular pipe shall be as indicated on the drawings.

For pipe arch, the span, rise, gage, corrugation size and coating thickness shall be as shown on the drawings. A tolerance of plus or minus 1 inch or 2 percent of equivalent circular diameter, whichever is greater, will be permissible in span and rise, with all dimensions measured from the inside crests of the corrugations.

4. Joint Material

Except as otherwise indicated, coupling bands and other hardware for galvanized or aluminized steel pipe shall conform to AASHTO M 36 for steel pipe and AASHTO M 196 for aluminum pipe. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of soil material during the life of the installation.

Coupling bands shall be not more than 3 nominal sheet thickness lighter than the thickness of the pipe to be connected and in no case lighter than 0.052 inch for steel or 0.048 inch for aluminum.

Coupling bands shall be made of the same base metal and coating (metallic or otherwise) as the pipe.

Coupling bands shall lap equally on each of the pipes being connected to form a tightly closed joint after installation.

Pipes furnished with circumferential corrugations shall be field jointed with corrugated locking bands. This includes pipe with helical corrugations, which has reformed circumferential corrugations on the ends. The locking bands shall securely fit into at least one full circumferential corrugation on each of the pipe ends being coupled. The minimum width of the corrugated locking bands shall be as shown below for the corrugation which corresponds to the end circumferential corrugations on the pipes being joined:

10½ inches wide for 2⅔ inches × ½-inch corrugations.

12 inches wide for 3 inches × 1 inch or 5 inches × 1-inch corrugations.

Helical pipe without circumferential end corrugations will be permitted only when it is necessary to join a new pipe to an existing pipe, which was installed with no circumferential end corrugations. In this event pipe furnished with helical corrugations at the ends shall be field jointed with either helically corrugated bands or with bands with projections or dimples. The minimum width of helically corrugated bands shall conform to the following:

12 inches wide for pipe diameters up to and including 72 inches.

14 inches wide for 1 inch deep helical end corrugations.

Bands with projections shall have circumferential rows of projections with one projection for each corrugation. The width of bands with projections shall be not less than the following:

12 inches wide for pipe diameters up to and including 72 inches.

The bands shall have 2 circumferential rows of projections.

16¼ inches wide for pipe diameters of 78 inches and greater.

The bands shall have 4 circumferential rows of projections.

Unless otherwise indicated, all bolts for coupling bands shall be ½-inch diameter. Bands 12 inches wide or less shall have a minimum of 2 bolts and bands greater than 12 inches wide shall have a minimum of 3 bolts.

Galvanized bolts may be hot dip galvanized conforming to AASHTO M 232, mechanically galvanized to provide the same requirements as AASHTO M 232 or electro-galvanized per ASTM A 164 Type RS.

5. Additional Coatings or Linings

a. Bituminous Coated

Bituminous Coated pipe or pipe arch shall be as indicated both as to base metal and fabrication and in addition shall be coated inside and out with a bituminous coating which shall meet the performance requirements set forth herein. The bituminous coating shall be 99.5 percent soluble in carbon bisulphide. The pipe shall be uniformly coated inside and out to a minimum thickness of 0.05 inch, measured on the crests of the corrugations.

The bituminous coating shall adhere to the metal tenaciously, shall not chip off in handling and shall protect the pipe from deterioration as evidenced by samples prepared from the coating material successfully meeting the Shock Test and Flow Test in accordance with Test Method Tex-522-C.

b. Paved Invert

Where a Paved Invert is indicated, the pipe or pipe arch, in addition to the fully coated treatment described above, shall receive additional bituminous material of the same specification as above, applied to the bottom quarter of the circumference to form a smooth pavement with a minimum thickness of ⅛ inch above the crests of the corrugations.

c. Cement Lined

(1) General

Except as modified herein, pipe shall conform to AASHTO M 36 for lock seam or welded helically corrugated steel pipe. Pipe shall be of full circle and shall be fabricated with two annular corrugations for purposes of joining pipes together with band couplers. Lock seams shall develop the seam strength as required in Table 3 of AASHTO M 36. Concrete lining shall conform to the following:

Composition

Concrete for the lining shall be composed of cement, fine aggregate and water that are well mixed and of such consistency as to produce a dense, homogeneous, non-segregated lining.

Cement

Portland Cement shall conform to AASHTO M 85.

Aggregate

Aggregates shall conform to AASHTO M 6 except that the requirements for gradation and uniformity of gradation shall not apply.

Mixture

The aggregates shall be sized, graded, proportioned and thoroughly mixed with such proportions of cement and water as will produce a homogenous concrete mixture of such quality that the pipe will conform to the design requirements indicated. In no case, however, shall the proportions of Portland Cement, blended cement or Portland Cement plus pozzolanic admixture be less than 470 lb/cu. yd of concrete.

Thickness

The lining shall have a minimum thickness of ⅛ inch above the crest of the corrugations.

Lining Procedures

The lining shall be plant applied by a machine traveling through a stationary pipe. The rate of travel of the machine and the rate of concrete placement shall be mechanically regulated so as to produce a homogenous nonsegregated lining throughout.

Surface Finish

The lining machine shall also mechanically trowel the concrete lining as the unit moves through the pipe.

Certification

Furnish manufacturer's standard certification of compliance upon request of the purchaser.

Joints

Pipe shall be joined together with coupling bands made from steel sheets to an indicated thickness of 0.064 inch (12 ga.). Coupling bands shall be formed with two corrugations that are spaced to provide seating in the third corrugation of each pipe end without creating more than ½ inch ± annular space between pipe ends when joined together.

Bands shall be drawn together by two ½ inch galvanized bolts through the use of a bar and strap suitably welded to the band.

When O-ring gaskets are indicated they shall be placed in the first corrugation of each pipe and shall be compressed by tightening the coupling band. Rubber O-ring gaskets shall conform to Section 5.9, ASTM C 361.

(2) Causes for Rejection

Pipe shall be subject to rejection on account of failure to conform to any of the indications. Individual sections of pipe may be rejected because of any of the following:

Damaged ends, where such damage would prevent making satisfactory joint.

Defects that indicate poor quality of work and could not be easily repaired in the field.

Severe dents or bends in the metal itself.

If concrete lining is broken out, pipe may be rejected or at the discretion of the E/A, repaired in the field in accordance with the manufacturer's recommendation.

Hairline cracks or contraction cracks in the concrete lining are to be expected and does not constitute cause for rejection.

d. Fiber Bonded

Where fiber bonded pipe is indicated, the pipe or pipe arch shall be formed from sheets whose base metal shall be as indicated. In addition, the sheets shall have been coated with a layer of fibers, applied in sheet form by pressing them into a molten metallic bonding. If a paved invert is indicated it shall be in accordance with the procedure outlined above. The test for spelter coating above is waived for fiber bonded pipe.

6. Slotted Drain Storm Sewers

The pipes for the slotted drain and slotted drain outfall shall be helically corrugated, lock seam or welded seam pipe. Materials and fabrication shall be in accordance with the above. The metal thickness shall be a minimum 16 gage.

The chimney assemblies shall be constructed of 3/16 inch welded plate or machine formed 14 gage galvanized steel sheets. The height of the chimney required shall be as indicated. Metal for the welded plate slot shall meet the requirements of ASTM A 36 and the completed plate slot shall be galvanized after fabrication in accordance with ASTM A 123.

Weld areas and the heat affected zones where the slot is welded to the corrugated pipe shall be thoroughly cleaned and painted with a good quality asphalt base aluminum paint.

7. Mortar

Mortar shall be composed of 1 part Type I Portland Cement and 2 parts clean, sharp mortar sand suitably graded for the purpose and conforming in other respects to the provisions for fine aggregate of Item No. 403, "Concrete for Structures". Hydrated lime or lime putty may be added to the mix, but in no case shall it exceed 10 percent by weight of the total dry mix.

(9) Geotextile Filter Fabric for Pipe Bedding Material

Geotextile filter fabric for pipe bedding material shall be Hanes Geo Components - TerraTex NO4.5 (AOS US Standard Sieve 70) geotextile fabric or approved equal.

510.3 Construction Methods

(1) General

Prior to commencing this Work, all erosion control and tree protection measures required shall be in place and all utilities located and protected as set forth in "General Conditions". Clearing the site shall conform to Item No. 102S, "Clearing and Grubbing". Maintenance of environmental quality protection shall comply with all requirements of "General Conditions" and Item No. 601S, "Salvaging and Placing Topsoil".

The Contractor shall Work such that a reasonable minimum of disturbance to existing utilities will result. Particular care shall be exercised to avoid the cutting or breakage of all existing utilities. If at any time the Contractor's operations damage the utilities in place, the Contractor shall immediately notify the owner of the utility to make the necessary repairs. When active wastewater sewer lines are cut in

the trenching operations, temporary flumes shall be provided across the trench while open and the lines shall be restored when the backfilling has progressed to the original bedding lines of the sewer so cut.

The Contractor shall inform utility owners sufficiently in advance of the Contractor's operations to enable such utility owners to reroute, provide temporary detours or to make other adjustments to utility lines in order that the Contractor may Work with a minimum of delay and expense. The Contractor shall cooperate with all utility owners concerned in effecting any utility adjustments necessary and shall not hold the City liable for any expense due to delay or additional Work because of conflicts arising from existing utilities.

The Contractor shall do all trenching in accordance with the provisions and the directions of the E/A as to the amount of trench left unfilled at any time. All excavation and backfilling shall be accomplished as indicated and in compliance with State Statutes.

Where excavation for a pipe line is required in an existing City street, a street cut permit is required and control of traffic shall be as indicated in accordance with the Texas Manual on Uniform Traffic Control Devices.

Wherever existing utility branch connections, sewers, drains, conduits, ducts, pipes or structures present obstructions to the grade and alignment of the pipe, they shall be permanently supported, removed, relocated or reconstructed by the Contractor through cooperation with the owner of the utility, structure or obstruction involved. In those instances where their relocation or reconstruction is impractical, a deviation from line and grade will be ordered by the E/A and the change shall be made in the manner directed.

Adequate temporary support, protection and maintenance of all underground and surface utility structures, drains, sewers and other obstructions encountered in the progress of the Work shall be furnished by, and at the expense of, the Contractor and as approved by the E/A.

Where traffic must cross open trenches, the Contractor shall provide suitable bridges in conformance with Standard 804S-4. Adequate provisions shall be made for the flow of sewers; drains and watercourses encountered during construction and any structures, which may have been disturbed, shall be satisfactorily restored upon completion of Work.

When rainfall or runoff is occurring or is forecast by the U.S. Weather Service, the Contractor shall not perform or attempt any excavation or other earth moving Work in or near the flood plain of any stream or watercourse or on slopes subject to erosion or runoff, unless given specific approval by the E/A. When such conditions delay the Work, an extension of time for working day contracts will be allowed in accordance with "General Conditions".

(2) Water Line/New Wastewater Line Separation

Separation between water, reclaimed water, and wastewater lines shall be provided as shown in the Drawings.

Crossings of water, reclaimed water, and wastewater lines shall conform to details in the Drawings.

Wastewater manholes within 9 feet of water and reclaimed water lines shall be made watertight according to details in the Drawings.

(3) Utility and Storm Sewer Crossings

When the Contractor installs a pipe that crosses under a utility or storm sewer structure and the top of the pipe is within 18 inches of the bottom of the structure, the pipe shall be backfilled as shown in the Drawings. When the Contractor installs a pipe that crosses under a utility or storm sewer structure that is not shown in the Drawings, the pipe shall be backfilled as directed by the Engineer. Payment for

backfilling pipe at utility or storm sewer structures not shown in the Drawings shall be by Change Order.

(4) Trench Excavation

Excavation in a paved street shall be preceded by saw cutting completely through any asphaltic cement concrete or Portland cement concrete surface, base, or subbase to the underlying subgrade. This requirement shall not apply to excavations made with trenching machines that use a rotating continuous belt or chain for cutting and removing of material.

Underground piped utilities shall be constructed in an open cut in accordance with Federal regulations, applicable State Statutes conforming to Item No. 509S, "Excavation Safety Systems" and with a trench width and depth described below. When pipe is to be constructed in fill above the natural ground, Contractor shall construct embankment to an elevation not less than one foot above the top of the pipe, after which trench is excavated. Required vertical sides shall be sheeted and braced as indicated to maintain the sides of the required vertical excavation throughout the construction period. Adequacy of the design of sheeting and bracing shall be the responsibility of the Contractor's design professional. The Contractor shall be responsible for installation as indicated. After the pipe has been laid and the backfill placed and compacted to 12 inches above the top of the pipe, any sheeting, shoring and bracing required may be removed with special care to insure that the pipe is not disturbed. As each piece of sheeting is removed, the space left by its removal must be thoroughly filled and compacted with suitable material and provisions made to prevent the sides of the trench from caving until the backfill has been completed. Any sheeting left in place will not be paid for and shall be included in the unit price bid for pipe.

(5) Trench Width

Trenches for water, reclaimed, and wastewater lines shall have a clear width on each side beyond the outside surfaces of the pipe bell or coupling of not less than 6 inches nor more than 12 inches.

Trenches for Storm Sewers up to 42 inches shall have a width of 1 foot on each side beyond the outside surfaces of the pipe. Pipes more than 42 inches shall have a trench width not to exceed 18 inches on each side beyond the outside surfaces of the pipe.

If the trench width within the pipe zone exceeds this maximum, the entire pipe zone shall be refilled with approved backfill material, thoroughly compacted to a minimum of 95 percent of maximum density as determined by TxDOT Test Method Tex-114-E and then re-excavated to the proper grade and dimensions. Excavation along curves and bends shall be so oriented that the trench and pipe are approximately centered on the centerline of the curve, using short lengths of pipe and/or bend fittings if necessary.

For all utilities to be constructed in fill above natural ground, the embankment shall first be constructed to an elevation not less than 1 foot above the top of the utility after which excavation for the utility shall be made.

(6) Trench Depth and Depth of Cover

All pipe and in-line appurtenances shall be laid to the grades indicated. The depth of cover shall be measured from the established finish grade, natural ground surface, subgrade for staged construction, street or other permanent surface to the top or uppermost projection of the pipe.

(a) Where not otherwise indicated, all potable/reclaimed water piping shall be laid to the following minimum depths:

1. Potable/reclaimed water piping installed in undisturbed ground in easements of undeveloped areas, which are not within existing or planned streets, roads or other traffic areas shall be laid with at least 36 inches of cover.

2. Potable/reclaimed water piping installed in existing streets, roads or other traffic areas shall be laid with at least 48 inches of cover below finish grade.

3. Unless approved by the E/A, installation of potable/reclaimed water piping in proposed new streets will not be permitted until paving and drainage plans have been approved and the roadway traffic areas excavated to the specified or standard paving subgrade, with all parkways and sidewalk areas graded according to any applicable provisions of the drainage plans or sloped upward from the curb line to the right-of-way line at a minimum slope of ¼ inch per foot. Piping and appurtenances installed in such proposed streets shall be laid with at least 36 inches of cover below the actual subgrade.

(b) Where not otherwise indicated, all wastewater piping shall be laid to the following minimum depths:

1. Wastewater piping installed in natural ground in easements or other undeveloped areas, which are not within existing or planned streets, roads or other traffic areas shall be laid with at least 42 inches of cover.

2. Wastewater piping installed in existing streets, roads or other traffic areas shall be laid with at least 66 inches of cover.

3. Wastewater piping installed in such proposed streets shall be laid with at least 48 inches of cover below the actual subgrade.

(7) Classification of Excavation

Excavation will not be considered or paid for as a separate item of Work, so excavated material will not be classified as to type or measured as to quantity. Full payment for all excavation required for the construction shall be included in the various unit or lump sum Contract prices for the various items of Work installed, complete in place. No extra compensation, special treatment or other consideration will be allowed due to rock, pavement, caving, sheeting and bracing, falling or rising water, working under and in the proximity of trees or any other handicaps to excavation.

(8) Dewatering Excavation

Underground piped utilities shall not be constructed or the pipe laid in the presence of water. All water shall be removed from the excavation prior to the pipe placing operation to insure a dry firm granular bed on which to place the underground piped utilities and shall be maintained in such unwatered condition until all concrete and mortar is set. Removal of water may be accomplished by bailing, pumping or by a well-point installation as conditions warrant.

In the event that the excavation cannot be dewatered to the point where the pipe bedding is free of mud, a seal shall be used in the bottom of the excavation. Such seal shall consist of Class B concrete, conforming to Item No. 403, "Concrete for Structures", with a minimum depth of 3 inches.

(9) Trench Conditions

Before attempting to lay pipe, all water, slush, debris, loose material, etc., encountered in the trench must be pumped or bailed out and the trench must be kept clean and dry while the pipe is laid and backfilled. Where needed, sump pits shall be dug adjoining the trench and pumped as necessary to keep the excavation dewatered.

Backfilling shall closely follow pipe laying so that no pipe is left exposed and unattended after initial assembly. All open ends, outlets or other openings in the pipe shall be protected from damage and shall be properly plugged and blocked watertight to prevent the entrance of trench water, dirt, etc. The interior of the pipeline shall at all times be kept clean, dry and unobstructed.

Where the soil encountered at established footing grade is a quicksand, saturated or unstable material, the following procedure shall be used unless other methods are indicated:

All unstable soils shall be removed to a depth of a minimum 2 feet below bottom of piped utility or as required to stabilize the trench foundation. Such excavation shall be carried out for the entire trench width.

All unstable soil so removed shall be replaced with a concrete seal, foundation rock or coarse aggregate materials placed across the entire trench width in uniform layers not to exceed 6 inches, loose measure and compacted by mechanical tamping or other means which shall provide a stable foundation for the utility.

Forms, sheathing and bracing, pumping, additional excavation and backfill required in unstable trench conditions shall be included in the unit price bid for pipe.

(10) Blasting

All blasting shall conform to the provisions of the "General Conditions" and/or "Public Safety and Convenience".

(11) Removing Old Structures

When out of service masonry structures or foundations are encountered in the excavation, such obstructions shall be removed for the full width of the trench and to a depth of 1 foot below the bottom of the trench. When abandoned inlets or manholes are encountered and no plan provision is made for adjustment or connection to the new sewers, such manholes and inlets within the construction limits shall be removed completely to a depth 1 foot below the bottom of the trench. In each instance, the bottom of the trench shall be restored to grade by backfilling and compacting by the methods provided above. Where the trench cuts through storm or wastewater sewers which are known to be abandoned, these sewers shall be cut flush with the sides of the trench and blocked with a concrete plug in a manner satisfactory to the E/A. When old structures are encountered, which are not visible from the existing surface and are still in service, they shall be protected and adjusted as required to the finished grade.

(12) Lines and Grades

Grades, lines and levels shall conform to the General Conditions and/or "Grades, Lines and Levels". Any damage to the above by the Contractor shall be re-established at the Contractor's expense. The Contractor shall furnish copies of all field notes and "cut sheets" to the City.

The location of the lines and grades indicated may be changed only by direction of the E/A. It is understood that the Contractor will be paid for Work actually performed on the basis of the unit Contract prices and that the Contractor shall make no claim for damages or loss of anticipated profits due to the change of location or grade.

All necessary batter boards or electronic devices for controlling the Work shall be furnished by, and at the expense of, the Contactor. Batter boards shall be of adequate size material and shall be supported substantially. The boards and all location stakes must be protected from possible damage or change of location. The Contractor shall furnish good, sound twilled lines for use in achieving lines and grades and the necessary plummets and graduated poles.

The Contractor shall submit to the E/A at least 6 copies of any layout Drawings from the pipe manufacturer for review and approval. The Contractor shall submit the layout Drawings at least 30 days in advance of any actual construction of the project. The E/A will forward all comments of the review to the Contractor for revision. Revisions shall be made and forwarded to the E/A for his acceptance. Prior to commencement of the Project, reviewed layout Drawings will be sent to the Contractor marked for construction.

Should the Contractor's procedures not produce a finished pipe placed to grade and alignment, the pipe shall be removed and relayed and the Contractors procedures modified to the satisfaction of the E/A. No additional compensation shall be paid for the removal and relaying of pipe required above.

(13) Surplus Excavated Materials

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

(14) Pipe Bedding Envelope

Pipe shall be installed in a continuous bedding envelope of the type shown on the drawings or as described herein. The envelope shall extend the full trench width, to a depth of at least 6 inches (150 mm) below the pipe and to a depth of the springline of storm water pipe and at least 12 inches (300 mm) above water, reclaimed, and wastewater pipe.

(a) Standard Bedding Materials

USE/PIPE MATERIAL	Cement Stabilized Backfill	Natural or Mf'd Sand	Pea Gravel	PIPE BEDDING STONE			
				Uncrushed Gravel	Crushed Gravel	Crushed Stone	Stone Screenings
WATER and RECLAIMED WATER							
Welded Steel	X					X	
Service Tubing ¾" to 2½"		X	X				X
WATER and RECLAIMED WATER (Ductile Iron)							
Up to 15 Inch ID		X	X	X			X
Larger Than 15 Inch ID			X	X			
WATER and RECLAIMED WATER (PVC only) and WASTEWATER							
Up to 15 Inch ID		X	X	X	X	X	X
Larger Than 15 Inch ID			X	X	X	X	
STORMWATER							
Concrete		X	X	X	X	X	X
Metal		X	X	X			X

(b) General requirements and limitations governing bedding selection.

(1) Crushed gravel or crushed stone shall not be used with polyethylene tubing or polyethylene film wrap.

(2) Uncrushed gravel may be used with polyethylene film wrap in trenches up to 6 feet deep and in deeper trenches where ample trench width, a tremmie, or conditions will allow controlled placement of the gravel without damaging the polyethylene wrap.

(3) Bedding shall be placed in lifts not exceeding 8 inches loose thickness and compacted thoroughly to provide uniform support for the pipe barrel and to fill all voids around the pipe.

(4) Pea Gravel or bedding stone shall be used in blasted trenches.

(c) Requirements to prevent particle migration.

Bedding material shall be compatible with the materials in the trench bottom, walls and backfill so that particle migration from, into or through the bedding is minimized. The E/A may require one or more of the following measures to minimize particle migration: use of impervious cut-off collars; selected bedding materials, such as pea gravel or bedding stone mixed with sand; filter fabric envelopment of the bedding; cement stabilized backfill; or other approved materials or methods. Measures to minimize particle migration will be shown on the Drawings or designated by the E/A, and, unless provisions for payment are provided in the contract documents, the cost of these measures shall be agreed by change order. The following limitations shall apply.

(1) Sand, alone, shall not be used in watercourses, in trenches where groundwater is present, or in trenches with grades greater than 5 percent.

(2) Pea gravel or bedding stone, alone, shall not be used in the street right-of-way within 5 feet of subgrade elevation in trenches that are 3 feet or wider.

(3) Each gravel or bedding stone, alone, shall not be used where the trench bottom, sides, or backfill is composed of non-cementitious, silty or sandy soils having plasticity indices less than 20, as determined by the E/A.

(4) Sand, alone, shall not be used for installation of concrete storm water pipe unless the bedding envelope is wrapped with a geotextile membrane and the joints of the stormdrain conduit are wrapped to prevent the migration of fines into the bedding envelope and into the stormdrain conduit.

(5) For concrete storm water pipe, if pea gravel, uncrushed gravel, crushed gravel, crushed stone, or combination thereof is used for pipe bedding material, a geotextile filter fabric shall be placed around the perimeter of the joint.

(15) Laying Pipe

No pipe shall be installed in the trench until excavation has been completed, the bottom of the trench graded and the trench completed as indicated.

Laying of corrugated metal pipes on the prepared foundation shall be started at the outlet end with the separate sections firmly joined together, with outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. Any metal in joints, which is not protected by galvanizing, shall be coated with suitable asphaltum paint. Proper facilities shall be provided for hoisting and lowering the sections of pipe into the trench without damaging the pipe or disturbing the prepared foundation and the sides of the trench. Any pipe which is not in alignment or which shows any undue settlement after laying or damage, shall be taken up and re-laid without extra compensation.

Multiple installations of corrugated pipe or arches shall be laid with the centerlines of individual barrels parallel. When not otherwise indicated, clear distances of 2 feet between outer surfaces of adjacent pipes shall be maintained.

No debris shall remain in the drainways or drainage structures.

All recommendations of the manufacturer shall be carefully observed during handling and installation of each material. Unless otherwise indicated, all materials shall be delivered to the project by the manufacturer or agent and unloaded as directed by the Contractor. Each piece shall be placed facing the proper direction near to where it will be installed.

The interior of all pipe, fittings and other accessories shall be kept free from dirt and foreign matter at all times and stored in a manner that will protect them from damage. Stockpiled materials shall be stacked so as to minimize entrance of foreign matter.

The interior of all pipeline components shall be clean, dry and unobstructed when installed.

Piping materials shall not be skidded or rolled against other pipe, etc. and under no circumstances shall pipe, fittings or other accessories be dropped or jolted.

During handling and placement, materials shall be carefully observed and inspected and any damaged, defective or unsound materials shall be marked, rejected and removed from the job site. Minor damage shall be marked and repaired in a manner satisfactory to the E/A. Joints, which have been placed, but not joined, backfilled, etc., shall be protected in a manner satisfactory to the E/A.

(16) Assembling of Pipe

Angular spacing of all joints shall meet the manufacturer's recommendations for the pipe and accessories being used. Side outlets shall be rotated so that the operating stems of valves shall be vertical when the valves are installed. Pressure pipe shall be laid with bell ends facing the direction of pipe installation. Pipe end bells shall be placed upgrade for all wastewater lines.

Orientation marks, when applicable, shall be in their proper position before pipe is seated.

Before joining any pipe, all foreign matter, lumps, blisters, excess coal tar coating, oil or grease shall be removed from the ends of each pipe and the pipe ends shall then be wire brushed and wiped clean and dry. Pipe ends shall be kept clean until joints are made.

Every precaution shall be taken to prevent foreign material from entering the pipe during installation. No debris, tools, clothing or other materials shall be placed in the pipe.

(17) Joints

(a) Mortar (Storm Drain joints only)

Pipe ends shall be clean, free of asphalt or other contaminants, which will inhibit the bond of the mortar to the pipe. The pipe ends shall be moistened immediately prior to placing the mortar in the joint.

(b) Cold Applied Preformed Plastic Gaskets (Storm Drain joints only)

The pipe ends shall be clean and the joint material applied to the dry pipe. In cold weather, the joint material shall be heated to facilitate the seal of the joint.

(c) O-Ring and Push-on Joints

Just before making a joint the ends of the pipe shall be clean, dry, free of any foreign matter, lump blisters, excessive coal tar coating and grease or oil and shall be wire brushed. The gasket and the inside surface of the bell shall be lubricated with a light film of soft vegetable soap compound (Flax Soap) to facilitate telescoping the joints. The rubber gasket if not factory installed shall be stretched uniformly as it is placed in the spigot groove to insure a uniform volume of rubber around the circumference of the groove. The spigot shall be centered in the bell, the pipe pushed home uniformly and brought into true alignment. Bedding material shall be placed and tamped against pipe to secure the joint. Care should be taken to prevent dirt or foreign matter from entering the joint space.

(d) Bolted Joints

All flanged, mechanical or other bolted joints shall be joined with nuts and bolts and be coated as indicated above in Iron Pipe.

(e) Storm Drain Joints

Storm drain joints sealed with preformed flexible joint sealants shall be provided and installed in compliance with ASTM C990. Storm drain joints sealed with rubber gaskets shall comply with ASTM C443 Install joint sealants in accordance with the pipe and joint sealant manufacturers'

recommendations. Place the joint sealer so that 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 with the final joint opening (gap) on the inside of the installed pipe being less than or equal to the pipe manufacturer's recommended dimensions. Protrusion of joint material greater than ⅛" into the interior of the pipe will not be accepted. Excess joint material will be removed to within ⅛''of pipe surface. Observe joint sealant manufacturer's recommendations for installation temperature of the joint sealant. Apply joint sealant to pipe joint immediately before placing pipe in trench, and then connect pipe to previously laid pipe.

If inspection (video or other means) reveal C-990 joints that show signs of backfill infiltration, or where joints or conduits exhibit excessive joint gap or are otherwise defective, then the contractor has the following options:

1. Conduits less than 36-inches in any dimension: pour a concrete collar around the joint or wrap joint with a wrap meeting requirements of ASTM C-877 or approved equal.
2. Conduits greater than or equal to 36-inches in all dimensions: repair joints using joint repair techniques recommended by the manufacturer to achieve a completed system that meets all Contract requirements.

(18) Pressure Pipe Laying

(a) Grout for Concrete Steel Cylinder Pipe (CSC) and Welded Steel Pipe

Aggregate, cement, etc., shall be as indicated in "Mortar" herein. Potable water shall be used in the preparation of any cement, mortar, or grout lining.

Grout shall be poured into the recess between the bell and spigot on the outside of the pipe and contained by a joint wrapper ("diaper") recommended by the pipe manufacturer. The wrapper shall have a minimum width of 7 inches for 30 inch and smaller and 9 inches for larger pipe, secured to the pipe by "Band Iron" steel straps. The grout shall be poured in one continuous operation in such manner that after shrinkage and curing the joint recess shall be completely filled.

Mortar for the inside recess shall be of the consistency of plaster. The inside recess between the bell and spigot shall be filled with mortar after the pipe joint on either side of the recess has been backfilled and well tamped with no less than one pipe joint installed ahead of the pipe forming the recess. The mortar shall completely fill the recess and shall be trowelled and packed into place and finished off smooth with the inside of the pipe.

The Contractor shall inspect the joint after the mortar has set and make repairs of any pockets, cracks or other defects caused by shrinkage to the satisfaction of the E/A. The inside surface shall be cleared of any mortar droppings, cement, water, slurry, etc., before they have become set and shall be cleared of any other foreign matter. The inside surface of the pipe shall be left clean and smooth.

Pipe shall be handled at all times with wide non abrasive slings, belts or other equipment designed to prevent damage to the coating and all such equipment shall be kept in such repair that its continued use is not injurious to the coating. The use of tongs, bare pinch-bars, chain slings, rope slings without canvas covers, canvas or composition belt slings with protruding rivets, pipe hooks without proper padding or any other handling equipment, which the E/A deems to be injurious to the coating, shall not be permitted. The spacing of pipe supports required to handle the pipe shall be adequate to prevent cracking or damage to the cement mortar lining.

(19) Placing Pipe in Tunnels

Piping installed as a carrier pipe in a tunnel, encasement pipe, etc., shall have uniform alignment, grade, bearing and conform to the reviewed Shop Drawings. All necessary casing spacers, bedding material, grout cradle or paving, bracing, blocking, etc., as stipulated by the Contract or as may be required to provide and maintain the required pipe alignment and grade, shall be provided by the Contractor at no cost except as provided by the Bid Items. This shall include casing spacers acceptable to the Owner attached to the carrier pipe in accordance with the manufacturer's recommendations. The insertion pushing forces shall not exceed the pipe manufacturer's recommendation. Such carrier piping shall have flexible bolted or gasketed push-on joints or Concrete Steel Cylinder pipe installed as follows:

(a) 21 Inch Pipe and Smaller

Prior to placing the pipe in the tunnel, the inside joint recess at the bell shall be buttered with cement mortar.

After the joint is engaged, the excess mortar shall be smoothed by pulling a tight fitting swab through the joint. Cement mortar protection shall then be placed in the normal manner to the exterior of the joint and allowed to harden sufficiently to avoid dislodgment during installation. If time is of the essence, a quick setting compound may be used.

(b) 24 Inch Pipe and Larger

Each length of pipe shall be pushed into the tunnel as single units. A flexible mastic sealer shall be applied to the exterior of the joint prior to joint engagement. The surfaces receiving the mastic sealer shall be cleaned and primed in accordance with the manufacturer's recommendation. Sufficient quantities of the mastic sealer shall be applied to assure complete protection of all steel in the joint area. The interior of the joint shall be filled with cement mortar in the normal manner after the pipe is in its final position within the tunnel.

(20) Temporary Pipe Plugs, Caps, Bulkheads and Trench Caps

Temporary plugs, caps or plywood bulkheads shall be installed to close all openings of the pipe and fittings when pipeline construction is not in progress.

All temporary end plugs or caps shall be secured to the pipe as provided under Item No. 507, "Bulkheads".

Trench caps shall be reinforced Class D concrete as indicated.

(21) Corrosion Control

(a) Protective Covering

Unless otherwise indicated, all flanges, nuts, bolts, threaded outlets and all other iron or steel components buried and in contact with earth or backfill shall be wrapped with 8-mil (minimum) polyethylene film meeting ANSI/AWWA C-105 to provide a continuous wrap.

(22) Pipe Anchorage, Support and Protection

Pressure pipeline tees, plugs, caps and bends exceeding 22½ degrees; other bends as directed shall be securely anchored by suitable concrete thrust blocking or by approved metal harness. Unless otherwise indicated, on 24 inch or larger piping, all bends greater than 11 ¼ degrees shall be anchored as described herein.

Storm sewers on steep grades shall be lugged as indicated.

(a) Concrete Thrust Blocking

Concrete for use as reaction or thrust blocking shall be Class B conforming to Item No. 403, "Concrete for Structures".

Concrete blocking shall be placed between solid ground and the fitting to be anchored. The area of bearing on the pipe and on the ground shall be as indicated or directed by the E/A. The blocking shall, unless otherwise indicated, be so placed that the pipe, fittings and joints will be accessible for repair.

The trench shall be excavated at least 6 inches outside the outermost projections of the pipe or appurtenance and the trench walls shaped or undercut according to the detail Drawings or as required to provide adequate space and bearing area for the concrete.

The pipe and fittings shall be adequately weighted and laterally braced to prevent floating, shifting or straining of the pipeline while the concrete is being placed and taking initial set. The Contractor shall be solely responsible for the sufficiency of such restraints.

(b) Metal Thrust Restraint

Fabricated thrust restraint systems such as those described below may be approved for use instead of concrete blocking. To obtain approval, the project Drawings must include sufficient drawings, notes, schedules, etc., to assure that the proposed restraints as installed will be adequate to prevent undesirable movement of the piping components. Such restraint systems may only be used where and as specifically detailed and scheduled on approved Project Drawings.

1. Thrust Harness

A metal thrust harness of tie rods, pipe clamps or lugs, turnbuckles, etc., may be approved. All carbon steel components of such systems, including nuts and washers, shall be hot-dip galvanized; all other members shall be cast ductile iron. After installation, the entire assembly shall be wrapped with 8-mil polyethylene film, overlapped and taped in place with duct tape to form a continuous protective wrap.

2. Restrained Joints

Piping or fitting systems utilizing integral mechanically restrained joints may be approved. All components of such systems shall be standard manufactured products fabricated from cast ductile iron, hot-dip galvanized steel, brass or other corrosion resistant materials and the entire assembly shall be protected with a continuous film wrap as described for 1. above. Manufacturers of pipe with restrained joints integral to the pipe shall be listed on SPL WW-27F. All pipe and fitting systems with restrained joints shall be identified by applying an adhesive-backed warning tape to the top of the pipe and for the full length of the pipe, regardless of the type of pipe. For plastic pipes the warning tape shall be applied directly to the top of the pipe. For metal pipes and fittings the warning tape shall be applied to the top of the polyethylene film wrap. The warning tape shall conform to 510.2(8)(b)5.

Location, configuration and description of such products shall be specifically detailed on the Drawings. (Add-on attachments such as retainer glands, all-thread rods, etc., are not acceptable.)

(c) Concrete Encasement, Cradles, Caps and Seals

When trench foundation is excessively wet or unstable or installation of water or wastewater pipe will result in less than 30 inches of cover, Contractor shall notify E/A. E/A may require Contractor to install a concrete seal, cradle, cap, encasement or other appropriate action.

All concrete cap, etc., shall be continuous and begin and end within 6 inches of pipe joints. Concrete cap, cradle and encasement shall conform to City of Austin Standard No. 510S-1, "Concrete Trench Cap". The pipe shall be well secured to prevent shifting or flotation while the concrete is being placed.

(d) Anchorage Bulkheads

Concrete bulkheads keyed into the undisturbed earth shall be placed as indicated to support and anchor the pipe and/or backfill against end thrust, slippage on slopes, etc. Concrete material and placement shall be Class A, Item No. 403, "Concrete for Structures".

(e) Trench Caps, Concrete Rip-Rap and Shaped Retards

Where called for by the Contract or as directed by the E/A, concrete trench caps, concrete rip-rap and/or shaped retards shall be placed as detailed by the Drawings as protection against erosion. Concrete material and placement shall be Class B, Item No. 403, "Concrete for Structures".

(23) Wastewater Connections

(a) Connections to Mains 12 Inches and Smaller

All branch connections of new main lines shall be made by use of manholes.

Service stubs shall be installed as indicated. Minimum grade shall be 1 percent downward to main and minimum cover shall be 4½ feet at the curb. Standard plugs shall be installed in the dead end before backfilling.

Where a service connection to a main 12 inches or smaller is indicated, a wye, tee or double wye shall be installed.

Where a service connection to a main 15 inches or larger is indicated, a field tap may be made with the pipes installed crown to crown. The tap should be made conforming to the pipe manufacturer's recommendations with the E/A's approval.

Where not otherwise indicated, (wastewater) service connections shall be installed so that the outlet is at an angle of not more than 45 degrees above horizontal at the main line.

(b) Connections to the Existing System

Unless otherwise specified by the E/A, all connections made to existing mains shall be made at manholes with the crown of the inlet pipe installed at the same elevation as the crown of the existing pipe. Service stubs installed on the existing system shall be installed by use of tapping saddles unless otherwise approved by the E/A. Extreme care shall be exercised to prevent material from depositing in the existing pipe as the taps are being made.

When connections to existing mains are made, a temporary plug approved by the E/A must be installed downstream in the manhole to prevent water and debris from entering the existing system before Final Completion. These plugs shall be removed after the castings are adjusted to finish grade or prior to Final Completion.

(c) Connecting Existing Services to New Mains

Where wastewater services currently exist and are being replaced from the main to the property line, those services shall be physically located at the property line prior to installing any new mains into which the services will be connected. Where wastewater services currently exist but are not being replaced to the property line, those services shall be physically located at the point of connection between the new and existing pipes prior to installing any new mains into which the services will be connected.

(24) Potable or Reclaimed Water System Connections

All necessary connections of new piping or accessories to the existing potable or reclaimed water system shall be made by, and at the expense of, the Contractor. To minimize any inconvenience from outages, the Contractor shall schedule all such connections in advance and such schedule must be approved by the E/A before beginning any Work.

(a) Shutoffs

The City will make all shutoffs on existing potable or reclaimed water mains. The Contractor shall be required to notify the Owner's Representative in writing a least twenty five (25) Calendar Days prior to the anticipated date for a wet-connection. The Owner's Representative is defined as the City Inspector. The Owner's Representative will notify any affected utility customers at least 48 hours prior to the shutoff. Austin Water (AW) will make the shutoff after ensuring that all appropriate measures have been taken to protect the potable or reclaimed water system, customers and employees.

The City will operate all valves to fill existing mains. Where a newly constructed main has not been placed in service and has only one connection to the potable or reclaimed system, the Contractor may operate one valve to fill the main after approval has been obtained from AW. The operation of the valve is to be conducted under the immediate supervision of the Owner's Representative.

Water for the Work shall be metered and furnished by the Contractor in accordance with Section 01500 of the Standard Contract Documents.

(b) Wet Connections to Existing Potable or Reclaimed Water System

The Contractor shall make all wet connections called for by the Contract or required to complete the Work. Two connections to an existing line performed during the same shutout, at the same time and at a distance less than 50 linear feet apart, will be considered one wet connection. Two connections to an existing line performed during the same shutout, at the same time and at a distance equal to, or greater than 50 linear feet will be considered two wet connections. A wet connection shall include draining and cutting into existing piping and connecting a new pipeline or other extension into the existing pressure piping, forming an addition to the potable or reclaimed water transmission and distribution network.

The Contract price for wet connections shall be full payment for all necessary shutoffs, excavation, removing plugs and fittings, pumping water to drain the lines, cutting in new fittings, blocking and anchoring piping, bedding and backfilling, placing the lines and service and all site cleanup.

No water containing detectable amounts of chlorine may be drained, released or discharged until specific planning and appropriate preparations to handle, dilute and dispose of such chlorinated water are approved in advance by the City and the disposal operations will be witnessed by an authorized representative from the City.

(c) Pressure Taps to Existing Potable or Reclaimed Water System

The Contractor shall make all pressure taps called for by the Contract Documents or required to complete the Work. A pressure tap shall consist of connecting new piping to the existing potable or reclaimed water system by drilling into the existing pipe while it is carrying water under normal pressure without taking the existing piping out of service.

Unless otherwise provided by the Contract, the Contractor shall, at the Contractor's expense, perform all necessary excavation, furnish and install the tapping sleeve, valve and accessories, provide the tapping machine, drill the tap and shall block, anchor and backfill the piping, valve

and all accessories, place the new piping in service and perform all site cleanup. When the City makes the tap, City forces are not obligated or expected to perform any Work except to provide tapping machine and drill the actual hole. If City crews are to make the tap, fiscal arrangements must be made in advance at the Taps Office, Waller Creek Center, 625 East 10th Street.

If a private Contractor makes the tap, an AW Inspector must be present. "Size on size" taps will not be permitted, unless made by use of an approved full bodied mechanical joint tapping sleeve. Concrete blocking shall be placed behind and under all tap sleeves 24 hours prior to making the wet tap.

(d) Service Connections

Service connection taps into PVC or AC pipe or into CI or DI pipe 12 inches or smaller shall be made using either a service clamp or saddle or a tapping sleeve as recommended by the pipe manufacturer and as approved by the E/A. Direct tapping of these pipes will not be permitted.

All potable or reclaimed water service connections shall be installed so that the outlet is at an angle of not more than 45 degrees above horizontal at the main line.

Precautions should be taken to ensure that the tapping saddle or sleeve is placed on the pipe straight to prevent any binding or deformation of the PVC pipe. The mounting chain or U-bolt strap must be tight.

Tapping shall be performed with a sharp shell type cutter so designed that it will smoothly penetrate heavy walled PVC DR14 and 200 psi AC and will retain and extract the coupon from the pipe.

(25) Backfilling

(a) General

Special emphasis is placed upon the need to obtain uniform density throughout the backfill material. The maximum lift of backfill shall be determined by the compaction equipment selected and in no case shall it exceed 18 inches, loose measurement.

No heavy equipment, which might damage pipe, will be allowed over the pipe until sufficient cover has been placed and compacted. All internal pipe bracing installed or recommended by the manufacturer shall be kept in place until the pipe bedding and trench backfill have been completed over the braced pipe section. Testing of the completed backfill in streets and under and around structures shall meet the specified density requirements. Initial testing shall not be at Contractor's expense and shall conform to the "General Conditions."

(b) General Corrugated Metal Pipe

After the corrugated metal pipe structure has been completely assembled on the proper line and grade and headwalls constructed where indicated; selected material free from rocks over 8 inches in size from excavation or borrow, as approved by the E/A, shall be placed along both sides of the completed structures equally, in uniform layers not exceeding 6 inches in depth (loose measurement), sprinkled if required and thoroughly compacted between adjacent structures and between the structures and the sides of the trench.

Backfill material shall be compacted to the same density requirements as indicated for the adjoining sections of embankment in accordance with the governing specifications thereof. Above the ¾ point of the structure, the fill shall be placed uniformly on each side of the pipe in layers not to exceed 12 inches, loose measure.

Prior to adding each new layer of loose backfill material, until a minimum of 12 inches of cover is obtained over the crown of the pipe, an inspection will be made of the inside periphery of the

corrugated metal structure to determine if any floating, local or unequal deformation has occurred as a result of improper construction methods.

(c) Backfill Materials

The Engineer or designated representative may approve any of the following well graded materials as backfill:

1. Select trench material
2. Sand
3. Crushed rock cuttings
4. Rock cuttings
5. Foundation Rock
6. Blasted material with fines and rock
7. Cement stabilized material
8. Borrow

Within the 100-year flood plain, sand will not be permitted for backfilling. The Engineer or designated representative will approve the topsoil for areas to be seeded or sodded.

(d) Backfill in Street Right-of-Way

Placement of backfill under existing or future pavement structures and within 2 feet of any structures shall be compacted to the specified density using any method, type and size of equipment, which will produce the specified compaction without damaging the pipe or bedding. Placement of backfill greater than 2 feet beyond structures in right-of-way shall conform to (g) below.

The thickness of lifts, prior to compaction, shall depend upon the type of sprinkling and compacting equipment used and the test results thereby obtained. Prior to and in conjunction with the compaction operation, each lift shall be brought to the moisture content necessary to obtain the specified density and shall be placed in a uniform thickness to ensure uniform compaction over the entire lift. Testing for density shall be in accordance with Test Method Tex-114-E and Test Method Tex-115-E.

It is highly desirable that the backfill lifts be placed in a flat (or level) configuration; however when approved by the Engineer or designated representative, the backfill lifts may be placed at gradients (percent of vertical rise or fall to horizontal run) that do not exceed 30%.

The proposed gradient for each lift or series of lifts shall be established based on the capabilities of the equipment proposed to attain the required compaction.

Each lift of backfill must provide the density as specified herein. Swelling soils (soils with a minimum Liquid Limit of 50, more than 50% passing a #200 sieve and a plasticity index greater than 22) shall be sprinkled as required to provide not less than optimum moisture nor more than 2 percent over optimum moisture content and compacted to the extent necessary to provide not less than 95 percent nor more than 102 percent of the density as determined in accordance with Test Method Tex-114-E. Non-swelling soils shall be sprinkled as specified and compacted to the extent necessary to provide not less than 95 percent of the density as determined in accordance with Test Method Tex-114-E.

After each lift of backfill is complete, tests may be made by the Engineer or designated representative. If the material fails to meet the density indicated, the course shall be reworked

as necessary to obtain the indicated compaction and the compaction method shall be altered on subsequent Work to obtain indicated density.

At any time, the Engineer or designated representative may order proof rolling to test the uniformity of compaction of the backfill lifts. All irregularities, depressions, weak or soft spots that develop shall be corrected immediately by the Contractor.

If the backfill, due to any reason, loses the specified stability, density or finish before the pavement structure is placed, it shall be recompacted and refinished at the sole expense of the Contractor. Excessive loss of moisture in the subgrade shall be prevented by sprinkling, sealing or covering with a subsequent backfill layer or granular material. Excessive loss of moisture shall be construed to exist when the subgrade soil moisture content is more than 4 percent below the optimum of compaction ratio density. Backfill shall be placed from the top of the bedding material to the existing grade, base course, subgrade or as specified. The remainder of the street backfill shall either be Flexible Base, Concrete or Hot Mix Asphalt Concrete as specified on the drawings or replacement "in kind" to the surface of the materials originally removed for placement of the pipe.

(e) Backfill in County Street or State Highway Right-of-Way

All Work within the right-of-way shall meet the requirements of (d) above, as a minimum and shall meet the requirements of the permit issued by the County when their requirements are more stringent. Prior to the start of construction, the Contractor shall be responsible for contacting the appropriate TxDOT office or County Commissioner's Precinct Office and following the operating procedures in effect for utility cut permits and pavement repair under their jurisdiction. Approval for all completed Work in the State or County right-of-way shall be obtained from the appropriate Official prior to final payment by the Owner.

(f) Backfill in Railroad Right-of-Way

All Work within the railroad right-of-way shall meet the requirements of (d) above, as a minimum and shall meet the requirements of the permit issued by the Railroad Owner when their requirements are more stringent. Approval for all completed Work in the railroad right of way shall be obtained from the Railroad prior to Final Completion.

(g) Backfill in Easements

Where not otherwise indicated, Contractor may select whatever methods and procedures may be necessary to restore entire Work area to a safe, useful and geologically stable condition with a minimum density of 85 percent or a density superior to that prior to construction.

In and near flood plain of all streams and watercourses, under or adjacent to utilities, structures, etc. all backfill shall be compacted to a density of not less than 95 percent conforming to TxDOT Test Method Tex-114-E, unless otherwise directed by E/A.

All soil areas disturbed by construction shall be covered with top soil and seeded conforming to Item No. 604, "Seeding for Erosion Control". All turf, drainways and drainage structures shall be constructed or replaced to their original condition or better. No debris shall remain in the drainways or drainage structures.

(h) Temporary Trench Repair/Surfacing

If details of temporary trench repair/surfacing are not provided in the contract documents, the Contractor shall submit for approval of the E/A (1) a plan for temporary trench repair for areas that will be open to traffic but will be excavated later for full depth repair, and (2) a proposed method for covering trenches to maintain access to properties. The temporary surfacing shall

afford a smooth riding surface and shall be maintained by the Contractor the entire time the temporary surface is in place.

(i) Permanent Trench Repair

The Contractor shall install permanent trench repairs conforming to details in the drawings.

(26) Quality Testing for Installed Pipe

(a) Wastewater Pipe Acceptance Testing

After wastewater pipe has been backfilled, the Contractor shall perform infiltration tests, exfiltration tests, or low pressure air tests as determined by the E/A. In addition, the Contractor shall perform deflection tests and shall assist OWNER'S personnel, as directed, in performing pipeline settlement tests. The Contractor shall be responsible for making appropriate repairs to those elements that do not pass any of these tests.

(b) Exfiltration Test

Water for the Work shall be metered and furnished by the Contractor in accordance with Section 01500 of the Standard Contract Documents.

Exfiltration testing shall be performed by the Contractor when determined by the E/A to be the appropriate test method. Exfiltration testing shall conform to requirements of the Texas Commission on Environmental Quality given in the Texas Administrative Code Title 30 Part 1 Chapter 317 Rule §317.2.

(c) Infiltration Test

Infiltration testing shall be performed by the Contractor when determined by the E/A to be the appropriate test method. Infiltration testing shall conform to requirements of the Texas Commission on Environmental Quality given in the Texas Administrative Code Title 30 Part 1 Chapter 317 Rule §317.2.

(d) Pipeline Settlement Test

During the infiltration test or after the exfiltration test, the pipe will be TV inspected for possible settlement. When air testing has been used, water shall be flowed into the pipe to permit meaningful observations. Any pipe settlement which causes excessive ponding of water in the pipe shall be cause for rejection. Excessive ponding shall be defined as a golf ball (1⅝" dia.) submerged at any point along the line.

(e) Low Pressure Air Test of Gravity Flow Wastewater Lines

(1) General

Wastewater lines up to 33-inch diameter shall be air tested between manholes. Wastewater lines 36-inch in diameter and larger shall be either air tested between manholes or at pipe joints. Backfilling to grade shall be completed before the test and all laterals and stubs shall be capped or plugged by the Contractor so as not to allow air losses, which could cause an erroneous, test result. Manholes shall be plugged so they are isolated from the pipe and cannot be included in the test.

All plugs used to close the sewer for the air test shall be capable of resisting the internal pressures and must be securely braced. Place all air testing equipment above ground and allow no one to enter a manhole or trench where a plugged sewer is under pressure. Release all pressure before the plugs are removed. The testing equipment used must include a pressure relief device designed to relieve pressure in the sewer under test at 10 psi or less and must allow continuous monitoring of the test pressures in order to avoid

excessive pressure. Use care to avoid the flooding of the air inlet by infiltrated ground water. (Inject the air at the upper plug if possible.) Use only qualified personnel to conduct the test.

(2) Ground Water

Since the presence of ground water will affect the test results, test holes shall be dug to the pipe zone at intervals of not more than 100 feet and the average height of ground water above the pipe (if any) shall be determined before starting the test.

(3) Test Procedure

The E/A may, at any time, require a calibration check of the instrumentation used. Use a pressure gauge having minimum divisions of 0.10 psi and an accuracy of 0.0625 psi. (One ounce per square inch.) All air used shall pass through a single control panel. Clean the sewer to be tested and remove all debris where indicated. Wet the sewer prior to testing. The average back pressure of any groundwater shall be determined (0.433 psi) for each foot of average water depth (if any) above the sewer.

Add air slowly to the section of sewer being tested until the internal air pressure is raised to 3.5 psig greater than the average back pressure of any ground water that may submerge the pipe. After the internal test pressure is reached, allow at least 2 minutes for the air temperature to stabilize, adding only the amount of air required to maintain pressure. After the temperature stabilization period, disconnect the air supply. Determine and record the time in seconds that is required for the internal air pressure to drop from 3.5 psig to 2.5 psig greater than the average backpressure of any ground water that may submerge the pipe.

For pipe less than 36-inch diameter, compare the time recorded with the time computed using the following equation:

$T = (0.0850 \times D \times K) \div Q$, where

T = time for pressure to drop 1.0 pounds per square inch gauge in seconds;

K = $0.000419 \times D \times L$, but not less than 1.0

D = nominal inside diameter, in inches, as marked on the pipe;

L = length of line of same pipe size in feet; and

Q = rate of loss, 0.0015 cubic feet per minute per square foot of internal surface area (ft3/min/ft sq) shall be used.

Because a K value of less than 1.0 shall not be used, there are minimum test times for each pipe diameter as shown in the following table:

Table For Low Pressure Air Testing of Pipe

Pipe Diameter (inches)	Minimum Time (seconds)	Minimum Time Applies to All Pipes Shorter than (feet)	Time for Longer Pipes (seconds)
8	454	298	1.520 × L
10 (See Note 1)	567	239	2.374 × L
12	680	199	3.419 × L
15	850	159	5.342 × L
18	1020	133	7.693 × L

21	1190	114	10.471 × L
24	1360	100	13.676 × L
30	1700	80	21.369 × L

Note 1. 10-inch diameter pipe to be used only by AW maintenance personnel.

Note 2. The test parameter for pipes larger than 30-inch diameter shall be shown on the construction plans.

Any drop in pressure, from 3.5 psig to 2.5 psig (adjusted for groundwater level), in a time less than that required by the above equation or table shall be cause for rejection. When the line tested includes more than one size pipe, the minimum time shall be that given for the largest size pipe included.

When joint testing, the minimum time allowable for the pressure to drop from 3.5 pounds per square inch to 2.5 pounds per square inch gauge during a joint test, regardless of pipe size, shall be twenty (20) seconds. A drop in pressure from 3.5 psig to 2.5 psig (adjusted for groundwater level) in less than twenty seconds shall be cause for rejection.

Manholes must be tested separately and independently. All manholes must be hydrostatically tested with a maximum loss allowance of 0.025 gallon per foot diameter per foot of head per hour.

When lines are air tested, manholes are to be tested separately by exfiltration or vacuum method (see Standard Specification Item No. 506S, "Manholes").

(f) Deflection Test

Deflection tests shall be performed by the Contractor on all flexible and semi-rigid wastewater pipes. The tests shall be conducted after the final backfill has been in place at least 30 days. Testing for in-place deflection shall be with a pipe mandrel at 95% of the inside diameter of the pipe. A second test of flexible and semi-rigid wastewater pipes 18 inch size and larger, also with a pipe mandrel sized at 95% of the inside diameter of the pipe, shall be conducted by the Contractor 30 days before the warranty expires on the Contractor's Work.

Contractor shall submit proposed pipe mandrels to the E/A or the E/A's designated representative for concurrence prior to testing the line.

Test(s) must be performed without mechanical pulling devices and must be witnessed by the E/A or the E/A's designated representative.

Any deficiencies noted shall be corrected by the Contractor and the test(s) shall be redone.

(g) Inspection of Installed Storm Drain Conduits

(1) General

All storm drain conduits (pipe and box culvert) shall be inspected for conformance to the requirements of this specification. Smart Housing, low/moderate income housing, and projects that are 100-percent privately funded are exempt from the cost of the initial video inspection. All deficiencies revealed by inspection shall be corrected. Video re-inspection meeting the requirements of this specification shall be provided at the Contractor's expense to show that deficiencies have been corrected satisfactorily. Further, the contractor shall provide video in complete segments (manhole to manhole) versus specific deficiency locations.

Projects that are not exempt from the cost of the initial video inspection are also subject to the following constraints:

- All inspectors utilized by the Contractor for video inspection shall be NASSCO-PACP certified for a minimum of 3 years.
- The Contractor will be required to inspect, assess, and record the condition of the storm drain pipe using National Association of Sewer Service Companies (NASSCOs) Pipeline Assessment Certification Program (PACP) coding standards.

(2) Video Inspection of Installed Storm Drain Conduits

Contractor shall provide all labor, equipment, material and supplies and perform all operations required to conduct internal closed-circuit television and video recording of all storm drain conduits. Video recording of each storm drain conduit section shall be conducted after the trench has been backfilled and prior to placement of permanent pavement repairs or permanent pavement reconstruction. The video recording shall be provided to the Owner for review. Contractor shall not place permanent pavement repairs or permanent pavement reconstruction over the storm drain conduit until Owner has reviewed the video and agrees that there are no defects in the storm drain conduit installation shown in the video submitted by the Contractor or shown in any video acquired by the Owner through other means. Placement of permanent pavement repair or permanent pavement reconstruction over the installed storm drain conduit before the Owner acknowledges no defects shall be at the Contractor's risk. Any defects revealed by the video inspection shall be corrected at the Contractor's expense and a new video submitted to the Owner for review prior to acceptance of the conduit.

All video work shall be conducted under the direct full-time supervision of a NASSCO-PACP certified operator.

The conduit inspection camera shall have the capability of panning plus/minus 275 degrees and rotating 360 degrees. The television camera shall be specifically designed and constructed for such use. The camera shall be operative in 100% humidity conditions. Camera shall have an accurate footage counter that displays on the monitor the exact distance of the camera (to the nearest tenth of a foot) from the centerline of the starting manhole or access point. Camera shall have height adjustment so that the camera lens is always centered within plus/minus 10% of the center axis of the conduit being videoed. Camera shall provide a minimum of 460 lines of horizontal resolution and 400 lines of vertical resolution. Camera shall be equipped with a remote iris to control the illumination range for an acceptable picture. Geometrical distortion of the image shall not exceed one percent (1%). The video image produced by each camera shall be calibrated using a Marconi Resolution Chart No. 1 or equivalent.

Lighting for the camera shall be sufficient to allow a clear picture of the entire periphery of the conduit without loss of contrast, flare out of picture or shadowing. A reflector in front of the camera may be required to enhance lighting in dark or large sized conduit. The video camera shall be capable of showing on the digital display the Owner's name, Project name, Contractor name, date, line size and material, conduit identification, and ongoing footage counter. The camera, television monitor, and other components of the video system shall be capable of producing a picture quality satisfactory to the satisfaction of the Owner. The recording of the internal condition of the storm drain conduit shall be clear, accurate, focused and in color. If the recording fails to meet these requirements, the, equipment shall be removed and replaced with equipment that is suitable. No payment will be made for an unsatisfactory recording.

If during video inspection, water is encountered inside the conduit, the conduit shall be dewatered by the Contractor. The storm drain section must be dry. Video recording conducted while the camera is floating is not acceptable unless approved by the Owner.

If during video inspection, debris is encountered that prohibits a proper inspection of the conduit, the Contractor shall remove the debris before proceeding.

All video shall be documented using a data logger and reporting system that are PACP compliant and which use codes as established by the National Association of Sewer Service Companies (NASSCO)s - Pipeline Assessment and Certification Program (PACP).

Computer printed location records shall be kept by the Contractor and shall clearly show the location and orientation of all points of significance such as joints, conduit connections, connections at manholes and inlets, and defects. Copy of all records shall be supplied to the Owner. Noted defects shall be documented as color digital files and color hard copy print-outs. Photo logs shall accompany each photo submitted.

The video recording shall supply a visual and audio record of the storm drain conduits that may be replayed. Video recordings shall include an audio track recorded by the video technician during the actual video work describing the parameters of the storm drain conduit being videoed (i.e. location, depth, diameter, pipe material), as well as describing connections, defects and unusual conditions observed during the video work. Video recording playback shall be at the same speed that it was recorded. Slow motion or stop-motion playback features may be supplied at the option of the Contractor. Once videoed, the CDs/DVDs shall be labeled and become the property of the Owner. The Contractor shall have all video and necessary playback equipment readily accessible for review by the Owner while the project is under construction.

Post-installation video shall not be completed until all work is completed on a section of storm drain conduit. Post-installation video work shall be completed by the Contractor in the presence of the Owner. The post-installation video work shall be completed to confirm that the storm drain conduits are free of defects. Provide a color video showing the completed work. Prepare and submit video logs providing location of storm drain conduit along with location of any defects. Manhole and inlet work shall be complete prior to post-installation video work.

For post-installation video, exercise the full capabilities of the camera equipment to document the completion and conformance of the storm drain installation work with the Contract Documents. Provide a full 360-degree view of conduit, all joints, and all connections. The camera shall be moved through the storm drain conduit in either direction at a moderate rate, stopping and slowly panning when necessary to permit proper documentation of the conduit condition at each pipe connection, joint, and defect. In no case shall the camera be pulled at a speed greater than 30 feet per minute. Manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the storm drain conditions shall be used to move the camera through the storm drain conduit. When manually operated winches are used to pull the camera through the conduit, telephones or other suitable means of communication shall be set up between the two access points of the conduit being videoed to insure good communication between members of the video crew.

Distance measurements shall be provided to an accuracy of one tenth of a foot.

Video shall be continuous for each storm drain conduit segment. Do not show a single segment on more than one CD/DVD, unless specifically allowed by the Owner.

Contractor shall submit to Owner the following:

A. National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP) certification of operators who will be performing video work.

B. Compact Disc (CD) or Digital Video Disc (DVD) of recording of storm drain conduits (concrete storm water pipe or box culvert).

a. The color CD or DVD shall include a digital color key map in a format acceptable to the Owner with each segment of storm drain conduit labeled with the appropriate inspection ID on the map.

b. The file folder for each segment of the storm drain conduit shall have a unique name based on the Owner's approved inspection naming convention and shall contain the following:

i. Video files

ii. Video inspection logs with information coded in accordance with the PACP

iii. Photo logs

iv. A report summarizing the results of the video inspection

v. A proposed method of repair for any defects discovered.

(3) Time commitments from City for projects that are exempt from the cost of the initial video inspection

Projects that are exempt from the cost of the initial video inspection are afforded the following time commitments from the City.

A. Initial inspection - contractor must inform the City of Austin construction inspector assigned to the project in writing that all stormdrain infrastructure for the project has been completed according to the permit and is ready for inspection. The inspector will then notify the Watershed Protection Department (WPD) in writing that the all of the stormdrain infrastructure for the project has been completed and is ready for inspection. The WPD is allowed 15-days to complete inspection from written notification by the inspector. The outcome of this item does not impact the one-year warranty requirements.

B. Video re-inspection by the contractor for deficient installed stormdrain infrastructure. The contractor must submit the video inspection data as defined in this specification to the City of Austin construction inspector assigned to the project along with a written letter of transmittal certified by a professional engineer stating that all identified stormdrain infrastructure installation deficiencies for the project have been corrected. The inspector will then notify the Watershed Protection Department (WPD) in writing and convey the video inspection data to the WPD. The WPD is allowed 15-days to complete review of the data from the date of delivery by the inspector.

(27) Pressure Pipe Hydrostatic Testing

After the pipe has been installed and backfilled and all service laterals, fire hydrants and other appurtenances installed and connected, a pressure test, followed by a leakage test, will be conducted by the City. The City will furnish the pump and gauges for the tests. The Contractor shall be present and

shall furnish all necessary assistance for conducting the tests. The specified test pressures will be based on the elevation of the lowest point of the line or section under test. Before applying the specified test pressure, all air shall be expelled from the pipe. If permanent air vents are not located at all high points, the Contractor shall install corporation cocks at such points.

All drain hydrant and fire hydrant leads, with the main 6-inch gate valve open, the hydrant valve seats closed and no nozzle caps removed, shall be included in the test.

(a) Pressure Test

The entire project or each valved section shall be tested, at a constant pressure of 200 psi for a sufficient period (approximately 10 minutes) to discover defective materials or substandard work. The Contractor assumes all risks associated with testing against valves. Repairs shall be made by the Contractor to correct any defective materials or substandard work. The Contractor shall pre-test new lines before requesting pressure tests by City Forces. The Contractor shall have new lines pressurized to a minimum of 100 psi, on the date of testing, prior to arrival of City Forces.

(b) Leakage Test

A leakage test will follow the pressure test and will be conducted on the entire project or each valved section. The Contractor assumes all risks associated with testing against valves. The leakage test shall be conducted at 150 psi for at least 2 hours. The test pressure shall not vary by more than ±5 psi for the duration of the test.

(1) Allowable Leakage

Leakage shall be defined as the quantity of water that must be supplied into any test section of pipe to maintain the specified leakage test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.

No pipe installation will be accepted if leakage exceeds the amount given by the following formula:

Allowable leakage (gal/hr) = [L × D] ÷ 10,875

Where L = length of pipe tested, in feet
D= nominal pipe diameter, in inches, as marked on the pipe

(2) Location and Correction of Leakage

If such testing discloses leakage in excess of this specified allowable, the Contractor, at the Contractor's expense, shall locate and correct all defects in the pipeline until the leakage is within the indicated allowance.

All visible leakage in pipe shall also be corrected by Contractor at the Contractor's expense.

(28) Service Charges for Testing

Initial testing performed by City forces for the Contractor will be at the City's expense. Retesting, by City forces, of Contractor's work that fails initial testing will be at the Contractor's expense. The City's charge for retests will be a base fee plus an hourly rate published in the current AW Fee Schedule. On City-funded projects, the charges incurred by the City for retesting will be deducted from funds due the Contractor. On non-City-funded projects, the charges incurred by the City for retesting will be billed to the Contractor. The City will withhold acceptance of the Contractor's work until the Contractor has paid the City for the retesting costs.

(29) Disinfection of Potable Water Lines

Prior to performing any disinfection of potable water lines, the Contractor shall submit a Disinfection Plan (Plan) and obtain approval in accordance with COA specification 01300, Submittals. The Plan shall comply with AWWA C651 (Disinfecting Water Mains) and AWWA C655 (Field Dechlorination), latest editions, and shall be developed using one of the following templates, unless otherwise approved by the Engineer and/or AW: Disinfection Plan for Tablet/Granule Method, or Disinfection Plan for Continuous-Feed Method. Templates for these two methods are located at http://www.austintexas.gov/department/construction-standards . The Contractor shall decide which disinfection method to use for a given project. The Slug Method and Spray Method are also acceptable if better suited for disinfection. The initial plan shall be submitted for review a minimum of 60 calendar days prior to when the water main is scheduled to be placed into service, or at the preconstruction conference if the project requires that the waterline be placed in service in less than 60 days, as indicated in the Contractor's Construction Schedule. If any appurtenances are required for injection, sampling, or flushing purposes that are not shown in the original plan/profile sheets, then the Contractor shall include the appurtenances in the project Record Drawings. The Contractor shall disinfect potable water lines only in accordance with an approved Plan.

(a) Preventing Contamination

The Contractor shall protect all piping materials from contamination during storage, handling and installation. Prior to disinfection, the pipeline interior shall be clean, dry and unobstructed. All openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped at the close of the day's work.

(b) Cleaning

Prior to disinfection the Contractor shall clean the pipeline to remove foreign matter. For pipelines 16” in diameter or smaller, cleaning shall consist of flushing the pipeline. For pipelines greater than 16” in diameter, cleaning shall be performed by operating hydrants and blow-offs located at low points in the pipeline, or by mechanical means (sweeping or pigging. Water for the Work shall be metered and furnished by the Contractor in accordance with Section 01500 of the Standard Contract Documents.

(c) Procedure and Dosage

For pipelines 16" or smaller in diameter, the Contractor may use either the AWWA C-651 "Tablet/Granular Method" or the "Continuous Feed Method" for disinfecting the pipeline. The Contractor, at its expense, will supply the test gauges and the Sodium Hypochlorite conforming to ANSI/AWWA B300, which contains approximately 5 percent to fifteen percent available chlorine, and will submit for approval a written plan for the disinfection process. Calcium Hypochlorite conforming to ANSI/AWWA B300, which contains approximately 65 percent available chlorine by weight, may be used in granular form or in 5 g tablets for 16” diameter or smaller lines, if it is included as part of the written plan of disinfection that is approved by the City of Austin. The Contractor, at its expense, shall provide all other equipment, supplies and the necessary labor to perform the disinfection under the general supervision of the City.

One connection to the existing system will be allowed with a valve arranged to prevent the strong disinfecting dosage from flowing back into the existing water supply piping. The valve shall be kept closed and locked in a valve box with the lid painted red. No other connection shall be made until the disinfection of the new line is complete and the water samples have met the established criteria. The valve shall remain closed at all times except when filling or flushing the line and must be staffed during these operations. As an option, backflow prevention in the form of a reduced pressure backflow assembly may be provided if the valve is left unattended. The new pipeline shall be filled completely with disinfecting solution by feeding the concentrated chlorine and approved water from the existing system uniformly into the new piping in such

proportions that every part of the line has a minimum concentration of 25 mg/liter available chlorine.

The disinfecting solution shall be retained in the piping for at least 16 hours and all valves, hydrants, services, stubs, etc. shall be operated so as to disinfect all their parts. After this retention period, the water shall contain no less than 10 mg/liter chlorine throughout the treated section of the pipeline.

For pipelines larger than 16" in diameter, the Contractor may use the AWWA C-651 "Slug Method" for disinfecting the pipeline. Chlorine shall be fed at a constant rate and at a sufficient concentration at one end of the pipeline to develop a slug of chlorinated water having not less than 100 mg/liter of free chlorine. The Contractor shall move the slug through the main so that all interior surfaces are exposed to the slug for at least three (3) hours. The chlorine concentration in the slug shall be measured as it moves through the pipeline. If the chlorine concentration drops below 50 mg/liter, the Contractor shall stop the slug and feed additional chlorine to the head of the slug to restore the chlorine concentration to at least 100 mg/liter before proceeding. As the slug flows past fittings and valves, related valves and hydrants shall be operated so as to disinfect appurtenances and pipe branches.

Unless otherwise indicated, all quantities specified herein refer to measurements required by the testing procedures included in the current edition of "Standard Methods". The chlorine concentration at each step in the disinfection procedure shall be verified by chlorine residual determinations.

(d) Final Flushing

The heavily chlorinated water shall then be carefully flushed from the potable water line by a dechlorination process until the chlorine concentration is no higher than the residual generally prevailing in the existing distribution system. This is necessary to insure that there is no injury or damage to the public, the water system or the environment. The plans and preparations of the Contractor must be approved by the City before flushing of the line may begin. The Contractor will supply the Dechlorination chemical conforming to ANSI/AWWA C655. Additionally the flushing must be witnessed by an authorized representative of the City.

Approval for discharge of the diluted chlorine water or heavily chlorinated water into the wastewater system must be obtained from AW. The line flushing operations shall be regulated by the Contractor so as not to overload the wastewater system or cause damage to the odor feed systems at the lift stations. The City shall designate its own representative to oversee the work.

Daily notice of line discharging must be reported to the AW Dispatch office.

(e) Bacteriological Testing

After disinfection and final flushing, samples shall be collected per one of the two options. Option A: Before approving a main for release, take an initial set of samples and then resample again after a minimum of 16 hours. Both sets of samples must pass for the main to be approved for release. Option B: Before approving a main for release, let it sit for a minimum of 16 hours without any water use. Then collect two sets of samples a minimum of 15 minutes apart while the sampling taps are left running. Both sets of samples must pass for the main to be approved for release. The two (2) sets of water samples from the line will be tested for bacteriological quality by the City and must be found free of coliform organisms before the pipeline may be placed in service. Each set shall consist of one (1) sample that is drawn from the end of the main, at least one from each branch greater than one pipe length, and additional samples that are collected at intervals of not more than 1,200 feet along the pipeline. All stubs shall be tested before connections are made to existing systems.

The Contractor, at its expense, shall install sufficient sampling taps at proper locations along the pipeline. Each sampling tap shall consist of a standard corporation cock installed in the line and extended with a copper tubing gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed and retained for future use.

Samples for bacteriological analysis will only be collected from suitable sampling taps in sterile bottles treated with sodium thiosulfate. Samples shall not be drawn from hoses or unregulated sources. The City, at its expense, will furnish the sterile sample bottles and may, at its discretion, collect the test samples with City personnel.

If the initial disinfection fails to produce acceptable sample test results, the disinfection procedure shall be repeated at the Contractor's expense. Before the piping may be placed in service, two (2) consecutive sets of acceptable test results must be obtained.

An acceptable test sample is one in which: (1) the chlorine level is similar to the level of the existing distribution system; (2) there is no free chlorine and (3) total coliform organisms are absent. An invalid sample is one, which has excessive free chlorine, silt or non-coliform growth as defined in the current issue of the "Standards Methods." If unacceptable sample results are obtained for any pipe, the Contractor may, with the concurrence of the Inspector, for one time only flush the lines and then collect a second series of test samples for testing by the City. After this flushing sequence is completed, any pipe with one or more failed samples must be disinfected again in accordance with the approved disinfection procedure followed by appropriate sampling and testing of the water.

The City of Austin Water Quality Laboratory will notify the assigned City of Austin Inspector in writing of all test results. The Inspector will subsequently notify the Contractor of all test results. The Water Quality Laboratory will not release test results directly to the Contractor.

(30) Cleanup and Restoration

It shall be the Contractor's responsibility to keep the construction site neat, clean and orderly at all times. Cleanup shall be vigorous and continuous to minimize traffic hazards or obstructions along the streets and to driveways. Trenching, backfill, pavement repair (as necessary), and cleanup shall be coordinated as directed by the City. The E/A will regulate the amount of open ditch and may halt additional trenching if cleanup is not adequate to allow for orderly traffic flow and access.

Materials at the site shall be stored in a neat and orderly manner so as not to obstruct pedestrian or vehicular traffic. All damaged material shall be removed from the construction site immediately and disposed of in a proper manner. All surplus excavated materials shall become the property of the Contractor for disposal at the Contractor's expense. After trenching, the Contractor shall immediately remove all excavated materials unsuitable for or in excess of, backfill requirements. Immediately following the pipe laying Work as it progresses, the Contractor shall backfill, grade and compact all excavations as provided elsewhere. The backfill placed at that time shall meet all compaction test requirements. The Contractor shall immediately clean up and remove all unused soil, waste and debris and restore all surfaces and improvements to a condition equal or superior to that before construction began and to an appearance which complements the surroundings. The Contractor shall grade and dress the top 6 inches of earth surfaces with soil or other material similar and equal to the surrounding, fill and smooth any visible tracks or ruts, replace and re-establish all damaged or disturbed turf or other vegetation and otherwise make every effort to encourage the return of the entire surface and all improvements to a pleasant appearance and useful condition appropriate and complementary to the surroundings and equal or similar to that before construction began.

Placement of the final lift of permanent pavement, if a pavement is required, shall begin immediately after all testing of each segment of piping is satisfactorily completed.

(31) Valve Turn Walk-though

As part of the acceptance of Water or Reclaimed Water pressure pipe, an AW Valve Walk-through will be performed after an initial inspection by the Owner's Representative to identify any deficient items. If deficient items are present during the AW Valve Walk-Through and the project fails acceptance, a re-inspection fee will apply and must be paid before a re-inspection is scheduled to confirm correction of deficient items. See AW Fee Schedule for the current Distribution Walk-Through Re-inspection Fee.

(32) 2-inch Jumper Hose

During connections to the water distribution system, the Contractor may be required to install a temporary jumper hose between the unpressurized water segment and an adjacent pressurized water segment for the purpose of maintaining water service to customers who can't operate without water service during the connection. The jumper shall include an approved backflow preventer and be of adequate size and pressure rating to maintain service to the customer. It shall be polyethylene tubing meeting the requirements of COA SPL WW-65. The jumper hose and other components in the temporary service shall be disinfected, and bacteriological samples will be taken and pass before the temporary service is provided to the customer. Contractor shall provide adequate protection for the jumper hose in vehicular traffic areas at all times during use.

Source: Rule No. R161-17.05 , 5-31-2017; Rule No. R161-17.19 , 11-28-2017; Rule No. R161-18.23 , 12-8-2018.

510.4 Measurement

Pipe will be measured by the linear foot for the various types, sizes and classes. Parallel lines will be measured individually.

Where a line ties into an existing system, the length of the new line will be measured from the visible end of the existing system at the completed joint. Unless otherwise indicated, the length of water, reclaimed, and wastewater lines will be measured along pipe horizontal centerline stationing through fittings, valves, manholes, and other appurtenances.

Ductile iron fittings, whether standard mechanical joint or integral factory restrained joint type, will be measured by the ton and paid for in accordance with the schedule in Standard Products List WW-27C. Bolts, glands and gaskets will not be measured for payment. Steel cylinder concrete pipe fittings and welded steel pipe fittings will not be measured separately and are included in the unit price for the respective pipe bid items.

Factory restrained joint pipe meeting the requirements of Standard Products List WW-27F will be measured by the linear foot. The estimated quantity on the bid form is only for restrained joint pipe having integral mechanically restrained joints.

Connecting a new water, wastewater, or reclaimed water service to an existing, comparable type of private service will be measured by each connection. Service pipe from the main to the service connection will be measured by the linear foot.

The Contractor shall be responsible for removing and treating ground water flowing into a trench up to a baseline flow rate of 350 gpm of sustained flow for each mainline open trench (no more that 300 linear feet open trench per work zone segment is allowed at one time). This baseline flow rate is not a prediction of ground water conditions to be expected on the Project. Rather, it establishes contract terms regarding the quantity of ground water for which the contractor is responsible without extra or separate compensation. The flow rate must exceed 350 gpm continuously for at least 4 consecutive hours to be considered sustained flow. It is expected that trench dewatering for this baseline rate may be accomplished with a single 3-inch trash-type pump per open trench;

however, measured flow rate, not pump size, type or characteristics shall be used to determine if the baseline rate has been exceeded. Flow rate shall be determined by measurements made at the discharge point of the water treatment facilities. Surface storm water flowing into a trench shall be the Contractor's responsibility to remove and treat without compensation, regardless of inflow rate or volume.

Adjustment of elevations during construction resulting in changes in flow line elevations of plus or minus two feet or less will not be considered for credit or additional compensation and no measurement for payment will be made.

Stormwater pipe will be measured along the slope of the pipe. Where drainage pipe ties into inlets, headwalls, catch basins, manholes, junction boxes or other structures that 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 so included.

Excavation and backfill, when included as pipe installation will not be measured as such but shall be included in the unit price bid for constructing pipe and measured as pipe complete in place including excavation and backfill.

When pay items are provided for the other components of the system, measurement will be made as addressed hereunder.

Video inspection of newly installed box culverts and storm drain pipe will be measured per linear foot of pipe videoed.

Jumper hose will be measured per linear foot of hose installed, including all depths, excavation and backfill, complete, and in place.

Source: Rule No. R161-17.05 , 5-31-2017.

510.5 Payment

Payment for pipe, measured as prescribed above, will be made at the unit price bid per linear foot for the various sizes of pipe, of the materials and type indicated, unless unstable material is encountered or trench excavation and backfill is bid as a separate item.

The concrete seal, foundation rock or coarse aggregate when used as directed in unstable material will be paid for at the unit price bid per cubic yard, which shall be full payment for all excavation and removal of unsuitable material and furnishing, placing and compacting the foundation rock, coarse aggregate or other approved material all complete in place.

Excavation and backfill, when included as a separate pay item, will be paid for by Pay Item No. 510-E or 510-F.

No separate payment will be made for dewatering a trench with ground water inflow of less than the baseline rate of 350 gpm of sustained flow as described above. Dewatering of those trenches shall be included in the contract unit price of the Pipe pay item. Payment for dewatering a trench with ground water inflow exceeding 350 gpm of sustained flow shall be agreed by change order. Dewatering of bore pits shall be included in the contract unit price for Bore Entry Pit or Exit Pit regardless of inflow rate or volume unless specified otherwise in the bid item for Bore Entry Pit or Exit Pit.

(1) Pipe

Payment for pipe, measured as prescribed above, will be made at the unit price bid per linear foot complete-in-place as designed and represented in the Drawings and other Contract documents. Restrained joint pipe meeting the requirements of Standard Products List WW-27F will be paid for separately at the unit price bid per linear foot. Unless otherwise provided herein, as separate pay item(s), the bid price per linear foot of pipe shall include the following:

a. clearing

b. constructing any necessary embankment

c. excavation

d. disposal of surplus or unusable excavated material

e. furnishing, hauling and placing pipe

f. field constructed joints, collars, temporary plugs, caps or bulkheads

g. all necessary lugs, rods or braces

h. pipe coatings and protection

i. connections to existing systems or structures, concrete blocking and thrust blocks and restrained joints

j. preparing, shaping, pumping for dewatering, and shoring of trenches

k. bedding materials

l. backfill materials

m. hauling, placing and preparing bedding materials

n. particle migration measures

o. hauling, moving, placing and compacting backfill materials

p. temporary and permanent pavement repairs and maintenance

q. temporary removal and replacement of pavement, curb, drainage structures, driveways, sidewalks and any other improvements damaged or removed during construction

r. cleanup

s. vertical stack on deep wastewater services

t. all other incidentals necessary to complete the pipe installation as indicated.

u. pipe joint restraint devices, where specified or allowed, meeting Standard Products List WW-27A or WW-27G.

No separate payment will be made for thrust restraint measures.

Steel cylinder concrete pipe fittings and welded steel pipe fittings will not be paid for separately. These will be included in the unit price bid for the bid item Pipe.

(2) Concrete Cradles and Seals

When called for in the Bid, concrete cradles and seals will be paid for at the unit Contract price bid per linear foot for the size of pipe specified, complete in place.

(3) Concrete Retards

When called for in the Bid, Concrete retards will be paid under Item No. 593S, Concrete Retards."

(4) Boring or Jacking.

When called for in the Bid, boring or jacking will be paid under Item 501S, "Jacking or Boring Pipe.

(5) Wet Connections to Potable or Reclaimed Water Mains

When called for in the bid, wet connections will be paid at the unit price bid per each, complete in place, according to the size of the main that is in service and shall be full compensation for all Work

required to make the connection and place the pipe in service. (See subsection 510.3 'Construction Methods' part (24) (b) 'Wet Connections to Existing Water System').

(6) Fittings

Ductile iron fittings, furnished in accordance with these specifications, will be paid for at the unit price bid per ton, complete in place, according to the schedule of weights in Standard Products List WW-27C. Bolts, glands, and gaskets will not be paid for separately and shall be included in the contract unit price for fittings.

(7) Concrete Trench Cap and Encasement

Where the distance between the top of the concrete encasement and the top of the trench cap is less than 36 inches, the concrete cap and encasement shall be poured as one unit and paid for under this bid item at the Contract price bid per linear foot. When the distance above is greater than 36 inches or when the trench cap is placed separately, the trench cap shall be paid for as a separate item, per linear foot, complete in place.

(8) Cement-Stabilized Backfill

Cement-stabilized backfill will be paid for at the unit price bid per linear foot and shall be full payment to the Contractor for furnishing and installing the required material, mixed, placed and cured complete in place.

(9) Concrete Encasement

When called for in the Bid, Concrete Pipe Encasement will be paid under Item No. 505S, "Encasement and Encasement Pipe".

(10) Pressure Taps

Pressure taps will be paid for at the unit price bid, complete in place, according to the size tap made and the size main tapped and shall be full payment for furnishing all necessary materials, including tapping sleeve and valve, making the tap, testing and placing the connection in service.

(11) Excavation Safety Systems

When called for in Bid, Trench Safety Systems shall conform to Item No. 509S, "Excavation Safety Systems."

(12) Connecting a New Water, Wastewater, or Reclaimed Water Service to an existing, comparable type of private service will be paid for at the unit price bid, complete in place, according to the size of new service and size of existing private service, and shall be full payment for furnishing and installing all necessary materials, such as cleanouts, pipe, couplings, and fittings, and including excavation and backfill.

(13) Video Inspection

Video Inspection of Newly Installed Box Culverts and Storm Drain Pipe will be paid for at the unit price bid per linear foot and shall be full payment for all labor, equipment, and materials required for video inspection per this specification, including all submittals of CD/DVD as required.

(14) Jumper Hose

Jumper Hose will be paid at the unit bid price, complete and in place, including installation and removal of all materials necessary to provide a fully functional jumper hose. This item shall also include adequate protection for the jumper hose within vehicular traffic areas.

Source: Rule No. R161-17.05 , 5-31-2017.

Payment, when included as a Contract pay item, will be made under one of the following:

Pay Item No. 510-AR___Dia.:	Pipe, ___ Dia. ___ Type (all depths), including Excavation and Backfill	Per Linear Foot.
Pay Item No. 510-ARRJ___Dia.:	Factory Restrained Joint Pipe, ___ Dia., Class ___ Ductile Iron, (all depths) including Excavation and Backfill	Per Linear Foot.
Pay Item No. 510-BR___×___Dia.:	Connecting New ___ Service to Existing Private Service (___ Dia. New Service to ___ Dia. Private Service)	Per Each.
Pay Item No. 510-CR:	Pipe Excavation, ___ Ft. Width	Per Linear Foot.
Pay Item No. 510-DR:	Pipe Trench Backfill, ___ Ft. Width	Per Linear Foot.
Pay Item No. 510-ER:	Concrete Seal or Cradle, ___ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-FR:	Concrete Trench Cap, ___ Ft. Width	Per Linear Foot.
Pay Item No. 510-GR:	Concrete Cap and Encasement, ___ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-HR:	Cement Stabilized Backfill, ___ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-IR: ___ × ___ Dia.:	Pressure Taps, ___ Dia. × ___ Dia.	Per Each.
Pay Item No. 510-JR: ___ × ___ Dia.:	Wet Connections, ___ Dia. × ___ Dia.	Per Each.
Pay Item No. 510-KR:	Ductile Iron Fittings	Per Ton.
Pay Item No. 510-ASD___Dia.:	Pipe, ___ Dia. (all depths), including excavation and backfill	Per Linear Foot.
Pay Item No. 510-CSD:	Pipe Excavation, ___ Ft. Width	Per Linear Foot.
Pay Item No. 510-DSD:	Pipe Trench Backfill, ___ Ft. Width	Per Linear Foot.
Pay Item No. 510-ESD:	Concrete Seal or Cradle, ___ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-FSD:	Concrete Trench Cap, ___ Ft. Width	Per Linear Foot.
Pay Item No. 510-GSD:	Concrete Cap and Encasement, ___ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-HSD:	Cement Stabilized Backfill, ___ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-AW___ Dia.:	Pipe, ___ Dia. ___ Type (all depths), including excavation and backfill	Per Linear Foot
Pay Item No. 510-AWRJ___ Dia.:	Factory Restrained Joint Pipe, ___ Dia., Class Ductile Iron, (all depths) including Excavation and Backfill	Per Linear Foot.
Pay Item No. 510-BW___ × ___ Dia.:	Connecting New ___ Service to Existing Private Service (___ Dia. New Service to ___ Dia. Private Service)	Per Each.
Pay Item No. 510-CW:	Pipe Excavation, ___ Ft. Width	Per Linear Foot.
Pay Item No. 510-DW:	Pipe Trench Backfill, ___ Ft. Width	Per Linear Foot.
Pay Item No. 510-EW:	Concrete Seal or Cradle, ___ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-FW:	Concrete Trench Cap, ___ Ft. Width	Per Linear Foot.
Pay Item No. 510-GW:	Concrete Cap and Encasement, ___ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-HW:	Cement Stabilized Backfill, ___ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-IW:___ × ___ Dia.:	Pressure Taps, ___ Dia. × ___ Dia.	Per Each.
Pay Item No. 510-JW: ___ × ___ Dia.:	Wet Connections, ___ Dia. × ___ Dia.	Per Each.
Pay Item No. 510-KW:	Ductile Iron Fittings	Per Ton.
Pay Item No. 510-AWW: ___ Dia.:	Pipe, ___ Dia. ___ Type (all depths), including Excavation and Backfill	Per Linear Foot.

Pay Item No. 510-AWWRJ___ Dia.:	Factory Restrained Joint Pipe, ___ Dia., Class ductile Iron, (all depths) including Excavation and Backfill	Per Linear Foot.
Pay Item No. 510-BWW___ × ___ Dia.:	Connecting New ___ Service to Existing Private Service (___ Dia. New Service to ___ Dia. Private Service)	Per Each.
Pay Item No. 510-CWW:	Pipe Excavation, ___ Ft. Width	Per Linear Foot.
Pay Item No. 510-DWW:	Pipe Trench Backfill, ___ Ft. Width	Per Linear Foot.
Pay Item No. 510-EWW:	Concrete Seal or Cradle, ___ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-FWW:	Concrete Trench Cap, ___ Ft. Width	Per Linear Foot.
Pay Item No. 510-GWW:	Concrete Cap and Encasement, ___ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-HWW:	Cement Stabilized Backfill, ___ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-KWW:	Ductile Iron Fittings	Per Ton.
Pay Item No. 510-VIDEO	Video Inspection of Newly Installed Box Culverts and Storm Drain Pipe	Per Linear Foot.
Pay Item No. 510-JH	2-inch Jumper Hose	Per Linear Foot.

An "R" after the pay item indicates the use for reclaimed water.

An "SD" after the pay item indicates the use for storm drain.

A "W" after the pay item indicates the use for water.

A "WW" after the pay item indicates the use for wastewater.

Source: Rule No. R161-17.05 , 5-31-2017.

End

Applicable References:

Standard Specifications Manual: Item Nos. Ref: 102S, 210S, 402S, 403, 501S, 505S, 506, 507S, 509S, 593S, 601S, 604S

Standards Manual: Standard Detail Nos. 510S-1, (520 - series).

Design Criteria Manuals: Utilities Criteria Manual, Section 5.

ITEM NO. 511 WATER VALVES 2/14/22

511.1 Description

This item shall govern the valves furnished and installed as indicated on the Drawings. Unless otherwise indicated on the Drawings, all valves 4 inches and larger shall be AWWA-type valves of suitable design and fully equipped for service buried in the earth, without need for further modification and shall be wrapped with 8-mil polyethylene film with all edges and laps securely taped to provide a continuous wrap. For reclaimed water piping, the polyethylene film shall be purple. Where not indicated, the Contractor may use valves with any type end-joint allowed for fittings of the pipe class being used. Unless otherwise indicated on the Drawings, all valve stems shall be adjusted to situate the operating nut not more than 24 inches below the proposed ground or paving surface of the finished project. Laydown valves shall not be used unless called out on the Drawings. Standard details shall not be used as an indicator of available options.

Source: Rules No. R161-22.04 , 2-14-2022.

511.2 Materials

The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation in the Work is of the kind and quality that satisfies the specified functions and quality. The Austin Water (AW) Standard Products Lists (SPL) are considered to form a part of these Specifications. Contractors may, when appropriate, elect to use products from the SPL; however, submittal to the Engineer/Architect (E/A) is still required. If the Contractor elects to use any materials from these lists, each product shall be completely and clearly identified by its corresponding SPL number when making the product submittal. This will expedite the review process in which the E/A, and, if necessary, the AW Standard Products Committee, decide whether the products meet the Contract requirements and the specific use foreseen by the E/A in the design of this engineered Project.

The SPL's should not be interpreted as being a pre-approved list of products necessarily meeting the requirements for a given construction Project. Items contained in the SPL cannot be substituted for items shown on the Drawings, or called for in the specifications, or specified in the Bidding Requirements, Contract Forms and Conditions of Contract, unless approved by the E/A in conjunction with the AW Standard Products Committee. The SPL current at the time of plan approval will govern.

A. Samples, Inspection and Testing Requirements

All tests and inspections called for by the applicable standards shall be performed by the manufacturer. Upon request, results of these tests shall be made available to the purchaser.

B. Other Requirements

Each submittal shall be accompanied by:

1. Complete data covering:
    a. the operator, including type and size, model number, etc.,
    b. the name and address of the manufacturer's nearest service facility,
    c. the number of turns to fully open or close the valve.
2. Detailed instructions for calibrating the limit stops for open and closed positions, and

3. Any other information, that may be necessary to operate and maintain the operator.

4. Complete dimensional data and installation instructions for the valve assembly as it is to be installed, including the operator.

5. Complete replacement parts lists and drawings, identifying every part for both the valve and operator.

Source: Rules No. R161-22.04 , 2-14-2022.

511.3 Valves

A. Iron-Body Gate Valves

Resilient-seated gate valves for potable or reclaimed service, including tapping valves, shall conform to AWWA C-509 and SPL item WW-282.

Reduced-wall, resilient-seated gate valves for potable or reclaimed service, including tapping valves, shall conform to AWWA C-515 and SPL item WW-700.

1. Stem Seals: All valves shall have approved O-ring type stem seals. At least two O-rings shall be in contact with the valve stem where it penetrates the valve body.

2. Operation: All valves shall have non-rising stems with a 2-inch square operating nut, or with a spoke type handwheel when so ordered, turning clockwise to close.

3. Gearing: Gate valves in 24-inch and larger sizes shall be geared and, when necessary for proper bury depth and cover, shall be the horizontal bevel-geared type enclosed in a lubricated gear case.

4. Bypass: Unless otherwise indicated on the Drawings, 30-inch and larger metal-seated gate valves shall be equipped with a bypass of the non-rising stem type which meets the same AWWA standard required for the main valve.

5. Valve Ends: Valve ends shall be push-on, flanged or mechanical joint, as indicated or approved.

6. Gear Case: All geared valves shall have enclosed gear cases of the extended type, attached to the valve bonnet in a manner that makes it possible to replace the stem seal without disassembly and without disturbing the gears, bearing or gear lubricant. Gear cases shall be designed and fabricated with an opening to atmosphere so that leakage past the stem seal does not enter the gear case.

7. Valve Body: Double disc gate valves in 30-inch and larger sizes installed in the horizontal position shall have bronze rollers, tracks, scrapers, etc. For reclaimed water valves, the body shall be manufactured in purple, factory painted purple, or field painted purple.

B. Reserved

C. Ball Valves

Ball valves shall be brass, bronze, stainless steel or PVC as indicated on the Drawings or Details or as approved by the Engineer or designated representative.

D. Air-Vacuum Release Valves

1. Valves shall be combination air-release, air-vacuum units having small and large orifice units contained and operating within a single body or assembled unit.

The small orifice system shall automatically release small volumes of air while the pipe is operating under normal conditions. The large air-vacuum orifice system shall automatically exhaust large volumes of air while the pipe is being filled and shall permit immediate re-entry of air while being drained.

Valves shall be rated for at least 150 psi {maximum}normal service pressure.

2. Material Requirements

Valve exterior bodies and covers shall be cast iron or reinforced nylon.

Internal bushings, hinge pins, float guide and retaining screws, pins, etc., shall be stainless steel, bronze, nylon, or Buna-N rubber.

Orifice seats shall be Buna-N rubber.

Floats shall be stainless steel, nylon, or Buna-N rubber, rated at 1,000 psi.

Unless otherwise indicated, these valves shall be as included in SPL WW-367 for water and WW-462 for wastewater force mains.

E. Fire Hydrants

All fire hydrants shall be Dry Barrel, Traffic Model (break-away), Post Type having Compression Type Main Valves with 5 ¼ inch opening, closing with line pressure. Approved models are listed on SPL WW-3.

1. Applicable Specifications

AWWA C-502 current: "AWWA Standard for Dry-Barrel Fire Hydrants."

NFPA 1963: "National (American) Standard Fire Hose Coupling Screw Thread" and City of Austin 4 inch Fire Hose Connection Standard.

ANSI A-21.11 current: "American National Standard for Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings."

2. Functional Requirements

Design Working Pressure shall be 200 psi and a test pressure of 400 psi.

Inlet shall be side connection hub end for mechanical joint (ANSI A-21.11-current). Shoe shall be rigidly designed to prevent breakage.

Lower Barrel shall be rigid to assure above ground break at traffic feature. Bury length of hydrant shall be 4 feet minimum, 5 feet maximum (hydrant lead pipe may be elbowed up from main using restrained joints; flanged joints in lead pipes are not allowed). Flange type connections between hydrant shoe, barrel sections and bonnet shall have minimum of six corrosion resistant bolts.

Hydrant Main Valve shall be 5 ¼ inch I.D. Valve stem design shall meet requirements of AWWA C502, with Operating Nut turning clockwise to close. Operating Nut shall be pentagonal, 1½ inch point to flat at base, and 1-7/16 inches at top and 1 inch minimum height. Seat ring shall be bronze (bronze to bronze threading) and shall be removable with lightweight stem wrench. Valve mechanisms shall be flushed with each operation of valve; there shall be a minimum of two drain ports.

Traffic Feature shall have replaceable breakaway ferrous metal stem coupling held to stem by readily removable type 302 or 304 stainless steel fastenings. Breakaway flange or frangible lugs shall be designed to assure aboveground break. Breakaway or frangible bolts will not be acceptable.

Outlet Nozzles shall be located approximately 18 inches above ground. Each hydrant shall have two 2½ inch nozzles 180 degrees apart with National (American) Standard Fire Hose Coupling Screw Thread NFPA 1963 and one 4 inch pumper nozzle with City of Austin (COA) standard thread-six threads per inch "Higbee" cut, 4.8590 inch O.D., 4.6425 inch root diameter. Nozzles shall be threaded or cam-locked, O-ring sealed, and shall have type 302 or 304 stainless steel locking devices. Nozzle caps (without chains) and cap gaskets shall be furnished on the hydrant. The cap nut shall have the same configuration as the operating nut.

Hydrants shall be Dry-Top Construction, factory lubricated oil or grease with the lubricant plug readily accessible. The system shall be described for City approval.

A blue Type II-B-B reflectorized pavement marker, conforming to Standard Specification Item No. 863S, shall be placed 2 to 3 feet offset from the centerline of paved streets, on the side of and in line with, all newly installed fire hydrants.

Hydrant shall have double O-ring seals in a bronze stem sheath housing to assure separation of lubricant from water and shall have a weather cap or seal, or both, as approved by the Owner, to provide complete weather protection.

3. Material Requirements

All below ground bolts shall be corrosion resistant. The hydrant valve shall be Neoprene, 90 durometer minimum. The seat ring, drain ring, operating nut and nozzles shall be bronze, AWWA C-502 current, containing not over 16 percent zinc. Break-away stem coupling shall be of ferrous material; its retaining pins, bolts, nuts, etc. of type 302 or 304 stainless steel.

Coatings shall be durable and applied to clean surfaces. Exterior surfaces above ground shall receive a coating of the type and color specified in the applicable version of AW SPL WW-3. The coating shall be applied according to coating manufacturer's specifications. Other exposed ferrous metal shall receive asphalt-based varnish, or approved equal, applied according to the coating manufacturer's specifications.

F. Pressure/Flow Control Valves

All control valves to regulate pressure, flow, etc., in City lines shall be models listed in the AW SPL.

G. Drain Valves

Drain valve materials and installation shall conform to COA Standard 511-AW-03.

H. Valve Stem Extensions:

Valve stem extensions shall consist of a single piece of the required length with a socket on one end and a nut on the other.

Source: Rules No. R161-22.04 , 2-14-2022.

511.4 Construction Methods

A. Setting Valves, Drains and Air Releases

Unless otherwise indicated, main line valves, drain valves and piping, air and vacuum release assemblies and other miscellaneous accessories shall be set and jointed in the manner described for cleaning, laying, and jointing pipe.

Unless otherwise indicated, valves shall be set at the locations shown on the Drawings and such that their location does not conflict with other appurtenances such as curb ramps. Valves shall be installed so that the tops of operating stems will be at the proper elevation required for the piping at the location indicated above. Valve boxes and valve stem casings shall be firmly supported and maintained, centered and aligned plumb over the valve or operating stem, with the top of the box or casing installed flush with the finished ground or pavement in existing streets, and installed with the top of the box or casing approximately 6 inches below the standard street subgrade in streets which are excavated for paving construction or where such excavation is scheduled or elsewhere as directed by the Engineer or designated representative.

Drainage branches or air blowoffs shall not be connected to any sanitary sewer or submerged in any stream or be installed in any other manner that will permit back siphonage into the distribution system (see COA

"Standard Series 500"). Every drain line and every air release line shall have a full sized independent gate valve flanged directly to the main. Flap-valves, shear gates, etc., will not be accepted.

B. Setting Fire Hydrants

Fire hydrants shall be located in a manner to provide accessibility and in such a manner that the possibility of damage from vehicles or conflict with pedestrian travel will be minimized. Unless otherwise directed, the setting of any hydrant shall conform to the following:

Hydrants between curb and sidewalk on public streets, shall be installed as shown on Standard 511-AW-02, with outermost point of large nozzle cap 6 inches to 18 inches behind back of curb. Where walk abuts curb, and in other public areas or in commercial areas, dimension from gutter face of curb to outermost part of any nozzle cap shall be not less than 3 feet, nor more than 6 feet, except that no part of a hydrant or its nozzle caps shall be within 6 inches of any sidewalk or pedestrian ramp. Any fire hydrant placed near a street corner shall be no less than 20 feet from the curb line point of tangency. Fire hydrants shall not be installed within 9 feet vertically or horizontally of any sanitary sewer line regardless of construction.

All hydrants shall stand plumb; those near curbs shall have the 4-inch nozzle facing the curb and perpendicular to it. The hydrant bury mark shall be located at ground or other finish grade; nozzles of all new hydrants shall be approximately 18 inches above grade. Lower barrel length shall not exceed 5 feet. Barrel extensions are not permitted unless approved by the Engineer or designated representative. Each hydrant shall be connected to the main by 6-inch ductile iron pipe; a 6-inch gate valve shall be installed in the line for individual shutoff of each new hydrant.

Below each hydrant, a drainage pit 2 feet in diameter and 2 feet deep shall be excavated and filled with compacted coarse gravel or broken stone mixed with coarse sand under and around the bowl of the hydrant, except where thrust blocking is located (COA Specification Item 510 and Standard 510-6) and to a level 6 inches above the hydrant drain opening.

The hydrant drainage pit shall not be connected to a sanitary sewer. The drain gravel shall be covered with filter fabric to prevent blockage of voids in the gravel by migration of backfill material. The bowl of each hydrant shall be well braced against unexcavated earth at the end of the trench with concrete thrust blocking (taking care not to obstruct the hydrant drain holes), or the hydrant shall be tied to the pipe with approved metal harness rods and clamps. The fire line shall be provided with joint restraint from the main line to the fire hydrant. Hydrants shall be thoroughly cleaned of dirt or foreign matter before setting.

Fire hydrants on mains under construction shall be securely wrapped with a poly wrap bag or envelope taped into place. When the mains are accepted and placed in service the bag shall be removed.

C. Pressure Taps: Refer to Section 510.3 (24) of Standard Specification Item Number 510, "Pipe."

D. Plugging Dead Ends

Standard plugs shall be inserted into the bells of all dead ends of pipes, tees or crosses and spigot ends shall be capped. All end plugs or caps shall be secured to the pipe conforming to Section 510.3 (22) of Standard Specification Item Number 510, "Pipe."

E. Protective Covering

Unless otherwise indicated, all flanges, nuts, bolts, threaded outlets and all other steel component shall be coal tar coated and shall be wrapped with standard minimum 8-mil low density polyethylene film or a minimum 4-mil cross laminated high-density polyethylene meeting ANSI/AWWA Specification C-105-current, with all edges and laps taped securely to provide a continuous and watertight wrap. Repair all punctures of the polyethylene, including those caused in the placement of bedding aggregates, with duct tape to restore the continuous protective wrap before backfilling. For reclaimed water piping, the polyethylene shall be purple.

F. Valve Box, Casing and Cover

Stems of all buried valves shall be protected by valve box assemblies. Valve box castings shall conform to ASTM A 48, Class 30B. Testing shall be verified by the manufacturer at the time of shipment. Each casting shall have cast upon it a distinct mark identifying the manufacturer and the country of origin. Valve boxes and covers for potable water shall be round. Valve boxes and covers for reclaimed water piping shall be square and shall have "Reclaimed Water" indicated on the lid.

G. Drain Valve Installations

Refer to COA Standard 511-AW-03.

H. Air Release Assemblies

Refer to COA Standard 511-AW-04.

I. Pressure/Flow Control Valves

Assemblies shall be installed as indicated.

J. Connections to Existing System

Refer to Item No. 510, "Pipe" for connections to the existing system.

K. Shutoffs

Refer to Item No. 510, "Pipe" for shutoffs.

Source: Rules No. R161-22.04 , 2-14-2022.

511.5 Measurement

All types of valves will be measured per each. Fire hydrants and drain valve assemblies will be measured per each. Fire Hydrant barrel extensions will be measured per vertical foot. Pressure/Flow control valve assemblies and both manual and automatic air release assemblies will be measured per each. Reflectorized pavement markers for identifying the location of newly installed fire hydrants shall be measured per each, as per Standard Specification Item No. 863S.7.

Bury depths exceeding 5.5 feet are defined as Additional Bury Depths. Additional bury depths will only be measured if indicated on the Drawings and identified in the Standard Contract Bid Form 00300U; otherwise, the unit bid price for each completed unit includes all depths.

Source: Rules No. R161-22.04 , 2-14-2022.

511.6 Payment

Payment shall include full compensation, in accordance with the pay item established in the bid, for excavation, furnishing, hauling and placing valves, drain valve assemblies, fire hydrants and barrel extensions including anchorage and all incidental materials and work; preparing, shaping, dewatering, bedding, placing and compacting backfill materials and for all other incidentals necessary to complete the installation, as indicated in the Drawings, complete in place.

Payment for iron fittings and for wet connections is covered in Section 510.6 of Standard Specification Item 510, "Pipe."

Payment for excavation safety systems is covered in Section 509S.10 of Standard Specification Item 509S, Excavation Safety Systems.

A. Valves: Valves will be paid for at the unit bid price for the size and type valve installed, including valve stem casing and cover, excavation and backfill, setting, adjusting to grade, anchoring in place, and other appurtenances necessary for proper operation.

B. Fire Hydrants: Fire Hydrants installation shall be paid for at the unit bid price, which includes all necessary labor and materials to set, adjust to grade and anchor the hydrant body, barrel extensions, concrete block, gravel drain and other appurtenances necessary for proper operation; but shall not include pipe and valve between the main line and fire hydrant base.

C. Pressure or Flow Control Valve Assemblies: Pressure control and flow control valve assemblies will be paid for at the unit bid price, including box or vault, setting, adjusting to grade, anchoring in place, adjusting the control device to the required conditions, providing other appurtenances necessary for proper operation, and placing in operation.

D. Drain Valve Assemblies: Drain valve installation shall be paid for at the unit bid price, which includes all necessary labor and materials to set, adjust to grade and anchor the bends, vertical piping, blind flange, joint restraint devices, concrete blocking, concrete pad the drain valve, setting, adjusting to grade, anchoring in place, and other appurtenances necessary for proper operation; but shall not include pipe and valve between the main line and drain valve buried bend.

E. Manual Air Release Assemblies: Manual air release installations will be paid for at the unit bid price and shall include valves, fittings, pipe, tapping the main, box and cover, and other appurtenances necessary for proper operation.

F. Automatic Combination Air/Vacuum Release Valve Assembly: Automatic air-vacuum release assemblies will be paid for at the unit bid price and will include the main line tap or outlet, all pipe, valves, fittings, box or vault and cover, and other appurtenances necessary for proper operation.

G. Additional Bury Depth: Additional bury depth will be paid for at the unit bid price, which will include all work necessary to install units with bury depths exceeding 5.5 feet.

H. Fire Hydrant Barrel Extensions: Hydrant barrel extensions will be paid for at the unit bid price which will include necessary hardware and rod extensions.

I. Reflectorized Pavement Markers: Pavement markers will be paid for at the unit bid price, which will include necessary surface preparation and adhesive, as per Standard Specification Item No. 863S.8.

Payment, when included as a contract pay item, will be made under one of the following:

Pay Item No. 511-A:	Valves, _____ Type, ___ Diameter	Per Each.
Pay Item No. 511-B:	Fire Hydrants (See Standard No. 511-AW-02)	Per Each.
Pay Item No. 511-C:	Pressure or Flow Control Valve Assemblies	Per Each.
Pay Item No. 511-D:	Drain Valve Assemblies (See Standard No. 511-AW-03)	Per Each.
Pay Item No. 511-E:	Manual Air Release Assemblies, ____Diameter	Per Each.
Pay Item No. 511-F:	Automatic Combination Air/Vacuum Release Valve Assembly, ___ Diameter.	Per Each.
Pay Item No. 511-G:	Additional Bury Depth	Per Vertical Foot.
Pay Item No. 511-H:	Fire Hydrant Barrel Extensions	Per Vertical foot.

Source: R161-22.04 , 2-14-2022.

END

SPECIFIC CROSS REFERENCE MATERIALS

Standard Specification Item No. 511, "Water Valves"	
COA Standard Specification Items	
Designation	Description
Item 510	Pipe
Item 510.3 (22)	Pipe Anchorage, Support and Protection
Item 510.3(24)	Water System Connections
COA Standard Details	
Designation	Description
511-AW-04	Air Release and Air/Vacuum Valve
511-AW-03	Drain Valve
511-AW-02	Fire Hydrant
AW Standard Products Lists	
Designation	Description
SPL WW-282	Resilient-Seated Gate Valves, AWWA C-509
SPL WW-367	Air Release Valves for Water
SPL WW-462	Air Release/Vacuum Relief Valves for Wastewater
SPL WW-700	Resilient-Seated Gate Valves, AWWA C-515
ANSI/AWWA Standards	
Designation	Description
A-21.11	American National Standard for Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings
C-105	American National Standard for Polyethylene Encasement for Ductile-Iron Pipe
C-500	Metal-Seated Gate Valves for Water Supply Service
C-502	Dry-Barrel Fire Hydrants
C-504	Rubber-Seated Butterfly Valves
C509	Resilient Seated Gate Valves for Water and Sewerage Systems
C-515	Reduced-Wall, Resilient-Seated Gate Valves For Water Supply Service-515
ASTM Standards	
Designation	Description
ASTM A48/A48M	Specification for Gray Iron Castings
ASTM A 536	Specification for Ductile Iron Castings
National Fire Protection Association (NFPA)	
1963 National (American) Standard Fire Hose Coupling Screw Thread	

RELATED CROSS REFERENCE MATERIALS	
Specification 511, "Water Valves"	
COA Standard Specification Items	
Designation	Description
Item No. 501	Jacking or Boring Pipe
Item No. 503	Frames, Grates, Rings and Covers

Item No. 505	Concrete Encasement and Encasement Pipe
Item No. 506	Manholes
Item No. 507	Bulkheads
Item No. 508	Miscellaneous Structures and Appurtenances
Item No. 509	Trench Safety Systems

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ITEM NO. 551 PIPE UNDERDRAINS 12-15-2021

551.1 Description

This item shall consist of pipe underdrains embedded in filter material, constructed at such places as indicated and in accordance with lines and grades established by Engineer. This item shall also consist of any pumping, bailing, drainage and Item No. 509, "Trench Safety Systems" for trench walls, when indicated.

551.2 Materials

(1) Pipe

The following materials will be permitted as alternates unless type is indicated. Size indicated shall be inside diameter. Pipe shall meet the following requirements:

Type 1 Vitrified Clay or Concrete Pipe

Pipe may be either thoroughly and perfectly burned or glazed vitrified clay or nonreinforced concrete conforming to ASTM C 14. Vitrified clay pipe shall be of first quality hub and spigot style, sound, without warps or cracks or other imperfections and shall be sufficiently tough so that it may be cut with a chisel and hammer.

Type 2 Clay Drain Tile

Standard clay drain tile shall conform to specifications of AASHTO M 179.

Type 3 Concrete Drain Tile

Butt end concrete drain tile shall conform to ASTM C 412. Tongue and groove concrete drain tile shall conform to ASTM C 118.

Type 4 Porous Concrete Pipe

Porous concrete pipe shall conform to AASHTO M 176.

Type 5 Perforated Clay Pipe

Perforated clay pipe shall conform to specifications for standard strength perforated clay pipe of AASHTO M 65 except that extra strength clay pipe may be substituted for standard strength clay pipe.

Type 6 Perforated Corrugated Metal Pipe

Perforated helically corrugated metal pipe shall be fabricated from corrugated galvanized sheets and shall conform to AASHTO M 36 or corrugated aluminum alloy sheets and shall comply with AASHTO M 196.

Type 7 Perforated Corrugated Metal Pipe (Bituminous Coated)

Pipe shall conform in all particulars to requirements specified above for perforated corrugated metal pipe. Steel pipe shall be uniformly coated inside and out with a bituminous coating to a minimum thickness of 0.05 inch.

Bituminous material used to coat pipe shall meet the following requirements when tested in accordance with TxDOT Test Method Tex-522-C:

Solubility, % by wt. in

Trichloroethylene	99.5 minimum
Brittleness Test	Pass
Flow, inches	0.25 maximum

Type 8 Perforated Concrete Pipe

Perforated concrete pipe shall conform to ASTM C 444, "Standard Strength Perforated Nonreinforced Concrete Underdrain Pipe", except that "Extra Strength Perforated Nonreinforced Concrete Underdrain Pipe" may be substituted for standard strength pipe.

Type 9 ABS Perforated Pipe

ABS pipe shall be extruded and fittings molded from virgin ABS plastic material conforming to ASTM D 1788, Type 4, except that minimum heat deflection temperature is 180?F. Contractor shall furnish certified test reports as evidence that material used for project meets ASTM requirements. Dimensions of ABS pipe shall be as shown in Table I. Fittings shall conform to manufacturer's standard for particular size of pipe required.

TABLE I

Nominal Size, Inches	Inside Diameter Inches, Minimum	Thickness of Barrel Inches, Minimum
4	3.82	0.19
6	5.70	0.28

Perforations shall conform to requirements for Type 5 pipe underdrains. Crushing strength of ASB pipe shall meet or exceed minimum values in Table II when tested in accordance with flat-plate loading method as outlined in ASTM Designation: D 2412.

TABLE II

Nominal Size, Inch	Minimum Strength lb. Inch
4	179
6	604

Pipe shall withstand at least 35 percent vertical deflection without rupture of pipe wall and stiffness shall equal or exceed valves at 5 percent deflection. Vertical deflection shall be computed as follows:

$$\text{Percent Deflection} = \frac{\text{Reduction Vert. I.D.}}{\text{Nominal I.D.}} \times 100$$

Ends of ABS pipe, couplings and fittings shall be perpendicular or square to longitudinal axis of main body within a maximum angle of 3 degrees. Outer and inner surface of pipe shall be free from blisters, voids and discontinuities.

Type 10 Preformed Corrugated Polyethylene Plastic Tubing

Tubing shall comply with AASHTO M 252.

Type 11 Perforated Polyvinyl Chloride Pipe

Pipe shall be Schedule 40 and conform to ASTM D 1785. Unless otherwise specified, the perforated pipe shall have two rows of holes 9.4 mm (⅜ in.) in diameter on 150 mm (6 in.) centers, with allowable

tolerances of ± 1 mm (1/16in.) on the diameter and + 6, -0 mm (+¼, -0 in.) on the spacing, and the rows shall be parallel to the axis of the pipe and 120 ± 5° apart.

(2) Filter Material

(a) Aggregate

Filter material for use in backfilling trenches under, around and over underdrains shall consist of hard, durable, clean, washed, rounded, river gravel, ranging in size from one-half (0.5) to one and one-half (1.5) inches and shall be free from organic matter, clay balls or other deleterious matter.

(b) Geotextile

Geotextile shall conform to Item No. 620 - Table 2, "High Flow Filter Fabric".

Source: Rule No. R161-21.27 , 12-15-2021.

551.3 Construction Methods

Excavation of each trench shall begin at its outlet and proceed toward its upper end. Trench must not be excavated below proposed grade line and shall be located as indicated or as directed by Engineer and true to line and grade. Trench shall be dressed with a tile hoe or shovel in such manner that will facilitate placement of underdrain. Closed joints shall be coupled with bands, solvent weld couplings or integral joints. Perforated ABS pipe shall be jointed by couplers or solvent welding according to manufacturer's recommendation. No tar paper strips shall be used.

Approved plugs shall be placed in upper ends of pipes and exposed ends of underdrains shall be covered with ½ inch galvanized hardware cloth and filter fabric.

When indicated, concrete riprap or headwalls of dimensions indicated shall be constructed at outlet ends of pipe underdrains. Concrete materials and proportions shall conform to requirements specified for Class B Concrete conforming to Item No. 403, "Concrete for Structures".

When perforated metal pipe is used and trench is founded in pervious material, a thin layer of tamped impervious material shall be placed on bottom of trench as indicated or as directed by Engineer. Sections shall be jointed with band couplers.

When clay or concrete pipe is used and trench is founded in pervious material, a bottom course of specified filter material shall be placed and tamped to a uniform depth of 2 inches. Pipe shall then be firmly embedded in filter material, hub upgrade and spigot firmly centered into adjacent hub end or in the case of butt end type drains with an open joint of approximately 3/8 inch. Open joints shall then be covered with approved 2 ply tar paper strips not less than 6 inches in width and of sufficient length to permit ends being turned outward and laid flat on bottom course of filter material of each side for a distance of 3 inches. When trench is founded in impervious material, the 2 inch bottom course of filter material shall be omitted, pipe laid directly in trench and filter material placed in trench to a depth of 2 inches on each side of pipe. Two ply tar paper strips shall then be placed as specified above.

551.4 Measurement

Work and accepted materials for "Pipe Underdrains" shall be measured by the linear foot of pipe measured along slope and shall include clearing, excavation, filter material, filter fabric, pipe, length of elbows, wyes, tees and other branches and backfill.

551.5 Payment

Work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit price bid per linear foot of "Pipe Underdrains" of type and size specified, which price shall be full compensation for furnishing and placing materials, for underdrain excavation and backfill, for filter materials, for plugs and screens and for labor, tools, equipment and incidentals necessary to complete the work.

Any riprap, headwalls or Trench Safety System indicated will be measured and paid for in accordance with provisions of Item No. 403, "Concrete for Structures", Item No. 410, "Concrete Structures", Item No. 509, "Trench Safety Systems" and Item No. 591, "Riprap for Slope Protection".

Payment will be made under:

Pay Item No. 551:	Pipe Underdrains, In.	Per Linear Foot.

End

Ref: 403, 410, 509, 591, 620

Item No. 591S
Riprap for Slope Protection

591S.1 Description

This item shall govern the excavation of all materials encountered for placing riprap, disposal of excess material and backfilling around the completed riprap to the grade indicated on the Drawings. The work shall include all pumping and bailing, furnishing and placing riprap of rock or concrete in accordance with the details and to the dimensions indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses. The work conducted under this item pertains to riprap for protection of slopes, cuts, fills, drainage facilities and other features susceptible to erosion.

591S.2 Submittals

The submittal requirements for this specification item shall include:

A. The type, size, gradation, physical properties and source of rock riprap material; test data for specific gravity, absorption, soundness and field verification of the rock riprap gradation including a size distribution plot and a list of the measured D15, D50, D85 and D100 (refer to Item No. 591S.3.A).

B. The type, size, and source of broken concrete riprap material.

C. Aggregate types, gradations and physical characteristics for the Portland cement concrete mix,

D. Proposed proportioning of materials for the mortar mix,

E. Type, details and installation requirements for reinforcement, joint material, tie backs and anchors,

F. Description of filter fabric including characteristics, test data and manufacturer's recommendations for installation.

G. The type, size, gradation and source of granular filter material.

Where vegetated soil-riprap is used, and proposed materials differ from the materials already approved for use elsewhere on the project, the submittal requirements also include:

H. Identification of the seed species, source, mixture, pure live seed (PLS) as listed on the analysis tags, certification tags from all seed bags, and seed calculation worksheet per item No. 604S, Table 9.

I. Soil retention blanket material type, evidence that the material is listed on the TxDoT Approved Product List, one (1) full set of manufacturer’s literature and installation recommendations and any special details necessary for the proposed application.

J. Identification of fill soil class, source, and characteristics of proposed borrow material as described in Item No. 130S Borrow.

K. Identification of topsoil source and characteristics including textural (clay/silt/sand) percentage.

591S.3 Materials

A. Rock

The rock shall be suitable in all respects for the purpose intended. Rock sources shall be selected well in advance of the time the rock will be required and shall be pre-approved by the Engineer. Rock used for riprap shall be hard, durable, and angular in shape and consist of clean field rock or rough unhewn quarry rock as nearly uniform in section as practicable. Neither the width nor the thickness of a single rock shall be less than one third of its length. The rocks shall be dense, resistant to weathering and water action, and free of overburden, spoils, shale, and organic material. Shale, chalk, and limestone with shale or chalk seams shall not be acceptable. Rounded rock (river rock) shall not be acceptable.

The rock durability shall be evaluated by visual inspection and laboratory tests for specific gravity, absorption, and soundness. The minimum specific gravity shall be 2.4 (150 pounds per cubic foot) and the maximum absorption 4.2% using ASTM D 6473 or Tex-403-A. Soundness shall be tested in accordance with ASTM D 5240 or Tex-411-A and weight loss shall not exceed 18% after 5 cycles of magnesium sulfate solution, nor 14% after 5 cycles of sodium sulfate solution.

The rock riprap material shall be provided as a gradation of larger and smaller rock sizes associated with a rock class or median diameter (D50) as specified in the drawings. Rock diameter for angular material represents the length of the intermediate axis of an individual rock. The material gradation shall conform to table below for the class sizes corresponding to the D50. The D15, D50, D85, and D100 are the rock sizes for which 15%, 50%, 85%, and 100% of the total sample are of equal size or smaller, respectively.

Rock Riprap Gradation Table								
Rock Riprap Class by Median Particle Diameter (D50)		D15 (in)		D50 (in)		D85 (in)		D100 (in)
Class	Diameter (in)	Min	Max	Min	Max	Min	Max	Max
I	6	3.7	5.2	5.7	6.9	7.8	9.2	12.0
II	9	5.5	7.8	8.5	10.5	11.5	14.0	18.0
III	12	7.3	10.5	11.5	14.0	15.5	18.5	24.0
IV	15	9.2	13.0	14.5	17.5	19.5	23.0	30.0
V	18	11.0	15.5	17.0	20.5	23.5	27.5	36.0
VI	21	13.0	18.5	20.0	24.0	27.5	32.5	42.0
VII	24	14.5	21.0	23.0	27.5	31.0	37.0	48.0
VIII	30	18.5	26.0	28.5	34.5	39.0	46.0	60.0
IX	36	22.0	31.5	34.0	41.5	47.0	55.5	72.0
X	42	25.5	36.5	40.0	48.5	54.5	64.5	84.0

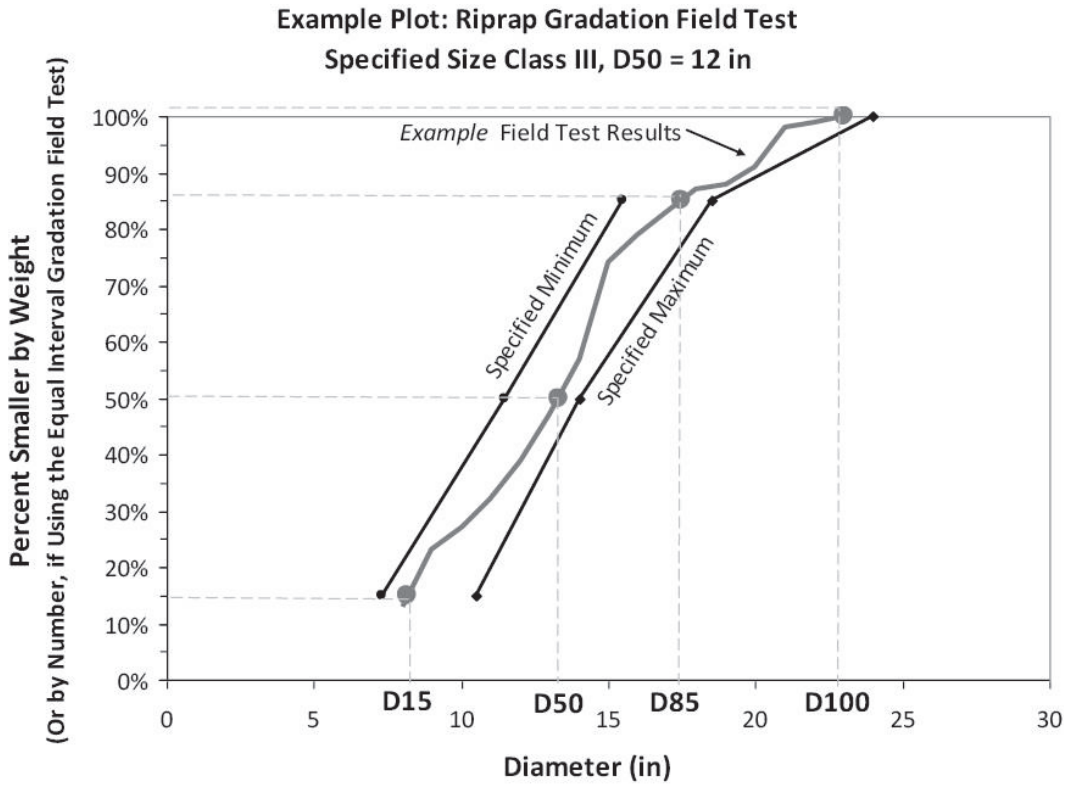
1. Reference: NCHRP Report 568
2. Conversion to weight-based gradation: $W = 0.0275D^3Sg$ where W is rock size in lbs, D is diameter in inches and Sg is the specific gravity of the rock.

Conformance of rock riprap to the gradation requirements shall be accomplished by field tests for rock sizes that cannot be analyzed via sieve or mechanical sorting machines. In order to perform a field test, the contractor shall provide a sample of the proposed rock riprap material meting the gradation for the specified size class. Gradation field tests shall follow the equal interval test

procedure in NCHRP Report 568, Section 3.2.3, ASTM D 5519, or the modified equal interval method. The general steps of the modified equal interval method are:

1. Spread a representative, well mixed sample of riprap to form a flat, rectangular pile. The thickness of the pile should be approximately equal to D100. The length and width of the footprint should be determined based on the rock size and the minimum sample size that is requested by the Engineer.
2. With a large tape measure, create a linear transect across the sample pile. Mark each rock that falls directly under the tape measure at an equal interval. The interval should be two feet or greater, depending on the D50, such that no rock is marked more than once.
3. Lay additional transects parallel to the first transect, at a spacing equal to the interval between marked rocks, Repeat step B for each transect such that the marked rocks form an equally spaced grid across the pile.
4. Measure the diameter of each marked rock across the intermediate (middle or B axis). The number of rocks measured shall be equal or greater than the minimum sample size.
5. Analyze the data by sorting and plotting a curve of percent smaller by number vs. diameter. Identify the diameters.

Gradation tests shall result in: (1) a size distribution plot comparing the measured sample data with the specified diameter ranges for the rock size class (example below) and (2) the calculated D100, D85, D50, and D15 of the rock sample. The sample gradation is acceptable if the calculated diameters fall within the specified ranges of the applicable gradation. The acceptability of rock that falls outside the specified gradation ranges shall be at the discretion of the Engineer.



Approved rock rip-rap samples shall be stored onsite as a reference for ongoing visual inspection of additional materials supplied. Supplementary tests may be required for supply materials where visual inspection determines there may be a deviation from the required gradation. Labor, equipment and site location needed to assist in checking gradation shall be provided by the contractor at no additional cost to the owner.

B. Broken Concrete

The rock used for mortar riprap may consist of broken concrete removed under the contract or obtained from other approved sources. Broken concrete shall be as nearly uniform in section as practicable and of the sizes indicated in Section 591S.5, "Dry Riprap".

C. Concrete

Cast in place concrete shall be Class A Concrete and shall conform to Standard Specification Item No. 403S, "Concrete for Structures".

D. Grout and Mortar

Grout and mortar shall consist of 1 part Portland Cement and 3 parts sand, thoroughly mixed with water. Mortar shall have a consistency such that it can be easily handled and spread by trowel. Grout shall have a consistency such that it will flow into and completely fill all joints.

E. Reinforcement

Reinforcement shall conform to Standard Specification Item No. 406S, "Reinforcing Steel".

F. Joints

Premolded expansion joint material shall conform to Standard Specification Item No. 408, "Concrete Joint Material".

G. Tie Backs and Anchors

Galvanized tie backs and anchors shall be as indicated on the Drawings.

H. Filter Fabric

Filter Fabric shall conform to Standard Specification Item No. 620S, "Filter Fabric".

I. Granular Filter

Aggregate used for granular filters shall conform to Standard Specification Item No. 403S "Concrete for Structures".

J. Soils

For vegetated soil-rock rip-rap, soil shall be integrated with the rock rip-rap at 30% soil to 70% rock by volume with minimal voids. Unless specified otherwise in the drawings, soil that is placed below six inches (6”) below the rip-rap top surface shall be Class A Select Borrow material, as described in Item No. 130S Borrow, and referred to herein as “fill soil.” Soil that is placed within the top six inches (6”) of the rip-rap top surface shall be topsoil material as described in Item No, 601S Salvaging and Placing Topsoil, Section 3.

K. For vegetated soil-rock rip-rap, the type of seed mix and application rates shall be as

specified on the Drawings and within the referenced Standard Specification. If no seed mix is specified, apply according to Item No. 604S Seeding for Erosion Control, Section 6.

L. Soil retention blanket

For vegetated soil-rock rip-rap, soil retention blanket shall be a TxDoT approved Class I Type C or D, shall be made of 100% biodegradable fibers, unless specified otherwise in the Drawings. Blanket shall comply with the requirements of Item No. 605S Soil Retention Blanket, Section 3.

591S.4 Construction Methods

Prior to commencement of this work, all required erosion control and tree protection measures (Standard Specification Item 610S, "Preservation of Trees and Other Vegetation) shall be in place and utilities located and protected as set forth in the "General Conditions". Construction equipment shall not be operated within the drip line of trees unless indicated on the Drawings. Construction materials shall not be placed under the canopies of trees. No excavation or embankment shall be placed within the drip line of trees until tree wells (Standard Detail Number 610S-6, "Tree Protection, Tree Wells") are constructed. Spalls and small stones used to fill open joints and voids in rock riprap shall be rocked and wedged to provide a tight fit.

Unsuitable excavated materials or excavation in excess of that needed for construction shall be known as "Waste" and shall become the Contractor's property and sole responsibility to dispose of this material in an environmentally sound manner off the limits of the right of way at a permitted disposal site.

All blasting shall conform to 01550, "Public Safety and Convenience." The Contractor shall comply with all laws, ordinances, applicable safety code requirements, International Fire Code Chapter 27 "Hazardous Materials General Provisions" and Chapter 33 "Explosives and Fireworks" and any other regulations relative to handling, storage and use of explosives. In all cases, a Blasting Permit must be obtained in advance from the appropriate City agency.

Areas to be protected by rock riprap shall be free of brush, trees, stumps and other objectionable materials and be graded to a smooth compacted surface. All soft or spongy material shall be removed and replaced with appropriate material to the depths shown on the plans or as directed by the engineer. Fill Areas, unless otherwise specified will be compacted in accordance with 132S - Embankment. Unacceptable subgrade conditions shall be reworked according to the Engineer's recommendations. Excavation areas shall be maintained until the riprap is placed.

A. Dry Rock Riprap

The mass of rock riprap shall be placed as to be in conformance with the required gradation mixtures, to the lines, grades and layers thickness that is shown on the drawings.

When the riprap will be placed on an erodible soil, as determined by the Engineer or designated representative, a layer of geotextile filter fabric or a granular filter layer shall be placed, prior to placement of the riprap material. In some cases multiple layers of granular filter material of varying gradations may be required. The median rock riprap size (D50), rock riprap layer thickness, filter type, when applicable the number of granular filter layers, granular filter aggregate gradations (grade/size classification), granular layer thicknesses shall be specified on the plans. The minimum granular filter layer thickness shall be 4 inches (102 mm). Geotextile filter fabric shall conform to Standard Specification No. 620 and be installed

with sufficient anchoring and overlap between seams according to the manufacturer's recommendations to ensure full filter barrier protection of the subgrade after riprap installation. When specified on the plans a four (4) inch minimum thickness granular cushion layer of gravel or sand may be placed over the filter fabric to prevent damage the fabric during placement of rock riprap.

Rock riprap shall be machine placed and distributed such that there will be no large accumulations of either larger or smaller sizes. Placing rock riprap by dumping into chutes or similar methods shall not be permitted. The rocks shall be placed in a single layer with close joints. The rock riprap layer thickness shall be no less than the maximum stone size (D100) or 1.5 times the D50, which ever produces the greater thickness. In areas exposed to flowing water the rock riprap layer thickness should be no less than 2.0 times the D50. The upright axis of the rocks shall make an angle of approximately 90 degrees with the embankment slope. The courses shall be placed from the bottom of the embankment upward, with the larger rocks being placed on the lower courses. Open joints shall be filled with spalls. Rocks shall be arranged to present a uniform finished top surface such that the variation between tops of adjacent rocks shall not exceed 3 inches (75 mm). Rocks that project more than the allowable amount in the finished work shall be replaced, embedded deeper or chipped.

B. Mortared Rock Riprap

Rock for this purpose, as far as practicable, shall be selected as to size and shape in order to secure fairly large, flat-surfaced rock which may be laid with a true and even surface and a minimum of voids. Fifty percent of the mass rock shall be broad flat rocks, weighing between 100 and 150 pounds (45 and 69 kilograms) each, placed with the flat surface uppermost and parallel to the slope. The largest rock shall be placed near the base of the slope. The spaces between the larger rocks shall be filled with rocks of suitable size, leaving the surface smooth, reasonably tight and conforming to the contour required on the Drawings. In general, the rocks shall be placed with a degree of care that will insure plane surfaces with variation from the true plane of no more than 3 inches in 4 feet (no more than 60 mm per meter). Warped and curved surfaces shall have the same general degree of accuracy as indicated for plane surfaces.

Before placing mortar, the rocks shall be wetted thoroughly and as each of the larger rocks is placed, it shall be surrounded by fresh mortar and adjacent rocks shall be shoved into contact. After the larger rocks are in place, all of the spaces or opening(s) between them shall be filled with mortar and the smaller rocks then placed by shoving them into position, forcing excess mortar to the surface and insuring that each rock is carefully and firmly embedded laterally. After the work described above has been completed, all excess mortar forced up shall be spread uniformly to completely fill all surface voids. All surface joints then shall be pointed up roughly, either with flush joints or with shallow, smooth raked joints.

B. Vegetated Soil-Rock Riprap

Adjacent stockpiles of rock riprap, fill soil, and topsoil shall be treated and there shall be no premixing of fill soil, top soil and rock prior to placement. Sufficient soil volume shall be provided to result in a final, complete-in-place ratio of 30% soil to 70% rock riprap by volume.

Place underlying filter material and first layer of rock riprap in accordance with 591S.4.A to a thickness equivalent to the D50 rock size of half the design rock layer thickness, whichever is greater. Place a layer of soil over and within the rock voids such that the top of the soil layer is approximately 75% of the rock layer thickness. Work the soil into the rock layer voids by wetting, prodding with a rock bar, and/or vibratory compaction until the soil height is

approximately 50% of the rock height. If the soil height becomes less than 50% of the rock height then repeat the previous steps.

Place the second layer of rock riprap per 591S.4.A up to the final design grade. Place soil over and within the rock riprap, working it into the voids as in the previous step and repeating application as needed until the top of the soil layer approximately matches the top surface of the rock riprap. Excess soil shall not be placed in the voids to the extent that the rock riprap is displaced. The resulting soil-riprap surface shall be smooth, with no lumps or depressions greater than two inches (± 2") from the final design grade.

Once the soil-rock matrix is placed, the surface of the soil-rock riprap shall be seeded per the Drawings and covered with biodegradable erosion control fabric.

C. Concrete Riprap

Concrete for riprap shall be placed as indicated on the Drawings or as directed by the Engineer or designated representative. Unless otherwise indicated on the Drawings, concrete riprap shall be reinforced using wire or bar reinforcement.

Concrete shall be Class A or as indicated otherwise on the Drawings and shall conform to Standard Specification Item No. 403S, "Concrete for Structures".

When welded wire reinforcement is indicated, it shall be a minimum of 6 x 6 W1.4 x W1.4 (150 x 150 MW9 x MW9) with a minimum lap of 6 inches (150 mm) at all splices. At the edge of the riprap, the wire fabric shall not be less than 1 inch (25 mm) nor more than 3 inches (75 mm) from the edge of the concrete and shall have no wires projecting beyond the last member parallel to the edge of the concrete.

When bar reinforcement is used, the sectional area of steel in each direction shall not be less than the sectional area of the wire fabric described above. The spacing of bar reinforcement shall not exceed 18 inches (450 mm) in each direction and the distance from the edge of concrete to the first parallel bar shall not exceed 6 inches (150 mm).

Reinforcement shall be supported properly throughout the placement to maintain its position approximately equidistant from the top and bottom surface of the slab.

Unless otherwise noted, expansion joints of the size and type indicated on the Drawings shall be provided at intervals not to exceed 40 feet (12.2 meters) and shall extend the full width and depth of the concrete. Marked joints shall be made 3/8 inch (9.5 mm) deep at 10 foot (3 meter) intervals. All joints shall be perpendicular and at right angles to the forms unless otherwise indicated on the Drawings.

Slopes and bottom of the trench for toe walls shall be compacted and the entire area sprinkled before the concrete is placed.

After the concrete has been placed, consolidated and shaped to conform to the dimensions indicated on the Drawings and has set sufficiently to avoid slumping, the surface shall be finished with a wooden float to secure a reasonably smooth surface.

Immediately following the finishing operation, the riprap shall be cured conforming to Standard Specification Item No. 410S, "Concrete Structures".

D. Pneumatically Placed Concrete Riprap, Type I and Type II

Pneumatically placed concrete for riprap shall be placed as indicated on the Drawings or as established by the Engineer or designated representative. Pneumatically placed concrete shall conform to Standard Specification Item No. 404S, "Pneumatically Placed Concrete". Reinforcement shall conform to the details indicated on the Drawings and Standard Specification Item No. 406S, "Reinforcing Steel". Reinforcement shall be supported properly throughout placement of concrete. All subgrade surfaces shall be moist when concrete is placed.

The surface shall be given a wood float finish or a gun finish as indicated on the Drawings.

The strength and design of Pneumatically Placed Concrete Riprap shall be either Type I or if indicated, Type II conforming to Standard Specification Item No. 404S, "Pneumatically Placed Concrete".

Immediately following the finishing operation, the riprap shall be cured conforming to Standard Specification Item No. 410S, "Concrete Structures".

591S.5 Measurement

Measurement of acceptable riprap will be made on the basis of the (a) area in square yards (square meters: 1 square meter equals 1.196 square yards) indicated on the Drawings, complete in place or (b) the volume of concrete placed in cubic yards (cubic meters: 1 cubic meters equals 1.308 cubic yards), complete in place as indicated on the Drawings for the thickness specified.

Concrete toe walls will not be measured separately but shall be included in the unit price bid for riprap of the type with which it is placed.

591S.6 Payment

The riprap quantities, measured as provided above, will be paid for at the unit bid prices per square foot or per cubic yard as indicated for riprap of the various classifications. The Unit Bid Price shall include full compensation for furnishing, hauling and placing all materials, including toe walls, geotextile filter fabric, granular filter material, fill soil and top soil, seed, erosion control fabric, granular cushion, reinforcement and premolded expansion joint material and for all labor, tools, equipment and incidentals necessary to complete the work.

Payment for excavation of toe wall trenches and for all necessary excavation below natural ground or the bottom of excavated drainage channels will be included in the unit bid price for riprap. Excavation, grading and fill materials required to shape drainage channels shall not be included in the unit bid price for riprap.

Payment for excavation required for shaping of slopes for riprap shall be included in the unit bid price for riprap, except for the situation when the header banks upon which the riprap is to be placed are built by prior contract. In this specific case the excavation for shaping of slopes, will be paid for conforming to Standard Specification Item No. 401, "Structural Excavation and Backfill".

Payment will be made under one of the following:

Pay Item No. 591S-A:	Dry Rock Riprap	Per Square Yard.
Pay Item No. 591S-B:	Dry Rock Riprap	Per Cubic Yard.

Pay Item No. 591S-D:	Mortared Rock Riprap	Per Square Yard.
Pay Item No. 591S-F:	Concrete Riprap, ___ In.	Per Square Yard.
Pay Item No. 591S-G:	Concrete Riprap	Per Cubic Yard.
Pay Item No. 591S-I	Vegetated Soil-Rock Riprap	Per Square Yard
Pay Item No. 591S-J	Vegetated Soil-Rock Riprap	Per Cubic Yard
Pay Item No. 591S-P	Pneumatically Placed Concrete Riprap, __In.	Per Square Yard.

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End

SPECIFIC CROSS REFERENCE MATERIALS
Specification 591S, “Riprap for Slope Protection"

International Fire Code

Designation	Description
Chapter 27	Hazardous Materials
Chapter 33	Explosives and Fireworks

City of Austin Standard Contract Documents

Designation	Description
01550	Public Safety and Convenience

City of Austin Standard Specifications

Designation	Description
Item No. 130S	Borrow
Item No. 403S	Concrete for Structures
Item No. 404S	Pneumatically Placed Concrete
Item No. 406	Reinforcing Steel
Item No. 408	Concrete Joint Material
Item No. 410	Concrete Structures
Item No. 601S	Salvaging and Placing Topsoil
Item No. 604S	Seeding for Erosion Control
Item No. 605S	Soil Retention Blanket
Item No. 610S	Preservation of Trees and Other Vegetation
Item No. 620S	Filter Fabric

American Society for Testing and Materials, ASTM

Designation	Description
ASTM D 5240	Standard Test Method for Evaluation of Durability of Rock for Erosion Control Using Sodium Sulfate or Magnesium Sulfate
ASTM D 5519	Standard Method Methods for Particle Size Analysis of Natural and Man-made Riprap Materials
ASTM D 6473	Standard Test Method for Specific Gravity and Absorption of Rock for Erosion Control

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-403-A	Test Procedure for Saturated Surface-Dry Specific Gravity and Absorption of Aggregates
Tex-411-A	Soundness of Aggregate Using Sodium Sulfate or Magnesium Sulfate

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Street, and Bridges

Designation	Description
Item No. 432	Riprap

RELATED CROSS REFERENCE MATERIALS
Specification 591S, “Riprap for Slope Protection"

City of Austin Standard Specifications

Designation	Description
Item No. 623S	Dry Stack Rock Wall

Engineering Design Manuals

Federal Highway Administration, 1989, Design of Riprap Revetment, Hydraulic Engineering Circular HEC-11, FHWA-1P-89-016.

National Cooperative Highway Research Program, 2006, Riprap Design Criteria, Recommended Specifications, and Design Criteria, NCHRP Report 568.

United States Bureau of Reclamation, 1983, Hydraulic Design of Stilling Basins and Energy Dissipators, Engineering Monograph No. 25.

U.S Department of Agriculture, 1983, Soil Conservation Service, Riprap for Slope Protection Against Wave Action, Technical Release No. 69, February.

US Army Corps of Engineers, 1994. Hydraulic Design of Flood Control Channels, US Army Corps of Engineers Engineer Manual EM 1110-2-1601.

Federal Highway Administration, 1998. "Geosynthetic Design and Construction Guidelines,” FHWA-HI-95-038.

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ITEM NO. 594S GABIONS AND REVET MATTRESSES 9-26-12

594S.1 Description

The work to be performed under this specification shall include furnishing, assembling, filling, and tying rock-filled wire mesh compartmented gabions and revet mattresses in accordance with the lines, grades, and dimensions shown on the Drawings or otherwise established in the field by the Engineer or designated representative. The type of construction (i.e. twisted woven mesh, welded mesh or both) and wire sizes [i.e. 13.5 gage (2.2 mm), 12 gage (2.7 mm) or 10 gage (3.4 mm)] shall be as defined in the Drawings or otherwise established by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

594S.2 Materials

Gabions and revet mattresses shall be constructed of galvanized steel wire with polyvinylchloride (PVC) flexible coating. The gabions and revet mattresses shall be of the construction and sizes specified in the Drawings and shall meet the specifications presented herein. Unless otherwise specified in the Drawings or approved by the Engineer or designated representative, the gabions and revet mattresses may be constructed of either double twist woven mesh or welded wire mesh.

Gabions shall be furnished in the specified dimensions within a tolerance of ± 5 percent. Revet mattresses shall be furnished in the specified dimensions within a tolerance of (5 percent for the length and width and (10 percent for the height. For each individual gabion or revet mattress, the same mesh style shall be used for the base, front, ends, back, diaphragms and lid panels. Each gabion or revet mattress shall be manufactured and divided into cells of equal length, no greater than 3 feet (0.9 meter), by diaphragm panels.

(1) Gabion and Revet Mattress Wire

Gabion wire shall be galvanized steel, Class 3 or A coating, soft temper conforming to ASTM A 641, and shall specifically meet the requirements given below for gabions (12 gage wire) and/or revet mattresses (13.5 wire gage) as called for in the Drawings. PVC coating of the wire may be fusebonded or extruded onto the wire. Galvanization of welded wire shall be performed either before or after welding.

Table 1: Requirements - Mesh Wire for Gabions and Revet Mattress Units

Characteristic	Gabions	Revet Mattresses
Wire Gage	12 gage	13.5 gage
Maximum Tensile Strength (ASTM 641)	70,000 psi (483 mPa)	75,000 psi (517 mPa)
Nominal Wire Diameter (ASTM A 641)	0.106 inch (2.7 mm)	0.0866 inch (2.2 mm)
Minimum Diameter (ASTM A 641, Table 3)	0.102 inch (2.6 mm)	0.0826 inch (2.9 mm)
Galvanizing, Zinc (ASTM A 641, Table 1)	0.80 oz/ft^2 (245 gr/m^2)	0.70 oz/ft^2 (215 gr/m^2)

(2) Gabion Mesh

(A) Woven Mesh

Woven mesh shall be of a uniform nonraveling, double twist hexagonal pattern nominally of dimensions 3.25 inches by 4.5 inches (83 mm by 114 mm). Selvedge wire shall be 10 gage (nominal diameter of 3.4 mm).

(B) Welded Mesh

Mesh opening shall be nominally 3 inches by 3 inches (75 mm by 75 mm). Strength of welds shall meet the following requirements when tested in accordance with section 13.4 of ASTM A-974:

Table 2: Minimum Weld Strength Requirements

Type of Structure	Wire Size (Diameter)	Minimum Average Weld Shear Strength
	Gage (mm)	English Units (SI Units)
Gabions	12 (2.7)	472 lbf (2.10 kN)
Revet Mattress	13.5 (2.2)	292 lbf (1.30 kN)

(C) Manufacturing

Twisted wire mesh gabions shall be manufactured in conformance with ASTM A-975, while welded wire mesh gabions shall be manufactured in conformance with ASTM A-974.

(3) Revet Mattresses

(A) Woven Mesh

Woven mesh shall be of a uniform nonraveling, double twist hexagonal pattern, nominally of dimensions 2.5" × 3.25" (64 mm by 83 mm). Selvedge wire shall be 12 gage (nominal diameter of 2.7 mm).

(B) Welded Mesh

Mesh opening shall be nominally 1.5" × 3.0" (38 mm by 76 mm). Strength of welds shall meet the requirements listed in Table 2 for 13.5 gage (2.2 mm) wire, when tested in accordance with section 13.4 of ASTM A-974:

(C) Manufacturing

Twisted wire mesh revet mattresses shall be manufactured in conformance with ASTM A-975, while welded wire mesh revet mattresses shall be manufactured in conformance with ASTM A-974.

(4) PVC Coating

All wire used in fabrication of the gabions, revet mattresses and wiring operations during construction shall, after zinc coating, have a fusebonded or extruded coating of PVC. The coating shall be gray in color. The thickness shall be nominally 0.020 inch (0.5 mm), and shall not be less than 0.015 inch (0.38 mm) in thickness. It shall be capable of resisting deleterious effects of natural weather exposure, and immersion in salt water.

For PVC-coated welded wire fabric panel, cutting of the panels shall not be allowed closer than ¼ inch (⅛ inch (6 mm (3.18 mm) after fabrication in order to prevent exposure near the welds.

(A) Initial Properties:

1) Woven Mesh:

The initial properties of the PVC coating material shall have a demonstrated ability to conform to the following requirements specified in ASTM A-975:

a) Specific Gravity:

The specific gravity as determined in accordance with ASTM D-792 shall be between 1.3 to 1.35.

b) Durometer Hardness:

The hardness as determined in accordance with ASTM D-2240 shall be between 50 to 60, Shore D.

c) Tensile Strength:

The tensile strength when tested in accordance with ASTM D-412 shall not be less than 2985 psi (20.6 mPa).

d) Modulus of Elasticity at 100% Elongation:

The Modulus of Elasticity when determined in accordance with ASTM D-412 shall not be less than 2700 psi (18.6 mPa).

e) Resistance to Abrasion:

The percentage loss in weight (mass) during abrasion testing in accordance with ASTM D-1242 shall be less than 12%.

f) Brittleness Temperature:

The brittleness temperature shall not be higher than 150F (-9.00C) or a lower temperature specified by the Engineer, when tested in accordance with ASTM D-746. The maximum brittleness temperature should be at least 150F (80C) below the minimum temperature at which the gabion will be handled or filled.

2) Welded Mesh:

The initial properties of the PVC coating material shall have a demonstrated ability to conform to the following requirements specified in ASTM A-974:

a) Specific Gravity:

The specific gravity as determined in accordance with ASTM D-792 shall be between 1.20 and 1.40.

b) Durometer Hardness:

The hardness as determined in accordance with ASTM D-2240 shall not be less than 75, Shore A.

c) Tensile Strength:

The tensile strength when tested in accordance with ASTM D-638 shall not be less than 2275 psi (15.7 mPa).

d) Modulus of Elasticity:

The Modulus of Elasticity when determined in accordance with ASTM D-638 shall not be less than 1980 psi (13.7 mPa).

e) Resistance to Abrasion:

The percentage loss in weight (mass) shall be less than 12 % during abrasion testing in accordance with ASTM D-1242, Method B, at 200 cycles, CSI-A abrader tape, 80 grit.

f) Brittleness Temperature:

The brittleness temperature shall not be higher than 150F (-9.00C) or a lower temperature specified by the Engineer, when tested in accordance with ASTM D-746. The maximum brittleness temperature should be at least 150F (80C) below the minimum temperature at which the gabion will be handled or filled.

g) Adhesion:

The PVC coating on the wire shall adhere to the wire such that the coating breaks rather than separates from the wire, when tested in accordance with the PVC Adhesion Test described in Section 13.3 of ASTM A-974.

h) Mandrel Bend:

The PVC-coated wire, when subjected to a single 3600 bend at 00F (-180C) around a mandrel ten times the diameter of the wire, shall not exhibit breaks or cracks in the PVC coating.

(B) Performance Tests:

The PVC coating shall have the demonstrated ability to withstand the specified exposure testing.

1) Exposure to Salt Spray: The PVC shall show no effect after 3000 hours of salt spray exposure in accordance with ASTM Test Method B-117.

2) Exposure to Ultraviolet Rays:

The PVC shall show no effect of exposure to ultraviolet light with test exposure of 3000 hours, using apparatus Type E and 145°F (63°C), when tested in accordance with ASTM Practice D-1499 and G-23.

(C) Properties After Exposure Tests:

After conclusion of the salt spay and exposure to ultraviolet light tests, the PVC shall not show cracks, blisters or splits, nor any noticeable change in color. In addition the PVC coating shall not show cracks or breaks after the wires are twisted in the fabrication of the mesh, nor shall there be any moisture intrusion under the PVC coating as a result of the test.

After completion of the exposure tests the following criteria shall also be met:

1) Woven Mesh:

a) The Specific Gravity shall not change more than 6% of its initial value.

b) The Durometer Hardness shall not change more than 10% of its initial value.

c) The Tensile Strength shall not change more than 25% of its initial value.

d) The Resistance to Abrasion shall not change more than 10% of its initial value.

2) Welded Mesh:

a) The Specific Gravity shall not change more than 6% of its initial value.

b) The Modulus of Elasticity shall not change more than 25% of its initial value.

c) The Tensile Strength shall not change more than 25% of its initial value.

d) The Resistance to Abrasion shall not change more than 10% of its initial value.

(D) Salt Spray Resistance for Fastener:

The fasteners for twisted mesh wire gabions and revet mattresses shall be subjected to Salt Spray Test of Test Method B-117 for a period of not less than 48 ±1 hour cycle length. After testing the fasteners, the selvedge, or mesh wire confined by the fasteners shall show no rusty spots on any part of the surface excluding the cut ends.

(5) Stone

(A) Gabion Basket Stones

Stone fill shall be durable and of suitable quality to ensure permanence in the structure. The stone used to fill the gabion baskets shall be a clean, sound, and durable rock meeting the following requirements. It shall have a wearing loss less than 35 percent when the stone is tested with the Los Angeles Abrasion Machine in accordance with ASTM Test Method C535 (TxDOT Test Method Tex-410A). The loss of material experienced during five cycles of magnesium sulfate exposure conducted in accordance with TxDOT Test Method Tex411A for Rock RipRap shall not exceed 18 percent. The stone shall be well graded to produce a dense fill, angular in texture, while meeting the following gradation requirements:

Table 3: Gabion Stone Gradation Requirements

Sieve Size		Percent by Weight (Mass) % Passing Each Individual Sieve
US	(SI)	
8 Inch	(200 mm)	100
4 Inch	(100 mm)	0—5
3 Inch	(75 mm)	0

The minimum unit weight (unit mass) of a rockfilled gabion shall be 120 pcf [1.92 megagrams (mg) per cubic meter]. Verification of unit weight (mass) shall be performed when ordered by the Engineer, by constructing a test gabion with materials supplied for construction with the same effort and method intended for production gabions.

(B) Revet Mattress Stone:

The stone used to fill the revet mattresses shall be as specified for gabions except that it shall have a maximum dimension of 5 inches (125mm) and a minimum dimension of 3 inches (75 mm). The majority of the stone shall be in the 3 to 4 inch (75 to 100 mm) range; cubical or rounded in shape. A tolerance of 5% shall be allowed on the upper and lower dimensions of the rock.

(6) Connections

(A) Wire

Lacing wire and connecting wire shall be 13.5 gage [0.087 inch (2.20 mm)] PVC coated galvanized steel, Class 3, soft temper, conforming to ASTM A-641. During testing, any separation of 2 inches (50 mm) or more between connecting wires shall be considered as a failure.

(B) Spiral Binder for Welded Wire Mesh

Spiral binders shall consist of 0.106 inch (2.7 mm) PVC coated wire for the gabion and 0.087 inch (2.2 mm) PVC coated wire for the revet mattresses. Spiral binders shall have a 3.0 inch (75 mm) maximum separation between continuous successive loops (3 inch or 75mm pitch).

The binder shall be made of galvanized steel, Class 3, soft temper, conforming to ASTM A-641.

(C) Alternate Fasteners for Twisted Woven Mesh

Alternate fasteners, acceptable for use by the intended gabion basket manufacturer, may be submitted to the Engineer for consideration and approval prior to construction. The fasteners may consist of split ring or interlocking fasteners. Alternate fasteners systems shall produce a joint that meets the requirements of ASTM A-975, Section 7, Table 2.

(7) Fastener System

The Contractor shall provide a complete description of the fastener system, including the number of fasteners required for all vertical and horizontal connections for single- and multiple-basket joinings, as well as the number and size wires the fastener is capable of properly joining. The Contractor shall provide a description of a properly installed fastener, including test reports, drawings and/or photographs. Properly formed fasteners shall meet the requirements of ASTM A-974 for welded wire mesh or ASTM A-975 for twisted woven mesh.

(A) Each interlocking fastener shall be locked and closed.

(B) Each overlapping ring fastener shall be closed and the free ends shall overlap an average of 1 inch (25 mm).

(C) Spiral binders shall be screwed into position such that they pass through each mesh opening along the joint. In order to prevent unraveling, both ends of the spiral shall be crimped back around itself.

(D) Wire fasteners shall not be used to join more wires, or larger wires, than tested and approved for the application.

(8) Panel to Panel Joint Strength

The minimum strength of the joined panels shall be as specified in Section 7.3 of ASTM A-974 for Welded wire panels or Section 7.3 of ASTM A-975 for twisted woven mesh.

(9) Miscellaneous

Aggregate bedding, geotextiles or other materials shall conform to the requirements established on the Drawings.

(10) Certificate of Compliance

The Contractor shall submit Certificates of Compliance for all materials proposed for use to the Engineer for review and approval one week prior to construction.

594S.3 Construction

Twisted wire mesh Gabon's and revote mattresses shall be supplied in the forms allowed in ASTM A-975, while welded wire mesh Gabon's and revote mattresses shall be supplied in a form allowed in ASTM A-974.

The Gabon/revote mattress manufacturer/supplier will be required to have a qualified representative on site at the start of gabion/revet mattress construction. The Contractor shall submit work experience documentation of the representative for review/approval by the Engineer or designated representative. The representative shall be available for consultation as needed throughout the gabion construction.

Gabions and revet mattresses shall be constructed to the lines and grades shown on the Drawings. Individual or groups of gabions or revet mattresses, which deviate from line and grade, shall, at the direction of the Engineer or designated representative, be removed and replaced at no cost to the owner. Gabions or revet mattresses, which are constructed with bulges, and/or underfilled, loosely filled, or otherwise lacking a neat and compact appearance shall, at the direction of the Engineer or designated representative, be repaired/replaced at no cost to the owner. Underfilling of gabion/revet mattress corners to facilitate insertion of spirals shall not be permitted.

(1) Foundation Preparation

The foundation shall be excavated to the extent shown on the Drawings or as directed by the Engineer or designated representative. All loose or otherwise unsuitable materials shall be removed. All depressions shall be carefully backfilled to grade. The depressions shall be backfilled with suitable materials from adjacent required excavation, or other approved source, and compacted to a density at least equal to that of the adjacent foundation. If pervious materials are encountered in the foundation depressions, the areas shall be backfilled with free draining materials.

Any buried debris protruding from the foundation that will impede the proper installation and detrimentally impact the final appearance of the gabion, shall also be removed, and the voids carefully backfilled and compacted as specified above. Immediately prior to gabion or revet mattress placement, the prepared foundation surface shall be inspected and approved by the Engineer and no material shall be placed thereon until that area has been approved.

Placement of filter material and/or filter fabric shall be as shown on the Drawings or directed by the Engineer.

(2) Gabion/Revet Mattress Basket Assembly

No work shall take place using PVC coated materials unless both the ambient air temperature and the temperature of the PVC materials are at least 15°F (8°C) above the brittleness temperature of the PVC materials.

Assembly of gabions and revet mattresses shall consist of shaping and tying each individual basket. Baskets shall be assembled by connecting all untied edges including diaphragms with lacing wire, spirals or approved fasteners. The connections for the completed assemblies shall conform to the requirements of Section 7 of ASTM specifications A-974 (welded wire) and Section 7.3 and Table 2 of A-975 (double twisted).

Assembly of baskets, connection of baskets together and lid closures shall be accomplished in accordance with one of the following approved procedures:

(A) Lacing Wire:

Using lacing wire of appropriate length, secure one end of the wire onto the basket corner by looping and twisting the lacing wire together. Proceed along the joint by tying with double loops every other mesh opening at intervals not more than 6 inches (150 mm) apart, while pulling the basket elements tightly together. Secure the other end of the lacing wire again by looping and twisting the wire around itself.

(B) Spiral Binders for Welded Wire Mesh:

Spiral binders, meeting the minimum acceptance criteria of article 594S.2(6)(c) shall be screwed into position such that they pass through each mesh opening along the joint. To prevent unraveling, each end of the spiral binder shall be crimped back against itself.

(C) Alternate Fasteners for Twisted Woven Mesh:

Interlocking fasteners meeting the minimum acceptance criteria of article 594S.2(6)(c), shall be installed with, as a minimum, one interlocking fastener in every other opening.

Ring fasteners meeting the minimum acceptance criteria of 594S.2(6)(c), shall be installed with, as a minimum, one split ring fastener in every opening, having a minimum 1 inch (25 mm) total overlap and securing only the number and diameter of wires for which tested.

Placing of gabions and revet mattresses shall consist of installing baskets to the lines and grades shown on the Drawings. Gabions and revet mattresses shall be securely fastened to each adjoining unit along the vertical and top reinforced edges of all contact surfaces. Overlying rows of baskets shall be staggered appropriately. Empty sections stacked on a filled line of gabions and revet mattresses shall be securely fastened to the bottom unit along the front, back and ends.

Prior to the placement of rock, the baskets used in the front vertical exposed faces of retaining walls shall be aligned. To facilitate alignment, tension may be applied to empty units at the direction of the Engineer or designated representative.

(3) Filling of Gabions and Revet Mattresses

The gabions and revet mattresses may be filled by machine, in maximum lifts of 12 inches (300 mm). The machine work shall be supplemented with handwork to avoid bulges and provide a compact mass with a minimum of voids. Care will be exercised so as not to damage the gabion/revet mattress elements or wire coating by limiting height of drop during filling to 3.0 feet (0.9 meter) for Gabions and 1.5 feet (0.5 meter) for revet mattresses. Undue deformation or bulging of the mesh shall be corrected prior to further stone filling. Where specified on the Drawings, select large stone shall be hand placed on vertical outside faces to achieve a desired neat appearance.

During placement, the depth of stone in any cell shall not exceed the depth in an adjoining cell by more than one foot (300 mm). Stone smaller than the mesh opening found against vertical faces shall be removed.

Two connecting wires in each direction for end units and two parallel connecting wires perpendicular to the exposed face for exposed face units shall be installed at every 12 inch (300 mm) lift. The connecting wires shall loop around two mesh openings, and the ends of wires shall be securely twisted with a minimum of three twists after looping. Prefabricated connecting wire may be used in lieu of connecting wire.

Connecting wires associated with 18inch (450 mm) gabions shall be installed when and as specified on the Drawings or as recommended by the gabion/revet mattress manufacturer.

The gabion or revet mattress unit shall be overfilled by 1½ to 2 inches (37.5 to 50 mm) and the lid shall be bent and stretched until it meets the perimeter edges of the front and end panels. The stretching shall be accomplished using an approved lid closing tool in order to prevent damage to the PVC coating. Crow bars or similar single point leverage devices will not be allowed. The lid shall then be securely tied with lacing wire, spirals or approved fasteners to the fronts, ends and diaphragms. Excessive deformation of the lid panel to facilitate closing of a bulging gabion or revet mattress will not be permitted.

All backfill shall be placed and compacted in sequence with the filling of the baskets; however, care shall be exercised in compacting the fill behind a single row of baskets since excessive compaction effort can displace the gabions/revet mattresses from the desired alignment.

Gabion or revet mattress units may be cut or shaped to fit odd length or odd shaped areas. They shall be cut at least 6” to 8” (150 mm to 200 mm) larger than the opening to allow sufficient material for overlap and lacing. All edges or faces formed in this manner shall be adjusted to present a finished and pleasing appearance.

At all times, care shall be taken to turn all loose and projecting ends of wire into the gabion units to prevent injury.

594S.4 Quality of Work

Wire of proper grade and quality, when fabricated and installed in the manner herein required, shall result in a strong, serviceable mesh-type product having substantially uniform openings. It shall be fabricated and finished properly, as determined by visual inspection, and shall conform to this specification.

594S.5 Measurement

Measurement of acceptable "Gabions and Revet Mattresses", complete in place, will be made on the basis of volume determined by the actual length, width and height.

594S.6 Payment

The Gabion and revet mattress quantities, measured as described above, will be paid for at the unit bid prices per cubic yard (cubic meter: 1 cubic meter equals 1.308 cubic yards) of the various types indicated. The price shall include full compensation for furnishing, hauling and placing all materials, including filter fabric, wire containers, connectors, reinforcement stones and backfill; for all labor, tools, equipment and incidentals needed to complete the work.

Excavation and all subgrade preparation required for shaping the foundation for the wire containers shall be included in the unit bid price for "Gabions and Revet Mattresses".

Payment will be made under one of the following:

Pay Item No. 594S-A:	Gabions, Twisted Woven Wire	Per Cubic Yard.
Pay Item No. 594S-B:	Gabions, Welded Wire	Per Cubic Yard.
Pay Item No. 594S-C:	Revet Mattresses, Twisted Woven Wire	Per Cubic Yard.
Pay Item No. 594S-D:	Revet Mattresses, Welded Wire	Per Cubic Yard.

End

SPECIFIC CROSS REFERENCE MATERIALS	
Specification Item 594S, "GABIONS AND REVET MATTRESSES"	
City of Austin Environmental Criteria Manual	
Designation	Description
Section 1.4.3.E	Permanent Structural Practices-Gabions
Figure 1.23	Gabions
City of Austin Standard Details	
Designation	Description
594S-1	Gabions
594S-2	Gabion Details
American Society for Testing and Materials (ASTM)	
Designation	Description
A-974	Standard Specifications for Welded Wire Fabric Gabions and Gabion Mattresses (Metallic-Coated or Polyvinyl Chloride (PVC) Coated)
A-975	Standard Specifications for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel with Poly Vinyl Chloride (PVC) Coating)

RELATED CROSS REFERENCE MATERIALS	
Specification Item 594S, "GABIONS AND REVET MATTRESSES"	
City of Austin Technical Specifications	
Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing

Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 120S	Channel Excavation
Item No. 130S	Borrow
Item No. 132S	Embankment
Item No. 220S	Sprinkling for Dust Control
Item No. 230S	Rolling (Flat Wheel)
Item No. 232S	Rolling (Pneumatic Tire)
Item No. 234S	Rolling (Tamping)
Item No. 236S	Proof Rolling
Item No. 510	Pipe
Item No. 601S	Salvaging and Placing Topsoil
Item No. 602S	Sodding for Erosion Control
Item No. 604S	Seeding for Erosion Control
Item No. 605S	Soil Retention Blanket
Item No. 606S	Fertilizer
Item No. 607S	Slope Stabilization
Item No. 608S	Planting
City of Austin Standard Details	
Designation	Description
642S-1	Silt Fence
Texas Department of Transportation: Manual of Testing Procedures	
Designation	Description
410-A	Abrasion of Coarse Aggregate Using The Los Angeles Machine
411-A	Soundness of Aggregate By Use of Sodium Sulfate or Magnesium Sulfate
American Society for Testing and Materials (ASTM)	
Designation	Description
A-313	Standard Specification for Stainless Steel Spring Wire
A-370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
A-641	Specification for Zinc Coated (Galvanized) Carbon Steel Wire
A-853	Standard Specification for Steel Wire, Carbon, for General Use
B-117	Test Method of Salt Spray (Fog) Testing
C-535	Standard Test Method for Resistance of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
D-412	Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension
D-638	Test Method for Tensile Properties of Plastics
D-746	Test Methods for Brittleness Temperature of Plastic and Elastomers by Impact
D-792	Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement
D-1203	Standard Test Methods for Volative Loss from Plastics Using Activated Carbon Methods
D-1242	Test Methods for Resistance of Plastics Materials to Abrasion

D-1499	Practice for Operating Light and Water Exposure Apparatus (Carbon-Arc Type) for Exposure of Plastics
D-2240	Test Method for Rubber Property-Durometer Hardness
D-2287	Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
G-23	Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Non-metallic Materials

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Item No. 601S
Salvaging and Placing Topsoil

601S.1 Description

This item shall govern the removal, storage and placement of approved on-site naturally occurring topsoil and topsoil mix (see 601S.3.A) to the depths and area shown on the Drawings or as directed by the Engineer or Landscape Architect.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

601S.2 Submittals

A. Submittal required before construction.

1. Soil test results ad soil classification necessary for approval of material as suitable topsoil. Soil test results should include, at minimum, texture, percentage organic matter (OM), salinity (soil salt) level; pH; and amounts of Phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg), nitrate-nitrogen (NO_3-N) and sulfate-sulfur (SO_4-S).

2. For topsoil mixes containing compost, the soil test for shall also include moisture content, C:N ratio and Solvita compost maturity index.

3. A sample (21 gallon) of proposed topsoil or topsoil mix shall be submitted to the Owner or their representative 30 calendar days before installation and be approved before installation. Sample shall be labeled including type of material, specification number; name, address, and telephone number of manufacturer or supplier; and address of the location of the source or material stockpile.

B. Submittals /Inspection required during construction:

1. Delivery Tickets indicating type/product name, source and quantities of imported topsoil mix or compost) for mixing with salvaged soil).

2. Deliveries of soil to a job site shall be inspected by the project Engineer or Landscape Architect or Owner’s construction inspector before placement to verify product compliance with specification.

601S.3 Materials

A. Topsoil Mix

1. Topsoil mix shall be composed of 4 parts of soil mixed with 1 part compost, by volume. The soil shall be locally available native soil that meets the following specifications:
   a. Shall be free of trash, weeds, deleterious materials, rocks and debris.

b. 100% shall pass through a 3/8-inch (9.5-mm) screen.

c. Soil to be a black or dark brown loamy material that meets the requirements of the table below in a accordance with the USDA textural triangle. Soil known locally as “red death” is not an allowable soil. Textural composition shall meet the following criteria:

Textural Class	Minimum	Maximum
Clay	5%	50%
Silt	10%	50%
Sand	15%	67%

d. Organic matter percentage shall be at least 5.0% after the addition of compost.

e. Salinity shall be below 6.00 mmhos/cm.

f. An owner/project designer(s) may propose use of onsite salvaged topsoil which does not meet the soil texture class required above by providing a soil analysis and a written statement from a qualified professional in soils, landscape architecture, or agronomy indicating the onsite topsoil will provide an equivalent growth media and specifying what, if any, soil amendments are required.

3. The compost shall be locally available and shall meet the following specifications:

a) Shall be well decomposed, stable to very stable, weed-free plant-based material source derived from yard trimmings or City approved alternate source. The Carbon/Nitrogen (C/N) ratio shall be less than 25:1 and trace metals test results should "pass".

b) Shall be blended and ground leaf, wood and other plant-based material, composted for a minimum of nine (9) months and at temperatures sufficient to break down all woody fibers, seeds and leaf structures, free of toxic material at levels that are harmful to plants or humans. Source material shall be yard waste trimmings blended with other plants or other materials designed to produce compost high in fungal material. Non-vegetal source materials may be acceptable upon approval by the Owner. The compost will possess no objectionable odors and shall not resemble the raw material from which it was derived.

c) Compost shall be commercially prepared compost and meet US Compost Council STA/TMECC criteria or as modified in this section for "Compost as a Landscape Backfill Mix Component".

http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/191/LandscapeArch_Specs.pdf

d) Compost shall comply with the following parameters:

PARAMETERS [1]	REPORTED AS (UNITS OF MEASURE)	GENERAL RANGE
pH	pH units	6.0 - 8.5
Salinity (electric conductivity)	dS/m (mmhos/cm)	Maximum 10
Moisture Content	%, net weight basis	30 - 60%
Organic Matter Content	%, dry weight basis	30 - 65%
Particle Size	% passing a selected mesh size, dry weight basis	98% pass through ¾ inch screen
Stability Carbon Dioxide Evolution Rate	mg CO2-C per g OM per day	<8
Solvita Compost Maturity Test	Solvita units	>6
Physical Contaminants (inerts)	%, dry weight basis	<1%
Chemical Contaminants [2]	mg/kg (ppm)	Meet or exceed US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels
Biological Contaminants Select pathogens Fecal coliform bacteria or Salmonella [3]	MPN per gram per dry weight MPN per 4 grams per dry weight	Meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) levels

[1] Recommended test methodologies are provided in Test Methods for the Examination of Composting and Compost (TMECC, The US Composting Council).

[2] US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels = Arsenic 41 ppm, Cadmium 39 ppm, Copper 1,500 ppm, Lead 300 ppm, Mercury 17ppm, Molybdenum 75 ppm, Nickel 420 ppm, Selenium 100 ppm, Zinc 2,800 ppm.

[3] US EPA Class A standard, 40 CFR § 503.32(a) levels = Salmonella <3 MPN/4grams of total solids or Fecal Coliform <1,000 MPN/gram of total solids.

e) Compost and other soil amendments shall be worked into the existing onsite topsoil with a disc or tiller to create a well-blended material.

2. All disturbed areas to be revegetated are required to provide a minimum of six (6) inches of topsoil. The topsoil shall be able to support the growth of planting (Standard Specification Item No. 608S), Seeding for Erosion Control (Standard Specification Item No. 604S), sodding (Standard Specification Item No. 602S) and Native Seeding and Planting for Restoration (Standard Specification Item No. 609S).

B. Water

Water shall be furnished by the Contractor and shall be clean and free from seed source, pesticide, fertilizer, industrial wastes and other objectionable matter.

601S.4 Sources

The salvaged topsoil may be obtained from the right-of-way at sites of proposed excavation or embankment when shown on the Drawings or identified by the Engineer or Landscape Architect. The approximate quantity of acceptable topsoil to be salvaged from the project will be shown on the Drawings. The topsoil or topsoil mix may also be obtained from approved sources, which are located outside the right-of-way and have been secured by the Contractor.

601S.5 Construction Methods

Tree protection fencing will be maintained at all times to protect all trees in the limits of construction. Where removal of trees is indicated on the Drawings, they shall be marked as directed by the Engineer or Landscape Architect, or certified Arborist.

Construction equipment shall not be operated nor construction materials stockpiled within the critical root zone of trees .Tree protection fencing shall remain in place per tree protection plan. Topsoil materials shall not be placed within the critical root zone until tree wells are constructed that conform to Item No. 610S, "Preservation of Trees and Other Vegetation " and Standard Details 591S-1 and 610S-6. The source and stockpile areas shall be kept drained, insofar as practicable, during the period of topsoil removal

The existing topsoil shall be removed from the area indicated on the Drawings, stockpiled in designated area on the site plan, windrow along the right of way or other designated area outside the 100-year floodplain (as defined in the Drainage Criteria Manual and Land Development Code), or spread over an area that is ready for topsoil application in accordance with the Drawings or as directed by the Engineer or Landscape Architect.

Trash, wood, brush, stumps, rocks over 1 1/2 inches (37.5 mm) in size and other objectionable material encountered shall be removed and disposed of as directed by the Engineer or Landscape Architect prior to beginning of work required by this item. Grass and other herbaceous plant materials may remain. Large clumps shall be broken up

Where the proposed planting area is compacted more than 85% proctor or 225 p.s.i., the existing soil should be tilled to a minimum depth of six inches before installation of the salvaged topsoil or topsoil mix. In the critical root zone of trees reference 661S.

The topsoil should not be placed if the ground is muddy, saturated, or frozen.

The topsoil should not be placed if the ground is extremely dry. Wet soil enough to prevent dust from leaving the site.

After the grading has been completed to the required alignment, grades and cross-sections and prior to the spreading of the salvaged topsoil, any clay or tight soil surfaces shall be scarified by plowing furrows approximately 4 inches (100 mm) deep along horizontal slope lines at 2 foot (600 mm) vertical intervals. The spreading of the salvaged topsoil or topsoil mix shall be undertaken as soon as the grading has been completed. The topsoil shall be spread so as to form a cover of uniform thickness indicated. After the topsoil has been placed and shaped, it shall be sprinkled with water and rolled to provide a suitable seed bed.

601S.6 Measurement and Payment

Salvaging, removal and/or placing topsoil materials will not be measured for payment, but shall be included in the unit price bid for the item of construction in which these activities are used.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification 601S, "Salvaging and Placing Topsoil"

City of Austin Standard Specification Items

Designation	Description
Item No. 602S	Sodding for Erosion Control
Item No. 604S	Seeding for Erosion Control
Item No. 608S	Planting
Item No. 609S	Native Grassland Seeding and Planting For Erosion Control
Item No. 610S	Preservation of Trees and Other Vegetation

City of Austin Standard Details

Designation	Description
591S-1	Dry Stack Rock Wall
610S-6	Typical Tree Well Applications

RELATED CROSS REFERENCE MATERIALS
Specification 601S, "Salvaging and Placing Topsoil"

City of Austin Standard Specification Items

Designation	Description
Item No. 102S	Clearing and Grubbing
Item No. 104S	Removing Concrete
Item No. 110S	Street Excavation
Item No. 111S	Excavation
Item No. 120S	Channel Excavation
Item No. 132S	Embankment
Item No. 606S	Fertilizer

City of Austin Standard Details

Designation	Description
610S-1	Tree Protection Fence Locations
610S-2	Tree Protection Fence, Type B Chainlink
610S-3	Tree Protection Fence, Type B Wood
610S-4	Tree Protection Fence, Modified Type A
610S-5	Tree Protection Fence, Modified Type B

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 160	Furnishing and Placing Topsoil
Item No. 164	Seeding for Erosion Control
Item No. 204	Sprinkling

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-103-E	**Determination of Moisture Content of Soil Materials**
Tex-104-E	**Determination of Liquid Limit of Soils**
Tex-105-E	**Determination of Plastic Limit of Soils**
Tex-106-E	**Method of Calculating the Plasticity Index of Soils**

ITEM NO. 604S SEEDING FOR EROSION CONTROL 6-17-21

604S.1 Description

This item shall govern the preparation of a seed bed for temporary or permanent erosion control; sowing of seeds; hydromulch with cellulose fiber wood chips or recycled paper mulch; and other management practices along and across such areas as indicated in the Drawings or as directed by the Landscape Architect, Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, inch-pound units are given preference with SI units shown within parentheses.

Source: Rule No. R161-14.29, 12-30-2014 ; Rule No. R161-15.14, 1-4-2016 ; ordbank" web="yes">Rule No. R161-21.12 , 6-17-2021.

604S.2 Submittals

The following submittal items are required in writing during construction:

A. Identification of the seed species, source, mixture, and pure live seed (PLS) of the seed as listed on the analysis tags and certification tags from all seed bags. Seed calculation worksheet per Table 7. PLS is the percentage of seed purity multiplied by the percentage of germination, plus dormant seed. The analysis tag, required on all seed sold in Texas, includes information on quality: kind and variety of seed, lot number, percent pure live seed, percent other crop seed, percent inert matter, percent weed seeds, germination percentage, and date of test. The certification tag also verifies seed quality, an assurance of seed variety and attesting to standards for germination and purity. Information provided includes class of certification, kind of crop, variety, lot number, and name and address of the owner.

B. If fertilizer is proposed to augment soil nutrients, submittals shall conform to Item 606S, Fertilizer.

C. For hydromulch applications, proposed application rate of seed, type of mulch and tacking agent, and other relevant information including fertilizer that is intrinsic to the hydromulch application. An example of the required documentation is in Table 1.

D. Type of hydraulic seeding equipment and nozzles proposed for use.

E. If pesticide use is proposed, an IPM plan for pest removal including pesticide label, proposed application rate and timing, and MSDS sheets.

F. If soil retention blanket is required because seed application is on slope of 3:1 or greater, submittals should conform to Item 605S, Soil Retention Blanket.

The following submittal items are required before Substantial Completion:

A. For hydromulch applications, the complete hydromulch application log, including date, time and quantity of product units placed in the slurry tank. An example of an application log is provided in Table 2. This log may be requested at any time during construction by the Landscape Architect, Engineer, designated representative, or authorized inspector.

B. Pesticide application tracking log. As of January 1, 2012, documentation of all outdoor pesticide use on city-owned properties is required to demonstrate compliance with the EPA/TCEQ mandated Municipal Stormwater Permit, the TPDES General Pesticide Permit, City Code, and the IPM program.

Table 1: Example of proposed hydromulch application rates

				Hydro Slurry Unit (per acre rates)				
Hydro Mix	**Sheet No.**	**Seed Mix**	**Acres**	**Seed (Bags/ac)**	**Tackifier (Buckets/ac)**	**Mulch (Bales/ac)**	**Fertilizer (Bags/ac)**	**Addl. Amendments (Bags/ac)**
1	L2	A	1.0	1	100	1000	50	5
2	L3	A	0.5	2	200	1500	50	5
3	L5	B	3.0	3	300	3000	50	5

Table 2: Example of hydromulch application log

						Hydro Slurry Unit (per acre rates)				
Date	**Start Time**	**Finish Time**	**ac/Tank**	**Water (gal)**	**Seed Mix**	**Seed (Bags/ac)**	**Tackifier (Buckets/ac)**	**Mulch (Bales/ac)**	**Fertilizer (Bags/ac)**	**Addl. Amendments (Bags/ac)**
4/13	10:30	11:15	1.0	3300	A	1	100	1000	50	5
4/17	2:00	2:30	0.5	3300	A	2	200	1500	50	5
5/20	8:30	10:00	1.2	3300	B	3	300	3000	50	5
					Totals	6	600	5500	127	15

Source: Rule No. R161-14.29, 12-30-2014 ; Rule No. R161-15.14, 1-4-2016 ; ordbank" web="yes">Rule No. R161-21.12 , 6-17-2021.

604S.3. Materials

A. **Seed.** All seed must meet the requirements of the Texas Seed Law including the labeling requirements for showing PLS, name and type of seed, and all other required elements of the Analysis and Certification Tags.

The seed furnished shall be of the previous season's crop and the date of analysis shown on each bag shall be within twelve (12) months of the time of delivery to the project. Each variety of seed shall be furnished and delivered in separate bags or containers, unless a specific mix is proposed for use. A sample of each variety of seed shall be furnished for analysis and testing when directed by the Landscape Architect, Engineer or designated representative.

The amount of seed planted per square yard (0.84 square meters) or acre (hectare [ha]) shall be of the type specified in Sections 604S.5 and 604S.6.

B. **Water.** Water shall be clean and free of industrial wastes and other substances harmful to the growth of plant material or the area irrigated.

C. **Topsoil.** Topsoil shall conform to Item No. 601S.3(A).

D. **Fertilizer.** The fertilizer shall conform to and be paid for by bid items under Item No. 606S, Fertilizer. The type and rate of fertilizer should be based on chemical tests of recent (no older than 6 months before application) representative site soil samples. Fertilizer should be applied only when plants can take them up for growth, during: 1) seed germination and plant establishment and 2) after plant establishment. Fertilizer shall not be applied within 48 hours of a potential rain event.

E. **Tackifier.** The hydromulch tackifer shall be a biodegradable tacking agent, approved by the Landscape Architect, Engineer or designated representative.

F. **Cellulose Fiber Mulch (Natural Wood) for hydromulch.** Cellulose Fiber Mulch shall be natural cellulose fiber mulch produced from grinding clean whole wood chips. 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 asphalt binder.

G. **Recycled Paper Mulch for hydromulch.** Recycled paper mulch shall be specifically manufactured from post-consumer paper and shall contain a minimum of 85% recycled paper content by weight, shall contain no more than 15% moisture and 1.6% ash, and shall contain no growth inhibiting material or weed seeds. The recycled paper mulch shall be mixed with grass seed and fertilizer as needed for hydro-seeding/mulching, erosion control, and a binder over straw mulch. The mulch, when applied, shall form a strong, moisture-retaining mat of a green color without the need of an asphalt binder.

H. **Pesticide.** A least toxic, integrated pest management (IPM) approach shall be used to control weeds. A written request for approval of weed control products and materials shall be submitted to the City of Austin Watershed Protection Department (ERM) IPM program coordinator for approval. Additional information can be found at http://www.austintexas.gov/ipm.

I. **Soil Retention Blanket.** Slopes that are 3:1 or greater, or if directed by the Engineer, Landscape Architect, or designated representative, shall be covered with soil retention blanket after the seed bed preparation and seeding is complete. The soil retention blanket shall conform to the class and type shown on the Drawings and meet all requirements of Item 605S.

Source: Rule No. R161-14.29, 12-30-2014 ; Rule No. R161-15.14, 1-4-2016 ; ordbank" web="yes">Rule No. R161-21.12 , 6-17-2021.

604S.4 Construction Methods

A. **General.** The Contractor shall limit preparation of the seedbed to areas that will be seeded immediately. When seeding for permanent erosion control, weed species listed in Table 3 shall be managed by application of an appropriate herbicide and/or by physical removal by the roots before the seeding operation. The goal of weed management is to facilitate establishment of the permanent vegetative cover. Additionally, the Owner may require removal of any plant species that appears to be out-competing seeded or planted species during the construction period.

Table 3: Weed List

Weed Type	Botanical Name	Common Name
Annual Grass	*Cenchrus spp.*	Sandbur
Herb	*Cnidoscolus texanus*	Bull Nettle
Herb	*Urtica spp.*	Stinging Nettle
Vine	*Toxicodendron radicans*	Poison Ivy
Perennial Grass	*Sorghum halapense*	Johnson Grass
Perennial Grass	*Arundo donax*	Giant Cane
Perennial Grass	*Phyllostachys aurea*	Golden Bamboo
Summer Annual Herb	*Ambrosia trifida*	Ragweed
Winter Annual Herb	*Rapistrum rugosum*	Bastard Cabbage
Winter Annual Herb	*Bromus arvensis*	Japanese Brome
Winter Annual Herb	*Lolium multiflorum*	Annual Ryegrass

B. **Preparing Seed Bed.** After the designated areas have been rough graded to the lines, grades and typical sections indicated in the Drawings or as provided for in other items of this contract and for any other soil area disturbed by the construction, a suitable seedbed shall be prepared. The seedbed shall consist of a minimum of either 6 inches (150 millimeters) of approved topsoil or 6 inches (150 millimeters) of approved salvaged topsoil.

The topsoil or growing medium must be prepared so that compaction is appropriate for plant growth, and to achieve acceptable bulk density or hydrologic function. Rippers and subsoilers may be used to loosen compacted soil and roughen the surface. Disks, plows and excavator attachments are good for compaction reduction, roughening and incorporating amendments. If tracked machinery is used in seedbed preparation, cleat marks should run with the contour to prevent rills. The optimum depth for seeding shall be ⅛ to ¼ inch (3 to 6 millimeters).

Water shall be gently applied as required to prepare the seedbed prior to the planting operation either by broadcast seeding or hydraulic planting. Seeding shall be performed in accordance with the requirements described below.

C. **Watering.** All watering shall comply with City Code Chapter 6-4 (Water Conservation). All seeded areas regardless of seed type and method of seeding (e.g., broadcast, hydroseed) shall be watered immediately after installation. For seed germination and establishment, it is important to keep the seedbed in a moist condition favorable for the growth of plant materials. Establishment is defined as 1.5" growth height and 95% coverage.

Watering applications shall constantly maintain the seedbed in a moist condition favorable for the growth of plant materials. Watering shall continue until the plant material is at least 1½ inches (40 mm) in height and accepted by the Engineer or designated representative. Supplemental watering can be postponed immediately after a half-inch (12.5 mm) or greater rainfall on the site but shall be resumed before the soil dries out.

D. **Cool Season Cover Crop.** From September 15 to March 1, non-native and native seeding shall include a cool season cover crop at the rate specified in Table 6. Cool season cover crops are not permanent erosion control. If installed separately from the permanently erosion control seed mix, the cool season cover crops shall be mowed to a height of less than one (1) inch after March 1, and the area shall be re-seeded at the specified seeding rate for non-native or native warm-season species (March 1 to September 15).

Source: Rule No. R161-14.29, 12-30-2014 ; Rule No. R161-15.14, 1-4-2016 ; ordbank" web="yes">Rule No. R161-21.12 , 6-17-2021.

604S.5 Non-Native Seeding

A. **Method A - Broadcast Seeding.** The seed or seed mixture in the quantity specified shall be uniformly distributed over the prepared seed bed areas indicated on the Drawings or where directed by the Engineer, Landscape Architect, or designated representative. If the sowing of seed is by hand, rather than by mechanical methods, the seed shall be sown in two directions at right angles to each other. If mechanical equipment is used, all varieties of seed, as well as fertilizer (if required), 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 a corrugated roller of the "Cultipacker" type. All rolling of the slope areas shall be on the contour.

Seed Mixture and Rate of Application for Broadcast Seeding:

From March 1 to September 15, non-native seeding may be with hulled Bermuda Grass at a rate of at least 45 lbs/ac (5.0 kilograms per hectare) with a minimum PLS = 0.83. Fertilizer shall be applied if warranted by a soil test, and shall conform to Item No. 606S, Fertilizer. Bermuda grass is a warm-season grass and is therefore considered permanent erosion control once established.

Method B - Hydraulic Planting (aka Hydromulch). The seedbed shall be prepared as specified above and hydraulic planting equipment, which is capable of placing all materials in a single operation, shall be used. Information about hydromulching for temporary and permanent vegetation stabilization is in the Environmental Criteria Manual (ECM) Section 1.4.7. Hydroseeding equipment shall be clean and free of all previous seeds, fertilizer, mulch, or any hydroseeding products used on prior jobs.

From March 1 to September 15.

Hydraulic planting mixture and minimum rate of application pounds per acre or square yard (kilograms per ha):

Hulled Bermuda Seed (min. PLS=0.83)	Fiber Mulch		Soil Tackifier
	Cellulose	Wood	
45 lbs/ac (50.44 kg/ha)	2000 lbs/ac (2242 kg/ha)		60.98 lbs/ac (68.36 kg/ha)
		2500 lbs/ac (2803 kg/ha)	65.34 lbs/ac (73.25 kg/ha)

Source: Rule No. R161-14.29, 12-30-2014 ; Rule No. 161-15.14, 1-4-2016 ; Rule No. 161-21.12, 6-17-2021.

604S.6 Native Grass and Forb Seeding

The seed mixture shall include both grasses and forbs. The dry and moist sites grass mix shall be seeded at rates of at least 23.5 and 17.0 lb/ac (26.32 and 19.04 kg/ha), respectively and the dry and wet site forb mix shall be seeded at a rate of at least 11.5 and 9.0 lb/ac (12.88 and 10.08 kg/ha), for total application rates of 35.00 lb/ac (39.20 and 29.12 kg/ha) [dry site] and 26 lb/ac (29.12 kg/ha) [wet site]. Minimum diversity for dry sites (Table 4) is eight species of grasses and 10 species of forbs. Minimum diversity for wet sites (Table 5) is six species of grasses and seven species of forbs. The species indicated with an asterisk shall be included in all proposed mixes. Application rates may be modified, but no species shall constitute more than 20% of a seed mix. Any species proposed for installation and not included in Table 4 or 5 shall by City of Austin representative including Environmental Reviewer, Environmental Inspector, or Watershed Protection Department representative, and shall be native to Central Texas as referenced by the LBJ Wildflower Center plant database (www.wildflower.org) or USDA plant database.

Table 4: Native Grasses and Forbs: Dry Sites

Type	Common Name	Botanical Name	Exposure	Recommended Application Rates	
				lbs/ac	kg/ha
Grass Seed Mix	Sideoats grama*	*Bouteloua curtipendula*	Full-part sun	7.0	7.8
	Green sprangletop*	*Leptochloa dubia*	Full sun	6.0	6.7
	Buffalograss	*Buchloe dactyloides*	Full sun	24.0	27.0
	Blue Grama Grass	*Bouteloua gracilis*	Full-part sun	10.0	11.2
	Canada Wild Rye	*Elymus canadensis*	Full-part sun	10.0	11.2
	Purple Three-Awn	*Aristida purpurea*	Full sun	4.0	4.5

	Cane Bluestem	*Bothriochloa barbinodis*	Full sun	3.0	3.3
	Galleta	*Pleuraphis jamesii*	Full sun	10.0	11.2
	Black Grama*	*Bouteloua eripoda*	Full sun	10.0	11.2
	Sand Dropseed*	*Sporobolus cryptandrus*	Full sun	1.0	1.1
	Alkali Sacaton	*Sporobolus airoides*	Full sun	0.5	1.7
	Curly Mesquite	*Hilaria belangeri*	Full sun	2.0	2.2
	Sand Lovegrass	*Eragrostis trichodes*	Full sun	2.0	2.2
	Black-Eyed Susan	*Rudbeckia hirta*	Full-part sun	2.0	2.2
	Illinois Bundleflower*	*Desmanthus illinoens* (legume)	Full-part sun shade	15.0	16.8
	Scarlet Sage	*Salvia coccinea*	Full-part sun shade	8.0	9.0
	Pink Evening Primrose	*Oenethera speciosa*	Full-part sun shade	1.0	1.1
	Drummond Phlox	*Phlox drummondii*	Full-part sun	8.0	9.0
	Plains Coreopsis	*Coreopsis tinctoria*	Full-part sun	2.0	2.2
	Greenthread	*Thelesperma filifoliu*	Full sun	6.0	6.7
	Purple Prairie Clover*	*Dalea purpurea*	Full sun	4.0	4.5
	Cutleaf Daisy	*Engelmannia pinnatifida*	Full-part sun	18.0	20.1
Forb Seed Mix	Partridge Pea*	*Chamaecrista fasciculate*	Full-part sun	20.0	22.4
	Indian Blanket	*Gaillardia pulchella*	Full-part sun	10.0	11.2
	Bluebonnet*	*Lupinus texensis* (legume)	Full sun	20.0	22.4
	Mexican Hat	*Ratibida columnaris*	Full-part sun	2.0	2.2
	Maximilian Sunflower	*Helianthus maximilia*	Full-part sun	5.0	5.6
	Prairie Coneflower	*Ratibidia columnifer*	Full-part sun	2.0	2.2
	Clasping Coneflower	*Dracopis amplexicau*	Full-part sun	3.0	3.4
	Purple Coneflower	*Echinacea purpurea*	Full-part sun shade	10.0	11.2
	Lemon Mint	*Monarda citriodora*	Full-part sun	3.0	3.4
	Huisache Daisy	*Amblyolepis setigera*	Full-part sun	8.0	9.0
	Texas Yellow Star	*Lindheimera texana*	Full-part sun	12.0	13.5
	Lanceleaf Coreopsis	*Coreopsis lanceolata*	Full-part sun shade	10.0	11.2
	Bush Sunflower	*Simsia calva*	Full-part sun	3.0	3.4
	Winecup	*Callirhoe involucrata*	Full-part sun shade	5.0	5.6
	Antelope horns	*Asclepias asperula*	Full sun	0.1	0.04
	Green milkweed	*Asclepias viridis*	Full sun	0.1	0.04

TOTAL
Total seed mix application rate is 35.0 lb/ac (23.5 lb/ac grasses and 11.5 lb/ac forbs), to be composed of at least 8 species from the grass list and 10 species from the forb list to include the required species.

*Required species that must be included in the mix.

Table 5: Native Grasses and Forbs: Wet Sites

Type	Common Name	Botanical Name	Exposure	Recommended Application Rates	
				lbs/ac	kg/ha
Grass Seed Mix	White Tridens	*Tridens albescens*	Full-part sun	0.5	0.56
	Plains Bristlegrass	*Setaria leucopila*	Full-part sun	6.0	6.7
	Switchgrass	*Panicum virgatum*	Full-part sun	4.0	4.5
	Inland Sea Oats	*Chasmanthium latifoliu*	Shade	12.0	13.5
	Canada Wild Rye	*Elymus canadensis*	Full sun - shade	10.0	11.2
	Big Bluestem	*Andropogon gerardii*	Full sun	4.0	4.5
	Bushy Bluestem	*Andropogon glomeratus*	Full sun	3.0	3.4
	Green Sprangletop*	*Leptochloa dubia*	Full sun	2.0	2.2
	Eastern Gamagrass	*Tripsacum dactyloides*	Full sun - shade	3.0	3.4
Forb Seed Mix	American Basketflower	*Centaurea americana*	Full sun	10.0	11.2
	Common milkweed	*Asclepias syriaca*	Full sun	0.1	0.04
	Butterfly weed	*Asclepias tuberosa*	Full sun	0.1	0.04
	Blue Mistflower	*Conoclinium coelestinum*	Full-part sun	0.5	0.6
	Clasping Coneflower	*Dracopsis amplexicaulis*	Full-part sun	3.0	3.4
	Maximilian Sunflower	*Helianthus maximliani*	Full-part sun	4.0	4.5
	Prairie Blazing Star	*Liatris pycnostachya*	Full sun	2.0	2.2
	Pink Evening Primrose	*Oenothera speciosa*	Full sun-dappled shade	1.0	1.1
	Mexican Hat	*Ratibida columnifera*	Full-part sun	2.0	2.2
	Black-eyed Susan	*Rudbeckia hirta*	Full sun-dappled shade	2.0	2.2
	Illinois Bundleflower	*Desmanthus illinoensis*	Full sun-dappled shade	15.0	16.8
	Obedient Plant	*Physostegia virginiana*	Full sun-dappled shade	4.0	4.5
	Partridge Pea*	*Camaecrista fasciculate*	Full-part sun	20.0	22.4

	Purple Prairie Clover	*Dalea purpurea var purpurea*	Full sun	4.0	4.5
	Pitcher Sage	*Salvia azurea*	Full-part sun	3.0	3.4
	Showy Tick Trefoil	*Desmodium canadense*	Full sun	0.5	0.6
	Winecup*	*Callirhoe involucrata*	Full-part sun	5.0	5.6
TOTAL Total seed mix application rate is 26.0 lb/ac (17.0 lb/ac grasses and 9.0 lb/ac forbs), to be composed of at least 8 species from the grass list and 10 species from the forb list to include the required species.					

Table 6: Cool Season Cover Crop

Common Name	**Botanical Name**	**Exposure**	**Application rates**	
			lbs/ac	**kg/ha**
Western Wheatgrass	*Pascopyrum smithii*	Full-pt sun; dappled shade	5.6	6.28
Oats	*Avena sativa*	Full sun	4.0	4.48
Cereal Rye Grain	*Secale cereale*	Full sun	34.0	38.11

One cover crop species of the listed species is required to be planted between September 15 to March 1. Contractor must ensure that any seed application requiring a cool season cover crop does not utilize annual ryegrass (*Lolium multiflorum*) or perennial ryegrass (*Lolium perenne*). Only cereal rye grain (*Secale cereale*), oats (*Avena sativa*) and western wheatgrass (*Pascopyrum smithii*) are approved as cool season cover crop.

Species substitution as necessary due to availability shall be approved by the Landscape Architect, Engineer or designated representative. Watering and fertilizer application shall follow procedures outlined above or as otherwise specified on the Drawings.

Seed shall be applied by broadcast, hydromulch, blown compost, or drill method and shall be distributed evenly over the topsoil areas. Mulching shall immediately follow seed application for broadcast and hydromulch applications.

Seed Rate Calculations

The amount of seed needed to be planted on a project shall be calculated before installation to ensure adequate seed is placed, and provided as a submittal. Table 7 is an example worksheet, followed by an example calculation. Information for calculation can be obtained from seed tags or the supplier.

Table 7. Seed Calculation Worksheet

Plant Group	**Desired Seeding Rate (lbs/ac)**	**PLS (pure live seed)**	**Bulk Rate (lbs/ac)**	**Seeding Area (ac)**	**Amt. of Seed to be Installed (lbs)**
Grasses					
Forbs					
TOTAL					

FORMULAS:

PLS (pure live seed) = (Purity × Germination) × 100. Can also use average PLS from seed tags.

Bulk Rate (lbs/ac) =Desired Seed Rate (lbs/ac)/PLS.

Amt. of Seed to be Installed (lbs) = Bulk Rate (lbs/ac) × Seeding Area (ac).

Example:

Plant Group	Desired Seeding Rate (lbs/ac)	PLS [pure live seed] (% decimal)	Bulk Rate (lbs/ac)	Seeding Area (ac)	Amt. of Seed to be Installed (lbs)
Grasses	131.00	0.81	161.73	1.50*	242.60
Forbs	65.34	0.87	75.10	1.50*	112.70
TOTAL	196.34	0.84 (ave.)	236.83	1.50	355.30

*Applied over the same 1.5 ac area.

Source: Rule No. R161-14.29, 12-30-2014 ; Rule No. R161-15.14, 1-4-2016 .

604S.7 Hydromulch

Hydromulch may be used to help prevent soil erosion until final stabilization is achieved. Hydromulch shall be used to cover broadcasted seeds, especially in sunny, open areas, to protect them from drying out during germination.

Refer to ECM Section 1.4.7 for hydromulching applications.

Source: Rule No. R161-14.29, 12-30-2014 ; ordbank" web="yes">Rule No. R161-21.12 , 6-17-2021.

604S.8 Management Practices

Management Practices include (1) weed management (pesticide application or mechanical removal) to so than 90 percent of the revegetation area is free of weeds listed in Table 3, and (2) reseeding areas of poor germination to achieve coverage and height per 604S.9, with no bare areas greater than 10 s.f.

Ninety (90) percent of a permanent revegetation area must be free of weeds listed in Table 3. Weeds shall be controlled in the most efficient manner possible. Management of weed species should begin early in the project, before seeding for permanent control, and extend into plant establishment, especially for perennial weeds. Manual removal or application of an appropriate herbicide may be required after the initial seeding if emergence of an annual weed species threatens establishment of sufficient preferred plant cover. Disturbance due to weed management after the initial seeding may necessitate re-seeding of the area to establish sufficient preferred plant coverage. Care should be taken to temporarily stabilize areas where physical removal of weeds has been performed to prevent erosion and sediment runoff.

The entire root system of perennial weeds shall be removed to prevent re-sprouting. Weeds may be controlled with an approved contact, systemic herbicide, provided the product is used with appropriate care and is applied in accordance with label instructions and the following guidelines:

1. Herbicide shall not be applied when the wind is greater than 8 mph (12.9 kph),
2. Herbicide shall not be applied when rainfall is expected within 24 hours,
3. Herbicide shall not contact surface water, i.e. creeks, rivers, and lakes,
4. Herbicide shall not contact desirable vegetation (a wicking method shall be used, if necessary, to accurately contact target weed only during application).

The Landscape Architect, Engineer or designated representative shall be consulted to determine appropriate weed control management when weeds are located in an environmentally sensitive location (e.g. near water or adjacent to a critical environmental feature).

At locations that fail to show an acceptable stand of planting for any reason during the initial seeding, repair and/or reseed locations as determined by the Landscape Architect, Engineer or designated representative. A successful stand of grasses and forbs for erosion control should exhibit the following:

- Seedlings with vigorous green foliage;
- Green leaves remaining throughout the summer, at least at the plant bases;
- Uniform density, with grasses and/or forbs well intermixed;
- Minimum of 95% cover; and
- No exposed soil greater than 10 s.f. in aerial extent.

The Contractor shall meet the requirements of the initial seeding, including seeding method, seed mix, and application rates, unless otherwise agreed to in writing by the Owner. Corrected deficiencies will be re-inspected and approved by the Owner, and final acceptance will be granted upon satisfactory completion.

Source: Rule No. R161-14.29, 12-30-2014 ; Rule No. R161-15.14, 1-4-2016 .

604S.9 Measurement

Work and acceptable material for Seeding for Erosion Control will be measured by the square yard (meter: 1 meter equals 1.196 square yards) or by the acre (hectare: 1 hectare equals 2.471 acres), complete in place so that all areas of a site that rely on vegetation for stability must be uniformly vegetated with a minimum of 95 percent total coverage for the non-native or native mixes. Bare areas shall not exceed 16 square feet (1.5 square meters), and the average height of vegetation shall stand at a minimum of 1½ inch (40 millimeters). Ninety (90) percent of the re-vegetated area, whether native or non-native re-vegetation, must be free of weeds listed in Table 3. Bare areas greater than 10 s.f. shall be re-prepared and reseeded as required to develop an acceptable stand of plant material.

Source: Rule No. R161-14.29, 12-30-2014 ; Rule No. R161-15.14, 1-4-2016 .

604S.10 Payment

The work performed and materials furnished and measured will be paid for at the unit bid price for Seeding for Erosion Control of the method specified on the Drawings and type of mulch. The unit bid price shall include full compensation for furnishing all materials, including all topsoil, water, seed, hydromulch and associated tackifier and for performing all operations necessary to complete the work.

All fertilizer will be measured and paid for conforming to Item No. 606S, Fertilizer.

Payment will be made under one of the following:

Pay Item No. 604S-A:	Non-Native Seeding for Erosion Control Method, Hydraulic Planting Per Square Yard.	
Pay Item No. 604S-B:	Non-Native Seeding for Erosion Control, Broadcast Seeding, Per Square Yard.	
Pay Item No. 604S-C:	Non-Native Seeding for Erosion Control Method, Hydraulic Planting Per Acre.	

Pay Item No. 604S-D:	Native Seeding for Erosion Control Method, Hydraulic Planting Per Square Yard.	
Pay Item No. 604S-E:	Native Seeding for Erosion Control, Broadcast Seeding, Per Square Yard.	
Pay Item No. 604S-F:	Native Seeding for Erosion Control Method, Hydraulic Planting Per Acre.	
Pay Item No. 604S-G:	Topsoil and Seedbed Preparation, Per Square Yard.	
Pay Item No. 604S-H:	Topsoil and Seedbed Preparation, Per Acre.	
Pay Item No. 604S-I:	Watering, Per 1000 gal (Kgal).	
Pay Item No. 604S-J:	Management Practices, Per Square Yard.	
Pay Item No. 604S-K:	Management Practices, Per Acre.	

Source: ordbank" web="yes">Rule No. R161-21.12 , 6-17-2021.

End

SPECIFIC CROSS REFERENCE MATERIALS	
Specification Item 604S Seeding for Erosion Control	
City of Austin Technical Specifications	
Designation	Description
Item No. 130S	Borrow
Item No. 601S	Salvaging and Placing Topsoil
Item No. 606S	Fertilizer
City of Austin Land Development Code	
Designation	Description
Section 6-4	Water Conservation

RELATED CROSS REFERENCE MATERIALS	
Specification Item 604S Seeding for Erosion Control	
City of Austin Technical Specifications	
Designation	Description
Item No. 601S	Salvaging and Placing Topsoil
Item No. 602S	Sodding for Erosion Control
Item No. 605S	Soil Retention Blanket
Item No. 607S	Slope Stabilization
Item No. 608S	Planting
City of Austin Standards (Details)	
Designation	Description
627S-1	Grass Lined Swale
633S-1	Landgrading
Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges	
Designation	Description
Item No. 160	Topsoil
Item No. 162	Sodding for Erosion Control
Item No. 164	Seeding for Erosion Control
Item No. 166	Fertilizer
Item No. 168	Vegetative Watering
Item No. 169	Soil Retention Blanket
Item No. 180	Wildflower Seeding
Item No. 192	Landscape Planting

Item No. 605S
Soil Retention Blanket

605S.1 Description

This item shall govern the provision and placement of 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 short-term or long-term protection of seeded or sodded areas indicated on the Drawings or as specified by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, inch-pound units are given preference with SI units shown within parentheses.

605S.2 Submittals

The submittal requirements for this specification item shall include the soil retention blanket material type and sample, evidence that the material is listed on TxDoT/TTI Approved Products List, one (1) full set of Manufacturer's literature and installation recommendations, and any special details necessary for the proposed application.

605S.3 Materials

A. Soil Retention Blankets

All soil retention blankets must be listed on TxDoT Approved Products List or approved by the Engineer or designated representative.

The soil retention blanket shall be one (1) of the following classes and types as shown on the Drawings:

1. Class 1. "Slope Protection"
   (a) Type A. Slopes 1:3 or flatter - Clay soils
   (b) Type B. Slopes 1:3 or flatter - Sandy soils
   (c) Type C Slopes steeper than 1:3 - Clay soils
   (d) Type D Slopes steeper than 1:3 - Sandy soils
2. Class 2. "Flexible Channel Liner"
   (a) Type E Short-term duration (Up to 2 years)
   Shear Stress (t_d) < 1 pound per square foot [psf] (48 Pa)
   (b) Type F Short-term duration (Up to 2 years)
   Shear Stress (t_d) 1 to 2 psf (48 to 96 Pa)
   (c) Type G Long-term duration (Longer than 2 years)
   Shear Stress (t_d) >2 to <5 psf (>96 to <239 Pa)
   (d) Type H Long-term duration (Longer than 2 years)
   Shear Stress (t_d) ≥ 5 psf (≥ 239 Pa)

B. Fasteners

The fasteners shall conform to the recommendations of the manufacturer for the selected soil retention blanket.

605S.4 Construction Methods

A. General

The soil retention blanket shall conform to the class and type shown on the Drawings. The Contractor has the option of selecting an approved soil retention blanket conforming to the class and type shown on the Drawings which is included on the Approved Products List published by TxDoT/TTI Hydraulics and Erosion Control Laboratory.

B. Site Preparation:

Prior to placement of the soil retention blanket, the seedbed area to be covered shall be relatively free of all clods and rocks over 1 1/2 inches (37.5 mm) in maximum dimension and all sticks or other foreign matter that will prevent close contact of the preparation mat with the soil surface. The area shall be smooth and free of ruts and other depressions. If the prepared seedbed becomes crusted or eroded as a result of rain 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 reseed or resod the area at the Contractor's own expense. After the area has been properly prepared, the blanket shall be laid out flat, even and smooth, without stretching or crimping the material.

C. Installation

The Soil Retention Blanket, whether installed as slope protection or as flexible channel liner in accordance with the TxDoT/TTI Approved Products List, shall be placed within 24 hours after seeding (Standard Specification Item No. 604S), sodding (Standard Specification Item No. 602S) or native grassland seeding and planting (Standard Specification Item No. 609S) erosion control operations have been completed, or as approved by the Engineer or designated representative. The soil retention blanket shall be installed and anchored in accordance with the Manufacturer's recommendations. The Contractor shall contact the Engineer or designated representative three (3) days prior to the installation of the soil retention blanket to allow for inspection of the installation by City of Austin personnel.

605S.5 Measurement

This work and acceptable material for "Soil Retention Blanket" will be measured by the square yard (square meter: 1 square meter is equal to 1.196 square yards) of surface area covered, complete in place.

605S.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 bid price for "Soil Retention Blanket" of the class shown on the Drawings or approved by the Engineer or designated representative. The unit price shall include full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the work. Anchors, checks, terminal and wire staples will not be paid for directly, but will be included in the unit price bid for this specification item.

Payment will be made under the following:

Pay Item No. 605S-A: Soil Retention Blanket Class__; Type __- Per Square Yard.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification 605S, "Soil Retention Blanket"

City of Austin Standard Specification Items

Designation	Description
Item No. 602S	Sodding for Erosion Control
Item No. 604S	Seeding for Erosion Control
Item No. 609S	Native Grassland Seeding and Planting for Erosion Control

RELATED CROSS REFERENCE MATERIALS

City of Austin Standard Specification Items

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 111S	Excavation
Item No. 120S	Channel Excavation
Item No. 132S	Embankment
Item No. 606S	Fertilizer
Item No. 608S	Planting
Item No. 610S	Preservation of Trees and Other Vegetation

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 132	Embankment
Item No. 158	Specialized Excavation Work
Item No. 160	Furnishing and Placing Topsoil
Item No. 162	Sodding for Erosion Control
Item No. 164	Seeding for Erosion Control
Item No. 166	Fertilizer
Item No. 168	Vegetative Watering
Item No. 169	Soil Retention Blanket
Item No. 204	Sprinkling

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Item No. 606S
Fertilizer

606S.1 Description

This item shall govern the provision and distribution of fertilizer over the areas indicated on the Drawings and in accordance with these specifications.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, inch-pound units are given preference with SI units shown within parentheses.

606S.2 Submittals

The submittal requirements for this specification item shall include:

A. Type of soil(s) at the site.
B. Type(s) of re-vegetation (seeding, sodding, etc).
C. Type(s) of fertilizer.
D. Rate(s) of application of fertilizer.
E. Chemical analysis of the fertilizer(s).

606S.3 Materials

All fertilizer used on site shall be delivered in bags or containers, which are clearly labeled and show the analysis. The figures in the analysis shall represent the percent of nitrogen, phosphoric acid and potash nutrients, respectively, as determined by the methods of the Association of Official Agricultural Chemists. The fertilizer may be subject to testing by the State Chemist in accordance with the Texas Fertilizer Law. A pelleted or granulated fertilizer shall be used.. Fifty percent or greater of the Nitrogen required shall be in the form of Nitrate Nitrogen ($N0_3$). The remaining Nitrogen required may be in the form of Urea Nitrogen [$CO(NH_2)_2$].

The total amount of nutrients furnished and applied per acre (hectare: 1 hectare equals 2.471 acres) shall equal or exceed that specified for each nutrient.

606S.4 Construction Methods

General requirements and criterion for vegetative activities, including fertilizing, for the City of Austin are presented in Section 1.4.4, "Vegetative Practice", and Section 1.5.4, "Revegetation Criteria" of the City of Austin Environmental Criteria Manual.

The fertilizer type and rate of application should be based on chemical tests of representative soil samples taken after completion of construction and ground work. Appropriate initial fertilizer application rates for the Austin area (in lieu of recommendations from soil testing) are provided in the sections of the City of Austin Environmental Criteria Manual identified below:

A. Permanent seeding. - [Section 1.4.4.B.4].
B. Restoring Climax Grasses - [Section 1.5.5.E].
C. Sod. -. [Section 1.4.4.E.5].
D. Maintenance of Mulch Sod. - [Section 1.4.4.C.4].

Pelleted or granulated fertilizer shall be applied uniformly into the soil to a depth of 4 inches (100 mm) over the area specified on the Drawings to be fertilized and in the manner directed for the particular item of work. The fertilizer shall be dry and in good physical condition. Fertilizer that is powdered or caked will be rejected. Distribution of the fertilizer for the particular item of work shall meet the approval of the Engineer or Designated Representative.

Maintenance fertilizing shall be applied every 6 months after the new sod or grass is placed or until the work is accepted by the City.

The fertilizer may also be applied with the hydromulch

606S.5 Measurement

Work and acceptable material for "Fertilizer" will be measured by the normal ton of 2,000 pounds (megagrams: 1 megagram equals 1.1023 tons) or by the 100 pounds (50 kilograms: 1 kilogram equals 2.205 pounds) as determined by approved scales or guaranteed weight of sacks shown by the manufacturer.

606S.6 Payment

The work performed and materials furnished and measured as provided under "Measurement" shall be included in the unit price bid for the item of construction in which fertilizer is used, unless specified in the Drawings as a Pay Item.

When fertilizer is specified on the Drawings as a pay item or included in the contract bid form, the work performed and materials furnished and measured as provided under "Measurement" will be paid for at the unit bid price for "Fertilizer" of the analysis specified on the Drawings. The unit bid price shall include full compensation for furnishing all materials and performing all operations necessary to complete the work.

Payment, when specified, will be made under one of the following:

Pay Item No. 606S-A:	Fertilizer	Per Ton.
Pay Item No. 606S-B:	Fertilizer	Per 100 Pounds.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item 606S "Fertilizer"

City of Austin Environmental Criteria Manual

Designation	Description
Section 1.4.4.B.4	Design Criteria of Section B. Critical Area Stabilization (with Permanent Seeding)
Section 1.4.4.C.4	Design Criteria of Section C. Critical Area Stabilization (with Mulch Sod)
Section 1.4.4.E.5	Site Preparation of Section E. Critical Area Stabilization (with Sod)
Section 1.5.5.E	Fertilizer, Section E of 1.5.5, "Restoring Climax Grasses"

RELATED CROSS REFERENCE MATERIALS
Specification Item 606S "Fertilizer"

City of Austin Technical Specifications

Designation	Description
Item No. 601S	Salvaging and Placing Topsoil
Item No. 602S	Sodding for Erosion Control
Item No. 604S	Seeding for Erosion Control
Item No. 605S	Soil Retention Blanket
Item No. 607S	Slope Stabilization
Item No. 608S	Planting
Item No. 609S	Native Grassland Seeding and Planting for Erosion Control
Item No. 610S	Preservation of Trees and Other Vegetation

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Item No. 609S
Native Grassland Seeding and Planting for Erosion Control

609S.1 Description

This item shall govern the preparation of a seeding and planting area to the lines and grades indicated on the Drawings. This may include seedbed preparation, sowing of seeds, planting of rooted plants, watering, hydromulch, compost and other management practices, as indicated in the Drawings or as directed by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, inch-pound units are given preference with SI units shown within parentheses.

609S.2 Submittals

The submittal requirements for this specification item shall include:

A. For seed, provide Identification of the species, source, mixture and pure live seed (PLS) of the seed as listed on each seed bag to be used. Copies of the analysis tags and certification tags from all seed bags shall be submitted.

B. Type of mulch or compost.

C. Watering frequency and amount as shown on an irrigation watering schedule.

D. Type of management practices (e.g., hand weeding, pesticide application, etc.) proposed, with a proposed schedule for observation and treatment.

E. For hydromulch applications, the proposed application rate of seed, type of mulch and tacking agent, and other relevant information. An example of the required documentation is in Table 1.

F. Type of hydraulic seeding equipment and nozzles proposed for use.

G. If pesticide use is proposed, an IPM plan for pest control including pesticide label, proposed application rate and timing, and MSDS sheets.

H. One gallon sample of proposed mulch or compost.

I. The following submittal items are required before Substantial Completion.

   A. For hydromulch applications, submit the complete hydromulch application log, including date, time and quantity of product units placed in the slurry tank. An example of an application log is in Table 2.

   B. Pesticide and fertilizer application tracking log. As of January 1, 2012, documentation of all outdoor pesticide and fertilized use on city-owned properties is required to demonstrate compliance with the EPA/TCEQ mandated Municipal Stormwater Permit, the TPDES General Pesticide Permit, City Code, and the IPM program.

Table 1: Example of proposed hydromulch application rates

				Hydro Slurry Unit (per acre rates)				
Hydro Mix	Sheet No.	SEC	Acres	Seed (Bags/ac	Tackifier (Buckets/ac)	Mulch (Bales/ac)	Fertilizer (Bags/ac)	Addl. Amendment (Bags/ac)
1	L2	A	1.0	1	100	1000	50	5
2	L3	A	0.5	2	200	1500	50	5
3	L5	B	3.0	3	300	3000	50	5

Table 2: Example of hydromulch application log

						Hydro Slurry Unit (per acre rates)				
Date	Start time	Finish time	ac/ Tank	Water (gal)	Seed Mix	Seed (Bags /ac)	Tackifier (Buckets /ac)	Mulch (Bales /ac)	Fertilizer (Bags /ac)	Addl. Amendment (Bags/ac)
4/13	10:30	11:15	1.0	3300	A	1	100	1000	50	5
4/17	2:00	2:30	0.5	3300	A	2	200	1500	50	5
5/20	8:30	10:00	1.2	3300	B	3	300	3000	50	5

609S.3. Materials

A. Seed

All seed must meet the requirements of the Texas Seed Law including the labeling requirements for showing PLS, name and type of seed, and all other required elements of the Analysis and Certification Tags. The seed furnished shall be of the previous season's crop and the date of analysis shown on each bag shall be within 12 months of the time of delivery to the project. Each variety of seed shall be furnished and delivered in separate bags or containers, unless a specific mix is proposed for use. A sample of each variety of seed shall be furnished for analysis and testing when directed by the Landscape Architect, Engineer or designated representative.

The amount of seed planted per square yard (.84 square meters) or acre (hectare) shall be of the type specified in section 609S.5.

B. Water. Water shall be clean and free of industrial wastes and other substances harmful to the growth of plant materials in the area irrigated.

C. Topsoil. Topsoil shall conform to Standard Specification Item No. 601S.3(A)

D. Pesticide. A least toxic, integrated pest management (IPM) approach shall be used to control weeds. A written request for approval of weed control product(s) and/or materials shall be submitted to the City of Austin Watershed Protection

Department (ERM), IPM program coordinator for approval. Additional information can be found at http:/www.austintexas.gov/ipm.

E. Fertilizer. If fertilizer use is deemed necessary, the fertilizer shall conform to Standard Specification Item No. 606S, "Fertilizer." The type and rate of fertilizer should be based on chemical tests of recent (no older than 6 months before application) representative site soil samples. Fertilizer should be applied only when plants can take them up for growth, during:

1) seed germination and plant establishment and
2) after plant establishment.

Fertilizer shall not be applied within 48 hours of a potential rain event.

F. Tackifier. The tacking agent shall be a biodegradable material approved by the Landscape Architect, Engineer, or designated representative.

G. Mulch. Mulch may be used to help prevent soil erosion until preferred plant establishment, whether the mulch be hydraulically applied or shredded vegetative matter. Hydromulching for temporary and permanent vegetation stabilization shall conform to Environmental Criteria Section 1.4.7.

H. Hydroseeding Equipment. Hydroseeding equipment shall be clean and free of all previous seeds, fertilizer, mulch, or any hydroseeding products used on prior jobs.

I. Rooted Plants. Where proposed, rooted plants shall conform to the requirements of Standard Specification 608S, Planting.

609S.4 Construction Methods

A. General.

The Contractor shall limit preparation to areas that will be seeded/planted immediately. All weedy species (Table 3) shall be controlled by application of a herbicide and/or by physical removal (by the roots) prior to, during the planting operation, and through establishment. The specified weedy species shall be maintained at ten (10) percent or less of total cover after seeding. Additionally, the Landscape Architect, Engineer, or qualified landscape professional may require removal of any plant species that appears to be out-competing seeded or planted species during construction or the establishment period.

Seeds and fruits of non-native woody invasive species should be separated from the rest of the removed plants before mulching or hauling off the material. It must be bagged and disposed of in a landfill to prevent unintentional reintroduction to the site or elsewhere.

Table 3: Weed List

Weed Type	Botanical Name	Common Name
Summer Annual Herb	Ambrosia spp.	Ragweed
Perennial Grass	Bothriochloa ischaemum	K.R. Bluestem
Annual Grass	Cenchrus spp.	Sandbur
Herb	Cnidoscolus texanus	Bull Nettle
Perennial Grass	Sorghum halapense	Johnson Grass
Perennial Grass	Arundo donax	Giant Cane
Perennial Grass	Phllostachys aurea	Golden Bamboo
Vine	Toxicodendron radicans	Poison Ivy
Herb	Urtica spp.	Stinging Nettle
Winter Annual Herb	Rapistrum rugosum	Bastard Cabbage
Winter Annual Grass	Bromus arvensis	Japanese Brome
Winter Annual Grass	Lolium multiflorum	Annual Ryegrass
Tree	Triadica sebifera	Chinese Tallow
Tree	Ligustrum sp.	Privet
Tree	Melia azedarach	Chinaberry
Tree	Lonicera japonica	Japanese Honeysuckle
Shrub	Nandina domestica	Heavenly Bamboo
Shrub	Photinia sp.	Photinia

B. Seed Bed Preparation.

After the designated seeding/planting areas have been rough graded, a suitable planting area shall be prepared. In areas where cut or fill is required, a minimum of 6 inches (150 mm) of topsoil (see Section 609S.3.C) shall be placed or use approved existing soil (that is not infested with invasive or noxious plant rootstock [e.g., *Arundo donax rhizomes*]) stockpiled over the entire planting area.

The topsoil or growing medium must be prepared so that compaction is appropriate for plant growth, and to achieve acceptable bulk density or hydrologic function. Ripper and subsoilers may be used to loosen compacted soil and roughen the surface. Disks, plows and excavator attachments are good for compaction reduction, roughening, and for incorporating amendments. If tracked machinery is used in seedbed preparation, cleat marks should run with the contour to prevent rills.

In areas with no soil disturbance, the weeds shall be eliminated and a minimum of 6 inches (150 mm) of topsoil, if none currently exists, shall be placed. The seedbed shall be prepared with limited irregularities, lumps or soil clods and the surface shall be raked or rolled to facilitate seed to soil contact.

Water shall be gently applied as required to prepare the seedbed before the planting operation either by broadcast seeding or hydraulic planting. Seeding shall be performed in accordance with the requirements hereinafter described.

C. Watering

All watering shall comply with City Code Chapter 6-4 (Water Conservation). Water the seeded/planted areas immediately after installation to achieve germination and a healthy stand of native plants that can ultimately survive without supplemental water.

Apply the water uniformly to the planted areas without causing displacement or erosion of the materials or soil.

Watering applications shall insure that the plantbed is maintained in a moist condition favorable for the growth of plant materials. Watering shall continue until minimum coverage is achieved and accepted by the Landscape Architect, Engineer or designated representative.

Watering may be postponed immediately after a half inch (12.5 mm) or greater rainfall on the site but shall be resumed before the soil dries out.

D. Cool Season Cover Crop.

From September 15 to March 1, non-native and native seeding shall include a cool season cover crop at the rate specified in Tables 4, 5, or 6. Cool season cover crops are not permanent erosion control. If installed separately from the proposed seed mix, the cool season cover crops shall be mowed to a height of less than one (1) inch after March 1, and the area shall be re-seeded at the specified seeding rate for native warm-season species (March 1 to September 15).

609S.5 Native Grassland Seeding and Planting

Seeding and planting shall be performed in accordance with the requirements described below. The optimum depth for seeding shall be 1/4 inch (6 millimeters). Seed shall be applied by a method that achieves consistent distribution across a site and proper seed to soil contact (i.e. hand broadcasting, hydromulch, or drill method).

Rooted plants should be strategically and thoughtfully placed on a site. They need not be installed at a consistent, regular pattern across the plantable area(s) of a site but can be clustered or placed irregularly. The goal is to place the rooted plants where they will have the greatest or best effect or impact, and where there is sufficient space (e.g., root space, space off of utilities) and proper conditions (e.g., soil depth, moisture, light) for their long-term success. Installation of rooted plants shall comply with Standard Specification 608S, but rooted plants must not be spaced closer than three-feet (3') on center. Mulching around seed and rooted plants is not required, but it is a good technique for protecting plants

during germination and establishment. Figure 609S.5-1 is an example of rooted plant layout on a hypothetical site.

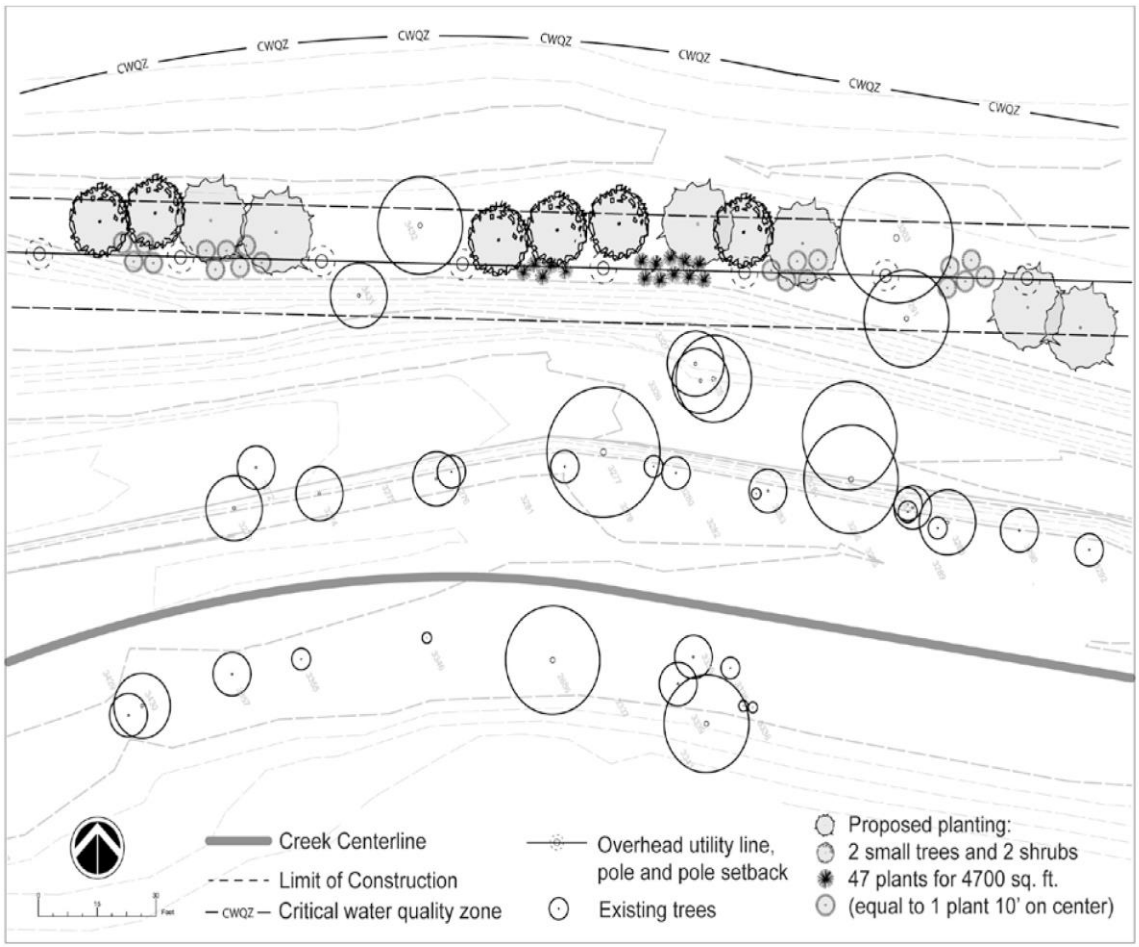

Figure 609S.5-1: Example of Rooted Plant Layout and Calculation

Rooted Plants such as trees, ornamentals, and shrubs are prohibited from being installed within fifteen (15) feet of any Austin Water Utility (AWU) infrastructure and/or within any easement dedicated for AWU infrastructure. Rooted plants such as grasses, succulents and/or ground cover are permitted within fifteen (15) of any AWU infrastructure and/or within any easement dedicated for AWU infrastructure.

Species substitution, when necessary due to availability, shall be approved by City of Austin representative including Environmental Reviewer, Environmental Inspector, or Watershed Protection Department representative. Only native or adapted species suitable for the designated environmental conditions shall be allowed as substitutes. Shorter growing natives such as Buffalograss should be sodded around manholes or other structures requiring higher visibility for access.

If the plant materials are being installed during the cool season (September 15 to March 1), a cool season cover crop species (as listed below) shall be included in the seed mix or installed separately.

The seed and rooted plant mixtures shall be applied in accordance with appropriate growing environments (Upland Full Sun-Table 4, Upland Shade-Dappled-Table 5 and Facultative Moderate to High Moisture-Table 6). Grasses shall constitute 67 percent of the seed mix, with forbs comprising 33 percent. No species shall constitute more than 20% of a seed mix.

Table 4. Upland Species, Full Sun Areas

Type	Common Name	Botanical Name	Recommended Application rate lbs/ac (kg/ha)	Rooted Plants Species, Diversity, Quantity & Size
Grass Seed Mix**	Buffalograss	Buchloe dactyloides	24.0 (27.0)	A minimum of two (2) native species of small or large trees, and two (2) native species of shrubs with Very Low or Low (VL or L) water needs and Sun or Sun/Part Shade light needs as listed in the current Grow Green Native and Adapted Landscape Plants guidance document***. Plants must be a minimum size of 1-gallon (see Table 8, equivalency chart) and minimum of 1 plant per 100 square feet.
	Blue Grama	Bouteloua gracilis	10.0 (11.2)	
	Green Sprangletop	Leptochloa dubia	2.0 (2.2)	
	Sand Dropseed	Sporobolus cryptandrus	1.0 (1.1)	
	Galleta	Pleuraphis jamesii	10.0 (11.2)	
	Canada Wild Rye	Elymus canadensis	10.0 (11.2)	
	Purple Threeawn	Aristida purpurea	4.0 (4.5)	
	Sideoats Grama	Bouteloua curtipendula	7.0 (7.8)	
Forb Seed Mix**	Bluebonnet	Lupinus texensis	20.0 (22.4)	
	Purple Prairie Clover	Dalea purpurea	4.0 (4.5)	
	Plains Coreopsis	Coreopsis tinctoria	2.0 (2.2)	
	Partridge Pea	Chamaecrista fasciculata	20.0 (22.4)	
	Greenthread	Thelesperma filifolium	6.0 (6.7)	
	Indian Blanket	Gaillardia pulchella	10.0 (11.2)	
	Lemon Mint	Monarda citriodora	3.0 (3.4)	

	Mexican Hat	Ratibida columnaris	2.0 (2.2)	
	Pink Evening Primrose	Oenethera speciosa	1.0 (1.1)	
	Sunflower (Common)	Helianthus annuus	5.0 (5.6)	
	Milkweed (Antelope Horn or Green milkweed)	Asclepias asperula or Asclepias viridis	0.1 (0.04)	
Total Total recommended seed mix application rate is 35 lbs/ac (23.5 lbs/ac grass, 11.5 lbs/ac forbs).				
Cool Season Cover Grasses	Cereal rye grain*	Secale cereale	34.0 (38.1)	Add at least one of the cool season grasses to the warm-season mix between September 15 and March 1.
	Oats*	Avena sativa	4.0 (4.5)	
	Western Wheatgrass*	Pascopyrum smithii	5.6 (6.3)	

* Plant only between. September 15 to March 1. Non-persistent winter cover crop for erosion control. Only one cool season species is required per installation.

** Any unavailable species can be substituted with the same quantity of another species from this list or another species approved by an authorized City of Austin representative including Environmental Reviewer, Environmental Inspector, or Watershed Protection Department representative. The total pounds/acre (lbs/ac) of the proposed seed mix can be calculated based on the desired percentage of each seed in a mix.

*** www.austintexas.gov/department/grow-green/plant-guide

Table 5. Upland Species, Shade-Dappled Light Areas

Type	Common Name	Botanical Name	Recommended Application rate lbs/ac (kg/ha)	Rooted Plants Species, Diversity, Quantity & Size
Grass Seed Mix***	Inland Seaoats**	Chasmanthium latifolium	12.0 (13.5)	A minimum of two (2) native species of small or large trees, and two (2) native species of shrubs with very low (VL), low (L), or low- medium (L-M) water
	Canada Wildrye	Elymus canadensis	10.0 (11.2)	
	Sideoats Grama	Bouteloua curtipendula	7.0 (7.8)	

Forb Seed Mix***	Purple Coneflower	Echinacea purpurea	10.0 (11.2)	needs and Sun /Part Shade light needs as listed in the current Grow Green Native and Adapted Landscape Plants guidance document****. Plants must be a minimum size of 1-gallon (see Table 8, equivalency chart) and minimum of 1 plant per 100 square feet.
	Lanceleaf Coreopsis	Coreopsis lanceolata	10.0 (11.2)	
	Scarlet Sage	Salvia coccinea	8.0 (9.0)	
	Drummond Phlox	Phlox drummondii	8.0 (9.0)	
	Black-Eyed Susan	Rudbeckia hirta	2.0 (2.2)	
	Cutleaf Daisy	Engelmannia pinnatifida	18.0 (20.2)	
	Tall Aster	Aster praealtus	1.0 (1.1)	
	Illinois bundleflower	Desmanthus illinoensis	15.0 (16.8)	
	Standing cypress	Ipomopsis rubra	6.0 (6.7)	
	Winecup	Callirhoe involucrata	5 (5.6)	
	Milkweed (Butterfly Weed or Showy Milkweed)	Asclepias tuberosa or Asclepias speciosa	0.1 (0.04)	
Total Total recommended seed mix application rate is 35 lbs/ac (23.5 lbs/ac grass, 11.5 lbs/ac forbs).				
Cool Season Cover Grasses	Cereal rye grain***	Secale cereale	34.0 (38.1)	Add at least one of the cool season grasses to the warm-season mix between September 15 and March 1.
	Oats***	Avena sativa	4.0 (4.5)	
	Western Wheatgrass***	Pascopyrum smithii	5.6 (6.3)	

** If unavailable replace with Prairie Wild Rye.

*** Plant only between September 15 to March 1. Non-persistent winter cover crop for erosion control. Only one cool-season species is required per installation.

**** Any unavailable species can be substituted with the same quantity of another species from this list or another species approved by an authorized City of Austin representative including Environmental Reviewer, Environmental Inspector, or Watershed Protection Department representative. The total pounds/acre (lbs/ac) of the proposed seed mix shall be calculated based on the desired percentage of each seed in a mix.

**** www.austintexas.gov/department/grow-green/plant-guide

Table 6. Facultative Species, Moderate - High Moisture Areas

Type	Common Name	Botanical Name	Recommended Application rate lbs/ac (kg/ha)	Rooted Plants Species, Diversity, Quantity & Size
Grass Seed Mix**	Big Bluestem	Andropogon gerardii	8.0 (9.0)	A minimum of two (2) native species of small or large trees, and two (2) native species of shrubs with low (L), low-medium (L-M), or medium (M) water needs and Sun/Part Shade or Shade light needs as listed in the current Grow Green Native and Adapted Landscape Plants guidance document***. Plants must be a minimum size of 1-gallon (see Table 8, equivalency chart) and minimum of 1 plant per 100 square feet.
	Big Muhuly (Lindhiemers)	Muhlenbergia lindheimeri	6.0 (6.7)	
	Bushy Bluestem	Andropogon glomeratus	6.0 (6.7)	
	Eastern Gamagrass	Tripsacum dactyloides	12.0 (13.5)	
	Indiangrass	Sorghastrum nutans	6.0 (6.7)	
	Inland Seaoats	Chasmanthium latifolium	12.0 (13.5)	
	Canada Wildrye	Elymus canadensis	10.0 (11.2)	
	Sand Lovegrass	Eragrostis trichodes	2.0 (2.2)	
	Switchgrass	Panicum virgatum	4.0 (4.5)	
Forb Seed Mix**	Black-Eyed Susan	Rudbeckia hirta	2.0 (2.2)	
	Illinois Bundleflower	Desmanthus illinoensis	15.0 (16.8)	
	Purple Prairie Clover	Dalea purpurea	4.0 (4.5)	
	Clasping Coneflower	Dracopis amplexicaulis	3.0 (3.4)	
	Plains Coreopsis	Coreopsis tinctoira	2.0 (2.2)	
	Goldenrod	Solidago altissima	1.0 (1.1)	
	Lazy Daisy	Aphanostephus sp.	1.0 (1.1)	
	Lemon Mint	Monarda citriodora	3.0 (3.4)	
	Sunflower (Common)	Helianthus annuus	5.0 (5.6)	
	Sunflower (Maximilian)	Helianthus maximiliana	4.0 (4.5)	

	Milkweed (common or Butterfly Milkweed)	Asclepias syriaca or Asclepia tuberosa	0.1 (0.04)	
Total Total recommended seed mix application rate is 26.0 lbs/ac (17.0 lbs/ac grass, 9.0 lbs/ac forbs).				
Cool Season Cover Grasses	Cereal rye grain*	Secale cereale	34.0 (38.1)	Add at least one of the cool season grasses to the warm-season mix between September 15 and March 1.
	Oats*	Avena sativa	4.0 (4.5)	
	Western Wheatgrass*	Pascopyrum smithii	5.6 (6.3)	

* Plant only between September 15 to March 1. Non-persistent winter cover crop for erosion control.

** Any unavailable species can be substituted with the same quantity of another species from this list or another species approved by an authorized City of Austin representative including Environmental Reviewer, Environmental Inspector, or Watershed Protection Department representative. The total pounds/acre (lbs/ac) of the proposed seed mix can be calculated based on the desired percentage of each seed in a mix.

*** www.austintexas.gov/department/grow-green/plant-guide

Table 7. Rooted Plant Size Equivalents

Potential Substitute		Equivalent To	
Quantity	Plant Size	Quantity	Plant Size
1	5-gallon	4	One-gallon
1	Two- or Three-gallon	2	One-gallon
4	4" pots or quarts	1	One-gallon
8	Plugs, live roots, saplings	1	One-gallon

Table 8. Seed Rate Calculation

Multiple species native seed mixes require careful calculations to ensure proper planting rates. The example below is for illustrative purposes only.

Species	Seeding Rate (lbs/ac)	Desired proportion of a species in the total mix (%)	Total quantity of seed in mix (lbs/ac)
Grass 1	7	.20	1.40
Grass 2	2	.20	0.40

Species	Seeding Rate (lbs/ac)	Desired proportion of a species in the total mix (%)	Total quantity of seed in mix (lbs/ac)
Grass 3	24	.20	4.80
Forb 1	10	.20	2.00
Forb 2	8	.20	1.60
TOTALS	- -	1.0 (100%)	10.2

Table 9. Seed Calculation Worksheet

The amount of seed needed to be planted on a project shall be calculated before installation to ensure adequate seed is placed, and provided as a submittal. Table 9 is an example worksheet, followed by an example calculation. Information for calculation can be obtained from seed tags or the supplier.

Plant Group	Desired Seeding Rate (lbs/ac)	PLS (pure live seed)	Bulk Rate (lbs/ac)	Seeding Area (ac)	Amt. of Seed to be Installed (lbs)
Grasses					
Forbs					
TOTAL					

FORMULAS:

PLS (pure live seed) = (Purity × Germination) × 100. Can also use average PLS from seed tags.

Bulk Rate (lbs/ac) =Desired Seed Rate (lbs/ac)/PLS

Amt. of Seed to be Installed (lbs) = Bulk Rate (lbs/ac) × Seeding Area (ac)

Example:

Plant Group	Desired Seeding Rate (lbs/ac)	PLS [pure live seed] (% decimal)	Bulk Rate (lbs/ac)	Seeding Area (ac)	Amt. of Seed to be Installed (lbs)
Grasses	131.00	0.81	161.73	1.50*	242.60
Forbs	65.34	0.87	75.10	1.50*	112.70
TOTAL	196.34	0.84 (ave.)	236.83	1.50	355.30

*Applied over the same 1.5 ac area.

609S.6 Management Practices

Management Practices include (1) weed management (pesticide application or mechanical removal) to so than 90 percent of the revegetation area is free of weeds listed in Table 3, (2) reseeding areas of poor germination to achieve coverage and height per 609S.8, with no bare areas greater than 10 s.f., and (3) replacement and replanting of rooted plants per 608S.5(O) [Plant Material Removal and Replacement] and 608S.7 (Acceptability of Plants).

Weeds, as defined in the Weed List (Table 3), shall be controlled in the most efficient manner possible. The timing of weed control may occur prior to soil disturbance, just before the installation of seed, and/or during the period of plant establishment. Weed control shall be introduced at one or all of these times, so that the greatest control is achieved. The preferred method of control is to remove weeds, either by physical or mechanical means, when the site is conducive (e.g. when the ground is moist) to this approach.

The entire root system of perennial weeds shall be removed to prevent re-sprouting. Table 9 provides management practices for woody invasive vegetation. Weeds may be controlled with an approved contact, systemic herbicide, provided the product is used with appropriate care and is applied in accordance with label instructions and the following guidelines:

1. Herbicide shall not be applied when the wind is greater than 8 mph (12.9 kph),
2. Herbicide shall not be applied when rainfall is expected within 24 hours,
3. Herbicide shall not contact surface water, i.e. creeks, rivers, and lakes,
4. Herbicide shall not contact desirable vegetation (a wicking method shall be used, if necessary, to accurately contact target weed only during application).

Table 10. Management Practices for Woody Invasive Vegetation

Before Seeding	
Stems ≤1 inch	Pull with weed wrench
Stems >1 inch	Cut at base and spray stump with appropriate herbicide within five minutes. Bag and dispose of seeds and fruit in landfill.
After Seeding	
Seedlings	Hand pull
Sprouts	Foliar application of appropriate herbicide

The Landscape Architect, Engineer or designated representative shall be consulted to determine appropriate weed control management when weeds are located in an environmentally sensitive location (e.g. near water or adjacent to a critical environmental feature).

609S.7 - Reseeding/Replanting

At locations that fail to show an acceptable stand of planting for any reason during the initial seeding, repair and/or reseed, replant locations as determined by the Landscape Architect, Engineer or designated representative. A successful stand of grasses and forbs should exhibit the following:

- Seedlings with vigorous green foliage;
- Green leaves remaining throughout the summer, at least at the plant bases;
- Uniform density, with grasses and/or forbs well intermixed;
- Minimum of 95% cover; and
- No patches of exposed soil greater than 10 s.f. in aerial extent.

The Owner or designated representative will inspect the seeding/planting during April of the calendar year following the year of initial seeding/planting and determine the necessity and extent of over seeding reseeding, or replanting required. Contractor shall ideally complete any required reseeding/replanting before May 15 of that year. This date may be extended if, in the opinion of the Owner and qualified landscape professional, the weather conditions before May 15 are not suitable for reseeding work. If the timing is bad, an annual cover crop can be over-seeded in a deficient area to temporarily provide coverage until a suitable time for seeding or planting perennial seed or rooted plants. If vegetation fails to grow and thrive, the soil must be tested to determine whether nutrient imbalances are responsible and, if so, an appropriate course of nutrient remediation (e.g., fertilizers, composts, topsoils, or other organic amendments) as recommended by a landscape professional must be implemented by the Contractor.

The Contractor shall meet the requirements for initial seeding and planting, including seeding method, seed mix, application rates, and slope texturing as applicable, unless otherwise agreed to in writing by the Owner and/or City staff. Corrected deficiencies will be re-inspected and approved by the Owner and designated representative, and final acceptance will be granted only upon satisfactory completion.

609S.8 Measurement

Work and acceptable material for Native Seed and Planting for Restoration will be measured by the square yard (square meter: 1 square meter equals 1.196 square yards) or by the acre (hectare: 1 hectare equals 2.471 acres), complete in place, so that all areas of a site that rely on vegetation for stability must be uniformly vegetated with a minimum of 95 percent total coverage with no bare areas exceeding 10 square feet (1.5 square meters) and a 1½ inch tall (40 millimeters) successful stand of plant materials. Ninety (90) percent of the overall planted area must be free of weeds listed in Table 3. Bare areas shall be re-prepared and reseeded as required by the Landscape Architect, Engineer or designated representative to develop an acceptable stand of vegetation.

609S.9 Payment

The work performed and materials furnished and measured will be paid for at the unit bid price for Native Grasslands and Planting For Restoration of the method specified on the Drawings.

The unit bid price shall include full compensation for furnishing all materials, including all topsoil, water, seed, or fertilizer or mulch and for performing all operations necessary to complete the work.

Payment will be made under one or more of the following pay items:

Pay Item No. 609S-A:	Topsoil and Seedbed Preparation	Per Square Yard.
Pay Item No. 609S-B:	Topsoil and Seedbed Preparation	Per Acre.
Pay Item No. 609S-C:	Native Seeding	Per Square Yard.
Pay Item No. 609S-D:	Native Seeding	Per Acre.
Pay Item No. 609S-E:	Rooted Plants	Per each.
Pay Item No. 609S-F:	Watering	Per 1,000 Gallons (Kgal).
Pay Item No. 609S-G:	Management Practices	Per Square Yard.
Pay Item No. 609S-H:	Management Practices	Per Acre.

End

SPECIFIC CROSS REFERENCE MATERIALS

Specification Item 609S "Native Grassland Seeding and Planting for Erosion Control"

City of Austin Standard Specifications

Designation	Description
Item No. 130S	Borrow
Item No. 601S	Salvaging and Placing Topsoil
Item No. 606S	Fertilizer

City of Austin Land Development Code

Designation	Description
Section 6-4	Water Conversation

RELATED CROSS REFERENCE MATERIALS

Specification Item 609S “Native Grassland Seeding and Planting for Erosion Control”

Designation	Description
Item No. 602S	Sodding for Erosion Control
Item No. 604S	Seeding (Non-Native) for Erosion Control
Item No. 605S	Soil Retention Blanket
Item No. 607S	Slope Stabilization
Item No. 608S	Planting

City of Austin Standards (Details)

Standard No.	Description
627S-1	Grass Lined Swale
62S7-2	Grass Lined Swale W/ Stone Center
633S-1	Landgrading

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 160	Furnishing and Placing Topsoil
Item No. 162	Sodding for Erosion Control
Item No. 164	Seeding for Erosion Control
Item No. 166	Fertilizer

Item No. 168	Vegetative Watering
Item No. 169	Soil Retention Blanket
Item No. 180	Wildflower Seeding
Item No. 192	Roadside Planting and Establishment

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ITEM NO. 610S PRESERVATION OF TREES AND OTHER VEGETATION 12-7-18

610S.1 Description and Definitions

This item shall govern the proper care, protection and treatment of trees and other vegetation in the vicinity of the permitted development activity (as defined in Land Development Code 25-1-21(27)). All work shall be performed in accordance with the City approved drawings and specifications (e.g. Standard Series 600) or as approved by the City Arborist (as defined below). Tree pruning and/or treatments shall be performed under the direct supervision of a qualified arborist (as defined below) or as allowed by the City Arborist.

Definitions

City Arborist - City official designated by the Director of the Planning and Development Review Department (Land Development Code 25-8-603) or as designated by the City Arborist.

Oak wilt - a tree disease caused by a fungus "Ceratocystis fagacearum" that infects the vascular system of Oak "genus Quercus" trees and prevents water transport through the trunk and canopy of the tree. This usually fatal tree disease can be spread by certain insects that come into contact with tree wounds or by interconnected tree roots. February through June is a high risk period due to the stage of the fungus and insect activity. See section 610S.4(H) for additional requirements for preventing Oak wilt infection.

Qualified Arborist - an individual engaged in the profession of arboriculture or closely related field who, through experience, education, and related training, possesses the competence to provide for, or supervise, the management of trees and other woody plants (as defined in the most current version of ANSI A300 (Part 1)-2001, section 4.1).

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

610S.2 Submittals

The following is a list of the minimum submittal requirements for this specification item shall include:

A. Identification of the location, type of protective fencing (i.e. A, B or C), materials of construction and installation details;

B. Qualified Arborist credentials (i.e. proof of certification from the International Society of Arboriculture, licenses, resume and/or references);

C. Type, location and construction details for proposed tree wells;

D. Location, type, materials of construction and installation details for permeable paving;

E. Proposed nutrient mix specifications and when required by the City Arborist, soil and/or foliar analysis for fertilizer applications.

610S.3 Materials

A. Protective Fencing and Signage

Protective fencing is designated as the materials used to protect the root zones of trees as illustrated in City of Austin Standard Detail 610S-1. Three basic types of protective fencing materials are allowed by the City of Austin. Type A and Type B are typical applications and shall be installed where damage potential to a tree

root system is high, while Type C shall be installed where damage potential is minimal. The specific type of protective fencing for the work shall be as indicated on the drawings. Type C fence materials shall be subject to approval by the City Arborist. Type C fencing shall be replaced by Type A or Type B fencing as directed by the City Arborist if it fails to perform the necessary function.

1. Type A Chain Link fence (Typical Application-high potential damage)

   Type A protective fencing shall be installed in accordance with City of Austin Standard Details 610S-2 and 610S-4 and shall consist of a minimum five-foot (1.5 meters) high chain link fencing with tubular steel support poles or "T" posts.

2. Type B Wood Fence (Typical Application-high potential damage)

   Type B protective fencing shall be installed in accordance with City of Austin Standard Details 610S-3 and 610S-5 and shall consist of any vertical planking attached to 2x4-inch (50 x 100 mm) horizontal stringers which are supported by 2x4-inch (50 x 100 mm) intermediate vertical supports and a 4x4-inch (100 x 100 mm) at every fourth vertical support .

3. Type C Other Materials (Limited Application-minimal potential damage)

   The following materials may be permitted as alternates for limited or temporary applications (3 days or less) where tree damage potential is minimal (as determined by the City Arborist):

   (a) High visibility plastic construction fencing.

   The fabric shall be 4 feet (1.2 meters) in width and made of high density polyethylene resin, extruded and stretched to provide a highly visible international orange, non-fading fence. The fabric shall remain flexible from -60°F to 200°F (-16°C to 93°C) and shall be inert to most chemicals and acid. The fabric pattern may vary from diamond to circular with a minimum unit weight of 0.4 lbs./Ft. (0.6 kilograms per meter).

   The fabric shall have a 4 foot (1.2 meters) width minimum tensile yield strength (Horizontal) of 2000 psi [13.9 megaPascals], ultimate tensile strength of 2680 psi [18.5 megaPascals] (Horizontal) and a maximum opening no greater than 2 inches (50 mm).

   (b) Other approved equivalent restraining material.

   The fencing materials, identified in (a) and (b) above, shall be supported bysteel pipe, tee posts, U posts or 2" × 4" (50 mm x 100 mm) timber posts that are a minimum of 5½ feet (1.68 meters) in height and spaced no more than 8 feet (2.44 meters) on centers. The fabric shall be secured to post by bands or wire ties.

4. Signage

   A laminated sign, no smaller than 8.5 X 11 inches, shall be posted on each tree protective device, and at least every 100 linear feet on protective fencing, identifying the following information: Tree & Root Protection Zone, Per City of Austin code (Chapter 25-8, Subchapter B, Article 1) this protective device is to remain in place for the entirety of the development project and illegal removal is subject to fines and work suspensions. Additional information can be obtained at the City Arborist (512-974-1876) web site (http://www.ci.austin.tx.us/trees). Zona de Protección del Árbol y las Raíces: el dispositivo protector debe quedarse en el lugar para la totalidad del proyecto de la construcción. Para información adicional, contacta la Arborista Municipal (512) 974-1876 o http://www.ci.austin.tx.us/trees/trees_spanish.htm.

B. Trunk Protection (Limited Application)

When indicated on the drawings or directed by the City Arborist tree trunk protection shall be provided in accordance with City of Austin Standard Details 610S-4 and 610S-5. Tree trunk protection shall consist of any

2 x 4-inch (50 x 100 mm) or 2 x 6-inch (50 x 150 mm) planking or plastic strapping and shall be attached in a manner that does not damage the tree.

C. Tree Dressing

Wound treatments should not be used to cover wounds or pruning cuts, except when recommended for disease (see section 610S.4 (H)), insect, mistletoe, or sprout control (from ANSI A300 (Part 1)-2001, section 5.4.1).

D. Tree Wells for Raised Grades

When existing grades are raised by more than 4 inches (10.16 cm), the tree root system shall be protected by the installation of tree wells in accordance with City of Austin Standard Detail 610S-6. Native stone or non-toxic timber shall be used for the separator wall of the well and PVC conforming to ASTM D-2729, SDR-35 shall be used for the aeration systems in fill areas.

E. Permeable Paving (Environmental Criteria Manual Section 3.5.A.1)

Permeable segmented pavers in conjunction with PVC pipe aeration system or concrete on gravel base with cored holes shall be used to protect existing tree root zones when indicated on the drawings or directed by the City Arborist.

F. Fertilizer

Humate/nutrient solutions with mycorrhizae components or soil injection at recommended rates are to be used when appropriate. Construction which will be completed in less than 90 days may use materials at half the recommended rates. Alternative organic fertilizer materials are acceptable when approved by the City Arborist.

610S.4 Construction Methods

A. Protective Fencing

All trees and shrubs in the proximity of the construction site shall be carefully checked for damage prior to initiation of the permitted development activity.

All individual or groups of trees, shrubs, and natural areas shown to be protected on the drawings or identified to be protected by the City Arborist, shall be protected during construction with temporary fencing as indicated on the drawings or as directed by the City Arborist.

Protective fences (section 610S.4.A) shall be installed prior to the start of any site preparation work (clearing, grubbing, or grading), and shall be maintained in functioning condition throughout all phases of the construction project.

Protective fence locations in close proximity to intersecting streets or drives shall adhere to the sight distance (Section 1.3.1.C.6) and desirable sight triangle (Figure 1-6 criteria found in the City of Austin Transportation Criteria Manual).

1. Protective fences shall be constructed at the locations (typically the outer limits of the critical root zone) and with materials indicated on the drawings to prevent the following (Environment Criteria Manual, Appendix P-2, Note 6):

    (a) Soil compaction in the root zone area resulting from vehicular traffic or storage of equipment or materials.

    (b) Critical root zone disturbances due to grade changes [greater than 4” (10.16 cm) cut or fill] or trenching not reviewed and authorized by the City Arborist.

    (c) Damage to exposed roots, trunks or limbs by mechanical equipment.

(d) Other activities detrimental to trees such as chemical storage, concrete truck cleaning, and fires.

2. Exceptions to the installation of protective fences at the tree drip lines may be permitted in the following cases:

(a) Where there is to be an approved grade change, impermeable paving surface, tree well, or other such site development, the fence shall be erected no more than 2 feet (0.6 meters) beyond the area of disturbance unless approved by the City Arborist;

(b) When permeable paving is to be installed within a tree's critical root zone, the fence shall be erected at the outer limits of the permeable paving area (prior to any site grading so that this enclosed area is graded separately to minimize root damage);

(c) When trees are located close to a proposed building or other construction activity (Environment Criteria Manual, Appendix P-2, Note 6.c), the fence shall be erected up to 10 feet (3 meters) to allow work space between the fence and the structure. Apply organic mulch to a depth of 8 inches [30.48 cm] in the unprotected root zone area;

(d) When there are street-side pedestrian walkways, fences shall be constructed in a manner that does not obstruct safe passage;

(e) When there are severe space constraints due to tract size or other special requirements, the Contractor shall contact the City Arborist to discuss alternatives.

When any of the exceptions listed above will result in a fence being located closer than five (5) feet (1.5 meters) to a tree trunk, the Contractor shall also protect the trunk with strapped-on planking to a height of 8 feet [2.4 meters] (or to the limits of lower branching) in addition to the fencing requirement (City of Austin Standard Details 610S-4 and 610S-5).

B. Pruning and Repair of Damage

Tree pruning, to provide clearance for the work and/or to remove hazards, shall be performed under the direct supervision of a qualified arborist and shall follow standards identified in ANSI A300 (Part 1), "Pruning". A minimum clearance height of eight (8) feet (2.4 meters) above the street level must be provided and maintained for all existing trees if adjacent to a sidewalk. However, if the limbs of trees overhang the curb line or edge of travel lane of any street, a minimum clearance height of fourteen (14) feet (4.2 meters) is required (Transportation Criteria manual section 6.2.3,A, 4, "Clearance Height"). Pruning shall provide the minimum clearance needed to perform the work or remove a hazard unless otherwise directed by the City Arborist to comply with transportation criteria or to mitigate for damage.

If tree damage compromises a tree's structural integrity then the area shall be adequately secured until a qualified arborist makes an assessment of the tree and corrective actions are completed with approval from the City Arborist. Damage to oak trees shall be treated immediately, with consideration for site safety, to reduce the risk of Oak Wilt infection (See 610S.4.H, "Oak Wilt Prevention"). Tree root wounds shall be treated to remove loose, damaged tissue from in and around the wound or if necessary the root shall be cut cleanly and covered with topsoil, or other material approved by the City Arborist, to prevent drying of root tissue and to create a favorable environment for root sprouting. Trunk wounds shall also be treated to remove loose, damaged tissue around the wound. Tree canopy repairs shall be performed in accordance with the most current version of ANSI A300 (Part 1), "Pruning", to prevent further damage to the tree and to promote recovery of the tree to sound condition. The ANSI standard describes proper pruning methods for limb removal and for making finish pruning cuts.

Trees damaged or removed without prior approval or where minimum design criteria is exceeded due to failure to maintain approved tree protection shall be mitigated (Environmental Criteria Manual section 3.5.4, "Mitigation Measures") in accordance with Land Development Code Chapter 25-8, Subchapter B, Article 1.

All trees damaged during construction shall receive an application of fertilizer within the drip line conforming to Standard Specification Item No. 606S, "Fertilizer" at the rate of 4 pounds per caliper inch (.07 kilograms per caliper mm).

C. Cutting and Filling Around Trees

When the depth of an excavation or embankment exceeds 4 inches (10.16 cm) within the critical root zone of any tree with a trunk diameter greater than 8 inches (200 mm), the City Arborist may require a tree well to be constructed per the City of Austin approved specifications and details (Section 610S.3.D and City of Austin Standard Detail 610S-6).

D. Paving Around Trees

Where new paving within the ½ critical root zone of any tree greater than a 8 inches (10.16 cm) diameter is approved, a permeable pavement and aeration system may be required by the City Arborist per the City of Austin Standard Detail (Section 610S.3.E, Environmental Criteria Manual Section 3.5.3.A.1 and Figure 3-8) must be installed as indicated on the Drawings, except for street construction.

E. Tree Removal

Tree removal shall comply with Land Development Code Chapter 25-8, Subchapter B, Article 1. An approved permit, or an approved site plan is required for removal of trees 8" and larger (see Environmental Criteria manual section 3.3.2.A.2 and figure 3-1 for measurement standards) with additional requirements for City Parkland properties and for Hill Country Roadway Corridor sites. Trees 19 inches in diameter and greater are defined as protected trees and require specific review from the City Arborist to approve a permit or site plan for removal. In addition heritage trees require a more extensive evaluation by the City Arborist and may require rulings from boards and commissions.

All trees to be removed shall be performed in a manner that does not damage the canopies, trunks or root systems of remaining trees and that protects all existing facilities, improvements and vegetation. Removal of oak trees shall follow the Oak Wilt Prevention procedures per the City of Austin Standards (Section 610S.4,(H)). All tree material shall be removed from the site unless authorized by the City Arborist or if it will be used as wood chips or mulch.

When a tree or shrub is scheduled for removal, it shall be cut to a maximum depth of 12 inches (30.5 cm) below the surrounding grade (the tree(s) should be removed at grade, and with hand saws, in situations where other tree root systems are present which are to be preserved). When applicable, after tree removal, soil shall be placed in the hole to a depth matching the existing grade.

All damage resulting from tree removal or pruning shall be repaired at the Contractor's own expense and shall follow guidelines in this specification.

F. Final Cleanup

All temporary tree and shrub preservation and protection measures shall be removed when the construction has been completed and any mulch applications shall be removed or reduced to no more than 3 inches (7.62 cm) depth.

G. Root Zone Aeration and Fertilization

As a component of an effective remedial tree care program per Environmental Criteria Manual section 3.5.4, preserved trees within the limits of construction may require soil aeration and supplemental nutrients. Soil and/or foliar analysis should be used to determine the need for supplemental nutrients. The City Arborist may require these analyses as part of a comprehensive tree care plan. Soil pH shall be considered when determining the fertilization composition as soil pH influences the tree's ability to uptake nutrients from the soil. If analyses indicate the need for supplemental nutrients, then humate/nutrient solutions with mycorrhizae components are highly recommended. In addition, soil analysis may be needed to determine if

organic material or beneficial microorganisms are needed to improve soil health. Materials and methods are to be approved by the City Arborist (512-974-1876) prior to application. The owner or general contractor shall select a fertilization contractor and ensure coordination with the City Arborist.

Pre-construction treatment should be applied in the appropriate season; ideally the season preceding the proposed construction. Minimally, areas to be treated include the entire critical root zone of trees as depicted on the City approved plans. Treatment should include, but not limited to, fertilization, soil treatment, mulching, and proper pruning.

Post-construction treatment should occur during final revegetation or as determined by a qualified arborist after construction. Construction activities often result in a reduction in soil macro and micro pores and an increase in soil bulk density. To ameliorate the degraded soil conditions, aeration via water and/or air injected into the soil is needed or by other methods as approved by the City Arborist. The proposed nutrient mix specifications and soil and/or foliar analysis results need to be provided to and approved by the City Arborist prior to application (Fax # 512-974-3010). Construction which will be completed in less than 90 days may use materials at ½ recommended rates. Alternative organic fertilizer materials are acceptable when approved by the City Arborist. Within 7 days after fertilization is performed, the contractor shall provide documentation of the work performed to the City Arborist, Planning and Development Review Department. P.O. Box 1088, Austin, TX 78767. This note should be referenced as item #1 in the Sequence of Construction.

H. Oak Wilt Prevention Policy

1. Purpose and Scope

The purpose of this Oak Wilt Prevention Policy is to identify measures that city staff and city-hired contractors and their sub-contractors, who perform the services of removing or trimming trees, will take to prevent the spread of oak wilt.

2. Definitions

Oak Wilt Disease: A tree disease caused by the fungus, Ceratocystis fagacearum. The fungus infects the vascular system of a tree. The vascular system contains vessels which transport moisture throughout the tree. The vessels of an infected tree effectively become blocked by the infection of the fungus, and cannot transport adequate moisture to sustain a healthy or living tree. In most cases, the end result is tree mortality.

3. Prevention Policy

(a) Prior to beginning field work, all city staff associated with projects involving potential contact with oak trees shall be made aware of the city's official Oak Wilt Policy by receiving and reading a written copy of this policy. Staff receiving a written copy of the policy shall include, but not limited to, project managers, equipment operators responsible for removing or trimming trees, or operators using heavy equipment which could cause wounding of susceptible oaks in the use of the equipment. In addition, individual city departments will provide a written copy of the Oak Wilt Policy to contractors participating in city projects in areas where oak trees are present before initiating field work.

(b) When possible, city staff and contractors should avoid trimming, pruning, or wounding Live Oaks and Red Oaks (Spanish, Shumard, Texas Red, and Blackjack oaks) from February through June.

(c) At all times and irrespective of limb size, all cuts and wounds to oak trees shall be dressed immediately using a non-phytotoxic tree wound dressing. Stump cuts and damaged roots (both above and below ground) shall also be dressed.

(d) Disinfection of pruning tools, saws, and related equipment is mandatory during the trimming or pruning of oak trees. Disinfection of tree removal and trimming equipment shall occur before work begins in a project area, between work in individual oak trees, and again prior to leaving a

project area. Acceptable disinfectants include either aerosol disinfectant or a 10 percent bleach-water solution.

*NOTE: Although this policy would require the disinfection of pruning equipment before and between oak trees as a precaution, research does not substantiate disinfection as a means of preventing the transmission of the oak wilt disease.

4. Disposal Policy

   (a) Chipping or shredding the wood from infected trees to use as mulch is an acceptable means of recycling the wood. Chipping or shredding allows the wood to dry out quickly, thereby killing the fungus.

   (b) Burning diseased wood is an acceptable means of disposal. Burning diseased logs will kill the fungus, and the fungus will not spread with the smoke.

   (c) Logs from diseased Red Oaks, that are not chipped, shredded, or burned shall be disposed of at a landfill.

   (d) Firewood from diseased Red Oak trees shall not be stored near healthy trees where fungal spores or insects that carry the spores have the potential to spread the fungus to healthy trees. It is recommended to store oak firewood under a sheet of clear plastic, tightly sealing the edges of plastic with soil or bricks. Doing so will prevent any spore carrying beetles from escaping and will solarize and heat the stored firewood to speed the drying process. It is also recommended to use clear plastic, as black plastic will reveal any escape holes to the beetles.

   (e) In situations where diseased Red Oak trees are identified and are not accessible for chipping, shredding, or removal, the trunk of the diseased tree should be girdled, and the stem treated with an appropriate herbicide to deaden the tree and hasten the desiccation and drying of the wood below the minimum moisture content that could support the development of fungal spores.

610S.5 Measurement

Tree and shrub pruning, fencing, drains, fertilization, etc. will not be measured for payment unless included as a contract pay item. Tree wells for tree protection will be measured by the units, complete in place, conforming to the Drawings and City of Austin Standard Detail 610S-6, "Tree Protection, Tree Wells".

Removal of existing trees will be measured per each tree.

610S.6 Payment

The work and materials prescribed herein with the exception of the Protective Fencing and Tree Well (Tree Protection) will not be paid for directly but shall be included in the unit price bid for the item of construction in which this activity is used, unless a payment item is included as a contract pay item.

Payment will be made under:

Pay Item 610S-A:	Protective Fencing Type A Chain Link fence (Typical Application-high damage potential)	Per Lineal Foot
Pay Item 610S-B:	Protective Fencing Type B Wood Fence (Typical Application-high damage potential)	Per Lineal Foot
Pay Item 610S-C:	Protective Fencing Type C Other Materials (Limited Application-minimal damage potential)	Per Lineal Foot
Pay Item 610S-D:	Tree Well (Tree Protection)	Per Each

Pay Item 610S-E:	Tree Trunk Protection (Wood Planking)	Per Each
Pay Item 610S-R:	Removal of Existing Trees	Per Each

Source: Rule No. R161-18.24 , 12-7-2018.

End

SPECIFIC CROSS REFERENCE MATERIALS	
Specification Item 610S, "Preservation of Trees and Other Vegetation"	
City of Austin Standard Specification Items	
Designation	Description
Item No. 606S	Fertilizer
City of Austin Standard Details	
Designation	Description
Item No. 610S-1	Tree Protection Fence Locations
Item No. 610S-2	Tree Protection Fence, Type A, Chainlink
Item No. 610S-3	Tree Protection Fence, Type B, Wood
Item No. 610S-4	Tree Protection Fence, Modified Type A, Chainlink
Item No. 610S-5	Tree Protection Fence, Modified Type B, Wood
Item No. 610S-6	Tree Protection, Tree Wells
City of Austin Transportation Criteria Manual	
Designation	Description
Section 1.3.1.C.6	Sight Distance
Section 6.2.3.A.4	Clearance Height
Figure 1-6	Desirable Sight Triangle
City of Austin Environmental Criteria Manual	
Designation	Description
Appendix P-2, Note 6	Exceptions to Installing Fences
Appendix P-2, Note 6c	Trees close to proposed buildings - - -
Appendix P-6	Remedial Tree Care Notes
Section 3.3.2.A.2	Diameter of trees - - -
Section 3.5.0	Design Criteria
Section 3.5.3.A.1	Permeable Paving
Figure 3-8	Example of Minimum Design Criteria Applied to Permeable Parking
City of Austin Land Development Code	
Designation	Description
Section 25-8-603	Tree Protection Administration
Section 25-8-623	Inspection by City Arborist
ASTM, American Society for Testing and Materials	
Designation	Description
D-2729	Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

RELATED CROSS REFERENCE MATERIALS	
Specification 610S, "Preservation of Trees and Other Vegetation"	
City of Austin Standard Specification Items	
Designation	Description
Item No. 101S	Preparing Right-of-way
Item No. 102S	Clearing and Grubbing
Item No. 111S	Excavation
Item No. 120S	Channel Excavation
Item No. 132S	Embankment
Item No. 608S	Planting
Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges	
Designation	Description
Item No. 100	Preparing Right-of-way
Item No. 110	Excavation
Item No. 132	Embankment
Item No. 158	Specialized Excavation Work
Item No. 160	Furnishing and Placing Topsoil
Item No. 166	Fertilizer
Item No. 168	Vegetative Watering

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Item No. 620S
Filter Fabric

620S.1 Description

This item shall govern the furnishing of materials and for placement of filter fabric as indicated on the Drawings or directed by the Engineer or designated representative. Filter Fabric shall have the capability for allowing the passage of ground water through it without transporting the soil placed around the filter fabric.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

620S.2 Submittals

The submittal requirements of this specification item include:

A. catalog cuts,
B. samples of material selected,
C. testing results,
D. manufacturer's recommended installation procedures, and
E. manufacturer certification of compliance with this specification.

620S.3 Materials

A. General

The fabric shall be constructed exclusively of synthetic thermoplastic fibers and may be either woven or non-woven to form a mat of uniform quality. Fabric fibers may be either continuous or discontinuous and oriented in either a random or an aligned pattern throughout the fabric. The fabric shall be mildew resistant, rot proof and shall be satisfactory for use in a wet soil and aggregate environment. The fabric shall contain ultraviolet stabilizers and shall have non-raveling edges.

B. Physical Requirements

The fabric shall meet the requirements of table 1, when sampled and tested in accordance with the methods indicated in the table below.

For applications such as water quality facility underdrain wrappings that require a high flow-through rate or when specified by the Engineer, the fabric shall be woven mono-filament and meet the requirements of Table 2.

All material shall be shipped with suitable wrapping to protect the fabric during shipping and storage at the job site.

620S.4 Construction Methods

The submittal requirements shall be completed before any materials are ordered.

The "Filter Fabric" shall be installed in accordance with the manufacturer's recommendations, as indicated on the Drawings or as directed by the Engineer or

designated representative. When lapping is required, it shall be in accordance with the manufacturer's recommendations. Backfilling around the Filter Fabric shall be done in such a manner that the Filter Fabric material will not be damaged during the placement.

TABLE 1: FILTER FABRIC REQUIREMENTS

Original Physical Properties	Test Method	Requirements
Fabric weight (mass), on an ambient temperature air-dried tension free sample, expressed in oz/ sq. yd (grams/ square meter)	TxDoT Tex-616-J*	Underdrains/Slope Stabilization 4.0 (135) minimum
		Gabions and Revet Mattresses 6.0 (200) minimum
Water flow rate by falling head method, 7.9 inches (20 cm) to 3.9 inches (10 cm) on 2 inch (50 mm) ID cylinder with 1 inch (25 mm) diameter orifice, with flow rate expressed in gal/sq.ft/minute (liters/square meter/minute).	TxDoT Tex-616-J*	80 (3,260) minimum
Breaking load in either machine or cross-machine direction, expressed in pounds (newtons)	ASTM D-1682 grab method G**	100 (445) minimum
Equivalent opening size for US Standard (SI) sieves.	CW-02215	70 to 100 (212 to 150μm)
"Apparent elongation" at breaking load in either machine or cross-machine direction, expressed as percent	ASTM D-1682 grab method G**	100 maximum

* TxDoT Tex-616-J, "Testing of Construction Fibers

** ASTM D 1682 grab method G, "Test Methods for Breaking Load and Elongation of Textile Fabrics"* as modified by TxDoT Test Method Tex-616-J

*** CW-02215, US Army Corps of Engineers, Civil Works Construction Guide Specification "Plastic Filter Fabric".

TABLE 2: HIGH FLOW FILTER FABRIC REQUIREMENTS

Property	Test Method	Requirements
Fabric weight	D 3776	3.0 ounces/square yard, minimum
Ultaviolet (UV) Radiation Stability	D 4355	70% strength retained minimum, After 500 hours in xenon arc device
Mullen burst strength	D- 3786	120 pound per square inch minimum
Water Flow Rate	D-4491	275 gallons/minute/square feet, minimum

620S.5 Measurement

Work and acceptable material for "Filter Fabric" and “High Flow Filter Fabric” will be measured by the square yard (square meter: 1 square meter equals 1.196 square yards), complete in place.

620S.6 Payment

The work performed and the materials furnished and measured as provided under "Measurement" will be paid at the unit bid price for "Filter Fabric". The unit bid price, when included in the contract as a pay item, shall include full compensation for all materials, excavation and backfilling and all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

Pay Item No. 620S-A:	Filter Fabric	Per Square Yard.
Pay Item No. 620S-B:	High Flow Filter Fabric	Per Square Yard.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification 620S, “Filter Fabric"

American Society for Testing and Materials (ASTM)

Designation	Description
D 1682	Test Methods for Breaking Load and Elongation of Textile Fabrics
D 3776	Standard Test Method for Mass Per Unit Area (Weight) of Fabric
D 4355	Test Methods for Deterioration of Geotextiles By Exposure to Ultraviolet Light, Moisture and Heat in a Xenon Arc Type Apparatus
D 3786	Standard Test Method for Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method
D 4491	Standard Test Method for Water Permeability of Geotextiles by Permittivity

Texas Department of Transportation Manual of Testing Procedures

Designation	Description
Tex-616-J	Testing of Construction Fabrics

RELATED CROSS REFERENCE MATERIALS

City of Austin Environmental Criteria Manual

Designation	Description
Section 1.4.2.E	Rock Berm
Section 1.6.5.A.4	Sand Filtration Bed Details

City of Austin Standard Details

Designation	Description
Number 639S-1	Rock Berm
Number 661-1	Sand Bed Filtration Configurations Using Geomembrane Liner
Number 661-2	Sand Bed Filtration Configurations Using Clay Liner/No Liner Required
Number 661-3	Biofiltration Bed Configurations Using Geomembrane/Clay Liner Required

City of Austin Standard Specifications

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 111S	Excavation
Item No. 120S	Channel Excavation
Item No. 401	Structural Excavation and Backfill
Item No. 602S	Sodding for Erosion Control
Item No. 604S	Seeding for Erosion Control
Item No. 605S	Soil Retention Blanket
Item No. 606S	Fertilizer
Item No. 608S	Planting
Item No. 610S	Preservation of Trees and Other Vegetation

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 132	Embankment
Item No. 158	Specialized Excavation Work
Item No. 166	Fertilizer
Item No. 168	Vegetative Watering
Item No. 169	Soil Retention Blanket
Item No. 204	Sprinkling

Item No. 627S
Grass-Lined Swale

627S.1 Description

This item governs natural or constructed drainage ways of parabolic or trapezoidal cross section that are located below adjacent ground level and is stabilized by suitable vegetation (Environmental Criteria Manual Section 1.4.3.B). The flow is normally wide and shallow and conveys the runoff down the slope.

A grass-lined swale shall be used when it is necessary to convey runoff only without causing erosion. In cases where there is base flow involved, it shall be handled by the addition of a subsurface drain or a stone or gabion mattress lined low flow channel to the grass-lined swale.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

627S.2 Submittals

The submittal requirements for this specification item shall include:

A. The submittal requirements (if necessary) for Standard Specification Item Numbers 594S, Gabions and Revet Mattresses", 602S, "Sodding for Erosion Control", 604S, "Seeding for Erosion Control" and 605S, "Soil retention Blanket".

B. Aggregate types, gradations, and physical characteristics for the Portland Cement Concrete mix,

627S.3 Materials

A. Grass-lined Swale

1 Seed and Mulch

Seed and mulch shall conform to Item No. 604S, "Seeding for Erosion Control".

2 Sod

Sodding shall conform to Item No. 602S, "Sodding for Erosion Control".

3 Soil Retention Blanket

The soil retention blanket shall conform to Standard Specification Item No. 605S, "Soil Retention Blanket".

627S.4 Construction Methods

Except as indicated on the Drawings or directed by the Engineer or designated representative, all trees, brush, stumps, obstructions and other objectionable material shall be removed and disposed of so as not to interfere with the proper functioning of the waterway.

The waterway shall be excavated or shaped to line, grade, typical sections, and cross-section indicated on the Drawings and shall be free of bank projections or other irregularities, which could impede normal flow.

Fill shall conform to Standard Specification Item No. 132S, "Embankment".

All soil and materials not needed to complete the swale shall be removed.

627S.5 Measurement

Acceptable work performed as prescribed by this item shall be measured by lineal feet (lineal meters: 1 lineal meter equals 3.281 lineal feet) along the centerline of the stone center "pilot" channel.

627S.6 Payment

Work performed and materials furnished for this item shall be paid at the unit bid price per lineal foot.

Payment will be made under:

Pay Item No. 627S-GSS: Grass-Lined Swale Per Lineal Foot

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification 627S, "Grass-Lined Swale ~~and Grass-Lined Swale with Stone Center~~"

City of Austin Environmental Criteria Manual

Designation	Description
Section 1.4.4.B.4	Permanent Erosion and Sedimentation Control
Section 1.4.6.B	Standards for Grass-Lined Swales

City of Austin Standard Specifications

Designation	Description
Item No. 132S	Embankment
Item No. 403S	Concrete for Structures
Item No. 594S	Gabions and Revet Mattresses
Item No. 602S	Sodding for Erosion Control
Item No. 604S	Seeding for Erosion Control
Item No. 605S	Soil Retention Blanket

City of Austin Standard Details

Designation	Description
No. 627S-1	Grass-Lined Swale

RELATED CROSS REFERENCE MATERIALS
Specification 627S, “Grass-Lined Swale "

City of Austin Standard Specifications

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 111S	Excavation
Item No. 120S	*Channel Excavation*
Item No. 401	Structural Excavation and Backfill
Item No. 404S	Pneumatically Placed Concrete
Item No. 406	Reinforcing Steel
Item No. 408	Concrete Joint Material
Item No. 410	Concrete Structures
Item No. 606S	Fertilizer
Item No. 608S	Planting
Item No. 610S	Preservation of Trees and Other Vegetation
Item No. 620S	Filter Fabric

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 132	Embankment
Item No. 158	Specialized Excavation Work
Item No. 166	Fertilizer
Item No. 168	Vegetative Watering
Item No. 169	Soil Retention Blanket
Item No. 204	Sprinkling

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ITEM NO. 639S
ROCK BERM

639S.1 Description

This item shall govern the construction of a temporary berm of open graded rock that is installed at the toe of a slope on the perimeter of a developing area. Rock berms are appropriate for use as flow diverters, energy dissipators, grade control, and level spreaders to release the water in sheet flow (Environmental Criteria Manual Section 1.4.5.E). This item shall also govern the removal of the "Rock Berm" and re-vegetation of the area.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

639S.2 Submittals

The submittal requirements for this specification item shall include:

A. Function (flow diversion, grade control, energy dissipator, level spreader, or other) and dimensions of the rock berm

B. Source, type and gradation of rock

C. Re-vegetation program, including:

1. Identification of the type, source, mixture, Pure Live Seed (PLS) and rate of application of the seeding.
2. Type of mulch.
3. Type of tacking agent.
4. Type and rate of application of fertilizer.

639S.3 Design Criteria

A detailed design is not required for the installation of a rock berm; however, the following criteria shall be observed:

Drainage area	less than 5 acres (2 hectares).
Height	18 inches (450 mm) minimum height, measured vertically from the top of the existing ground at the upslope toe to the top of the berm.
Top width	2 feet (0.6 meter) minimum.
Side slopes	2:1 or flatter.
Grade	Berms will be built along a contour as near possible to a 0 percent grade.

639S.4 Materials

Surplus rock excavated from utility trenches or from other excavations may be used in construction of these berms. In general, the rocks shall be sound with a minimum of 3 inches (75 mm) in smallest dimension and shall weigh between 10 and 30 pounds (4.5 to 13.6 kilograms) each. Seeding for re-vegetation shall conform to Item No. 604S, "Seeding for Erosion Control".

Use only open-graded rock of the size indicated on Standard Detail No. 639S-1, with most of the fines removed.

639S.5 Construction Methods

All trees, brush, stumps and objectionable material shall be removed and disposed in a manner that will not interfere with the construction of the berm.

A trench shall be excavated to a minimum depth of 4 inches (100 mm) below existing grade for placement of the rock as indicated on Standard Detail No. 639S-1 and the Drawings. The rocks shall be placed in interlocking layers with close joints starting at the base. Open joints shall be filled with rock-spalled materials as required to stabilize the berm.

The area upstream from the rock berm shall be maintained in a condition, which will allow sediment to be removed following the runoff from a rainfall event. After each rainfall event with an accumulation of 1 inch (25 mm) or more, an inspection of the rock berm will be made by the Contractor and the stone shall be replaced, when the structure ceases to function as intended because of sediment accumulation among the rocks, washout, construction traffic damage, etc.

If the sediment reaches a depth equal to 1/3 the height of the berm or 6 inches (150 mm), whichever is less, the Contractor will remove the accumulated sediment and dispose of it at an approved disposal site in a manner that will not contribute to additional sedimentation. The berm will be reshaped as needed during construction.

When the site is completely stabilized, the berm will be removed and disposed of in a manner approved by the Engineer or designated representative.

The area will be re-vegetated as required by Item No. 604S, "Seeding for Erosion Control".

639S.6 Measurement

Acceptable work performed and prescribed in this item will be measured by the linear foot (lineal meter: 1 lineal meter equals 3.281 lineal feet) along the centerline of top of berm.

639S.7 Payment

The work performed and material furnished and measured as provided under "Measurement" to construct this item will be paid for at the unit bid price per linear foot of rock berm barrier as indicated on the Drawings. The Unit Bid Price shall include full compensation for:

(a) furnishing, hauling and placing all materials including all labor, tools, equipment and incidentals needed to complete the work,
(b) maintaining the berm,
(c) removing sediment accumulations,
(d) rock replacement,
(e) removing and disposing of all materials when the berm is no longer required and
(f) re-vegetating the site upon removal of the berm.

Payment will be made under:

Pay Item No. 639S:	Rock Berm	Per Lineal Foot.

End

SPECIFIC **CROSS REFERENCE MATERIALS**

Specification 639S, “Rock Berm"

City of Austin Environmental Criteria Manual

Designation	Description
Section 1.4.2.E	Rock Berm

City of Austin Standard Details

Designation	Description
Number 639S-1	Rock Berm

City of Austin Standard Specifications

Designation	Description
Item No. 604S	Seeding for Erosion Control

RELATED **CROSS REFERENCE MATERIALS**

Specification 639S, “Rock Berm"

City of Austin Environmental Criteria Manual

Designation	Description
Table 1-1.3	Recommended Design Values For Functional Controls
Table 1-2	Maximum Water Depth At The Barrier

City of Austin Standard Specifications

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 111S	Excavation
Item No. 120S	Channel Excavation
Item No. 401S	Structural Excavation and Backfill
Item No. 602S	Sodding for Erosion Control
Item No. 605S	Soil Retention Blanket
Item No. 606S	Fertilizer

Item No. 608S	Planting
Item No. 610S	Preservation of Trees and Other Vegetation
Item No. 620S	Filter Fabric

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 100	Preparing Right of Way
Item No. 110	Excavation
Item No. 132	Embankment
Item No. 158	Specialized Excavation Work
Item No. 166	Fertilizer
Item No. 168	Vegetative Watering
Item No. 169	Soil Retention Blanket
Item No. 204	Sprinkling

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ITEM NO. 641S STABILIZED CONSTRUCTION ENTRANCE 6-21-07

641S.1 Description

This item governs the construction of a stabilized pad of crushed stone located at any point where traffic will be entering or leaving a construction site to or from a public right-of-way, street, alley, sidewalk or parking area. The removal of the stabilized pad of crushed stone shall also be included in the item. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking or deposition of sediment onto public right-of-way (Environmental Criteria Manual Section 1.4.2.N.4).

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

641S.2 Submittals

The submittal requirements for this specification item shall include:

A. Source, type and gradation of rock.

B. Drainage technique (i.e. drainage swale or entrance grading) proposed to prevent runoff from exiting the construction site.

641S.3 Materials

Aggregate for construction shall conform to the following gradation:

Table 1: Aggregate Gradation Chart (TEX 401-A, % Retained per sieve)		
US 8 inch (SI 200 mm)	US 5 inch (SI 125 mm)	US 2 inch (SI 50 mm)
0	90-100	100

641S.4 Construction Methods

All trees, brush, stumps, obstructions and other objectionable material shall be removed and disposed of in a manner that will not interfere with the excavation and construction of the entrance as indicated on the Drawings or as presented in Standard Details No. 641S-1. The entrance shall not drain onto the public right-of-way or shall not allow surface water runoff to exit the construction site.

When necessary, vehicle wheels shall be cleaned to remove sediment prior to entrance onto public right-of-way. When vehicle washing is required, it shall be done on an area stabilized with crushed stone, which drains into an approved sediment trap or sediment basin. All sediment shall be prevented from entering any storm drain, ditch or watercourse through use of sand bags, gravel, boards, silt fence (Standard Specification Item No 642S) or other methods approved by the Engineer or designated representative.

The entrance shall be maintained in a condition that will prevent tracking or disposition of sediment onto public right-of-way. This restriction may require periodic top dressing with additional stone as conditions demand, as well as the repair and/or cleanout of any measures used to trap sediment. All sediment that is spilled, dropped, washed or tracked onto public right-of-way must be removed immediately.

641S.5 Measurement

Acceptable work performed as prescribed in this item will be measured by unit of each stabilized construction entrance installed.

641S.6 Payment

The work performed and materials furnished and measured as provided under "Measurement" will be paid for at the unit bid price per each "Stabilized Construction Entrance." The price shall include full compensation for furnishing, hauling and placing all materials, labor, tools, equipment and incidentals necessary to complete the work including inspecting, repairing, replacing and relocating existing fencing, removal of silt and removal and disposal of all materials at the completion of construction. The price shall include full compensation for furnishing, installing, maintaining, moving, and removing any traffic control devices required by the installation of a stabilized construction entrance.

Payment, when included as a contract pay item, will be made under:

Pay Item No. 641S:	Stabilized Construction Entrance	Per Each.

Source: Rule No. R161-21.01 , 3-25-2021.

End

SPECIFIC CROSS REFERENCE MATERIALS	
Specification 641S, "Stabilized Construction Entrance (SCE)"	
City of Austin Environmental Criteria Manual	
Designation	Description
Section 1.4.2.N.4	Stabilized Construction Entrance "Design Criteria"
City of Austin Standard Details	
Designation	Description
Number 641S-1	Stabilized Construction Entrance
City of Austin Standard Specifications	
Designation	Description
Item No. 642S	Silt Fence (SF)

RELATED CROSS REFERENCE MATERIALS	
Specification 641S, "Stabilized Construction Entrance (SCE)"	
City of Austin Environmental Criteria Manual	
Designation	Description
Section 1.4.2.J	Sandbag Berm
Figure 1-11	Sand Bag Berm
Section 1.4.2.G	Silt Fence
City of Austin Standard Specifications	

Designation	Description
Item No. 101S	Preparing Right-of-way
Item No. 102S	Clearing and Grubbing
Item No. 111S	Excavation
Item No. 120S	Channel Excavation
Item No. 401S	Structural Excavation and Backfill
Item No. 610S	Preservation of Trees and Other Vegetation
Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges	
Designation	Description
Item No. 100	Preparing Right-of-way
Item No. 110	Excavation
Item No. 132	Embankment
Item No. 158	Specialized Excavation Work
Item No. 168	Vegetative Watering

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ITEM NO. 642S
SILT FENCE

642S.1 Description

This item shall govern the provision and placement of a silt fence fabric fence (Environmental Criteria Manual Section 1.4.5.G) including maintenance of the fence, removal of accumulated silt, removal of the silt fence and re-vegetation of disturbed areas upon completion of the project.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

642S.2 Submittals

The submittal requirements for this specification item shall include:

A. Source, manufacturer, characteristics and test data for the silt fence fabric,

B. Manufacturer, characteristics and test data for the posts and wire fence.

C. Re-vegetation program, including:

1. Identification of the type, source, mixture, Pure Live Seed (PLS) and rate of application of the seeding.
2. Type of mulch.
3. Type of tacking agent.
4. Type and rate of application of fertilizer.

642S.3 Materials

A. Fabric

1. General:

   The silt fence fabric shall be of nonwoven polypropylene, polyethylene or polyamide thermoplastic fibers with non-raveling edges. The silt fence fabric shall be non-biodegradable, inert to most soil chemicals, ultraviolet resistant, unaffected by moisture or other weather conditions, and permeable to water while retaining sediment. The silt fence fabric shall be supplied in rolls a minimum of 36 inches (0.9 meter) wide.

2. Physical Requirements:

   The fabric shall meet the requirements presented in Table 1, when sampled and tested in accordance with the methods indicated herein, on Standard Detail No. 642S-1 and/or on the Drawings.

B. Posts:

Posts shall be steel Tee or Y-posts, not less than 4 feet (1.22 meters) in length with a minimum weight of 1.25 pounds per foot (1.86 kilograms per meter) with a minimum Brinell Hardness of 143. Hangers shall be adequate to secure fence and fabric to posts. Posts and anchor plates shall conform to ASTM A-702. Caps are required (*not specifying discretionary criteria).

C. Wire Fence:

Wire fence shall be welded wire fabric 2 in. x 4 in. 12.5 SWG, wire diameter 0.099 in (±0.005 in.), and shall conform to Standard Specification Item No. 406, "Reinforcing Steel".

TABLE 1. Silt Fence Fabric Requirements

Physical Properties	Method	Requirements
Fabric Weight in ounces per square yard (grams/square meter)	TEX-616-J[1]	5.0 minimum (150 minimum)
Equivalent Sieve Opening Size: US Standard (SI Standard sieve size)	CW-02215[2]	40 to 100 (425 to 150 □m)
Mullen Burst Strength: lbs. per sq. inch (psi) megaPascal (mPa)	ASTM D-3786[3]	280 minimum (1.9 minimum)
Ultraviolet Resistance; % Strength Retention	ASTM D-1682[4]	70 minimum

[1] TxDoT Test Method Tex-616-J, "Testing of Construction Fabrics".
[2] US Army Corps of Engineers Civil Works Construction Guide Specification CW-02215, "Plastic Filter Fabric".
[3] ASTM D-3786, " Test Method for Hydraulic Bursting Strength of Knitting Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method".
[4] ASTM D-1682, " Test Methods for Breaking Load and Elongation of Textile Fabrics ".

642S.4 Construction Methods

The silt fence fabric shall be securely attached to the posts and the wire support fence with the bottom 12 inches (300 mm) of the material buried in a trench a minimum of 6 inches (150 mm) deep and 6 inches (150 mm) wide to prevent sediment from passing under the fence. When the silt fence is constructed on impervious material, a 12-inch (300-mm) flap of fabric shall be extended upstream from the bottom of the silt fence and weighted to limit particulate loss. No horizontal joints will be allowed in the silt fence fabric. Vertical joints shall be overlapped a minimum of 12 inches (300 mm) with the ends sewn or otherwise securely tied.

The silt fence shall be a minimum of 24 inches (0.6 meter) high. Posts shall be embedded a minimum of 12 inches (300 mm) in the ground, placed a maximum of 8 feet (2.4 meters) apart and set on a slight angle toward the anticipated runoff source. When

directed by the Engineer or designated representative, posts shall be set at specified intervals to support concentrated loads.

* Per OSHA §1926.701, 'all protruding reinforcing steel, onto and into which employees could fall, shall be guarded to eliminate the hazard of impalement'. Caps must be large enough to dissipate the forces of impact to prevent impalement from a reasonably foreseeable fall distance. It should be noted that the use of impalement protection caps is but one method of protection; covers or wooden troughs can be another means of meeting the guarding requirement. For City of Austin purposes, this also applies to t-posts and wooden stakes.

The silt fence shall be repaired, replaced, and/or relocated when necessary or as directed by the Engineer or designated representative. Accumulated silt shall be removed when it reaches a depth of 6 inches (150 mm).

642S. 5 Measurement

The work performed and the materials furnished under this item will be measured by the lineal foot of "Silt Fence", complete in place.

642S.6 Payment

The work performed and materials furnished and measured as provided under "Measurement" will be paid for at the unit bid price per lineal foot of "Silt Fence". The price shall include full compensation for furnishing, hauling and placing all materials, labor, tools, equipment and incidentals necessary to complete the work including inspecting, repairing, replacing and relocating the fence, removal of silt and removal and disposal of all materials at the completion of construction in and re-vegetation of disturbed areas.

Payment will be made under:

Pay Item No. 642S:	Silt Fence for Erosion Control	Per Lineal Foot.

END

SPECIFIC CROSS REFERENCE MATERIALS
Specification 642S, “Silt Fence”

City of Austin Environmental Criteria Manual

Designation	Description
Section 1.4.5.G	Silt Fence

City of Austin Standard Details

Designation	Description
Number 642S-1	Silt Fence

City of Austin Technical Specifications

Designation	Description
Item No. 406	Reinforcing Steel

American Society For Testing and Materials (ASTM)

Designation	Description
A-702	Specification for Steel Fence Posts and Assemblies, Hot Wrought
D-1682	Test Methods for Breaking Load and Elongation of Textile Fabrics
D-3786	Test Method for Hydraulic Bursting Strength of Knitting Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method

Texas Department of Transportation Manual of Testing Procedures

Designation	Description
Tex-616-J	Testing of Construction Fabrics

U.S. Army Corps of Engineers

Designation	Description
CW-02215	Civil Works Construction Guide Specification "Plastic Filter Fabric"

RELATED CROSS REFERENCE MATERIALS
Specification 642S, “Silt Fence”

City of Austin Environmental Criteria Manual

Designation	Description
Table 1-1.3	Recommended Design Values For Functional Controls
Table 1-2	Maximum Water Depth At The Barrier

City of Austin Standard Specifications

Designation	Description
Item No. 101S	Preparing Right of Way
Item No. 102S	Clearing and Grubbing
Item No. 111S	Excavation
Item No. 120S	Channel Excavation
Item No. 401S	Structural Excavation and Backfill
Item No. 610S	Preservation of Trees and Other Vegetation

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ITEM NO. 648S
MULCH SOCK

648S.1 Description

A Mulch sock consists of material encased in a tube of mesh. It is used to intercept, settle, and filter sheet flow and pond runoff. Mulch socks provide an environmentally sensitive and cost-effective alternative to sediment fences.

648S.2 Submittals

The submittal requirements for this specification item shall include the following:

A. Mulch Material

1. A small sample of mulch material proposed to be used on the site will be provided to the engineer.
2. Provide a designated project stockpile of mulch for sampling and testing at the producer's site.
3. A copy of the lab analysis, performed by an STA-certified lab, verifying that the mulch material meets the requirements of Table 1.

Table 1

Item	Requirement	Reference Specification
Particle Size	3" minus screening process	Equivalent to TXDOT item 161, Compost, Section 1.6.2.B, Wood Chip requirements
pH	5.5 – 8.5	TMECC 04. 11-A, "1.5 Slurry pH"
Organic Matter Content	25%, dry weight basis	TMECC 05.07-A, "Loss-On-Ignition Organic Matter Method"

B. Tube Material

The CONTRACTOR shall submit a sample of the material that the CONTRACTOR proposes to use on the project. A sample of the material should be accompanied by material data sheet identifying composition, ability of the material to biodegrade, and size of openings in tube at a minimum.

648S.3 Materials

A. Mulching material can be manufactured on or off the project site and may consist of:

1. Shredded bark
2. Stump grindings
3. Composted bark

B. The mulch shall have the following composition:

1. Wood chips shall be produced from a 3-inch minus screening process (equivalent to TxDOT item 161, Compost, Section 1.6.2.B Wood Chip Requirements).
2. Large portions of silts, clays, or fine sands are not acceptable.
3. The pH of the mulch shall be between 5.5 and 8.5.
4. The organic matter content shall be greater than or equal to 25% on a dry weight basis.

C. Mulch material must be free of refuse, physical contaminants, and material toxic to plant growth. It is not acceptable for the mulch material to contain ground construction debris, biosolids, manure, or recyclable material.

D. Prior to placement, a representative sample of the mulching material must be tested and certified by the project engineer or his/her designee and accepted by the city inspector.

E. “Sock” material will be 100% biodegradable, photodegradable, or recyclable such as burlap, twine, UV photodegradable plastic, polyester, or any other acceptable material. The material mesh opening should be equal to or less than 3/8 inch (10 mm) and the material tensile strength should be equal to or greater than 44 psi (3.09 kg/cm2).

648S.4 Installation

A. Use 12 or 18 inch diameter mulch socks for all sediment control applications. This diameter of mulch sock material has proven to be the most consistent for all sediment control applications (TxDOT, April 2006).

B. Install mulch socks per Figure 1.4.5.F in the City of Austin Environmental Criteria Manual.

C. Mulch socks should be used at the base of slopes no steeper than 2:1 and should not exceed the maximum spacing criteria provided in the following table.

Slope	Max. Slope Length Between *18 in. Dia. Sock* (ft)	Max. Drainage Area (sf) per 100ft of Sock
100:1 - 50:1	100	10,000
50:1 - 30:1	75	7,500
30:1 - 25:1	65	6,500
25:1 - 20:1	50	4,800
20:1 - 10:1	25	2,600
10:1 - 5:1	15	1,300
5:1 - 2:1	10	1,000

Slope	Max. Slope Length Between *12 in. Dia. Sock* (ft)	Max. Drainage Area (sf) per 100ft of Sock
100:1 - 50:1	100	6,000
50:1 - 30:1	40	4,000
30:1 - 25:1	30	3,000
25:1 - 20:1	25	2,600
20:1 - 10:1	15	1,300
10:1 - 5:1	10	1,000
5:1 - 2:1	5	500

D. Place mulch socks at a 5 ft or greater distance away from the toe of the slopes to maximize space available for sediment deposition.

E. When placed on level contours, sheet flow of water should be perpendicular to the mulch sock at impact and unconcentrated.

F. Install mulch socks using rebar (#5 minimum with safety caps) a minimum of 48 inches in length placed on 2-ft centers. In order to prevent the movement or floating of the mulch sock during rain events or construction operations, install steel posts on alternating sides of the sock. Drive the posts into the ground to a minimum depth of 24 inches, leaving less than 12 inches of post above the exposed mulch sock.

G. In order to prevent water flowing around the ends of the mulch socks, point the ends of the socks up slope.

H. In order to prevent water from flowing between the gaps at adjacent ends of mulch socks, overlap the ends of adjacent mulch socks a minimum of 12 inches. Never stack mulch socks on top of one another.

I. Mulch Socks should be placed using ‘smiles’ and ‘j-hooks’. See ECM Section 1.4.5 G (Silt Fence)

J. For steeper slopes, an additional mulch sock can be constructed on the top of the slope and within the slope area as determined by specific field conditions. Multiple mulch socks are recommended on steeper slopes.

K. Do not use mulch socks in areas of concentrated flow as they are intended to control sheet flow only.

648S.5 Inspection and Maintenance

A. Inspect mulch socks after installation for gaps under the mulch socks and for gaps between the joints of adjacent ends of mulch socks. Contractor shall repair gaps such that no water flows under or around sock.

B. Inspect every seven days and within 24 hours of a rainfall event of 0.5 inches or greater. Replace and repair mulch socks as necessary.

C. Sediment retained by the mulch socks shall be removed when it has reached one third of the exposed height of the mulch socks.

D. Mulch socks can be vegetated or un-vegetated. Vegetated mulch socks can be left in place. The vegetation will grow in the slope, further anchoring the sock.

648S.6 Payment

The work performed and the materials furnished as prescribed by this item shall be paid for by the linear foot of mulch sock installed.

Payment will be made under:

Pay Item No. 648S:	Mulch Sock	Per Lineal Foot.

END

SPECIFIC **CROSS REFERENCE MATERIALS**
Specification Item No. 648S, “Mulch Sock”

City of Austin Environmental Criteria Manual

Designation	Description
1.4.5.F	Mulch Sock
1.4.5.G	Silt Fence

City of Austin Standard Details

Designation	Description
648S-1	Mulch Sock

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Item No. 700S
Mobilization

700S.1 Description

This item shall govern the mobilization of personnel, equipment and materials at the work site for other contract items that will be performed by the Contractor. Mobilization shall include, but not be limited to the movement of equipment, personnel, material, supplies, etc. to the Work site; the installation of temporary facilities (when not paid for separately) and the establishment of office and other necessary facilities prior to the initiation of the Work. The cost of the Payment Bond and Performance Bond on the Work that is delayed due to circumstances beyond Contractor's control, a closed construction season or for the convenience of the City of Austin will be considered part of the mobilization item under this Contract.

700S.2 Measurement.

Measurement of the Specification Item, "Mobilization", as specified herein as "Total Mobilization Payment", will be by the "Lump Sum", as the Work progresses.

700S.3 Payment.

The adjusted contract amount as used below is defined as the original contract amount less the lump sum bid for Mobilization and any payments for materials or equipment not yet incorporated in the Work. The Contractor shall submit a lump sum amount for Payment Item No. 700S-TM, "Total Mobilization Payment".

"Initial Mobilization Payout" as used below is defined as:

1. 8% of the original contract amount for projects with an original contract amount of $ 0.5 million or less; or
2. 4% of the original contract amount for projects with an original contract amount greater than $ 0.5 million.

In those instances where the "Initial Mobilization Payout", as defined above, exceeds the "Total Mobilization Payment" lump sum bid item (i.e. Payment Item No. 700S-TM), the "Total Mobilization Payment" shall be used as the "Initial Mobilization Payout". In no instance shall the "Initial Mobilization Payout" exceed the "Total Mobilization Payment" bid item.

Partial payments of the "Initial Mobilization Payout" shall be as follows:

A. Upon presentation of a paid invoice for the Payment Bond, Performance Bond and/or required insurance, the Contractor will be paid that cost from the amount bid for "Total Mobilization Payment".

B. The Mobilization of tunnel boring machines, batch plants or other similar facilities, along with supporting materials and equipment, to the work site or to the vicinity of the Work site will be considered as partial Mobilization under this contract. The Contractor shall provide a certified statement of the Contractor's

expenditure for the Mobilization and setup of the facility and supporting equipment. Upon approval by the Engineer or designated representative, the certified expenditure will be paid from the amount bid for the Specification Item, “Total Mobilization Payment”. In no case shall the combined amount for all of these facilities be more than 10 percent of the Mobilization “Total Mobilization Payment" lump sum bid or one (1) percent of the total contract amount, whichever is less.

C. When one (1) percent of the adjusted contract amount is earned, 50 percent of the "Initial Mobilization Payout” will be paid. Previous payments under this item will be deducted from this amount.

D. When five (5) percent of the adjusted contract amount is earned, seventy-five (75) of the "Initial Mobilization Payout” will be paid. Previous payments under this item will be deducted from this amount.

E. When ten (10) percent of the adjusted contract amount is earned, one hundred (100) percent of the "Initial Mobilization Payout” will be paid. Previous payments under this item will be deducted from this amount.

F. Payment for the remainder of Pay Item No. 700S-TM, “Total Mobilization Payment” will be made upon receipt of the final pay estimate.

Payment will be made under:

Pay Item No. 700S-TM: **"**Total Mobilization Payment" Lump Sum

END

RELATED CROSS REFERENCE MATERIALS
Specification 700S, “MOBILIZATION”

City of Austin Standard Contract Documents

Designation	Description
00020	Invitation for Bids
00100	Instructions To Bidders
00300	Bid Form
00425	Insurance Cost Form
00500	Agreement
00610	Performance Bond
00620	Bid Bond
00650	Certificate of Insurance
00700	General Conditions
00810	Supplemental General Conditions
00820	Modifications to Bidding Requirements & Contract Forms
01010	Summary of Work
01300	Submittals
01500	Temporary Facilities
01550	Public Safety and Convenience
01700	Contract Closeout
01710	Final Cleaning

Item No. 701S

Fencing

701S.1 Description

This item shall govern furnishing and installing fencing and gates at locations shown on the Drawings or directed by the Engineer or designated representative, including all posts, bracing and accessories as specified in this Item and as indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text inch-pound units are given preference followed by SI units shown within parentheses.

701S.2 Submittals

Prior to installation of the fencing the Contractor shall furnish the Engineer or designated representative with certification from the manufacturer that all fencing materials comply with the requirements specified in this Item.

701S.3 Materials

A. Chain Link Fabric

1. Wire fabric for fencing shall be 9 gauge (3.76 mm) steel with a minimum breaking strength of 1,290 pounds per foot (1 750 Newtons per square meter). The overall height of the fence when erected shall be the height above grade as indicated on the Drawings. The fabric shall be woven into an approximately 2-inch ± 1/8-inch (50 mm ± 3 mm) mesh such that in a vertical dimension of 23 inches (585 mm) along the diagonals of the openings there shall be at least 7 meshes. Unless indicated otherwise on the Drawings the fabric shall have a knuckled (K) and twisted (T) finish for the top and bottom selvages respectively. The wire in the fabric shall withstand a minimum tensile strength test of 75,000 psi (517 kPa) after galvanizing. Except as provided herein, the chain link fence fabric shall conform to ASTM A392, Class I or ASTM A491.
2. The fabric shall be hot dip galvanized after weaving and shall have a minimum coating of 1.2 ounces per square foot (0.4 kilograms per square meter) of uncoated surface conforming to ASTM A392, Class I.
3. Between posts the fabric shall be fastened at 12-inch (300-mm) intervals to a top and bottom tension wire. When a top rail is shown on the Drawings, the fabric shall also be fashioned in the same manner. On gate frames, the fabric shall be fastened to top and bottom of the gate frame at all 12-inch (300-mm) intervals. Steel or aluminum wire fabric ties with a minimum 9 gauge (3.76 mm) diameter shall be used.

B. Woven Wire Fencing

Woven wire fencing shall be either galvanized steel wire fencing or aluminum-coated steel wire fencing conforming to the following requirements:

1. Galvanized steel wire fencing shall conform to ASTM A116, Class 1.

2. Aluminum-coated steel wire fencing shall consist of aluminum-coated steel wire conforming to the requirement for galvanized steel wire fencing, except the wire shall be aluminum coated. The wire shall not have less than 0.40 ounce (11 grams) coating of aluminum alloy per square foot of uncoated surface in accordance with ASTM A491

C. Wire Fencing

Wire shall be either galvanized or aluminum alloy coated 9 gage (3.76 mm) steel wire conforming to the specifications for galvanized steel or aluminum alloy coated woven wire fencing above.

D. Wood Fencing

Wood for wood fencing shall be Wolmanized pine, cedar or as indicated on the Drawings. The timber shall be sound and free from all decay, shakes, splits or any other defects, which would make it structurally unsuitable for the intended purpose.

E. Metal Posts, Top Rails, Braces and Gates

Steel pipe used for posts, top rails, braces and gate frames shall conform to the specifications of ASTM A 53. Steel sections used for posts, top rails, frames and braces shall be a good commercial quality weldable steel. All material shall be new and no used, re-rolled or open seam material will be acceptable. All posts shall meet the weight and length requirements indicated. The fabric bands and steel wire ties shall conform to the gauge and spacing indicated and shall be of suitable design to fasten fabric to the posts. Wire ties of the gauge shown may be used in lieu of fabric bands. All fittings required for posts shall be pressed or rolled steel, forge steel, malleable iron or wrought iron of good commercial quality and spaced as indicated on the Drawings.

1. Line Posts

Line posts may be either C-section or tubular. Tubular line posts shall be fitted with watertight malleable iron caps. Line posts shall be furnished in sufficient quantity to provide a maximum spacing of 10 feet (3 meters)

2. Terminal Posts

All end, corner and pull posts shall be known as terminal posts and shall be of either round or square sections. All terminal posts shall be furnished with watertight malleable iron caps. Fabric shall be fastened to terminal posts by steel stretcher bars and stretcher bar bands fitted with carriage bolts and nuts of the size and spacing indicated on the Drawings.

3. Gate Posts

Gateposts shall be either round or square. All gateposts shall be furnished with watertight malleable iron caps. The fabric shall be attached to the gateposts by means of steel stretcher bars and stretcher bar bands fitted with carriage bolts and nuts of the size and spacing indicated on the Drawings.

4. Post Caps

Post caps for pipe sections shall be designed to exclude all moisture. Where a top rail is shown on the Drawings, post caps shall have an opening for the top rail. All post caps shall have a 2-inch (50-mm) skirt for rigidity. When barbed wire is allowed for topping a six-foot (1.82 meter) or higher fence (LDC Section 10-1-9) the barbed wire support arms shall be integral with post caps.

5. Gates

a. Single Swing Gate

The gate frames shall be fabricated from sections either round or square of the size and weight indicated on the Drawings and shall be filled out with the same type fabric specified for the chain link fence. All gates shall be equipped with approved malleable iron or steel latches, stops and center rest. A satisfactory locking device suitable for padlocking shall be provided. The gates shall be hung by at least 2 steel or malleable iron hinges securely fastened to the posts. Hinges shall not twist or turn under the action of the gate, shall be capable of allowing a full 180 degree opening turn, shall be so arranged that a closed gate cannot be lifted off the hinges to obtain entry and shall be easily operated by one person.

b. Double Swing Gate

Double Swing gates shall be furnished and installed as indicated on the drawings. Gates shall be of the same height as the fence and shall have a single vertical mat of barbed wire. The gates shall be hinged to swing 180 degrees from closed to open. The gates shall be complete with frames, latches, stops, keepers, hinges, fabric, braces, padlocks and three strands of barbed wire. Gates shall have intermediate members and diagonal truss rods as required for rigid construction and shall be free from sag and twist. Gates shall be fitted with vertical extension arms or shall have frame end members intended to carry barbed wire.

Hinges shall be pinned type, heavy pattern with large bearing surface and shall not twist or turn under the action of gate. Latches for double swing gates shall be plunger bar type, full gate height, and arranged to engage the gate stop. Stops shall consist of a roadway plate with anchor set in Portland Cement concrete and arranged to engage the plunger. Keepers shall consist of mechanical devices for securing and supporting the free end when in the full open position. Latches shall be arranged for padlocking with padlock accessible from sides of the gate. Gates shall be installed so that they cannot be removed without disassembly of the hardware. Hardware attachment bolt shall be penned to prevent easy removal.

6. Top Rail

The top rail shall be of size and weight indicated on the Drawings and shall be furnished in random lengths, not less than 18 feet (5.5 meters) per section with outside sleeve type couplings at least 6 inches (150 mm) long and having a wall thickness of not less than 0.70-inch (18-mm). One coupling in five shall have a heavy spring to take up expansion and contraction of the rail. The top rail shall be installed before installing chain link fabric and shall pass through post tops.

7. Braces

All braces shall be of the size, weight and length indicated on the Drawings. All braces shall be trussed with rods and turnbuckles of the dimensions indicated on the Drawings. Braces shall be installed on all terminal posts and shall extend to the adjacent line posts. All corner and pull posts shall have braces on each side of terminal.

8. Fittings, Bolts and Other Miscellaneous Hardware

All fittings, bolts and miscellaneous hardware shall be hot dip galvanized in conformance with TxDoT Standard Specification Item No. 445, “Galvanizing.

9. Tension Wire

Between posts, the fabric shall be fastened to a top and bottom tension wire or to the top rail and bottom tension wire by steel wire ties of the gauge and spacing indicated on the

Drawings. The tension wire shall be at least 7 gauge (4.5 mm) galvanized coil spring steel of good commercial quality.

Tension wire shall have a minimum coating of 0.8 ounce per square foot (0.2 kilogram per square meter) of uncoated surface when tested in conformance with ASTM A116.

10. Security Fence

The security fence shall be 8 feet (2.44 meters) high with brackets and 3 strands barbed wire.

Barbed wire, when specified on the Drawings, shall be 12-1/2 gauge wire (2.51 mm), twisted with two-point 14 gauge (2.03 mm) barbs spaced approximately 5 inches (125 mm) apart and shall conform to ASTM A121 or ASTM A585. Three strands of barbed wire will be required when a barbed wire top is specified on the Drawings.

Barbed wire support arms shall be at an angle or 45^{o} from vertical and shall have clips for attaching three (3) strands of barbed wire to each support arm. Each support arm shall be of sufficient strength to support a 200-pound (90 kilograms) weight (mass) applied at the outer strand of barbed wire.

11. Galvanizing

Thin-wall, high-strength pipe posts shall be externally hot-dip galvanized with a minimum weight of coating of 0.9 ounce per square foot (0.3 kilogram per square meter). After galvanizing, thin-wall, high-strength pipe posts shall be externally chromated by total immersion followed by application of clear polyurethane finish.

Interior surfaces shall have a hot-dip galvanized coating, a zinc base coating with thickness 0.5 mil ± 0.2 mil (13 micrometer ± 5 micrometer). The coating shall be 94 percent zinc powder by weight (mass).

All tubular posts, rails and braces shall comply with the following salt spray performance requirements when tested in accordance with ASTM B117.

Exterior – 1250 hours to maximum 5 % red rust

Interior – 650 hours to maximum 5 % red rust

The uniformity of the zinc coating shall be determined by visual inspection. If, in the opinion of the Engineer or designated representative, visual examination is not conclusive, he may use the Preece Test as described in ASTM A239. When so tested, all items shall withstand a minimum of 6 one-minute dips except for those items designated in ASTM A153 as Class B-2, B-3, C and D, which shall withstand a minimum of 4 one-minute dips.

Careful visual inspection shall be made to determine the quality of the zinc coating. Excessive roughness, blisters, salammoniac spots, bruises and flaking if present to any considerable extent, shall provide a basis for rejection. Where practicable, all inspection and tests shall be made at the place of manufacturer prior to shipment and shall be so conducted as not to interfere unnecessarily with the progress of the work.

Damaged spelter coating shall be repaired by thoroughly wire brushing the damaged area and removing all loose, cracked or weld-burner spelter coating. The cleaned area shall be painted with 2 coats of zinc oxide-zinc dust paint conforming to the requirements of Federal Specification TT-P-641B. The paint shall be furnished at the Contractor's expense.

F. Concrete Post Anchorages

Concrete for post footings, catch blocks, anchors and other such items related to the fence construction, shall be Class B Concrete conforming to Item No. 403S, "Concrete for Structures" or as indicated on the Drawings. Maximum size of aggregate shall be 3/4 inch (19 mm). Hand mixing of concrete will be permitted on batches under 1/2 cubic yard (0.38 cubic meter). All batches exceeding this volume will be machine mixed.

Concrete shall be placed promptly and without segregation after mixing. The Contractor shall consolidate the concrete satisfactorily by tamping or vibrating. Excess excavation from footings shall be satisfactorily disposed of.

The tops of post footings shall extend slightly above ground and shall be steel troweled to a smooth finish sloped to drain away from posts. Posts, braces and other units shall be centered in footings.

G. Mowing Strip

When called out in the drawings, a mowing strip shall be Class A concrete. It shall be 24 inches (610 mm) wide and a minimum of 4 inches (100 mm) thick. Three (3) number (#3) bars shall be evenly spaced and supported along the full length of the mow strip, and a number 3 (#3) bar shall be cross-tied every 4 feet (1.2 m). Fence posts shall be installed in center of mow strip.

701S.4 Inspection and Sampling

The Contractor shall furnish, upon request of the Engineer or designated representative, samples of each component part of the fence including fittings. These samples shall be subjected to the galvanizing, weight and where required, strength tests. A sample may be taken for each project or for each shipment to a project, when requested by the Engineer or designated representative. All samples shall be furnished to the City free of charge.

If any specimen tested fails to meet the requirements of this specification, two (2) additional specimens shall be cut from the remainder of the sample and tested, both of which shall meet the requirements in every respect or the lot represented by the sample may be rejected.

701S.5 Construction Methods

The Chain Link Fence shall be erected to lines and grades established by the Engineer or designated representative in accordance with the details indicated on the Drawings. The fence shall be true to line, taut and shall comply with the best practice for fence construction of this type.

A. Clearing and Grading

The Contractor shall perform all clearing of brush, rocks and debris necessary for the installation of this fencing.

B. Erection of Posts

Posts shall be set plumb and permanently positioned and anchorages firmly set before fabric is placed. Posts shall be set in concrete, unless otherwise indicated on the Drawings.

Concrete footings shall be carried to the depth and dimensions indicated on the Drawings. Where rock is encountered within the required depth to which the post is to be erected, a hole of a diameter slightly larger than the largest dimension of the post may be drilled into the rock and the post grouted in. The regular dimensioned concrete footing as indicated on the Drawings shall then be placed between the top of the rock and required grade indicated on the Drawings. Posts shall be approximately centered in their footings. All concrete shall be placed promptly and compacted by tamping or other approved methods. Concrete shall be finished in a dome and shall be cured a minimum of 48 hours before further work is done on the posts.

Pull posts shall be placed not over 500 feet (15.25 meters) apart in straight runs and at each vertical angle point, all as directed by the Engineer or designated representative. Corner posts shall be placed at each horizontal angle point greater than 15 degrees. Corner and pull posts shall have horizontal braces and tie rods as specified above and as indicated or designated representative.

C. Erection of Top Rail and Tension Wire

The top rail and bottom tension wire and/or top and bottom tension wires shall be installed before installing the chain link fabric. The top rail shall be firmly attached in final position. Tension wires shall be within 4 inches (100 mm) of the top and bottom of the fabric and shall be pulled taut.

D. Erection of Fabric

After all posts have been permanently positioned and anchorages firmly set with the cables drawn taut with the turnbuckles, the fabric shall be placed by securing one end and applying sufficient tension to the other end to remove all slack before making attachments. Unless otherwise indicated on the Drawings, the fabric shall be cut and each span shall be attached independently at all corner posts and pull posts.

Fabric shall be fastened as indicated on the Drawings and the bottom of the fabric shall be placed a normal distance of 2 inches (50 mm) above the ground line; however, over irregular ground this distance may vary between 1 inch (25 mm) and 6 inches (150 mm) for a distance not to exceed 8 feet (2.44 meters). Any necessary backfilling required, in order to comply with these provisions, will be considered as incidental work.

E. Fence Grounding

This fence shall be grounded where a power line passes over the fence. In any case, a ground shall be provided at locations not to exceed 1,000 feet (30 meters) apart in straight runs of fence. Each individual section of fence shall have at least 1 ground. The ground shall consist of a copper-weld rod 8 feet (2.44 meters) long and a minimum of 5/8 inch (16 mm) in diameter driven or drilled in vertically until the top of the rod is approximately 6 inches (150 mm) below the top of the ground. A No. 6 solid copper conductor shall be brazed to the rod and to the fence in such a manner that each element of the fence is grounded.

F. Erection of Wood Fencing Material

After all posts have been permanently positioned and anchorages firmly set, stringers shall be placed and boards secured to the stringers. Other techniques utilizing modular precut panels may be used, when indicated on the Drawings.

701S.6 Measurement

Chain Link Fence, of each height specified, will be measured by the lineal foot of fence measured at the bottom of the fabric along the centerline of fence from center to center of terminal posts, excluding gates. Gates will be measured as each gate, complete in place.

701S.7 Payment

The work performed and material furnished as prescribed by this item, measured as provided under "Measurement" will be paid for at the unit bid price for "Chain Link Fence" of the height specified. The unit bid price shall include full compensation for furnishing and installing all fencing materials (except gates) including all miscellaneous fittings, braces, post caps, line wires, connection clips or wires; digging post holes and grouting in rock where required; furnishing and placing concrete for setting posts; furnishing and installing all electrical grounds; all hauling and handling charges; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work, including excavation, backfilling and disposal of surplus material.

Gates measured as provided under "Measurement" will be paid for at the unit bid price for "Pedestrian Gate" or "Vehicular Gate", of the type, height and opening specified. The unit bid price shall include full compensation for furnishing all materials; fabricating, preparation, hauling, handling charges and erecting, including all miscellaneous fittings, braces, latches, gate hinges, stops and center anchorage; and for all manipulations, labor, tools, equipment and incidentals necessary for complete installation.

Payment will be made under one of the following:

Pay Item No. 701*S* -AS: Chain Link Fence, - Per Lineal Foot
Pay Item No. 701*S* –B: Chain Link Pedestrian Single Swing Gate, ___Foot. x __Foot. Per Each
Pay Item No. 701S -BD: Chain Link Pedestrian Double Swing Gate, __Foot. x __Foot. Per Each
Pay Item No. 701S -CS: Chain Link Vehicular Single Swing Gate, ____Foot. x ___Foot. Per Each
Pay Item No. 701S -CD: Chain Link Vehicular Double Swing Gate, __Foot. x ___Foot. Per Each
Pay Item No. 701*S* -D: Wire Fence Per Lineal Foot
Pay Item No. 701*S* -E: Wood Fence Per Lineal Foot
Pay Item No. 701*S* -F: Wood Fence Pedestrian Gate, ___Foot. x __Foot. Per Each
Pay Item No. 701*S* -G: Wood Fence Vehicular Gate, ___Foot. x ___Foot. Per Each
Pay Item No. 701*S* -H: Security Fence, ___Foot, High Type ___ Per Lineal Foot
Pay Item No. 701*S* -T: Temporary Fence, ___Foot High, ____Type Per Lineal Foot
Pay Items No. 701S-MS: Mowing Strip Per Lineal Foot

End

SPECIFIC CROSS REFERENCE MATERIALS

City of Austin Standard Specifications

Designation	*Description*
Item No. 403S	Concrete for Structures

City of Austin Code of Ordinances, Volume I

Designation	*Description*
Section 10-1-9	Barbed Wire Fences

Texas Department of Transportation: Standard Specifications For Construction of Highways, Streets and Bridges

Designation	*Description*
Item No. 445	Galvanizing

American Society For Testing And Materials (ASTM)

Designation	*Description*
A 53/A 53M	Specification For Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A 116	Specification For Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric
A 121	Specification For Zinc-Coated (Galvanized) Steel Barbed Wire
A 153/A 153M	Specification For Zinc-Coated (Hot-Dip) on Iron and Steel Hardware
A 239	Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron and Steel Articles
A 392	Specification For Zinc-Coated Steel Chain-Link Fence Fabric
A 491	Specification For Aluminum-Coated Steel Chain-Link Fence Fabric
A 585	Specification For Aluminum-Coated Steel Barbed Wire
B 117	Practice for Operating Salt Spray (Fog) Apparatus

Federal Specification TT-P-641B

RELATED CROSS REFERENCE MATERIALS

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	*Description*
Item No. 550	Chain Link Fence
Item No. 552	Wire Fence

Item No. 702S
Removal and Relocation of Existing Fences

702S.1 Description

This item shall govern the removal and relocation of existing fence, gates and hardware to a new alignment at the location in conformance to the typical details indicated on the Drawings or as directed by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text inch-pound units are given preference followed by SI units shown within parentheses.

702S.2 Removal of Existing Materials

The existing boards, fabric, posts, wire, rails, braces, hardware, gates and miscellaneous items shall be carefully removed, bundled, rolled and stockpiled as indicated on the Drawings for installation at the new fence assignment. The removal and handling shall be such that the fence materials may be reused in the relocated fence.

A. Removal of Fabric and Wire

Fabric and wire of all types shall be carefully untied or disassembled from the posts and other appurtenances and shall be rolled in bundles of a size that will allow handling with ordinary equipment.

B. Removal of Posts

Posts shall be carefully removed from the ground and the concrete footing removed. The concrete shall be disposed of off site. Post holes shall be filled with suitable embankment material and thoroughly compacted.

C. Removal of Boards

Boards of all types shall be carefully disassembled from the rails and other appurtenances to facilitate removal in panels. Excess material removed shall be disposed of as indicated below.

D. Storage of Materials

Storage of all salvageable materials, that will be reinstalled at a new location, shall be stored on-site or at such other locations as the Contractor may elect, subject to approval by the Engineer or designated representative. Security and maintenance of the salvageable materials shall be the responsibility of the Contractor.

E. Excess Materials

Materials, that are damaged, unsuitable for reinstallation or unnecessary for completion of the scope of the fence work in the new alignment shall be considered as excess but shall be offered to the Owner before removal from the site by the Contractor.

702.S 3 New Materials

New materials that are required to complete the fence at the location indicated on the Drawings shall be of equal quality to the existing materials. Used materials from other projects or from the Contractor's own used material stocks will not be allowed. The new materials to be furnished will be those necessary to replace items from the existing fence which were damaged during removal operations or which for other reasons cannot be reused.

702S.4 Construction Methods

The removed fence shall be installed at the new assignment in accordance with the typical details indicated on the Drawings and shall comply with Standard Specification Item No. 701S, “Fencing” and the best practice for fence construction of the specified type.

702S.5 Measurement

Fences of the height and type to be relocated will be measured by the lineal foot (lineal meter: 1lineal foot equals 0.31 meters) of fence in its new location measured at the bottom of the fence along the centerline of the fence from center to center of terminal posts, excluding gates.

702S.6 Payment

The work performed and material furnished as prescribed by this item measured under "Measurement" will be paid for at the unit bid price for "Removing and Relocating Fences" of the size and type specified to be relocated. The unit bid price shall include full compensation for removing, salvaging, storing and handling all existing fence materials; furnishing new posts, boards, rails, braces, tie wires, connection clips, fabric, rails, brace rods and any other fence component items that were damaged during removal and necessitating new material being furnished to complete the project; digging post holes and grouting in rock where required; furnishing concrete for post footings; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work including excavation, backfilling and disposal of surplus materials.

Gates as provided under "Measurement" will be paid for at the unit bid price for Removal and Relocation of Existing Pedestrian or Vehicular Gates of the type and size specified to be relocated. The unit bid price shall include full compensation for removing the gate from the existing locations, handling, storing and hauling all gate materials, furnishing any new materials necessary for installing at new locations; providing new center anchorage blocks, latches and catch blocks and for manipulations, labor, tools, equipment and incidentals necessary to complete the gate relocation.

Payment will be made under one of the following:

Pay Item No. 702S -A:	Removing and Relocating Existing _Ft. Chain Link Fence	Per Lineal Foot.
Pay Item No. 702S -B:	Removing and Relocating Existing _Ft. x _Ft. Chain Link Pedestrian Gate	Per Each.
Pay Item No. 702S-C:	Removing and Relocating Existing _Ft. x _Ft. Chain Link Vehicular Gate	Per Each.
Pay Item No. 702S-D:	Removing and Relocating Existing _Ft. Wooden Fence	Per Lineal Foot.

Pay Item No. 702S-E: Removing and Relocating
Existing _Ft. x _Ft. Wooden Pedestrian Gate Per Each.

Pay Item No. 702S-F: Removing and Relocating
Existing _Ft. x _Ft. Wooden Vehicular Gate Per Each.

Pay Item No. 702S-G: Removing and Relocating
Existing _Ft. Wire Fence Per Lineal Foot.

Pay Item No. 702S-H: Removing & Relocating Existing __Ft. x _Ft. Metal Gate Per Each.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification 702S, "Removal and Relocation of Existing Fences"

City of Austin Standard Specifications

Designation	Description
Item No. 701S	Fencing

RELATED CROSS REFERENCE MATERIALS

City of Austin Standard Specifications

Designation	Description
Item No. 403S	Concrete for Structures

Texas Department of Transportation: Standard Specifications For Construction of Highways, Streets and Bridges

Designation	Description
Item No. 445	Galvanizing

American Society For Testing And Materials (ASTM)

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A 491	Specification For Aluminum-Coated Steel Chain-Link Fence Fabric
A 585	Specification For Aluminum-Coated Steel Barbed Wire
B 117	Practice for Operating Salt Spray (Fog) Apparatus

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Item No. 720S
Metal for Structures

720S.1 Description

This item shall govern all structural and miscellaneous steel, anchor bolts, and miscellaneous metals used in structures. Reinforcing steel (Item 406S) and other structural materials are not included. This specification is optional and is applicable for projects or work involving either inch-pound or SI units. Within the text inch-pound units are given preference followed by SI units shown within parentheses.

720S.2 Submittals

The submittal requirements of this specification item include:

A. Certification or mill test reports indicating that all materials supplied are in accordance with this specification.

B. Any material proposed for use and not designated herein, including type and trade name for any material not generically specified by the American Society for Testing and Materials (ASTM). Submittal shall include material specification and technical data as required to show that the proposed material meets the intent of those specified herein.

C. When SI unit bolts are proposed for use on a project, submit sizing of bolt(s) and the U.S. Customary Unit (USCU) bolt size(s) the SI unit bolt(s) will be substituted for. Note: although this specification includes ASTM standards for both USCU and SI, there is no conversion between these standards; each contains a different set of bolts with different physical size characteristics. When SI unit bolts are used, appropriately sized SI unit nuts and washers shall also be provided.

720S.3 Structural Steel for Main Members

Unless otherwise indicated, structural steel for main members shall conform to the longitudinal Charpy V-notch (CVN) requirements in accordance with Table A. Sampling and testing shall be in accordance with ASTM A673 (A673M).

A. Structural Steel

When indicated as Structural Steel, the material shall conform to ASTM A 36 (A36M), with a minimum specified yield strength of 36 ksi (250 MPa).

B. High Strength Structural Steel (HS)

When indicated as Structural Steel-HS, the material shall have a minimum required yield strength of 50 ksi (345 MPa), conforming to one of the following ASTM specifications:

1. ASTM A 572 (A572M).

2. ASTM A 588 (A588M).

3. ASTM A709 (A709M).

4. ASTM A992 (A992M).

C. Extra High Strength Structural Steel (XHS)

When indicated as Structural Steel-XHS, the material shall have a minimum specified yield strength of 90 ksi (620 MPa), conforming to one of the following ASTM specifications:

1. ASTM A 514 (A514M). Structural shapes and seamless tubing, meeting the requirements of A514 (A514M) will be permitted with a maximum tensile strength of 140 ksi (965 MPa) for structural shapes and 145 ksi (1,000 MPa) for seamless tubing.

2. ASTM A 517 (A517M).

ASTM A514 (A514M) and ASTM A517 (A517M) steels are considered weldable.

TABLE A

Min. Spec. Yield Strength, Fy [ksi (MPa)]	Thickness, t [in. (mm)]	Welded	Mech. Fastened	Min. CVN Toughness [ft. lb. @ °F (J @ °C)]
Fy ≤ 40 (275)	t ≤ 4 (100)	X	X	15 @ 70 (20 @ 21)
40 (275)< Fy ≤ 65 (450)	t ≤ 2 (50)	X	X	15 @ 70 (20 @ 21)
	2 (50) < t ≤ 4 (100)		X	15 @ 70 (20 @ 21)
	2 (50) < t ≤ 4 (100)	X		20 @ 70 (27 @ 21)
65 (450)< Fy ≤ 90 (620) (Refer to note 3 below)	t ≤ 2.5 (65)	X	X	20 @ 50 (27 @ 10)
	2.5 (65) < t ≤ 4 (100)		X	20 @ 50 (27 @ 10)
	2.5 (65) < t ≤ 4 (100)	X		25 @ 50 (34 @ 10)

Notes for Table A:
1. For Fy ≤ 50 ksi (345 MPa), use the (H) frequency of testing in accordance with ASTM A673 (A673M).
2. For Fy > 50 ksi (345 MPa), use the (P) frequency of testing in accordance with ASTM A673 (A673M).
3. If the yield strength of the material exceeds 90 ksi (585 MPa), the testing temperature shall be reduced 15°F (8.3°C) per 10 ksi (69 MPa) increment, or portion thereof.

720S.4 Miscellaneous Steel

A. High Strength Bolts

High strength bolts shall conform to ASTM A325, A325M, A490, or A490M, unless otherwise indicated. For submittal requirements of SI unit bolts, refer to 720S.3 C. Nuts for high strength bolts shall conform to ASTM A563 or A563M and washers shall conform to ASTM F436 or F436M.

B. Unless otherwise indicated, structural steel for secondary members such as shoes, diaphragms, stiffeners, bearing stiffeners, lateral bracing, diagonals, armor joints, and finger joints shall conform to one of the following:

1. ASTM A36 (A36M), with a minimum specified yield strength of 36 ksi (250 MPa).

2. ASTM A500, with a minimum specified yield strength of 46 ksi (315 MPa).

Structural steels used for secondary or nonstress-carrying members will not be subject to

impact requirements.

All steels greater than 0.5 inch (13 mm) in thickness used for structural supports for highway signs, luminaries, and traffic signals shall conform to the longitudinal Charpy V-notch requirements of Table A.

C. Stud shear connectors, slab anchors, and anchors on armor and finger joints shall conform to ASTM A108, Grades 1015, 1018, or 1020, either semi- or fully-killed, with a minimum specified yield strength of 50 ksi (345 MPa).

D. Piling

Steel piling shall conform to one of the following:

1. ASTM A36 (A36M), with a minimum specified yield strength of 36 ksi (250 MPa).

2. ASTM A252, greater than or equal to 10 gauge, with a minimum specified yield strength of 35 ksi (240 MPa).

3. ASTM A328 (A328M), with a minimum specified yield strength of 39 ksi (270 MPa).

4. ASTM A1011 (A1011M), with a minimum specified yield strength of 33 ksi (230 MPa).

E. Deck Plates

Material for deck plates shall be corrosive-resistant structural steel conforming to ASTM A242 (A242M). The material must be of weldable quality and shall contain alloying elements that furnish corrosion resistance at least twice that of copper bearing structural steel. The type and trade name shall be submitted for review.

F. Rail Posts

Material for rail posts shall conform to ASTM A36 (A36M), with a minimum specified yield strength of 36 ksi (250 MPa).

G. Forgings

Steel forgings from which pins, rollers, trunnions, or other forged parts are to be fabricated shall conform to ASTM A668 (A668M), class C, D, F, or G, with a minimum specified yield strength of 33 ksi (230 MPa). As an alternate for pins four (4) inches in diameter or less, ASTM A108, grades 1016-1030, with a minimum specified yield strength of 36 ksi (250 MPa) may be used.

H. Castings

Steel castings shall conform to ASTM A27 (A27M), Grade 70-36, with a minimum specified yield strength of 36 ksi (250 MPa).

I. Anchor Bolts

Anchor bolts shall conform to one of the following:

1. Plain and threaded bars used for anchorage purposes, ASTM A36 (A36M).

2. Headed bolts and nuts, ASTM A307, Grade A.

3. High strength anchor bolts, ASTM A193 (A193M). Nuts for high strength anchor bolts shall conform to ASTM A194 (A194M).

Anchor bolts shall not be galvanized unless otherwise indicated. When galvanized, anchor bolts and nuts shall be tapped or chased after galvanizing.

When heat treated material is specified or required, the test report for certification shall include the necessary certification relative to the heat treating process.

J. Steel Pipe

Steel pipe shall conform to Item No. 510, “Pipe”.

K. Tubing

Steel tubing shall conform to one of the following:

1. ASTM A500, Grade B.

2. API Standard 5L, Grade X52, except as noted herein, may be used if produced by a mill recognized as authorized to produce pipe with the API monogram and listed as such in the standard API specifications. Hydrostatic tests will not be required.

In lieu of the mill test report, a certificate from the manufacturer will be required for each lot or shipment certifying that the tubing meets the requirements stated above.

L. Pipe Rail

Pipe rail shall be construed to include special extruded and bent shapes and shall be of the section indicated. Pipe may be rolled or extruded to the shape indicated or may be cold pressed from a round pipe or flat plate.

If cold pressed, the design of the press and dies shall result in a pipe of uniform section and free from die marks. After the pipe has been formed to the required section, it shall be cut to the lengths required. The end cuts and notches shall be made at such angles with the axis of the pipe as required to produce vertical end faces and plumb posts when indicated. Cutting and notching of pipe shall be done with a saw or machine guided torch or other means that will insure a neat and uniform finish.

M. Deep Beam Rail

Deep beam rail shall conform to AASHTO M180, 10 or 12 gage (exclusive of protective

coating). The terminal connector shall be of the same material, not less than 10 gage. Unless otherwise indicated, the rail element shall be galvanized.

720S.5 Miscellaneous Metals

A. Iron

All iron castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended. Castings shall conform to the following ASTM designations:

1. Malleable iron, ASTM A47 (A47M), grade 35018.

2. Gray iron, ASTM A48 (A48M), class 30 or 35.

3. Ductile iron, ASTM A536, grade 60-40-18 or 65-45-12.

B. Lead

Sheet lead shall conform to ASTM B29, refined lead or pig.

C. Copper

Copper strip or sheet shall conform to the following:

1. ASTM B100, alloy 510 or 511.

2. ASTM B152 (B152M).

D. Aluminum

Unless otherwise indicated, aluminum materials shall conform to the following:

1. Castings, ASTM B108, alloy A444-T4.

2. Extrusions, ASTM B221, alloy 6061-T6.

3. Sheet and plate, ASTM B209, alloy 2024-T3. If welding is required, alloy 6061-T6 can be substituted, but must be heat treated after fabrication and welding.

4. Deep beam rail, ASTM B209, alloy 2024-T3. The minimum thickness of the rail element shall be 0.156 inch (nominal) unless otherwise indicated.

E. Bronze

Bronze bearing and expansion plates shall conform to ASTM B22, alloy 911.

720S.6 Fabrication, Erection, and Painting

Fabrication, erection, and painting of metal for structures shall conform to the following:

A. Item No. 721S, "Steel Structures".

B. Item No. 722S, "Paint and Painting". Aluminum or galvanized steel members shall not require painting.

C. Item No. 723, "Structural Welding".

720S.7 Galvanizing

Galvanizing, where indicated, shall conform to the following:

A. Fabricated items, rolled, pressed or forged steel shapes, plates, pipes, tubular items, and bars, ASTM A123 (A123M).

B. Steel or iron castings, ASTM A153 (A153M).

C. Bolts, nuts, screws, washers, and other miscellaneous hardware, ASTM A153 (A153M), Class C or D or ASTM B695, Class 50.

The measurements of thickness and weight of galvanized coating shall be in accordance with TxDOT test method Tex-728-I.

720S.8 Measurement

Measurement shall be in accordance with the following:

A. Weights of supplied metal for structures shall be determined in accordance with Table B:

TABLE B	
Material	Weight [lb./cu. ft. (kg/cu. m)]
Steel	490 (7,849)
Iron, cast	450 (7,208)
Iron, wrought	485 (7,769)
Lead	710 (11,373)
Copper	556 (8,906)
Aluminum	165 (2,643)
Bronze	509 (8,153)

B. Weights of bolts, nuts, and washers shall be in accordance with the American Institute of Steel Construction's "Steel Construction Manual".

C. The quantity of metal for structures furnished and placed will be based on the weight of metal in the fabricated structure. The weight of erection bolts, paint or weld metal shall be excluded.

D. The weights of secondary metals in steel or concrete structures (such as castings, bearing plates, anchor bolts, drains, deck plates, armor joints, and finger joints) for which no separate measurement is specified, shall be in accordance with this specification.

E. The weights of rolled shapes and plates shall be computed on the basis of their normal weights and dimensions.

F. The weights of castings will be computed from the dimensions indicated.

G. Deductions will be made for all cuts, copes, perforations, and all holes except bolt holes.

Splices will be measured as follows:

A. No additional weight will be allowed for weld metal in a welded splice.

B. Where a bolted splice is permitted as an alternate for a welded splice, measurement will be made on the basis of a welded splice.

C. Where a bolted splice is required, the weight of splice material, bolt heads, washers and nuts, with no deduction for holes, will be measured.

A change in design may be required and approved by the Engineer or designated representative, due to unforeseen conditions or other reason, which either increases or decreases the quantity of metal in the completed structure; the increase or decrease in weight will be measured in accordance with this specification and shall be included as a change from the original quantity computed. No adjustment will be made for a change which has not been approved by the Engineer or designated representative and which either increases or decreases the quantity of metal in the completed structure. These changes are subject to approval by the Engineer or designated representative nonetheless to assure that the completed structure is in accordance with the original design intent.

720S.9 Payment

Structural steel for main members will be paid for at the unit price bid per pound for “Structural Steel”, “Structural Steel-HS”, “Structural Steel-XHS”, or such other classification(s) of metal indicated.

Shipping invoice or acceptance slip weights will not be used as basis for payment.

Payment will be made based on the quantity indicated, except as may be modified by the following:

A. Either party to the contract may request an adjustment of the quantities indicated (by each separate bid item), if the weights calculated in accordance with this specification vary from those indicated by more than the following:

   1. Over 500 tons – 0.5 percent.

   2. 50 tons through 500 tons – 1 percent.

   3. Less than 50 tons – 1.5 percent.

   When adjustment is required, the Contractor shall furnish the Engineer or designated representative three sets of shop bills showing the calculated weights of all parts of the

structure. The weights shall be computed from the approved shop drawings, except as noted above. When this quantity is certified correct by the Engineer or designated representative, it will become the revised plan quantity. Quantities revised in this manner will not be subject to the provisions of the "General Conditions".

B. When quantities are revised by a change in design, the plan quantity will be increased or decreased by the amount involved in the design change. Quantities revised in this manner will be subject to the provisions of the "General Conditions".

The unit bid price(s) shall include full compensation for furnishing all materials and for all fabrication, shopwork, transportation, erection, paint, painting, galvanizing, and for furnishing all equipment, tools, labor, and incidentals necessary to complete the work.

Payment, when included as a contract pay item, will be made under:

Pay Item No. 720S-A:	Structural Steel	Per Pound.
Pay Item No. 720S-B:	Structural Steel-HS	Per Pound.
Pay Item No. 720S-C:	Structural Steel-XHS	Per Pound.

End

SPECIFIC Cross Reference Materials
Specification Item 720S, “Metal for Structures”

City of Austin Standard Specification Items

Designation	Description
Item 510	Pipe
Item 721S	Steel Structures
Item 722S	Paint and Painting
Item 723	Structural Welding

American Association of State Highway and Transportation Officials (AASHTO)

Designation	Description
M180	Standard Specification for Corrugated Sheet Steel Beams for Highway Guardrail

American Petroleum Institute (API)

Designation	Description
5L	Line Pipe

American Society for Testing and Materials (ASTM)

Designation	Description
A27/A27M	Standard Specification for Steel Castings, Carbon, for General Application
A36/A36M	Standard Specification for Carbon Structural Steel
A47/A47M	Standard Specification for Ferritic Malleable Iron Castings
A48/A48M	Standard Specification for Gray Iron Castings
A108	Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

A123/A123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A153/A153M	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A193/A193M	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications
A194/A194M	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
A242/A242M	Standard Specification for High-Strength Low-Alloy Structural Steel
A252	Standard Specification for Welded and Seamless Steel Pipe Piles
A307	Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
A325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A325M	Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength [Metric]
A328/A328M	Standard Specification for Steel Sheet Piling
A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
A490	Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
A490M	Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints [Metric]
A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A514/A514M	Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
A517/A517M	Standard Specification for Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered
A536	Standard Specification for Ductile Iron Castings
A563	Standard Specification for Carbon and Alloy Steel Nuts
A563M	Standard Specification for Carbon and Alloy Steel Nuts [Metric)
A572/A572M	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
A588/A588M	Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi [345 MPa] Minimum Yield Point to 4-in. [100-mm] Thick
A668/A668M	Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
A673/A673M	Standard Specification for Sampling Procedure for Impact Testing of Structural Steel
A709/A709M	Standard Specification for Structural Steel for Bridges
A992/A992M	Standard Specification for Structural Steel Shapes

A1011/A1011M	Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
B22	Standard Specification for Bronze Castings for Bridges and Turntables
B29	Standard Specification for Refined Lead
B100	Standard Specification for Wrought Copper-Alloy Bearing and Expansion Plates and Sheets for Bridge and Other Structural Use
B152/B152M	Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
B108	Standard Specification for Aluminum-Alloy Permanent Mold Castings
B209/B209M	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
B221/B221M	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
B695	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
F436	Standard Specification for Hardened Steel Washers
F436M	Standard Specification for Hardened Steel Washers [Metric]

TxDOT Specifications

Designation	Description
Tex-728-I	Measurements of Dry Film Coating Thickness on Steel

RELATED Cross Reference Materials
Specification Item 720S, “Metal for Structures”

City of Austin Standard Specification Items

Designation	Description
Item 406S	Reinforcing Steel

American Society for Testing and Materials (ASTM)

Designation	Description
A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products

Item No. 721S
Steel Structures

721S.1 Description

This item shall govern the furnishing, fabricating, erecting, and painting steel and other metals for structures or portions of structures. The materials related to this specification are specified in Item 720S, “Metal for Structures” unless otherwise noted. Reinforcing steel (Item 406S) and other structural materials are not included. This specification is optional and is applicable for projects or work involving either inch-pound or SI units. Within the text inch-pound units are given preference followed by SI units shown within parentheses.

721S.2 Submittals

The submittal requirements of this specification item include*:*

A. Shop Drawings

1. The Contractor shall prepare and submit seven (7) copies of detailed shop drawings (or as required by the Contract Documents) for each detail of the Contract Drawings requiring the use of materials specified herein or in Item No. 720S, “Metal for Structures”.

2. Shop drawings shall include complete details and schedules for fabrication and assembly, as well as camber and erection diagrams for all structures, bridges, plate girders, and other structural members as indicated on the drawings. The equipment, sequence of erection, location and type(s) of falsework (including calculations), location of splices, and proposed method of support to determine any overstress caused by the erection procedure shall also be included.

3. The drawings shall be prepared on sheets 22 x 36 inches (A1 sheet size or 559 x 914 mm) or larger. Each sheet shall include the following:

    a. Project name and location.

    b. Name of structure or detail. For details, include structure name or location of detail within the project.

    c. Fabricator name and person responsible for preparation of drawing.

    d. Contractor name.

    e. Sheet numbering.

3. Preparation and submission of shop drawings may be on 11 x 17 inch sheets (A3 sheet size or 279 x 432 mm) or full size drawings may be reduced to half scale size if they are completely clear and legible.

4. Field Verification

    a. The Contractor shall be responsible for field verification of design information and

shall inform the Fabricator of any discrepancies with the Contract Documents.

b. When discrepancies are more than minor dimensional changes, the Contractor shall resolve with the Architect/Engineer.

c. Any changes from the Contract Documents due to field verification of information shall be clearly noted on the shop drawings.

5. All shop drawings shall be checked by the Fabricator before submitting them to the City of Austin. The Contractor shall also be responsible for reviewing the shop drawings prior to submittal to assure correctness and completeness and to coordinate shop fit and field connections. Resolution of problems and corrections to drawings, if necessary, shall be done prior to submittal.

6. Changes in section(s), as allowed per this specification (P721S.4 C), shall be clearly noted on the shop drawings.

7. Members proposed for heat curving. Also include with the shop drawings a detailed procedure for heat curving work.

8. Color coding for any grade of steel to be used on the project and not listed in ASTM A6 (A6M).

B. Painting shall conform to Item No. 722S, "Paint and Painting". Submit any proposed shop primers or paints that are not otherwise specified.

C. Connections

1. When structural members are to be fabricated by welding, a welding procedure shall be submitted. A welding procedure shall include the standard AWS symbol, size, length, type of weld, and any other pertinent information. Upon approval, the welding procedure will be assigned a Welding Procedure Number and the shop drawings shall include this number adjacent to the appropriate welding symbol.

2. When structural members with calculated stress are to fabricated by bolting, a fabrication procedure shall be submitted . A fabrication procedure shall include a list of equipment to be used, sequence of assembly, sequence and detail of connections made, special processes such as planing, facing, etc., detail of heat treating procedures, when applicable and any other information concerning fabrication, as may be required by the Engineer/Architect.

3. Submit seven (7) copies of connection procedures along with the shop drawings.

4. Provide calculations for all standard connections, sealed by a Licensed Professional Engineer registered in the state of Texas.

D. Product Data

1. Submit product data for all items in accordance with this specification and those materials specified in Item No. 720S, “Metal for Structures”. Include certification, mill

test reports, or other data as required. Mill test reports will not be required for miscellaneous hardware.

2. Quality Control

   a. The Contractor shall provide, if requested, facilities in the shop and as many helpers as needed for the inspector to properly inspect the materials and work quality. The Inspector shall be allowed free access to the necessary parts of the work.

   b. The inspector will have the authority to reject any material or work which does not meet the requirement of this specification. In case of dispute, the Contractor may appeal to the Engineer or designated representative, whose decision will be final.

   c. The acceptance of any material or finished members by the inspector will not prohibit subsequent rejection if found defective. Rejected material shall be replaced promptly, or made good by the Contractor to the satisfaction of the Engineer or designated representative.

3. As materials are shipped, the Fabricator shall furnish the Engineer or designated representative with four (4) copies of the shipping invoice. The Fabricator's shipping invoice shall include:

   a. Member piece mark identification.

   b. Number of pieces shipped.

   c. Total calculated or scale weight for each shipment per bid item.

4. Final payment for structural steel will not be made until shipping invoices indicating total weight of material used have been received and checked by the Engineer or designated representative. Shipping weights will not be used as measurement for payment.

E. Notice of Beginning Fabrication Work

1. The Contractor shall give the Engineer or designated representative seven (7) days notice prior to the beginning of fabrication work in the shop.

2. No work shall be performed in the shop before the Engineer or designated representative has authorized fabrication. Any purchases of material prior to authorization shall be at the Contractor's risk.

F. Material Safety Data Sheets (MSDS)

Submit MSDS for materials as required and keep on the project job site.

G. Welder Certifications

Provide certification that welders working on the project have satisfactorily passed qualification tests in accordance with AWS D1.1 (D1.1M). If recertification is required, retesting will be at the Contractor’s expense.

H. Repair Procedures

Submit repair procedures in accordance with the requirements herein.

721S.3 Delivery, Storage, and Handling

A. Delivery

1. Deliver materials to the site at such intervals as required so as to ensure uninterrupted progress of work.

2. Anchor bolts, anchorages, and other embedded items shall be delivered to the site in ample time so as not to delay related work. Also, provide setting drawings, templates, and directions for installation as required to properly install these items.

B. Storage and Handling

1. Store materials so as to permit easy access for inspection and identification. Do not store materials in a manner that might cause distortion or damage to materials or support.

2. Keep materials off the ground using pallets, platforms or other supports.

3. Protect materials from corrosion and deterioration.

4. If bolts and nuts become dry or rusty, clean and lubricate them before use.

C. Repair or replace damaged materials, structures, or portions of structures as directed.

D. The handling of material, fabrication, blocking of partially completed members, and movement of completed members shall be done in such a manner that the safety of workers and inspection personnel will not be impaired at any time.

E. The storage, handling, and cleaning of corrosion resistant ("weathering") steel shall be in accordance with ASTM A242 (A242M), ASTM A588 (A588M), or the requirements of the proprietary manufacturer as applicable.

721S.4 Quality of Work

A. Fabrication and Assembly

1. Fabrication shall be in accordance with either AISC 325 or 360.

2. Fabricate and assemble structural assemblies in the shop when possible. When shop fabrication is not practical, provide markings as required to facilitate assembly.

3. Fabricate in such a manner so as to limit storage and handling and not to hinder construction progress.

B. Fabrication tolerances for rolled shapes, plate girders, plates, bars, wide flange sections, and miscellaneous steel shall be in accordance with ASTM A6 (A6M) or AWS D1.5 (D1.5M).

C. Rolled fabricated sections of slightly different dimensions and weight than the standard sections shown will be acceptable, provided they have equal or greater Moment of Inertia and Section Modulus than the section(s) detailed. . Changes in section(s) shall be clearly noted on the shop drawings.

D. Maximum deviation from flatness for webs of wide flange sections shall be the same as for built-up girders.

E. Shoes shall be fabricated with a tolerance not greater than the following:

1. The top bolster shall have the center 75 percent of the long dimension true to 1/32 inch (0.8 mm), with the remainder true to 1/16 inch (1.6 mm) and shall be true to 1/32 inch (0.8 mm) across its entire width in the short dimension.

2. For a pin and rocker type expansion shoe, the axis of rotation shall coincide with the central axis of the pin.

3. When the shoe is completely assembled and the top bolster is moved horizontally simulating the movement of the shoe in the finished structure, no point in the plane of the top bolster shall change elevation by more than 1/16 inch (1.6 mm) for the full possible travel of the rocker both ways from the neutral position nor shall the top bolster change inclination with respect to the horizontal by more than 1 degree during this same travel.

F. I-beams and girders shall be fabricated with a tolerance not greater than the following:

1. The plane of the bearing area of beams and girders shall be perpendicular to the vertical axis of the beam within 1/16 inch (1.6 mm).

2. Correction of bearing areas of shoes, beams and girders to the above tolerances shall be with heat and/or external pressure. Grinding or milling will be permitted if reduction of required thickness of member is not reduced by more than 1/16 inch (1.6 mm).

3. Rolled material must be straight before being laid off or worked.

4. If straightening is necessary, it shall be done by procedures submitted to and approved by the Engineer or designated representative. Sharp kinks and bends will be cause for rejection of the material unless corrected to the satisfaction of the Engineer or designated representative.

721S.5 Execution

A. Finishing

1. Finishing details of materials specified herein and Item No. 720S, unless noted otherwise, shall be in accordance with AISC 325, Steel Construction Manual, and AISC

360, Specification for Structural Steel Buildings.

2. Surface finishes shall be in accordance with ASME B46.1 and as indicated in Table A:

TABLE A	
Condition	Roughness Value [micro inches (micrometers)
Member ends not subject to calculated stress	2000 (50.8)
Cut surfaces 4 inches (100 mm) to 8 inches (200 mm) thick	1500 (38.1)
Cut surfaces up to 4 inches (100 mm) thick	1000 (25.4)
Milled ends of compression members, stiffeners, and fillers	500 (12.7)
Top surfaces of steel slabs, base plates, column cap plates, and pedestal cap plates	250 (6.4)
Surfaces of bearing plates intended for sliding contact, pins, and pin holes	125 (3.2)

3. Sheared edges of plates greater than 5/8 inch (15.9 mm) thickness and carrying calculated stress shall be planed to a depth of 1/4 inch (6.4 mm).

4. Re-entrant cuts shall be filleted to a minimum radius of 3/4 inch (19.1 mm), except for the corners of welding access cope holes adjacent to a flange.

5. Oxygen cutting shall be in accordance with AWS D1.1 and D1.5. Hand cutting shall be done only where approved by the Engineer or designated representative.

6. Edges of all main members which are sheared or oxygen cut, and all other exposed edges to be painted shall be rounded or chamfered to an approximate 1/16 inch (1.6 mm) dimension by grinding.

7. Unless otherwise indicated, steel plates for main members shall be cut and fabricated so that the primary direction of rolling is parallel to the direction of the main tensile and/or compressive stresses.

8. In all oxygen cutting, the flame shall be adjusted and manipulated to avoid cutting inside the prescribed lines. Roughness exceeding the values of Table A and occasional notches or gouges not more than 3/16 inch (4.8 mm) deep on otherwise satisfactory surfaces shall be removed by machining or grinding. Cut edges shall be left free of slag. Correction of defects shall be faired to the oxygen cut edges with a slope not exceeding 1 in 10.

9. Air carbon-arc or oxygen gouging, oxygen cutting, chipping, or grinding may be used for joint preparation or the removal of defective work or material. Oxygen gouging shall not be used on ASTM A514 (A514M), A517 (A517M), A242 (A242M), and A588 (A588M) corrosion resistant (“weathering”) steels.

10. The top and bottom surfaces of steel slabs, base plates, and cap plates of columns and pedestals shall be planed or else the steel slabs and base plates hot-straightened. Parts of members in contact with plates shall be faced to fit.

11. In planing the surfaces of expansion bearings, the cut of the tool shall be in the direction of expansion.

12. Stiffeners shall provide an even bearing against flanges. Tight-fit, when indicated, shall have at least 1 point bearing on the flange surface and the remainder with a maximum clearance of 1/16 inch (1.6 mm) at any point. Where stiffeners are to be welded to the flange, the opening prior to shall not exceed 3/16 inch (4.8 mm) with the fillet weld size increased by the amount of the opening.

13. Structural members which are indicated on the Contract Documents to be annealed or normalized shall have finish machining, boring, and straightening done subsequent to heat treatment. Normalizing and annealing shall be as defined by ASTM A941. The temperatures during the heating and cooling process shall be maintained uniformly throughout the furnace so that the temperature at any two points on the member will not differ by more than 100 F (38 C) at any one time.
14. Special requirements for ASTM A514 (A514M) and A517 (A517M) shall be as follows:

    a. Annealing and normalizing is not allowed.

    b. Stress relieve only with the approval of the Engineer or designated representative.

    c. Allowance for springback should be about three (3) times that of carbon steel.

    d. For break press forming, the lower die span should be at least sixteen (16) times the plate thickness.

    e. If steel plates to be bent are heated to a temperature greater than 1125 F (605 C), they must be requenched and tempered in accordance with the producing mill's practice.

    f. The holding temperature for stress relieving shall not exceed 1100 F (595 C), except that 950 F (510 C) shall be maximum for welds and six (6) inches surrounding welds.

15. Short radii on steel plates shall be hot bent at a temperature not greater than 1200 F (650 C).

16. When indicated, bridge shoes, pedestals, or other parts which are built up by welding sections of plate together shall be stress relieved in accordance with approved procedures.

B. Repair of Defects

1. Correction of cutting defects and of occasional notches or gouges less than 7/16 inch (11.1 mm) deep for material up to 4 inches (100 mm) thick and less than 5/8 inch (15.9 mm) for material over 4 inches (100 mm) thick may be made on steel with yield strengths up through 65 ksi (450 MPa) by welding.

2. Discontinuities or defects in plate edges which form the faces of groove welds shall be removed to a depth of 5/8 inch (15.9 mm) and repaired by welding. Laminations

opening to these edges shall be removed. Weld repairs shall be made by suitably preparing the defect, welding in accordance with AWS D1.1 (D1.1M), and grinding the completed weld smooth and flush with the adjacent surfaces.

3. Occasional notches, gouges, or defects in oxygen cut edges of ASTM A514 (A514M) and A517 (A517M) steel may be repaired by welding when approved by the Engineer or designated representative under the following conditions:

   a. Cutting defects not more than 3/16 inch (4.8 mm) deep in plate edges which will form the faces of a groove weld joint and which will subsequently be completely fused with the weld may be repaired by welding. Discontinuities or defects to these edges shall be removed to a depth of 1/4 inch (6.4 mm) below the surface by grinding or chipping and the gouge repaired by welding. Laminations opening to these edges shall be removed.

   b. Cutting defects not more than 3/16 inch (4.8 mm) deep in plate edges which will form a fillet-welded corner joint shall be repaired by welding only on the part of the edge which will become the faying surface for the joint and the fusion zone of the fillet weld. The part of the defect outside the toe of the completed fillet weld shall be removed by machining or grinding and faired to the oxygen cut surface with a slope not exceeding 1 in 10. If the actual net cross-sectional area which would remain after removal of the discontinuity is 98 percent or greater than the area of the plate based on nominal dimensions, weld repairs shall be made as specified above using E11018-M electrodes and grinding the completed weld smooth and flush with the adjacent surface to produce a proper finish.

4. Straightening Bent Material

   a. The straightening of plates, angles, miscellaneous shapes, and built up members, when approved by the Engineer or designated representative be done by methods that will not produce fracture or other damage. A detailed procedure for straightening bent materials shall be submitted to the Engineer or designated representative for approval.

   b. Straightening of individual pieces shall be done prior to assembly into a built-up member.

   c. The temperature for heat straightening of steel members shall not exceed 1200 F (650 C).

   d. Heat straightening or correction of errors in camber of ASTM A514 (A514M) and A517 (A517M) steel members shall be done only under rigidly controlled procedures, each application subject to the approval of the Engineer or designated representative. The temperature shall not exceed 1100 F (595) nor shall the temperature exceed 950 F (510) at the weld metal or within 6 inches (150 mm) thereof.

   e. The temperature of the steel shall be controlled by approved temperature indicating devices, such as crayons, liquids or bimetal thermometers.

   f. Heat shall not be applied directly on weld metal.

g. Following straightening, the metal shall be carefully inspected for evidence of fracture.

5. Pins, Pinholes, and Rockers

a. Pinholes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other, unless otherwise indicated. Pins and pinholes shall be finished to an ASME B46.1 value of 125.

b. The diameter of the pinhole shall not exceed that of the pin by more than 1/50 inch (0.5 mm) for pins 5 inches (127 mm) or less in diameter or 1/32 inch (0.8 mm) for larger pins.

c. Rockers shall be finished to an ASME B46.1 value of 250.

6. The limits of acceptability and repair of surface imperfections for all steels shall be in accordance with ASTM A6 (A6M).

4. Discontinuities

a. Roughness exceeding an ASME B46.1 value of 2000 in oxygen cut surfaces and occasional notches or gouges not more than 3/16 inch (4.8 mm) deep on otherwise satisfactory surfaces, shall be removed by machining or grinding to a slope not exceeding 1 in 10.

b. In the determination and repair of limits of internal discontinuities visually observed on rolled, sheared or oxygen cut edges and caused by entrapped slag or refractory, deoxidation products, gas pocket or blow holes, the metal removed shall be the minimum necessary to remove the defect or to determine that the permissible limit is not exceeded. All repairs made by welding shall be approved by the Engineer and shall conform to the applicable provisions of AWS D1.1 (D1.1M).

c. The limits of acceptability and the repair of visually observed edge discontinuities in plates 4 inches (100 mm) or less in thickness shall be in accordance with Table B where the length of defect is the visible long dimension on the plate edge and the depth is the distance the defect extends into the plate from the edge.

TABLE B	
Description of Discontinuity	Repair Required
Any discontinuity 1 inch (25 mm) in length or less.	None – need not be explored.
Any discontinuity over 1 inch (25mm) in length and 1/8 inch (3.2 mm) maximum depth.	None – depth should be explored.
Any discontinuity over 1 inch (25 mm) in length with depth over 1/8 inch (3.2 mm) but not greater than 1/4 inch (6.4 mm).	Remove – need not weld.
Any discontinuity over 1 inch (25 mm) in length with depth over 1/4 inch (6.4 mm)	Completely remove and weld. Aggregate length of welding not over 20

but not greater than 1 inch (25 mm).	percent of plate edge length being repaired.
Any discontinuity over 1 inch (25 mm) in length with depth greater than 1 inch (25 mm).	Subject to approval by the Engineer. Gouge out to 1 inch (25 mm) and block off by welding. Aggregate length of welding not over 20 percent of plate edge length being repaired unless approved by the Engineer.

d. Removal of metal by gouging shall be done in a manner assuring adequate width and slope for welding.

e. Multiple discontinuities should be considered continuous when located in the same plane within 5 percent of the plate thickness and separated by a distance less than the length of the smaller of two adjacent continuities.

C. Heat Curving

The Contractor shall submit a list of steel members proposed for heat curving and a detailed procedure for this work to be completed. Heat curving shall not proceed prior to written approval by the Engineer or designated representative.

D. Color Coding

1. For each steel approved for use on the project, a distinct color code shall be required. The color code shall be as specified in ASTM A6 (A6M). White shall be required for A36 steel.

2. The color code used for any steels not specified by ASTM A6 (A6M) must be submitted to and approved by the Engineer or designated representative.

3. The appropriate color(s) shall be placed on the material upon entry into the shop and shall be carried on all pieces to final fabrication. Loss of color code marking on any piece and with no other positive identification shall require testing thereof prior to its use to re-establish positive identity of the material to the satisfaction of the Engineer or designated representative.

E. Shop Painting

Preparation of surfaces and shop painting shall conform to Item No. 722S, "Paint and Painting".

F. Marking and Shipping

1. All structural members shall be marked in accordance with the erection diagram.

2. The markings shall be over the painted surface. In no case shall shop paint be left off in

order to preserve original markings on steel to be painted.

3. Members weighing more than 3 tons (2.7 MT) shall have the weight marked thereon.

4. The loading, transporting, unloading, and storing of material shall be conducted so it will be kept clean and free from injury.

5. Bolts of each length and diameter and loose nuts or washers of each size, shall be packed separately and shipped in boxes, crates, kegs or barrels. A list and description of the contents shall be plainly marked on the outside of each package.

721S.6 Bolted Members

A. Detailing

Detailing of bolted connections, where not indicated on the drawings or specified herein, shall conform to the latest edition of AISC 325, Steel Construction Manual.

B. Bolts

Bolts shall be in accordance with Item No. 720S, "Metal for Structures".

C. Bolt Holes

1. All holes for bolts shall be either punched or drilled. Material forming parts of a member composed of not more than five (5) thicknesses of metal may be punched 1/16 inch (1.6 mm) larger than the nominal diameter of the bolts, if the thickness of the metal is not greater than 3/4 inch for carbon steel, 5/8 inch (16.9 mm) for HS or 1/2 inch (12.7 mm) for XHS steel. For more than five (5) thicknesses or when any of the main material is thicker than shown herein, all the holes shall be subpunched or subdrilled 3/16 inch (4.8 mm) smaller and after assembling, reamed 1/16 inch (1.6 mm) larger or drilled from the solid to 1/16 inch (1.6 mm) larger than the nominal diameter of the bolts.

2. For punched holes, the diameter of the die shall not exceed that of the punch by more than 1/16 inch (1.6 mm). If any holes must be enlarged to admit the bolts, they shall be reamed. Holes shall be clean cut without torn or ragged edges. Poor matching of holes will be cause for rejection.

3. Reamed, punched, and drilled holes shall be cylindrical, perpendicular to the member, and 1/16 inch (1.6 mm) larger than the nominal diameter of the bolts. Reamers and drills shall be guided by mechanical means. Only holes which are not accessible to mechanically guided equipment shall be done by hand. Reaming and drilling shall be done with twist drills, except that for poorly aligned holes tapered reamers shall be used in conjunction with a template so placed and held so as to force the reaming to the best center of holes for that group. Connecting parts shall be assembled and held securely during reaming or drilling operations and match-marked before disassembling.

D. Preparation of Holes for Field Bolting

1. Holes in all field splices of main truss members, box girders, continuous I-beams, and plate girders shall be subpunched and reamed while assembled or drilled full size with all parts assembled, taking into account their relative position in the finished structure

due to grade, camber, and curvature. The assembly, including camber, alignment, accuracy of holes, and milled joints shall be approved by the Engineer or designated representative before reaming or drilling full size is started.

2. All holes for floor beams and stringer end connections shall be subpunched and reamed to a steel template of not less than 1 inch (25 mm) thickness or reamed while assembled.

3. Holes for secondary members such as diaphragms, laterals, sway bracing, etc. may be punched full size unless subpunching or subdrilling.

E. Accuracy of Holes

1. Accuracy of all holes punched full size, subpunched, or subdrilled shall be such that a cylindrical pin 1/8 inch (3.2 mm) smaller in diameter than the nominal size of the punched hole may be entered perpendicular to the face of the member, without drifting, in at least 75 percent of the adjoining holes in the same plane after assembling and prior to any reaming. Pieces not meeting this requirement will be rejected. Any hole which will not pass a pin 3/16 inch (4.8 mm) smaller in diameter than the nominal size of the punched hole will be cause for rejection.

2. After reaming or drilling, 85 percent of the holes in any adjoining group shall show no offset greater than 1/32 inch (0.8 mm) between adjacent thickness of metal.

3. Layout of shop work shall be done so that gage lines for bolts shall not vary from plan dimensions more than 1/16 inch (1.6 mm). Full size holes in any adjoining group or line shall not vary more than the following:

   a. At least 8 percent of the holes shall be within 1/16 inch (1.6 mm) of plan gage.

   b. Not more than 10 percent of the holes may vary as much as 1/8 inch (3.2 mm) from plan gage.

   c. Holes varying more than 1/8 inch (3.2 mm) from plan gage will not be accepted.

F. Shop Assembly

1. Each truss or box girder section shall be assembled in its relative position in the shop before reaming is started. Match-marks shall be stamped in the metal at all field connections, conforming to erection diagrams, at the time reaming is done.

2. Surfaces of metal to be in contact shall be cleaned before assembling.

3. Disassembling after reaming will be required to remove shavings, burrs, etc.

4. When bolting is required, shop or field, faying surfaces of all joints, including splice plates, shall be cleaned in accordance with AISC 325, Steel Construction Manual, and AISC 360, Specification for Structural Steel Buildings.

5. The members shall be free from twists, bends, and other deformations. In no case shall tack welding be used in assembly for bolting without prior approval of the Engineer or

designated representative.

6. If necessary, the bolt holes shall be spear-reamed for the admission of bolts preparatory to the shop bolting of full-sized punched material. The spear reamer used for this purpose shall be not more than 1/16 inch (1.6 mm) larger than the nominal diameter of the bolts.

7. Parts not completely bolted in the shop shall be secured by temporary bolts, where practicable, to prevent damage in shipment and handling.

8. The drifting done during assembling shall be only that required to bring the parts into position and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit bolts, they shall be reamed.

G. Preparation and Fit of Members

1. When indicated, abutting joints shall be milled and brought to an even bearing. Where joints are not milled, the openings shall not exceed 1/4 inch (6.4 mm).

2. Floor beams and girders with end connection angles shall be built to exact length back to back of connection angles. If end connections are faced, the finished thickness of the angles shall be not less than that indicated.

721S.7 Welded Members

A. General

1. All welding operations, processes, equipment, materials, qualifications of welders, quality of work, nondestructive testing, and inspection shall conform to Item No. 723S – "Structural Welding", AWS D1.1 (D1.1M), AWS D1.5 (D1.5M), and the Shop Drawings.

2. Unless otherwise indicated, nondestructive testing (magnetic particle and radiographic) required in the shop will be done by, and at the expense of, the Contractor. This will include furnishing all materials, equipment, tools, labor and incidentals necessary to perform the required testing.

3. All magnetic particle inspection and all radiographic inspection shall be done in the presence of and at the locations selected by the Engineer or designated representative. The Engineer or designated representative shall examine and interpret all tests made.

4. Magnetic particle inspection shall conform to ASTM E709 and the following unless otherwise indicated:

   a. For built-up members, 100 percent of the web to flange and bearing stiffener fillet welds on not less than 1 fabricated piece for each 15 pieces or fraction thereof when the maximum flange thickness is less than 2 1/2 inches (63.5 mm).

   b. For built-up members, 100 percent of the web to flange and bearing stiffener fillet welds on not less than 1 fabricated piece for each 10 pieces or fraction thereof when the maximum flange thickness is 2 1/2 inches (63.5 mm) or greater.

c. Welds requiring repairs shall be retested by magnetic particle inspection after the repairs are made.

d. No magnetic particle inspection will be required for rolled sections.

5. Radiographic inspection shall conform to ASTM E94, AWS B1.10, and the following unless indicated otherwise on the Drawings:

a. For shop welds of material 65 ksi (450 MPa) yield strength and less, radiographic inspection will be made as follows:

1) The full flange width of 35 percent of all flange splices where the plate thickness at the weld is 2 inches (50 mm) or less.

2) The full flange width of 50 percent of all flange splices where the plate thickness at the weld is greater than 2 inches (50 mm).

3) 1/5 the depth of the web of 50 percent of the web splices on each structure.

4) If unacceptable work is found, additional radiographs will be made on sections welded by the same equipment and/or operator just prior to and just after the section containing the defect.

b. For shop welds of material greater than 65 ksi (450 MPa) yield strength, radiographic inspection shall be made on all groove welds. These welds shall be inspected not less than 48 hours after they are completed.

c. Welds requiring repairs shall be retested by radiography after repairs are made. All radiographic inspection and necessary repairs shall be done prior to assembly.

d. When radiographic inspection of particular welds is required by the plans, this shall be in addition to the radiographic inspection required herein.

B. Surface Preparation for Welding

1. Surfaces to be welded shall be smooth, uniform, and free from fins, tears, and other defects which would adversely affect the quality of the weld. Surfaces to be welded shall be free from loose scale, slag, rust, grease, or other material. Mill scale that withstands vigorous wire brushing or a light film of drying oil or rust inhibitive coating may remain. Finish of bevels of groove welds shall be milled or ground. Oxygen cut bevels without grinding will not be allowed.

2. When a zinc-rich paint is specified, surfaces within 4 inches (100 mm) of a groove weld joining main stress carrying members and within 2 inches (50 mm) of fillet welds joining diaphragms or lateral bracing to stiffeners or gusset plates shall be sandblast cleaned and coated with linseed oil. After welding is completed, the areas shall be sandblast cleaned and painted as required for the specified paint system.

3. For other paint systems, surfaces within 2 inches (50 mm) of any weld joining main stress carrying members shall be free from any paint or other material that would prevent proper welding.

4. Sheared plates for webs of built-up members shall be wide enough to allow for trimming of edges where built-in camber is required. Plates with rolled edges used for webs shall be trimmed by oxygen cutting.

5. The faying surfaces of the web and flange plates and the adjacent surfaces that are to be fillet welded shall be cleaned by grinding prior to assembly and welding of web to flange.

C. Assembly of Parts

1. Parts to be joined by fillet welds shall be brought into as close contact as possible, with a maximum separation of 3/16 inch (4.8 mm). If the separation is 1/16 (1.6 mm) inch or greater, the leg of the fillet weld shall be increased by an equivalent amount. The separation between faying surfaces of lap joints and of butt joints landing on a backing strip shall not exceed 1/16 inch (1.6 mm). The fit of joints not sealed by welds throughout their length shall be close enough to exclude water after painting. Where irregularities in rolled shapes or plates after straightening prevents this, the procedure necessary to bring them within the above limits shall be approved by the Engineer or designated representative. The use of fillers is prohibited, except as indicated or as approved by the Engineer.

2. Members to be welded shall be brought into correct alignment and held in position by clamping, welding, or tacking until the joint has been welded.

3. Adequate clamps must be provided to prevent cupping or warping of the parts when welding them to the web. The clamping devices must be designed to not interfere with the operation or guiding of automatic welding equipment.

4. Temporary stiffeners used for jigs and/or warpage control shall not be tack welded to the flange material. Tacking to the web is permissible if the welds are at least d/6 distance away from the flange, where "d" is the web depth. The tack weld shall be removed by grinding flush with the parent metal prior to acceptance.

5. Suitable allowance shall be made for shrinkage. The joint shall never be restrained on both sides when welding.

6. Abutting parts to be joined by groove welds shall be aligned carefully. All shop groove welds in flange plates shall be ground smooth and flush with the base metal on all surfaces. This shall apply both to parts of equal thickness and parts of unequal thickness.

7. The surfaces shall be ground so that the radii at the points of transition will be 4 inches (100 mm) minimum.

8. When groove welds are used to join materials of different thickness or width, there shall be a smooth transition between offset surfaces with a slope of not greater than 1 in 4 in

thickness transition and to the proper radii in the case of width transition.

9. Groove welds in web plates need not be ground unless indicated.

10. Grinding shall be done in the direction of stress and in a manner that keeps the metal below the blue brittle range of 350 F (177 C).

11. Intermediate stiffeners within 12 inches (300 mm) of a splice point shall be shipped tack welded in place. Final welding shall be done in the field.

D. Surface Preparation and Shop Assembly for Field Welds

1. Ends of beams and girders shall be prepared in accordance with the requirements herein or as indicated. The centerline of the land of opposing web and flange bevels shall not deviate from each other by more than 1/16 inch.

2. For Shop Assembly, members should be brought into abutting contact in accordance with the shop drawings . Root faces shall not vary in excess of 1/16 inch (1.6 mm) from contact. Corrections by additional cutting and/or grinding shall be made to bring the splice within this tolerance. Finish of bevels for groove welds shall be milled or ground. Oxygen cut bevels without grinding will not be allowed.

3. Ends of beams or girders to be welded shall be prepared in the shop taking into account their relative positions in the finished structure due to grade, camber, and curvature. Each splice shall be completely shop assembled, checked and match-marked while assembled.

721S.8 Field Erection

A. General

1. Field erection shall be in accordance with the approved shop drawings. Such approval shall not relieve the Contractor of responsibility for the safety or adequacy of methods or equipment or from carrying out the work in full as indicated. No work shall be done without the approval of the Engineer or designated representative.

2. Field erection plans for I-beam units will not be required unless indicated.

3. Spot welding for the purpose of eliminating field erection bolts or for holding steel parts together while bolting will not be permitted.

4. The Contractor shall provide falsework and all tools, machinery, and appliances (including drift pins and fit-up bolts) necessary for the expeditious handling of field erection work. Drift pins sufficient to fill at least 1/4 of the field holes for main connections shall be provided.

5. When railroad or roadway traffic must be maintained beneath girders or beams already placed, traffic shall be protected against falling objects during the erection of diaphragms

and other structural members, during the placing of cast-in-place concrete, and during the erection and dismantling of forms thereof. The protection shall consist of safety nets of 1 inch (25 mm) mesh maximum or a flooring with openings not larger than 1 inch (25 mm).

B. Storing, Handling, and Assembling Materials

1. All material shall be handled in a manner that prevents damage.

2. Stored material shall be placed on skids above the ground and kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns, shall be supported on skids placed closely enough to prevent excessive deflection.

3. The parts shall be match-marked and assembled accurately as indicated on the approved erection drawings

4. Hammering which will injure or distort the members is not allowed.

5. All bearing and faying surfaces of structural steel in bolted connections shall be cleaned before the connection members are assembled. When ASTM A588 (A588M) steel is used these, surfaces shall receive a Class B blast cleaning conforming to Item No. 722S, "Paint and Painting", prior to assembly of the connection members. The areas of the outside ply under washers, nuts, or bolt heads shall be cleaned prior to installation of the bolts.

6. Unless erected by the cantilever method, truss spans shall be erected on blocking located so as to provide proper camber. The blocking shall be left in place until the tension chord splices are fully connected and all other truss connections pinned and bolted. Main connections shall have 1/2 of the holes filled with bolts and erection pins (1/2 bolts and 1/2 pins) before swinging the span. Splices and connections carrying traffic during erection shall have 3/4 of the holes so filled.

7. Fit-up bolts shall be of the same nominal diameter as the connection bolts. Erection pins shall be 1/32 inch (1 mm) larger diameter.

8. There shall be no temporary welds for transportation, erection, or other purposes on main members, except at approved locations more than 1/6 the depth of the web from the flanges of beams and girders, unless otherwise approved by the Engineer or designated representative.

C. Falsework

1. Falsework shall be properly designed for the loads to be supported and shall be substantially constructed and properly maintained. The Contractor shall prepare and submit to the Engineer falsework plans, including calculations.

2. The falsework plans shall include all details of members, connections, equipment, etc., so that a structural check can be made of them.

3. Approval of the falsework plans does not relieve the Contractor of responsibility/liability

for the falsework during field erection.

D. Welding and Nondestructive Testing

Welding and nondestructive testing shall conform to Item No. 723S, “Structural Welding".

E. Ancillary Items

All ancillary items such as castings, bearing plates, etc. shall be in accordance with the drawings or as specified elsewhere.

F. Errors in Shop Work

1. Any errors in shop work which prevent the proper assembling and fit-up of parts by the moderate use of drift pins or a moderate amount of reaming and slight chipping or cutting shall be reported immediately to the Engineer or designated representative, along with the proposed method(s) of correction.

2. Corrections of minor misfits and a reasonable amount of reaming will be considered a legitimate part of the work.

3. Corrections shall be made in the presence of the Engineer or designated representative, unless otherwise directed. Such work is to be done at the entire expense of the Contractor.

721S.9 Paint and Painting

Unless otherwise indicated, painting shall conform to Item No. 722S, "Paint and Painting".

721S.10 Measurement and Payment

No direct compensation will be made for "Steel Structures". Measurement and payment for quantities of metals, concrete, reinforcement, railing, ancillary items, and other bid items which constitute the completed and accepted structure(s) shall conform to pertinent specifications.

End

SPECIFIC Cross Reference Materials
Specification Item 721S, "Steel Structures"

City of Austin Standard Specification Items

Designation	Description
Item 406S	Reinforcing Steel
Item 720S	Metal for Structure
Item 722S	Paint and Painting
Item 723	Structural Welding

American Institute of Steel Construction (AISC)

Designation	Description
325	Steel Construction Manual
360	Specification for Structural Steel Buildings

American Society for Testing and Materials (ASTM)

Designation	Description
A6/A6m	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
A242/A242M	Standard Specification for High-Strength Low-Alloy Structural Steel
A588/A588M	Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi [345 MPa] Minimum Yield Point to 4-in. [100-mm] Thick
A941	Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
E94	Standard Guide for Radiographic Examination
E709	Standard Guide for Magnetic Particle Examination

American Society of Mechanical Engineers (ASME)

Designation	Description
B46.1	Surface Texture (Surface Roughness, Waviness & Lay)

American Welding Society (AWS)

Designation	Description
B1.10	Guide for Nondestructive Inspection of Welds
D1.1/D1.1M	Structural Welding Code – Steel
D1.5/D1.5M	Bridge Welding Code

RELATED Cross Reference Materials
Specification Item 721S, "Steel Structures"

City of Austin Standard Specification Items

Designation	Description
Item 406S	Reinforcing Steel

TxDOT Specifications

Designation	Description
Item 441	Steel Structures
Item 442	Metal for Structures
Item 447	Structural Bolting
Item 448	Structural Field Welding

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ITEM NO. 802S PROJECT SIGNS 9-14-21

802S.1 Description

This item shall govern furnishing, fabricating, erecting, maintaining and removing Project Signs on Capital Improvement Projects (C.I.P.), Bond Program Projects and for project identification at other construction sites, when required on the Drawings. The C.I.P. signs shall be constructed in accordance with Standards 802S-1, 802S-1A, 802S-2, 802S-2A, 802S-2B and 804S-5 or as indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

802S.2 Materials

A. Sign Face

Sign face shall be manufactured on standard exterior waterproof plywood sheets or other suitable material approved by the Engineer or designated representative. Unless indicated otherwise on the Standard Details or Drawings, the thickness of the plywood sheet shall be a minimum of ¾ inches (19 mm).

B. Posts

Lumber posts, of the size indicated on the Standard Details or on the Drawings, shall be pressure treated with pentachlorophenol.

C. Paint

Exterior oil base paint, colors as indicated on the Standard Details or on the Drawings.

D. Decals for Capital Improvement Projects and Bond Program Projects

City seal shall be in color using the 4 color process. Electronic images, in EPS format, are available from the Public Works Website (www.ci.austin.tx.us/publicworks/techspecs.htm) for downloading.

802S.3 Installation

The signs shall be erected at each major entrance to the project for maximum public identification and exposure. At locations where construction is confined to a specific area, the installed sign size shall be 4 foot x 8 foot (1.2 meter x 2.4 meter). At locations where C.I.P. roadway construction is in progress, such as a street paving or construction of a sidewalk, the sign shall be 2 foot x 3 foot (0.2 meter x 0.8 meter). Signs for Bond Program Projects shall be 3 x 4 foot (0.9 x 1.2 meters).

The signs shall be posted on portable wood frames or stanchions and will be located in the proximity of the work area as construction progresses. All lumber shall be painted with two coats of paint as indicated herein, on the Standard Details or in the Drawings.

In special cases the size of the sign may be changed to meet special requirements, but general proportions shall be maintained.

It shall be the responsibility of the contractor to maintain and relocate signs, if necessary during the progression of the project. Care shall be exercised to assure that placement of the signs does not interfere with or cause sight obstruction to vehicular and pedestrian traffic.

For projects located on a street with curb and gutter, signs shall be installed no closer than 2 feet (0.6 meter) from the face of curb on the street.

For projects located on a street without curb and gutter, signs shall be installed no closer than 6 feet (1.8 meters) from the edge of street pavement.

The contractor may install, at the Contractor's own expense, company signs to identify the contractor, architectural firm, etc. Signs are to be securely attached to the posts at locations indicated on the drawings and shall not be larger than 18 x 36 inches (0.45 x 0.90 meter).

802S.4 Measurement

In the CIP contract and/or Bond Program, signs shall be measured by either lump sum or per each.

802S.5 Payment

The work performed and the materials furnished as prescribed by this item shall be paid for by lump sum or per each price bid only. The "lump sum" bid or "per each" price bid shall include full compensation for all work performed and all materials furnished in constructing, transporting, temporarily storing and relocating as required, and maintaining and removing the signs as specified on the Drawings and as directed by the Engineer or designated representative.

Payment will be made under one of the following:

Pay Item No. 802S-AC.I.P.:	C.I.P.Project Signs	Lump Sum.
Pay Item No. 802S-BC.I.P.:	C.I.P. Project Sign	Per Each.
Pay Item No. 802S-ABOND:	Bond Project Signs	Lump Sum.
Pay Item No. 802S-BBOND:	Bond Project Sign	Per Each.

Source: Rule No. R161-21.17 , 9-14-2021.

End

SPECIFIC CROSS REFERENCE MATERIALS	
Specification Item No. 802S, "Project Signs"	
City of Austin Standard Details	
Designation	Description
Item No. 802S-1	2.4 m × 1.2 m (8′ × 4′) C.I.P. Building Project Sign
Item No. 802S-1A	2.4 m × 1.2 m (8′ × 4′) Bond Program Building Project Sign
Item No. 802S-2	600 mm × 900 mm (24″ × 36″) C.I.P. Movable Sign Type II
Item No. 802S-2A	600 mm × 900 mm (24″ × 36″) Joint C.I.P. Movable Sign Type II
Item No. 802S-2B	900 mm × 1.2 m (36″ × 48″) Bond Program Project Movable Sign Type II
Item No. 804S-5	Typical CMTA/C.I.P. Sign Locations

Item No. 803S
Barricades, Signs and Traffic Handling

803S.1 Description

This item shall govern for providing, installing, moving, replacing, maintaining, cleaning and removing upon completion of the work, all temporary or permanent street closure barricades, signs, cones, lights or other devices required to handle the traffic in conformance with the current edition of the Texas Manual of Uniform Traffic Control Devices for Street and Highways and as indicated on the Drawings or directed by the Engineer or designated representative.

Constructing A Detour, if required, shall conform to Standard Specification Item No. 801S, " Constructing A Detour". Capital Improvement Project Signs shall conform to Standard Specification Item No. 802S, " Project Signs".

This item shall also include the installation of all required safety fencing as described in the latest adopted version of Standard Detail 804S-4.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

803S.2 Submittals

The submittal requirements of this specification item include:

A. Type of Barricade and proposed materials and Construction of the barricade,

B. Test results for Retro-Reflective sheeting.

803S.3 Materials

All barricades, signs, cones, lights and other types of devices to handle traffic, as indicated on the Drawings or directed by the Engineer or designated representative, shall conform to details shown on the Drawings or those indicated in the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

803S.4 Construction Methods

Prior to commencement of construction, suitable "Barricades, Signs and Traffic Handling" devices shall be installed to protect the workers and the public.

The Contractor shall be responsible for the installation of all markers, signs and barricades in accordance with the Drawings and in conformance with the Texas Manual on Uniform Traffic Control Devices (TMUTCD) and/or as indicated on the Drawings or directed by the Engineer or designated representative. If, in the opinion of the Engineer or designated representative, additional markers, signs or barricades are needed in the interest of safety, the Contractor will install such as are required or as directed by the Engineer or designated representative. All changes and/or revisions to the detour/traffic control plan shall be approved by the Engineer or designated representative.

Lumber shall be painted with 2 coats of paint as indicated on the Drawings.

803S.5 Maintenance

It shall be the Contractor's responsibility to maintain, clean, move and replace if necessary, barricades, signs and traffic handling devices during the time required for construction of the project. Permanent barricades shall be constructed as required after the completion of the street by drilling holes to place the posts and concrete foundations. Foundation concrete shall be cured before the rails are attached. When no longer needed, all temporary Barricades, Signs and Traffic Handling Devices shall be removed and the area restored to its original condition or as directed by the Engineer or designated representative.

803S.6 Measurement

The work performed and material furnished as prescribed by this item, City of Austin Standard Details, details included on the Drawings or indicated in the TMUTCD shall be measured as follows:

A. Pavement Markings.

All pavement marking required for proper installation of the designated Traffic Control Plans and Details, as well as required removal of existing pavement marking, shall be measured and paid for under Standard Specification Item No. 870S, “Work Zone Pavement Markings” and Standard Specification Item No. 874S, “Eliminating Existing Pavement Markings”.

B. Barricades, Signs and Traffic Handling.

All work performed and material furnished as prescribed by this item, City of Austin Standard Details, details shown on the Drawings or indicated in the TMUTCD, that are not included in the above paragraph, shall be measured by the number of calendar days, working days or months of actual service.

Traffic control for the project will be measured and paid for once per contract defined time period, i.e. either per Calendar Day, Working day or Month at the contract rate, regardless of the number of set-ups, locations or streets under construction.

C. Safety Fencing

Safety fencing will be measured by the lineal foot.

803S.7 Payment

The work performed and materials furnished as prescribed by this item, measured as provided under section “803S.6 Measurement” shall be paid for at the contract unit price for barricades, signs and traffic handling. This unit price shall include full compensation for furnishing, placement and removal of all materials and for all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item No. 803S -CD:	Barricades, Signs, and Traffic Handling	Per Calendar Day.
Pay Item No. 803S-WD:	Barricades, Signs, and Traffic Handling	Per Working Day.
Pay Item No. 803S-MO:	Barricades, Signs, and Traffic Handling	Per Month.
Pay Item No. 803S-SF:	Safety Fence	Per Lineal Foot.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 803S, "Barricades, Signs and Traffic Handling"

City of Austin Standard Specifications

Designation	Description
Item No. 801S	Constructing A Detour
Item No. 802S	Project Signs
Item No. 870S	Work Zone Pavement Markings
Item No. 874S	Eliminating Existing Pavement Markings and Markers

Texas Technical Documents:

Designation	Description
(TMUTCD)	Texas Manual on Uniform Traffic Control Devices

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 803S, "Barricades, Signs and Traffic Handling"

City of Austin Standard Specifications

Designation	Description
Item No. 403S	Concrete for Structures
Item No. 860S	Pavement Marking Paint (Reflectorized)
Item No. 863S	Reflectorized Pavement Markers
Item No. 864S	Abbreviated Pavement Markings
Item No. 867S	Epoxy Adhesive
Item No. 871S	Reflectorized Pavement Markings
Item No. 875S	Pavement Surface Preparation For Markings

City of Austin Standard Details

Designation	Description
803S-1	Street-End Barricades

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 502	Barricades, Signs and Traffic Handling
Item No. 508	Constructing Detours
Item No. 510	One-Way Traffic Control
Item No. 512	Portable Concrete Traffic Barrier
Item No. 514	Permanent Concrete Traffic Barrier
Item No. 662	Work Zone Pavement Markings
Item No. 666	Reflectorized Pavement Markings
Item No. 667	Prefabricated Pavement Markings
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

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SPECIAL PROVISION To

Standard Specification to Item No. 130S
BORROW

For this project Item No. 130S Borrow of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

1. 130S.1 Description: **ADD** the following sentence to the end of the paragraph:

Non-expansive Select Fill is Class A (Select Borrow).

End

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SPECIAL PROVISION To
Standard Specification to Item No. 401S
STRUCTURAL EXCAVATION AND BACKFILL

For this project Item No. 401S Structural Excavation and Backfill of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

1. 401S.2 Submittals: **DELETE** section in its entirety and **INSERT** the following:
   The submittal requirements of this specification item shall include:

   Supplier and certified test results for sand material.

   Supplier and certified test results for flexible base material.

   Certified test results for native material.

   Supplier and certified test results for granular material.

   Supplier and certified test results for non-expansive select material.

   Supplier and certified test results for crushed rock.

   Mix design and test results for controlled low strength material (CLSM)

   Excavation Safety System Plan for proposed trench excavation and special shoring installations.

2. 401S.3, Materials:

   A. Sand:
   DELETE subsection 1. "Fine aggregate sand …" and renumber subsection 2 to subsection 1.

   C. Lime Stabilized Base:
   DELETE subsection C in its entirety and **INSERT** the following:

   "C. Gravel: As defined in Tex 100-E."

   D. Concrete Base:
   DELETE subsection D in its entirety and **INSERT** the following:

   "D. Native material:
   1. The use of native material is restricted. See specifications for acceptable uses of native material. Native material may not be used as Select Material.
   2. Sound, earthen material passing 1-inch sieve.
   3. Percent of material by weight passing Number 200 sieve shall not exceed 30 when tested in accordance with ASTM D 422.
   4. Expansion index less than 35 when tested in accordance with ASTM D 4829.

E. Granular Material:
DELETE Paragraphs 2 and 3.

F. Cement Stabilized Backfill:
DELETE section in its entirety and **INSERT** the following:

F. Non-expansive Select Material:
1. Select fill shall meet the TxDOT Standard Specification Item 247, Flexible Base, Type A or Type B, Grades 1 through 3.
2. Excavated material from the site is not suitable for use as Select material.

Following Paragraph G, **ADD** the following:

H. Crushed Rock:
1. 100 percent passing 2” sieve, less than 10 percent passing No. 4 sieve, and less than 5 percent passing the No. 200 sieve.
2. Greater than 90 percent of material shall have at least three broken faces. No more than 2 percent unbroken fraction allowed.

I. Drain Rock
1. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.
2. Consists of hard, durable particles of stone or gravel; screened or crushed to specified size and gradation; and free from organic matter, lumps or balls of clay, or other deleterious matter.
3. Crush or waste coarse material and waste fine material as required to meet gradation requirements.
4. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and C136.

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
2 inch	100
1-1/2 inch	95 - 100
3/4 inch	50 -100
3/8 inch	15 -55
Number 200	0 -2

3. 401S.4, Construction Methods: **DELETE** the last paragraph under Paragraph A “Erosion Control and Tree Protection” and **INSERT** the following:

Burning of materials at the site shall not be allowed.

4. 401S.4 (B)(1) First Paragraph, last sentence, **DELETE** "3 feet (0.9 meter)" and **INSERT** "5 feet (1.5 meter)".

5. 401S.8, Backfilling: **DELETE** from Paragraph A General, in the seventh paragraph, the references to Standard Specification Item No. 110S, "Street Excavation" and Standard Specification Item No. 120S, "Channel Excavation."

6. 401S8. Backfilling: **DELETE** from Paragraph B Pipe Culverts, in the third paragraph, the reference to Standard Specification Item No. 132S, "Embankment".

End

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SPECIAL PROVISION To

Standard Specification to Item No. 403S
CONCRETE FOR STRUCTURES

For this project Item No. 403S Concrete for Structure of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

403S.2 Submittals: **DELETE** existing text in its entirety and **INSERT** the following:

1.01 PRODUCT DATA:

A. Submit data completely describing products and demonstrating compliance with the requirements of this Section.

B. Data for all products in the mix for each class of concrete shall be submitted concurrently with that mix design.

C. Where products conforming to NSF-61 are required, submit evidence of testing and listing under NSF-61 for use in direct contact with potable water. Testing and listing shall be by a nationally recognized agency acceptable to the Engineer.

D. Admixtures:
   1. For each admixture included in concrete mixes, submit manufacturer's product data demonstrating compliance with standards specified.
   2. If air entraining admixture requires test method other than ASTM C173 to accurately determine air content, make special note of requirements in submittal.
      a. Curing compound: Submit complete data on proposed compound.

1.02 DESIGN DATA:

A. Concrete mix designs:
   1. Submit full details, including mix design calculations and plots, for concrete mixes proposed for use for each class of concrete.
   2. Include mix design calculations of proportions by both weight and volume.
   3. Determine and include the alkali load of the proposed mix.
   4. Include information on correction of batching for varying moisture contents of fine aggregate.
   5. Submit source quality test records with mix design submittal.
   6. Provide calculations demonstrating that the mixes proposed provide the required average compression strength of concrete (f'cr) based on source quality test records.
   7. For each Class A mix design submitted, plot the mix design on a "Coarseness Factor Chart" as shown in Attachment B.
   8. For each Class A mix design submitted, plot the combined aggregate gradation on the chart shown in Attachment C.

1.03 CONCRETE MIXES - TRIAL BATCHES:

A. Drying shrinkage test results.
   1. Submit results of testing.
   2. Submit test specimens from drying shrinkage tests for trial batches.
      a. Submit all specimens from each mix accepted by Engineer.
      b. Using indelible marker, clearly label each specimen with concrete class, trial batch mix designator, and specimen number.

B. Compression strength test results.
   1. Submit results of testing. Provide data for each cylinder tested.
   2. Submit data indicating trial batch mix designator, slump, and specimen number for each test cylinder.

C. If there is any change in suppliers or in quality of concrete mix constituents, submit new test data.

1.04 TEST REPORTS:

A. Dated not more than 18 months prior to the date of submittal.

B. Aggregate:
   1. Submit certified copies of commercial laboratory tests proposed for use in concrete.
   2. Sieve analyses:
      a. During construction, submit sieve analyses of coarse, fine, and combined aggregates used any time there is a change in supplier, or a significant change in the character and/or grading of materials, and when requested by the Engineer.
   3. Aggregates - coarse:
      a. Physical properties:
         1) Sieve analysis.
         2) Percentage of particles having flat and/or elongated characteristics.
         3) Abrasion loss.
         4) Soundness.
      b. Deleterious substances:
         1) Clay lumps and friable particles content.
         2) Materials finer than 200 sieve (percentage).
         3) Shale and chert content.
         4) Coal and lignite content.
      c. Alkali reactivity.
      d. Deleterious substances:
         1) Clay lumps and friable particles content.
         2) Chert and shale content.
         3) Coal and lignite content.
         4) Materials finer than No. 200 sieve.
      e. Alkali reactivity.
   4. Aggregates - Fine:
      a. Physical properties:
         1) Sieve analysis and fineness modulus.
         2) Soundness.

b. Deleterious substances:
    1) Clay lumps and friable particles (percentage).
    2) Materials finer than No. 200 sieve (percentage).
    3) Coal and lignite (percentage).
    4) Shale and chert.
    5) Organic impurities ("Color" as determined by ASTM C40).
c. Alkali reactivity.

5. Aggregates - Combined:
    a. Test combined gradation for the following sieve sizes: 1.5 inches, 1 inch, 3/4 inch, 1/2 inch, 3/8 inch, Number 4, Number 8, Number 16, Number 30, Number 100, Number 200.
    b. Bulk density in accordance with ASTM C29.
    c. Void content in accordance with ASTM C29.
    d. Submit at:
        1) Initial mixture design submittal,
        2) Intervals of not more than 4 weeks,
        3) Any time there is a change in character or grading of constituent materials,
        4) When requested by the Engineer.

C. Cement:
    1. Mill tests, including alkali content measured as equivalent alkalis, for each shipment of cement included in the Work.
        a. During construction, submit mill certificates for cement being used at intervals of not more than 90 days, any time there is a change in supplier or a significant change in the character of the materials, and when requested by the Engineer.

D. Supplemental cementitious material:
    1. Fly ash: Identify source and provide testing results to demonstrate compliance with requirements of ASTM C618 and this Section.
        a. Include supplier's report certifying the total alkali content of the material, expressed as equivalent percentage of sodium oxide (Na_2Oe).

1.05 CERTIFICATES:

A. Current NRMCA certification for all plants and trucks that will be used to supply concrete.

1.06 SOURCE QUALITY CONTROL SUBMITTALS:

A. Truck batch tickets for each load of concrete delivered to the site, whether accepted or rejected.

B. Concrete supplier's quality control plan. Include the following elements, at a minimum:
    1. Names and qualifications of key quality control personnel:
        a. Quality control manager.
        b. Testing and inspection personnel.

2. Names and qualifications of testing laboratories:
    a. Each laboratory shall hold current accreditation from the AASHTO Accreditation Program, or other accreditation program acceptable to the Engineer, for each test performed.
3. Example forms for: inspection reports, certificates of compliance, and test results.
4. Quality control procedures: Method and frequency of performing each procedure, including inspections and materials testing. At a minimum, the plan shall include:
    a. Daily testing of aggregate gradation.
    b. Monthly testing of cement quality.
    c. Monthly testing of fly ash quality.
5. Procedures to control quality characteristics, including standard procedures to address properties outside the specified operating limits, and example reports to document non-conformances and corrective actions taken. Include procedure for notifying Contractor and Engineer of non-conformances.
6. Procedures for verifying that:
    a. Materials are properly stored during concrete batching operations.
    b. Batch plants have the ability to maintain concrete consistency during periods of extreme heat and of low temperatures.
    c. Admixtures are dispensed in the correct dosages within the accuracy requirements specified.
    d. Delivery trucks have a valid NRMCA certification card.
7. Procedures for verifying that weighmaster certificate for each load of concrete shows:
    a. Cement and supplementary materials are from sources designated in the approved submittals.
    b. Concrete as-batched complies with the constituent weights designated in the approved submittals.
    c. Corrections for aggregate moisture are being correctly applied.
    d. Any mix water withheld from the batch.
8. Procedures for visually inspecting concrete during discharge.

1.07 FIELD QUALITY CONTROL SUBMITTALS:

A. Contractor's notifications of readiness for concrete placement.

B. Contractor's reports of field quality control testing.
1. Include with each report the concrete batch ticket number and identification numbers for associated cylinders used for compressive strength testing.
2. Testing results for slump, temperature, unit weight, and air entrainment.
3. Testing results for compressive strength at 7 and 28 days, and for any compressive strength tests after 28 days.
4. Note on batch ticket the amount of water that was withheld and the maximum amount that can be added on site as "Max add water." Record on the batch ticket the volume of water actually added at site.
5. Note on the batch ticket the concrete mix classification as defined in Table 3 of this Section.

1.08 SPECIAL PROCEDURE SUBMITTALS:

A. Sequence of concrete placing:
   1. Submit proposed sequence of placing concrete showing proposed beginning and ending of individual placements. Submittal shall include plans sections and details to address all pours.

B. Cold weather concreting plan.

C. Hot weather concreting plan.

D. Repair of defective concrete: Submit mix design for repair materials to be used.

403S.3 Materials:

DELETE paragraph A, Cementitious materials, in its entirety and **INSERT** the following:

A. Cementitious materials:
   1. Portland cement:
      a. In accordance with ASTM C150.
         1) Type II Single source: To provide uniformity of appearance, for each structure use only one source, type, and brand of portland cement for walls and slabs that will be exposed in the finished work.
         2) Confirm adequate supply of cement over duration of project before making trial batches or beginning concrete placements.
      b. Cement for finishing: Provide cement from same source and of same type as concrete to be finished or repaired.
   2. Fly ash:
      a. Class C or Class F fly ash in accordance with the requirements of ASTM C618, except as modified in this Section.
         1) Class C, may be used in concrete made with Type II portland cement.
         2) Class F required if used in concrete mixes containing aggregates classified as potentially reactive based on ASTM C1293 or ASTM C1260.
            a) CaO content: Less than 18 percent.
      b. Loss on ignition: Not exceeding 3 percent.
      c. Replace portland cement at ratio of 1.0 pound fly ash for each pound of cement, up to minimum and maximum replacement as specified in "Requirements for Mix Proportioning."

DELETE Paragraph C. Coarse Aggregate, in its entirety and **INSERT** the following:

C. Aggregate:
   1. General:
      a. Provide concrete aggregates that are sound, graded as specified, and free of deleterious material in excess of allowable amounts specified.
      b. Provide aggregates to produce in place concrete with unit weight as follows:
         1) Normal weight concrete: Not less than 140 pounds per cubic foot.

c. Do not use aggregate made from recycled materials such as crushed and screened hydraulic-cement concrete, brick, and other construction materials.
d. Do not use aggregate recycled from fresh concrete returned to the batching facility.

2. Alkali-silica reactivity:
   a. Provide aggregate classified as aggregate-reactivity class of R0 in accordance with ASTM C1778 with expansion not greater than 0.10 percent at 14 days when tested in accordance with ASTM C1260, and not greater than 0.04 percent at one year when tested in accordance with ASTM C1293.
3. Fine aggregate:
   a. Material graded such that 95 to 100 percent of material passes the No. 4 (4.75 mm) sieve, when sampled in accordance with ASTM D75 and D3665, and tested in accordance with ASTM C136.
   b. Provide fine aggregate consisting of clean, natural sand, or sand prepared from crushed stone or crushed gravel.
   c. In accordance with ASTM C33 requirements for grading, deleterious substances, soundness, and alkali reactivity, except as modified in the following paragraphs.
      1) Grading: For sieve sizes listed in ASTM C33 for fine aggregate, not more than 45 percent passing any sieve and retained on the next consecutive sieve.
      2) Deleterious substances: not in excess of the percentages by weight specified in Table 1 of this Section.

Table 1: Fine Aggregate, Limits on Deleterious Substances

Item	Test Method	Percent (maximum)
Materials finer than No. 200 sieve(2)	ASTM C117	3.00(2)
Clay lumps and friable particles	ASTM C142	1.00
Lightweight particles (SG < 2.40)	ASTM C123	1.00
• Chert or shale(1)	ASTM C295	1.00(1)
Coal and lignite	ASTM C123	0.50

Notes:
(1) ASTM C123 tests for particles in the sample having a specific gravity less than 2.40. ASTM C295 is used to identify which of those lightweight particles are chert, shale, or coal and lignite. If testing under ASTM C123 indicates a combined percentage of lightweight particles (sum of shale, chert, coal and lignite) not greater than 1.00, testing under ASTM C295 will not be required.
(2) For manufactured sand, if material finer than the No. 200 sieve consists of crusher dust and the aggregate is essentially free of clay or shale, maximum percentage may be increased to 5.0 percent.

      3) Organic impurities: Free of injurious amounts of organic matter and producing a supernatant liquid with color not darker than “standard color” when tested in accordance with ASTM C40.
      4) Soundness: In accordance with requirements of ASTM C33 when tested in accordance with ASTM C88 using sodium sulfite solution.

4. Coarse aggregate:
   a. Materials graded such that not more than 10 percent of material passes the 3/8-inch sieve, when sampled in accordance with ASTM D75 and D3665, and tested in accordance with ASTM C136.
   b. Consisting of gravel, crushed gravel, crushed stone, or a combination of these materials having clean, hard, durable particles free from calcareous coatings, organic matter, or other deleterious substances.
   c. Conforming to the requirements of ASTM C33, Class 3M for physical properties, deleterious substances, and alkali reactivity, except as modified in the following paragraphs.
      1) Grading:
         a) Size number as specified in ASTM C33, and as indicated in Table 3 of this Section, except as otherwise specified or accepted by the Engineer.
         b) Weights of flat or elongated particles (particles having a length greater than 3 times average width or thickness) not exceeding 15 percent when tested in accordance with ASTM D4791.
      2) Deleterious substances: Not in excess of the percentages by weight specified in Table 2 of this Section and having total of all deleterious substances exceeding 2 percent.

Table 2: Coarse Aggregate, Limits on Impurities

Item	Test Method	Percent (maximum)
Clay lumps and friable particles	ASTM C142	0.50
Lightweight particles (SG < 2.40)	ASTM C123	1.25
• Chert or shale(1)	ASTM C295	1.00(1)
Materials finer than No. 200 sieve	ASTM C117	0.50(2)
Coal and lignite	ASTM C123	0.25

Notes:
(1) ASTM C123 tests for particles in the sample having a specific gravity less than 2.40. ASTM C295 is used to identify which of those lightweight particles are chert, shale, or coal and lignite. If testing under ASTM C123 indicates a combined percentage (sum of shale, chert, coal and lignite) not greater than 1.25, testing under ASTM C295 will not be required.
(2) When material finer than No. 200 sieve consists of crusher dust, maximum percentage may be increased to 1.00 percent. When mix design complies with provisions of ASTM C33, Table 4, footnote C, the maximum percentage may be increased in accordance with the equation in footnote C, up to a maximum of 1.5 percent.

      3) Abrasion loss: Loss not greater than 45 percent after 500 revolutions when tested in accordance with ASTM C131.
      4) Soundness: Loss not greater than 10 percent when tested in accordance with ASTM C88 using sodium sulfate solution.

DELETE Paragraph D. Fine Aggregate.

DELETE Paragraph E. Mineral Filler.

DELETE Paragraph F, Mortar and Grout, in its entirety and **INSERT** the following:

F. As specified in Section 03600 - Grouting.

DELETE Paragraph G, Admixtures, in its entirety and **INSERT** the following:

G. Admixtures:
    a. General:
        1) Do not include admixtures, other than those specified, unless written acceptance has been obtained from the Engineer during submittal of mix designs.
        2) Admixtures shall be compatible with concrete constituents and with other admixtures.
            a) All admixtures in a given mix shall be products of the same manufacturer to ensure compatibility.
            b) Admixture manufacturers: One of the following, or equal.
                (1) BASF Corp., Master Builders Solutions.
                (2) Euclid Chemical.
                (3) GCP Applied Technologies (formerly W.R. Grace).
                (4) Sika Corp.
        3) Do not use admixtures containing chlorides, calculated as chloride ion, in excess of 0.5 percent by weight of cement.
        4) Use in accordance with manufacturer's recommendations. Add each admixture to concrete mix separately.
        5) Admixtures used shall be the same products used in concrete trial batches, or the same products used in concrete represented by submitted field test records.
    b. Air entraining admixture (AEA):
        1) In accordance with ASTM C260, and dosed to provide entrained air percentages specified in this Section.
        2) Provides entrained air as bubbles, evenly dispersed at the time of placement and during curing.
    c. Water reducing admixture(WRA):
        1) May be used at the Contractor's option.
        2) Conforming to ASTM C494, Type A (water-reducing).
            a) ASTM C494, Type D (water-reducing and retarding) may be used during periods of hot weather with prior acceptance by the Engineer.
        3) Not containing air-entraining agents.
        4) Liquid form before adding to the concrete mix.
    d. High range water reducing admixtures ("super-plasticizers") (HRWR):
        1) Not permitted without acceptance by Engineer.
    e. Shrinkage reducing admixture (SRA):
        1) May be used at Contractor's option.
            a) Provide shrinkage reducing admixture in sufficient dosage so as to produce shrinkage within the limits specified.
        2) Not containing expansive agents.
        3) In accordance with ASTM C494, Type S (specific performance).
        4) One of the following, or equal:
            a) BASF Corporation, Master Builders Solutions: SRA Series.
            b) Euclid Chemical: Eucon SRA Series.
            c) GCP Applied Technologies: Eclipse Series.

f. Set-controlling admixtures:
   1) Shall not be used without prior acceptance from Engineer.
   2) Accelerating admixtures: not permitted.
      a) Coloring admixtures:
g. Conduit encasement coloring agent:
   1) Red color concrete used for encasement of electrical ducts, conduits, and similar type items.
   2) Manufacturers: One of the following or equal:
      a) Davis Co., #100 Utility Red.
      b) I. Reiss Co., Inc., equivalent product.
      c) Euclid Chemical Co., Increte Division, “Colorcrete Brick Red.”
   3) Conduit encasement concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

DELETE Paragraph H, Air Entrainment, in its entirety and **INSERT** the following:

H. Concrete sealer: Not for use in water-containment structures.

I. Evaporation retardant:
   1. Use: For mitigating surface moisture evaporation from freshly placed concrete during rapid drying conditions. Placed after screeding.
   2. Waterborne, monomolecular, spray-applied compound, with fugitive dye to indicate coverage.
   3. Manufacturers: One of the following or equal:
      a. BASF, MasterKure ER 50.
      b. Euclid Chemical Co., Eucobar.

J. Nonslip abrasive:
   1. Aluminum oxide abrasive size 8/16, having structure of hard aggregate that is, homogenous, nonglazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds.
   2. Manufacturers: One of the following or equal:
      a. Exolon Co.
      b. Abrasive Materials, Inc.
      c. “Non-Slip Aggregate”, Euclid Chemical Co.

K. Plastic membrane for curing:
   1. Polyethylene film: In accordance with ASTM C171.
   2. Properties:
      a. Color: White.
      b. Thickness: Nominal thickness of polyethylene film shall not be less than 0.0040 inches when measured in accordance with ASTM D2103. Thickness of polyethylene film at any point shall not be less than 0.0030 inches.
      c. Loss of moisture: Not exceed 0.055 grams per square centimeter of surface when tested in accordance with ASTM C156.

L. Sprayed membrane curing compound:
   1. Combination curing and sealing products ("cure and seal") will not be permitted.

2. Properties:
    a. Clear type with fugitive dye conforming with ASTM C309, Type 1D and containing no wax, paraffin, or oils.
    b. For concrete placed or cured during hot weather, curing compound shall be as specified, except that:
        1) It shall include a white, reflective fugitive dye.
        2) Moisture loss during a 72-hour period shall not exceed 9 pounds per cubic yard when tested in accordance with ASTM C156.

M. Surface-applied sealing system:
1. Manufacturers: One of the following or equal:
    a. Euclid Chemical Co., Vandex Super.
    b. Kryton International, Inc., Krystol T1.
    c. Xypex Chemical Corp., Xypex Concentrate.
2. Where surface-applied sealing system is placed over concrete containing permeability reducing admixture for concrete exposed to hydrostatic conditions (PRAH), provide products of same manufacturer providing the admixture.

403S.5, Measurement of Materials: **DELETE** section in its entirety.

403S.6 Mix Design: **DELETE** subsection in its entirety and **INSERT** the following:

1.09 CONCRETE MIXES

A. General:
1. Develop and provide mix design for each Concrete Class listed in Table 3 of this Section.
2. Select and proportion mixes and document properties using one of the two methods that follow. Procedures and requirements for use of each alternative are specified in subsequent paragraphs of this Section.
    a. Field experience method.
    b. Trial batch method.
3. Organize and submit mix designs with data on all constituent materials and products for that mix, for Engineer's review.
4. Do not place concrete until the mix design for that Concrete Class has been accepted by Engineer.
5. After acceptance, do not modify accepted mixes or provide new mixes without Engineer's prior review and acceptance of the proposed alternative.
    a. Exception: At all times, adjust batching of water to compensate for free moisture content of the fine aggregate used.
    b. For any change to approved mixes, Engineer may require new trial batching and testing program as specified in this Section before acceptance and use.
    c. For any change to approved mixes, make modifications within limits set forth in this Section.
    d. If there is change in source or quality of any constituent of the concrete class or mix, the revised mix will be considered a new class of concrete and shall require full re-submittal of all data describing mix constituents, design, and testing.
6. Material sampling, mix designs, trial batch preparation and testing, modifications to mix designs, and any re-testing required to satisfy the

requirements of this Section or to obtain satisfactory performance shall be at Contractor's expense and shall not be considered cause for delay.

B. Measurements of materials:
   1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the Engineer.
   2. Furnish apparatus for weighing aggregates and cementitious materials that is suitably designed and constructed for this purpose.
   3. Accuracy of weighing devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within 1 percent of desired amount of that material.
   4. Measuring or weighing devices: Subject to review by the Engineer. Shall bear valid seal of the Sealer of Weights and Measures having jurisdiction.
   5. Weighing cementitious materials:
      a. Weigh cementitious materials separately.
      b. Cement in unbroken standard packages (sacks): Need not be weighed.
      c. Weigh bulk cementitious materials and fractional packages.
   6. Measure mixing water by volume or by weight.

C. Requirements for mix proportioning:
   1. Develop and provide mixes that:
      a. Can be readily worked into corners and angles of forms and around reinforcement, without excessive vibration, and without permitting materials to segregate or free water to collect on surface.
      b. Prevent unnecessary or haphazard changes in the consistency of the concrete supplied.
   2. Constituent materials:
      a. Provide concrete mixes composed of portland cement, blended aggregates, admixtures and water.
         1) Admixtures required for each concrete class are indicated in Table 3 of this Section. Admixtures not specifically required by that table for a specific Concrete Class are optional and may be included at the discretion of the Contractor based on Contractor's planned means and methods of construction.
      b. In no case shall returned fresh concrete or its constituents be incorporated into concrete batched for the Work.
   3. Minimum specified compressive strength:
      a. Minimum specified compressive strength is designated at 28 days, unless otherwise indicated in Table 3 of this Section.
      b. For locations where the placed concrete is adequately protected and is not subjected to loads for an extended period during construction, the Contractor may request that the period for achieving the minimum specified compressive strength be extended to 56 days. If accepted by the Engineer, provide mixes that achieve at least 75 percent of their minimum specified compressive strength after 28 days.
   4. Proportions and consistency:
      a. Ratio of water to cementitious materials, and cementitious materials content:
         1) Conform to maximum and minimum cementitous material content requirements specified in Table 3 of this Section.
         2) Cementitious materials content: Consisting of portland cement as indicated in Table 3 of this Section, plus supplemental cementitious

materials if aggregate testing indicates potentially reactive aggregates:
    a) Minimum fly ash content: 15 percent of the total weight of cementitious materials.
    b) Maximum fly ash content: 25 percent of the total weight of cementitious materials.

b. Aggregate size and content:
    1) Blend aggregates to produce an optimized gradation that combines well-graded coarse, intermediate, and fine aggregates in proportions that maximize the aggregate content of the mix, and that minimize the cement paste content of the mix.
        a) Percentage of individual fractions of the combined aggregate gradation retained on individual sieve sizes: Within the range shown in Attachment C ("Tarantula Curve").
        b) Sum of the percentages of individual fractions retained on the No. 8, No. 16, and No. 30 sieves: Greater than 20 percent.
        c) Sum of the percentages of individual fractions retained on the No. 30, No. 50, No. 100, and No. 200 sieves: Within the range of 25 percent to 40 percent.

c. Determine bulk density and void content of the combined gradation of aggregates in accordance with ASTM C29. Results for combined aggregates shall not be the summation of results of testing of the individual gradations.
    1) Sample the combined aggregate from a flowing aggregate stream or conveyor in accordance with ASTM D75. Take care to ensure that the sample is representative of the proportions of the combined aggregate of the proposed mix.
    2) Reduce sample of combined aggregate to test sample size in accordance with ASTM C702, Method A - mechanical splitter or Method B - quartering.
    3) Perform bulk density test of combined aggregate in accordance with ASTM C29, Procedure A - rodding.
    4) Determine void content of the combined aggregate in accordance with ASTM C29, Procedure A - rodding. Specific gravity of the combined aggregate shall be determined in accordance with ASTM C136.

d. Paste content: Limited to the following:
    1) Class A mixes without air entrainment: Maximum 28 percent measured by volume.
    2) Class A mixes with air entrainment: Maximum 28 percent measured by volume plus the target air content.
    3) Paste content shall be limited to 175 percent of the void content of the combined aggregate gradation determined by ASTM C29.

e. Total water content:
    1) Not exceeding the water to cementitious material ratio specified in Table 3 of this Section.

f. Coarseness/workability (Shilstone Method):
    1) Proportion mixes to fall into the "Optimal" zone (Zone II) when plotted on the Coarseness Factor Chart ("Coarseness Factor" versus "Workability Factor") included as Attachment B to this Section. Provide plot for each Class A mix to be used in the Work.

2) Coarseness factor (CF) for each mix shall be calculated as the percent of the combined aggregate gradation retained on the 3/8 inch sieve, divided by the percent of the combined aggregate gradation retained on the Number 8 sieve, multiplied by 100: or:

$$CF = \frac{\text{(\% retained on 3/8" sieve)}}{\text{(\% retained on No. 8 sieve)}} \times 100$$

3) Workability factor (WF) for each mix shall be the percent of the combined aggregate gradation retained on the Number 8 sieve, adjusted for cement content in the mix.
   a) Determine volume of total cementitious material in the mix.
   b) pounds per cubic yard, increase workability factor by 2.5 units.
   c) For each 94 pounds of portland cement below 564 pounds per cubic yard, decrease workability factor by 2.5 units.
   d) Proportion adjustment factor by linear interpolation for each fraction of 94 pounds above or below the 564 pound basis.
   e) Example:
      650 pounds per cubic yard = 564 pounds + 86 pounds.
      Adjustment = (86 lb / 94 lb) x 2.5 = + 2.28.

D. Concrete Classes for use in the Work:
   1. Provide concrete classes listed in Table 3 of this Section.
   2. Provide normal weight concrete, having minimum weight of 140 pounds per cubic foot, unless otherwise noted.
   3. Pumped concrete:
      a. Provide pumped concrete that complies with all requirements of this Section.
      b. Mixes placed by pumping shall be considered a sub-class of each concrete class listed in Table 3 of this Section. Prepare and submit a separate mix design for each mix to be placed by pumping.
   4. Class PM concrete: In addition to the requirements of Table 3 of this Section, conform to the following:
      a. Minimum 28 day flexural strength: 650 psi when tested in accordance with ASTM C293.
      b. Cementitious materials content: 75 percent portland cement plus 25 percent Class F fly ash (by weight).
      c. Aggregate:
         1) Minimum 55 percent coarse aggregate conforming to ASTM C33 size number 357 or size number 467.
         2) Substitute ASTM C33 size number 57 or size number 67 if mechanical paving equipment is not used.

Table 3: Concrete Classes

Concrete Class[1]	Minimum Specified Compressive Strength at 28 days, f'c [2] (pounds per square inch)	Ratio of water to cementitious materials[3] (minimum - maximum).	Cementitious Materials Content (pounds per cubic yard of concrete by weight)[4]	Cement Type	Maximum Chloride Content (percent by weight of cement)	Maximum Size of Coarse Aggregate (ASTM C33)	Air Entrainment (percent), (n/a : not applicable)	Admixtures required[4,5,6]	Slump Range (inches)
A	4,500	0.40 to 0.42	535 to 575	II	0.30	#57	6±1.5	AEA WRA	2 to 4
A-NA	4,500	0.40 to 0.45	535 to 575	II	0.30	#57	n/a	WRA	2 to 4
C	2,500	0.62 max.	min. 423	II	No limit	#57	6±1.5	AEA WRA	3 to 6
CE	3,000	0.62 max.	min 423	II	No limit	#8	5±1.5	AEA WRA	3 to 6
P	4,500	0.40	535 to 575	II	0.30	#57	n/a	WRA HRWR	6 to 9
PM	5,000	0.40	535 to 575	II	0.15	#57	5**[6]**+1.5	AEA WRA	3 to 6

Table 3: Concrete Classes

Concrete Class[1]	Minimum Specified Compressive Strength at 28 days, f'c [2] (pounds per square inch)	Ratio of water to cementitious materials[3] (minimum - maximum).	Cementitious Materials Content (pounds per cubic yard of concrete by weight)[4]	Cement Type	Maximum Chloride Content (percent by weight of cement)	Maximum Size of Coarse Aggregate (ASTM C33)	Air Entrainment (percent), (n/a : not applicable)	Admixtures required[4,5,6]	Slump Range (inches)

Notes:

(1) Sub classes within major concrete classes are designated as follows:

NA: Without air entrainment.

(2) At locations where concrete will not be subjected to load from other elements of the structure or from Contractor's placing and/or backfilling operations, maximum time period for achievement of specified compressive strength may be extended to 56 days when accepted by the Engineer.

(3) W/C Ratio = Ratio of water to cementitious materials (portland cement plus supplemental cementitious material) by weight. Include weight of admixtures in the water content of the mix when the quantity of the admixtures exceeds 10 ounces per 100 pounds of cement.

(4) Cementitious material includes portland cement plus supplemental cementitious materials. If trial batch testing demonstrates that the required strength cannot be met at 28 or 56 days with the specified combined aggregate gradation and the paste content limits, cementitious material content may be increased with Engineer's approval if a shrinkage-reducing admixture (SRA) is included in the mix design.

Table 3: Concrete Classes

Concrete Class[1]	Minimum Specified Compressive Strength at 28 days, f'c [2] (pounds per square inch)	Ratio of water to cementitious materials[3] (minimum - maximum).	Cementitious Materials Content (pounds per cubic yard of concrete by weight)[4]	Cement Type	Maximum Chloride Content (percent by weight of cement)	Maximum Size of Coarse Aggregate (ASTM C33)	Air Entrainment (percent), (n/a : not applicable)	Admixtures required[4,5,6]	Slump Range (inches)

(5)Admixtures are designated as follows:

AEA: Air entraining admixture

HRWR: High-range water-reducing admixture SRA: Shrinkage-reducing admixture.

SFR: Synthetic fiber reinforcement.

WRA: Water-reducing admixture

PRAH: Permeability-reducing admixture for concrete exposed to hydrostatic conditions.

E. Install Concrete Classes in accordance with the following requirements unless otherwise indicated on the Drawings.
   1. Class A concrete: Structural concrete.
      a. Use Class A concrete at all locations unless other Classes are specified or indicated on the Drawings.
   2. Class A-NA concrete: Structural concrete without air entrainment.
      a. Class A-NA concrete may be used in lieu of Class A at indoor slabs (not subject to freezing and thawing) where inclusion of an air-entraining admixture makes it difficult to achieve the specified concrete finish.
   3. Class C concrete: Miscellaneous concrete fill and encasement.
      a. Class C concrete may be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
   4. Class CE concrete: Use Class CE for electrical conduit encasements.
   5. Class P concrete: Use Class P concrete for drilled piers.
   6. Class PM concrete: Use for concrete pavement, cart paths, curbs, gutters, and sidewalks.

403S.7, Consistency and Quality of Concrete: **DELETE** subsection in its entirety and **INSERT** the following:

1.10 CONCRETE MIX DESIGN DOCUMENTED BY FIELD EXPERIENCE:

A. Mix design:
   1. Prepare preliminary mix design for each Concrete Class. Submit mix design with product and testing data for materials to be used in the mix for Engineer's review.

B. Historical records for similar mix.
   1. Determinations of similarity of materials and proportions between historical and proposed mixes shall be by the Engineer, and that shall be final.
   2. Historical record - Materials:
      a. Submit with each mix design the following data for a previously-supplied concrete mix similar to that proposed for this Work.
      b. Records demonstrating that the previously supplied mix included similar materials and proportions as those of the proposed mix.
         1) Documentation that the same concrete supplier will provide both mixes.
         2) Documentation that the materials used was from the same suppliers and had essentially the same properties, demonstrated by test data, as those proposed.
         3) Documentation that proportions of materials in the record mix are essentially the same as those proposed and that the specified compressive strength of the record mix is within 1,000 pounds per square inch of that required by this Section.
         4) Concrete supplier's statement describing any changes made to production of the record mix during the time period reported.
         5) Concrete supplier's statement that preparation and quality control procedures for the record mix were essentially the same as those to be employed for this Work.

3. Historical record - Testing:
    a. Submit with each record mix, corresponding test data for slump, compressive strength (with relationships for rate of strength gain between testing ages), and drying shrinkage.
    b. Only records satisfying the following requirements will be accepted.
        1) All tests were conducted within a period of 1-year preceding the date of the submittal.
        2) All tests were conducted over a period including not less than 45 days.
        3) The record of compressive strength testing includes at least 30 tests for slump and 28-day compressive strength.
        4) The record of compressive strength tests is consecutive. In other words, it includes all tests conducted on the subject mix within the 1-year time period described above (not just selected tests during that period).
        5) Submit concrete supplier's sworn statement confirming that all tests for the record mix have been reported.
        6) Tests for drying shrinkage are described in subsequent paragraphs of this Section for "concrete mix design documented by trial batch preparation and testing,"
        7) Provide supplementary testing if requested by Engineer.
4. For mixes determined to be similar and to have an acceptable test history, acceptance criteria shall be as follows:
5. Acceptance criteria:
    a. Slump: All tests within limits specified for record mix.
    b. Compressive strength: Average compression strength for tests, as determined by ACI 318 and ACI 350 not less than minimum required average strength.
    c. Drying shrinkage: Within limits stated in subsequent paragraphs of this Section for "concrete mix design documented by trial batch preparation and testing."

1.11 CONCRETE MIX DESIGN DOCUMENTED BY TRIAL BATCH PREPARATION AND TESTING:

A. Mix design and trial batches:
    1. Prepare preliminary mix design for each Concrete Class. Submit mix design with product and testing data for each combination of materials and proportions to be used for Engineer's review.
        a. Determine water content of the mix based on curves showing the relation between water-cementitious materials ratio and the 7 and 28 day compressive strength of the concrete.
        b. Determine each curve using 4 or more points, each representing the average compressive strength value of at least 3 specimens tested at each age.
    2. After materials and proposed mix designs have been accepted by Engineer, have trial batches for each concrete mix design prepared by Contractor's testing laboratory.
        a. Prepare trial batches using the cementitious materials, aggregates, and admixtures proposed to be used for the Work.

b. Provide batches of sufficient quantity to determine slump, workability, consistency, and finishing characteristics, and to provide sufficient specimens for testing.

3. For each trial batch, make and test specimens to determine and report slump, compressive strength (with relationships for rate of strength gain between testing ages), and drying shrinkage.
   a. If trial batches do not produce concrete conforming to the specified requirements for slump, strength, workability, consistency, drying shrinkage, restrained shrinkage, and finishing, change mix proportions and, if necessary, sources of materials.
   b. Make additional trial batches and perform additional tests until a batch that conforms to requirements of this Section is produced.

B. Testing - Slump:
   1. Determine slump in accordance with ASTM C143.
   2. Acceptance criterion: Slump within range specified.

C. Testing - Compressive strength:
   1. Prepare 4 inch diameter by 8 inch long cylinders in accordance with ASTM C31 for tests specified in this Section.
   2. Determine average compressive strength:
      a. Test at least 12 cylinders from each trial batch for compressive strength in accordance with ASTM C39.
      b. Test 4 cylinders at 7 days, another 4 at 28 days, and another 3 at 56 days. Calculate average compression strength for 7 day tests, for 28 day tests, and for 56 day tests.
      c. Calculate ratios for:
         1) Average 7 day strength to average 28 day strength.
         2) Average 28 day strength to average 56 day strength.
   3. Determine the required average compressive strength for each mix, f'cr, as described in the following paragraphs:
      a. Calculate required average compressive strength (f'cr) based on the minimum specified 28-day compressive strength, f'c, plus a standard deviation determined from the test history available for that mix.
      b. Determine f'cr as specified in ACI 318 and ACI 350, except as modified in the following paragraphs.
         1) Where 15 or more 28-day compressive strength tests are available, calculate standard deviation as described in the preceding paragraphs for "concrete mix design documented by field experience." Add this standard deviation to the specified minimum compressive strength to determine the required average compressive strength (f'cr) for the mix.
         2) Where fewer than 15 compressive strength tests at 28-days are available, determine minimum required compressive strength, (f'cr) from Table 4 of this Section.

Table 4: Required Average Compressive Strength, Fewer than 15 Tests Available	
Minimum Specified Compressive Strength, f'c (pounds per square inch)	**Required Average Compressive Strength, f'cr (pounds per square inch)**
Less than 3,000	f'c + 1,000
3,000 to 5,000	f'c + 1,200
Over 5,000	f'c + 1,400

4. Acceptance criterion: Average compressive strength of the 4 cylinders tested at 28 days, or of the 4 cylinders tested at 56 days when permitted by the Engineer, shall equal or exceed the required average compression strength, f'cr for that concrete mix design.

D. Testing – Chloride content:
   1. Submit test results showing that the concrete mix contains water-soluble chloride ion content contributed from the constituents including water, aggregates, cementitious materials, and admixtures is less than the limit specified in Table 3 of this Section. Test shall be performed in accordance with ASTM C1218 at age between 28 and 42 days.

E. Testing - Drying shrinkage - Prism specimens:
   1. Class A (including A, A-NA, A-SP, and A-NA-SP) and Class PM: From trial batch for each mix, prepare 10 drying shrinkage specimens in accordance with ASTM C157 Divide specimens into 2 groups of 5 specimens each: One group including shrinkage-reducing admixture, and one group without shrinkage-reducing admixture.
   2. Prepare, cure, and test both groups in accordance with ASTM C157, except as modified in the following paragraphs.
      a. Remove drying shrinkage specimens from molds at age of 23 hours plus or minus 1 hour after trial batching.
         1) Immediately place them in lime-saturated water maintained at 73 degrees Fahrenheit plus or minus 3 degrees for at least 30 minutes.
         2) Remove specimens from the water, and wipe with a damp cloth.
         3) Measure to nearest 0.0001 inch to determine original length.
         4) Record measurements and re-submerge specimens in lime-saturated water at 73 degrees Fahrenheit plus or minus 3 degrees for moist curing.
      b. Maintain submerged curing conditions at 73 degrees Fahrenheit plus or minus 3 degrees for 7 days. 7 days after batching, remove specimens from water and repeat measuring procedures.
      c. Immediately store specimens in a humidity controlled room maintained at 73 degrees Fahrenheit plus or minus 3 degrees, and at 50 percent relative humidity plus or minus 4 percent for remainder of the test.
      d. At periods of 14, 21, 28 and 56 days after batching, remove specimens from curing room and repeat measurements.
   3. Drying shrinkage test report:
      a. Report measurements of all specimens at 1, 7, 14, 21, 28, and 56 days after batching.

b. Using measured length at 7 days as base length for drying shrinkage, calculate the following for each measuring period:
    a) Drying shrinkage of each specimen. Determine as difference between the 7-day base length and measured length for each period.
    b) Average of these differences. If drying shrinkage of any specimen departs from the average of the measurements for each period by more than 0.0004 inch, disregard results obtained from that specimen.
    c) Percentage of drying shrinkage from batching to date of measurement.

c. Drying shrinkage acceptance criteria:
    1) Average shrinkage of trial batch concrete specimen group at 28 days after batching, when measured and cured as indicated, shall not exceed 0.035 percent.

d. Mixes accepted by Engineer:
    1) Retain drying shrinkage test specimens. Bag in re-sealable plastic bags and submit to Engineer.
    2) Indicate trial batch identifier, specimen number, and date of final measurements on each specimen bag.

403S.8, Mix Design Options: **DELETE** subsection in its entirety and **INSERT** the following:

1.12 MIX DESIGN OPTIONS

A. For the structural concretes identified in Table 3 (Class A concrete (and variations A-NA) and any other class of concrete designed using more than 535 lbs. of cementitious material per cubic yard; one of the mix design options presented below shall be used.

B. For the non-structural concretes identified in Table 3 (Classes C and CE.) and any other class of concrete designed using less than 423 lbs. of cementitious material per cubic yard, one of the mix design options presented below will be used.
    1. Option 1: Fifteen (1) to twenty-five (25) percent of the cement may be replaced with Class F fly ash.

403S.9, Mixing and Mixing Equipment: **ADD** the following text in front of sub paragraph B. 1) and renumber the existing sub paragraphs accordingly:

B. Machine mixing:
    1. Prevent cementitious materials from coming into contact with aggregate or with water until materials are in mixer and ready for complete mixing with all mixing water.
    2. Procedure of mixing cementitious materials with sand, or with sand and coarse aggregate, for delivery to project site for final mixing and addition of mixing water is not permitted.
    3. Remixing of concrete that has started to take its initial set (“retempering”) is not permitted.
    4. Discharge entire batch before recharging.
    5. Volume of mixed material per batch: Not exceeding manufacturer's rated capacity of mixer.

C. Transit-mixed concrete:
   1. Mix and deliver in accordance with ASTM C94, except as modified in this Section.
   2. Total elapsed time between addition of water at batch plant and discharging completed mix:
      a. Not to exceed 90 minutes nor 300 revolutions of the mixing drum.
      b. Under conditions contributing to rapid setting, total elapsed time permitted may be reduced by the Engineer.
   3. Temperature - minimum and maximum allowable during mixing and transporting:
      a. Minimum: 50 degrees Fahrenheit.
      b. Maximum: 90 degrees Fahrenheit.
   4. Continuously revolve drum after it is started until it has completely discharged its batch.
      a. Do not add water until drum has started revolving.
      b. Engineer reserves the right to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. Contractor will not be entitled to additional compensation because of such increase or decrease.

403S.10, Excavation, Placing of Concrete, Finishing, Curing and Backfilling: **DELETE** the entire paragraph and **INSERT** the following:

1.13 PREPARATION

A. Prepare and submit mix designs for each Concrete Class indicated in Table 3 of this Section.

B. Submit proposed sequence of concrete placements. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested by the Contractor and accepted by the Engineer.
   1. Use construction methods and sequence work to allow concrete placement to reach adequate strength and to be constructed with required support to prevent overstress of the concrete structure during construction.

C. Make provisions for monitoring weather conditions:
   1. Install an outdoor weather station capable of measuring and recording ambient temperature, wind speed, and humidity. Furnish instruments accurate to within 2 degrees Fahrenheit, 5 percent relative humidity, and 1 mile per hour wind speed.
   2. Monitor the weather forecast beginning at least 48 hours prior to any concrete placement and make provisions for cold weather concreting or hot weather concreting if those conditions exist or are forecast to exist during the period of placement, finishing, and curing.
      a. Record temperature, relative humidity, and wind speeds for each placement beginning at least 24 hours before scheduled delivery of concrete.

D. Place no concrete without Engineer’s prior acceptance of conditions.

E. Notify the Engineer in writing that all preparations are complete and ready for placement of concrete. Such notification shall indicate readiness - not just intention - to place concrete for the designated portion of the Work.
   1. Submit notification to Engineer on forms provided by or acceptable to the Engineer and bearing the signature of Contractor's superintendent.
      a. Sample form is included at the end of this Section, see Attachment B.
   2. Submittal of notification will be Contractor's certification that preparations are complete and in accordance with the Contract Drawings and Specifications.
   3. Provide notification for Engineer to make final observations at the locations of concrete placements not less than 24 hours before commencing placement of concrete.

1.14 CONCRETE JOINTS

A. Locations of joints are indicated on the Drawings.
   1. In order to preserve strength and watertightness of structures, make no other joints, except as authorized by the Engineer.
   2. Construct joints where indicated, and as indicated on the Drawings.
   3. Where joint locations are not indicated on the Drawings, submit Contractor's proposed locations for Engineer's review and acceptance. Provide construction joints in slabs and walls at intervals not greater than 35 feet.

B. Time between placements of adjacent concrete separated by joints.
   1. Provide not less than 3 days (72 hours) between placement of adjacent sections for the following:
      a. Slabs.
      b. Walls.
   2. Provide not less than 7 days (168 hours) between placement of the lower and upper pours for the following:
      a. Walls over slabs.
      b. Slabs over walls.
      c. Slabs keyed into the sides of walls.

C. Edges of joints:
   1. Provide joints have edges detailed as indicated on the Drawings.
   2. Protect wall and slab surfaces at edges from concrete splatter. Thoroughly clean adjacent surfaces after completion of each placement.

D. Joint construction:
   1. Preparation of forms:
      a. Provide cleanout holes at base of each wall and column for inspection and cleaning.
      b. Wash forms and adjacent joint surfaces of sawdust, chips, and other debris after forms are built, and immediately before concrete or grout placement.
      c. Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use a vacuum cleaner for their removal, and then flush cleaned surfaces with water.
   2. Before placing concrete against previously placed concrete, thoroughly clean the prior placement of laitance, grease, oil, mud, dirt, curing compounds,

mortar droppings, or other objectionable matter by means of pressure washing.

3. Provide and install waterstops, expansion joint material, and other similar materials as indicated on the Drawings and as specified.
    a. Take special care to ensure that waterstops are secured in proper position.
    b. Take special care to ensure that concrete is well consolidated around and against waterstops during placement.
4. Horizontal joints:
    a. As initial placement over cold joints, thoroughly spread bed of cement grout as specified in Section 03600 - Grouting.
        1) Thickness: not less than 1/2 inch nor more than 1 inch.
    b. For wall placements above planned cold joints, placement of cement grout will not be required for locations where the wall mix includes high-range water-reducing admixture (“superplasticizers”), and the Contractor can demonstrate dense concrete joints without voids or honeycomb after the forms are removed.

1.15 MEASURING AND BATCHING MATERIALS

A. Measurements of materials:
    1. Proportion and measure cementitious materials and aggregates by weight.
        a. Weigh cementitious materials separately.
        b. If bulk cementitious materials are used, weigh them on separate visible scale that will accurately register scale load at any stage of weighing operation from zero to full capacity.
        c. Cement in unbroken standard packages (sacks) need not be weighed.
    2. Mixing water: Measure by volume or by weight.
    3. Other mix constituents: Measure by weight, except as otherwise specified or accepted by the Engineer.
    4. Weighing and measuring devices:
        a. Use equipment designed and constructed specifically for that purpose.
        b. Furnish devices capable of weighing successive quantities of individual material measured to within 1 percent of desired weight of that material.
        c. Bearing valid seal of the department of weights and measures for the authority having jurisdiction over the Work.
    5. Measurements and measuring devices:
        a. Subject to review by the Engineer.

B. Batching:
    1. Admixtures shall be added at the concrete batch plant.
    2. Addition of admixtures in the field is permitted only with prior acceptance by the Engineer, and only when the following conditions are satisfied:
        a. The dosage and mixing is personally overseen by concrete supplier's trained technologist.
        b. Adequate mixing is provided after addition.
        c. The maximum time to placement of concrete remains 90 minutes after water added to mix - not 90 minutes after any field additions/adjustments.
        d. Slump at discharge after additions/modifications conforms to the requirements of Table 3 of this Section.

1.16 PLACING AND CONSOLIDATING

A. Preparation:
   1. Obtain Engineer's acceptance of completed preparations before placing concrete.
      a. Notify Engineer in writing that all preparations are complete and ready for placement of concrete. Such indication shall indicate readiness, not just intention, to place concrete for the designated portion of the work.
   2. Confirm completeness of the following before notification of readiness is given to Engineer:
      a. Place forms, reinforcement, screeds, anchors, ties, and inserts in final position.
      b. Reinforcement is secure and properly fastened in its correct position.
      c. Loose form ties at construction joints have been retightened.
      d. Dowels, bucks, sleeves, hangers, pipes, conduits, anchor bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
      e. Forms have been cleaned of debris and form release agents are applied as specified.
   3. Preparation for placement of footings and slabs on grade:
      a. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the Engineer.
      b. If necessary, sprinkle subgrade with water not less than 6 or more than 20 hours in advance of placing concrete.
      c. If subgrade surface becomes dry prior to actual placing of concrete, sprinkle again, without forming pools of water.
      d. Do not place concrete if subgrade is muddy or soft.
   4. Keep sufficient protective coverings on hand at all times for protection of concrete during and after placement.
      a. Protect concrete placed before rain to prevent water from coming in contact with such concrete
      b. Protect concrete placed before winds to prevent excessive drying or embedment of debris in the finished surfaces.

B. Concrete placement:
   1. Do not place concrete:
      a. With slump outside the limits specified in Table 3 of this Section.
      b. In which initial set has occurred, or that has been retempered.
      c. During rainstorms or high velocity winds.
   2. Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
      a. Do not deposit concrete in large quantities in one place, and then work material along forms with vibrator or by other methods.
   3. Do not drop concrete freely into place from height greater than 5 feet. Use tremies for placing concrete where drop is over 5 feet.
   4. Place concrete on slopes starting from bottom of slope and working upward.
   5. Place concrete in horizontal lifts not exceeding 24 inches in depth and bring up evenly in all parts of forms.
   6. After concrete placement begins, continue in a continuous operation without significant interruption until the end of the placement. Plan and implement precautions to prevent any delay, between layers or adjacent volumes, from exceeding 20 minutes.

7. If concrete is to be placed over previously placed concrete and more than 20 minutes has elapsed, spread layer of cement grout over surface before placing additional concrete. Provide grout layer thickness of not less than 1/2-inch, nor more than 1 inch.
8. Placement of concrete for slabs, beams, or walkways:
    a. If cast monolithically over walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.
    b. Allow set time of not less than 1 hour for shrinkage.
        1) During waiting time, keep top surface of concrete moist, but not wet.
        2) Do not permit water to pond or stand on the surface.
        3) Do not coat surface with evaporation retarders or curing agents.
    c. Start placement above wall or column with layer of cement grout as described in the preceding paragraph.

C. Consolidating concrete:
1. Consolidate concrete with aid of acceptable mechanical vibrators.
2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the work.
3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
4. Vibrators:
    a. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
    b. In addition to vibrators in actual use while concrete is being placed, have on hand a minimum of 1 spare vibrator in operable condition.
    c. Do not place concrete until it has been confirmed that all vibrating equipment, including spares, are in operable condition.
5. Place concrete solidly against forms and concrete surfaces, leaving no voids or honeycomb.
6. Make concrete solid, compact, and smooth. If for any reason surfaces or interiors have voids or are in any way defective, repair such concrete in manner acceptable to the Engineer.
7. Do not over-vibrate so as to produce segregation.

1.17 FINISHING CONCRETE

A. Provide concrete finishes in accordance with Section 01999_04011S – Surfaces Finished for Concrete unless otherwise indicated on the Drawings.

B. Liquid evaporation retardant:
1. Under conditions that result in rapid evaporation of moisture from the surface of the concrete, coat the surface of the concrete with a liquid evaporation retardant immediately after screeding.
2. Conditions that result in rapid evaporation of moisture are defined as any combination of ambient temperature, concrete temperature, relative humidity, wind speed, and solar radiation intensity that creates conditions that will evaporate water from a free concrete surface at a rate equal to or greater than 0.1 pounds per square foot per hour as determined by the Menzel Formula and nomograph published in ACI 305R, and included as Attachment A to this Section.

3. Apply evaporation retardant again after each finishing operation as necessary to prevent drying shrinkage cracks.
4. Do not work evaporation retardant into the surface of the concrete.
5. Do no use evaporation retardant as finishing aid (to rehydrate surface a creamy state for finishing).

C. Concrete sealer:
1. Floors and slabs to receive concrete sealer: See Room Finish Schedule on the Drawings.

1.18 CURING

A. Cure concrete by methods specified in this Section.

B. Keep concrete continuously moist and at an average daily temperature of at least 50 degrees Fahrenheit for a minimum of 7 days after placement.
1. Provide at least 350 degree days of curing (350 degrees times 7 days of 24 hours each).
2. If hourly temperatures at any surface of a concrete placement drop below 50 degrees Fahrenheit during the curing period, count the period below 50 degrees Fahrenheit as zero degrees, and extend the curing time to compensate.

C. Schedule of curing methods:
1. Cure the following concrete surfaces using water curing, or plastic membrane curing.
a. Floor surfaces of water containment structures.
b. Surfaces where additional concrete will be placed over or against the surface, including concrete joints.
c. Surfaces where grout or other toppings will be placed over the surface.
d. Slabs scheduled to receive concrete sealer, or other bonded or adhered architectural finishes.
e. Formed surfaces scheduled to receive coatings, paint, adhered masonry, cementitious materials, or other similar finishes, and where formwork is removed within 7 days after concrete placement.
f. Horizontal concrete surfaces at tops of walls.
2. Cure the following concrete surfaces by water curing, plastic membrane curing, or sprayed curing membrane. Selection of methods shall be at the Contractor's option.
a. Surfaces not listed in the preceding paragraph.

D. Water curing:
1. Keep surfaces of concrete constantly and visibly wet, day and night, for period of not less than 7 days.
a. Each day forms remain in place will be counted as 1 day of water curing.
b. Do not loosen form ties during period when concrete is cured by leaving forms in place. No further curing credit will be allowed for forms remaining in place after contact has been broken between concrete surface and forms.
2. Begin water curing as soon as concrete attains initial set.

3. Maintain a wet surface by ponding, continuous sprinkling, covering with saturated burlap, or otherwise saturating the surface by means acceptable to Engineer.
    a. Flood top of walls with water at least 3 times per day and keep surfaces moist at all times during 7 day curing period.
    b. Provide plastic sheet material over surfaces if required to maintain a wet surface during arid or windy conditions. See plastic membrane curing requirements for additional details.
4. Use water having a temperature within 20 degrees Fahrenheit of the temperature of concrete, and not lower than the minimum temperature allowed for the concrete surface during curing.

E. Plastic membrane curing:
1. Install plastic membrane as soon as concrete is finished and can support limited pedestrian traffic without damage.
2. Cover entire surface of finished concrete with membrane.
3. Anchor membrane to prevent uplift from wind or air trapped below the sheet.
4. Fully seal joints and edges to provide full seal around perimeter.
5. Keep concrete under plastic membrane moist, regularly monitoring surfaces and adding supplemental moisture if necessary. Add water as specified for water curing.

F. Sprayed membrane curing compound:
1. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
    a. If more than 1 hour elapses after removal of forms, do not use membrane curing compound. Instead, provide water curing for not less than 7 days.
    b. Do not remove sprayed membrane curing compound from concrete in less than 7 days after initial application.
    c. When application of curing compound at concrete joints is accepted by Engineer, take care to apply curing compound to all surfaces along full profile of joints.
2. Apply curing compound by mechanical, power operated sprayer with mechanical agitator that will uniformly mix all pigment and compound.
    a. Apply curing compound in at least 2 coats.
    b. Apply each coat in direction turned 90 degrees from application direction of the preceding coat.
    c. Apply curing compound in sufficient quantity so that concrete has uniform appearance and its natural color is effectively and completely concealed immediately after spraying.
    d. Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
3. Thickness and coverage of curing compound:
    a. Provide curing compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
    b. Contractor is cautioned that method of applying curing compound specified in this Section may require more curing compound than normally suggested by manufacturer of curing compound and is more than is customary in the trade. Apply amounts specified in this Section, regardless of manufacturer's recommendations or customary practice.
4. If Contractor desires to use a curing compound other than specified product, coat sample areas of concrete wall with proposed curing compound, and also

coat similar adjacent area with the specified compound in the manner specified, for comparison:
   a. If proposed sample is not equal or better, in opinion of the Engineer, the proposed substitution will not be allowed.
5. Removal of curing compound.
   a. After curing period is complete, remove curing compound placed on surfaces that will receive additional concrete, including all concrete joint surfaces, by heavy sandblasting or by other means acceptable to Engineer. Complete removal and cleanup prior to placing any new concrete against the surface.
   b. Where additional finishes will be applied over concrete surfaces, unless otherwise recommended by the manufacturer of the finish to be applied, remove curing compound by sandblasting. Provide blasting as necessary to fully remove curing compound.
6. Prior to final acceptance of the work, remove, by sandblasting or by other method acceptable to the Engineer, any curing compound on surfaces exposed to process water or exposed to view, so that only natural color of finished concrete is visible and uniform over the entire surface.

1.19 PROTECTION

A. General:
   1. Keep forms in place, as specified in the following paragraphs, to provide curing and to protect concrete surfaces and edges from damage.
   2. Immediately after forms are removed, carefully examine concrete surfaces, and repair any irregularities in surfaces and finishes as specified.

B. Form removal:
   1. Do not remove forms from concrete which has been placed when outside ambient air temperature is below 50 degrees Fahrenheit until the following conditions are satisfied:
      a. Concrete has sufficient strength to allow form removal without damage to surfaces.
      b. At least 48 hours have elapsed since the end of concrete placement.
      c. Provisions are in place to maintain moisture for curing concrete, and temperature at or above the required minimum curing temperature specified.
   2. Vertical forms:
      a. Retain in place for a minimum of 24 hours after concrete is placed.
      b. If concrete has sufficient strength and hardness to resist surface or other damage after 24 hours, forms may be removed.
   3. Other forms supporting concrete, and shoring: Retain in place as follows:
      a. Formed sides of footings: 24 hours minimum.
      b. Formed vertical sides of beams, girders, and similar members: 48 hours minimum.
      c. Forms below slabs, beams, and girders: Until concrete strength reaches specified strength f’c or until shoring is installed.
         1) Shoring for slabs, beams, and girders: Shore until concrete strength reaches minimum specified 28-day compressive strength.
   4. Wall bracing: Brace walls until strength of concrete beams and slabs laterally supporting wall reaches minimum specified 28-day compressive strength.

C. Loading of concrete members:
   1. Placement of loads on or against green concrete is not permitted.
   2. Do not place soil against walls, or fill over the top of concrete until conditions designated in the following paragraphs are satisfied:
      a. Walls have been cast to their full height in the structure and have achieved their minimum specified 28-day compressive strength.
      b. Connecting slabs and beams that brace the walls are in place, are complete, and (in the case of concrete) have achieved their minimum specified 28-day compressive strength.

1.20 HOT WEATHER CONCRETING

A. Implement hot weather concrete procedures during periods of hot weather as defined in this Section.
   1. Comply with the recommendations of ACI 305R and this Section.

B. If placements during hot weather are expected, and when requested by the Engineer, prepare a hot weather concreting plan. Maintain at least 1 copy on site. Provide plan for review if requested by the Engineer.
   1. Include procedures for batching, delivery, placement, curing, protection, and monitoring and recording the temperature of the concrete and the surrounding environment.
   2. Describe procedures to be implemented in the event of abrupt changes in weather conditions, or in the event of equipment failure.
   3. Review hot weather concreting plan during pre-construction meeting. Make provisions to address any concerns expressed by Engineer before beginning concrete placements.

C. Preparation:
   1. Do not place concrete against forms, reinforcement, or embedments with a surface temperature greater than 120 degrees Fahrenheit.
      a. If necessary, to maintain maximum concrete temperature during placing, cool forms and reinforcement to temperature below 90 degrees Fahrenheit using water or shades.
      b. Do not allow water to puddle in forms or placement areas.
   2. Moisten forms or subgrade to maintain a saturated surface without standing water or soft spots.
   3. Provide windbreaks, shades, fog spray, sprinkling, wet cover, or other means required to protect concrete from premature loss of moisture and rapid temperature gain.

D. Batching and delivery:
   1. Retarding admixtures will not be permitted.
   2. Temperature of concrete delivered for placement shall not exceed 90 degrees Fahrenheit.
      a. Maintain uniform temperature in the mix below this level during batching, delivery, placing, and consolidation.
      b. Temperature of mix, even if below the maximum allowable temperature specified, shall be maintained at a level to avoid loss of slump, flash setting, or cold joints in placements.

3. If necessary:
    a. Mix water may be chilled or replaced with ice to maintain mix temperature. Where mix water is replaced with ice, provide replacement at a 1 to 1 ratio by weight.
    b. Shade transit mixed concrete trucks, or cool mixing outside of container with water to control temperature of concrete.

E. Placing and finishing:
1. Place and finish concrete promptly. Place so that vertical lift lines will not be visible in exposed concrete surfaces.
2. Provide plastic sheeting, fog nozzles, shades or other means to reduce concrete temperature and protect from moisture loss.

F. Protection and curing:
1. Furnish and locate maximum/minimum temperature recording thermometers in sufficient numbers to confirm concrete temperatures over full area and edges of concrete.
2. Flatwork: Protect and cure using water curing methods as specified in this Section.
    a. Water curing:
        1) Keep concrete continuously wet and make provisions for runoff.
        2) For sprinkling or soaker hoses, maintain temperature of water as close as possible to the temperature of the concrete to minimize effects of thermal shock.
3. Formed surfaces: Protect and cure using forms left in place or membrane curing methods as specified in this Section.
    a. Cover forms and keep continuously moist for at least 24 hours after placement.
    b. Loosen forms as soon as this can be accomplished without damaging the concrete.
    c. Maintain continuously moist surfaces by fogging or spraying with water, or by application of curing compound as specified.

1.21 FIELD QUALITY CONTROL BY CONTRACTOR

A. Provide quality control over the Work of this Section as required.

B. Field tests:
1. During progress of construction, provide testing to determine whether the concrete, as being produced, complies with requirements specified.
2. Sampling and testing shall be performed by Contractor’s testing laboratory. See Section 01455 - Regulatory Quality Assurance - Special Tests and Inspections for requirements.
    a. Cooperate in testing by allowing free access to the Work for testing laboratory to sample and test materials.
    b. Provide full access for Engineer to observe concrete sampling and testing at any time.
    c. Contractor is responsible for providing care of and curing conditions for test specimens in accordance with ASTM C31 until specimens are collected by testing laboratory.
    d. Provide 4 firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold 10 specimens. Include cold weather temperature and

hot weather temperature control thermostat for initial curing and storage from time of fabrication through shipment to Owner's testing laboratory.

3. Testing shall include:
   a. Sampling of concrete in accordance with ASTM C172.
   b. Temperature of concrete at delivery in accordance with the requirements of ASTM C1064 and as specified in this Section.
   c. Slump of concrete using slump cone in accordance with requirements of ASTM C143. Test slump at the following intervals:
      1) At the beginning of each placement.
      2) As often as necessary to keep slump within the specified range, but not less than every 6th truck.
      3) When requested to do so by the Engineer.
      4) Observe concrete during slump test for signs of segregation.
         a) Observe concrete to see if mortar or moisture flows from slumped concrete.
         b) Reject concrete if mortar or moisture flows out of mix.
   d. Unit weight of concrete in accordance with ASTM C138.
   e. Air entrainment in accordance with ASTM C173. Test air content at the following intervals:
      1) At beginning of each placement.
      2) As often as necessary to keep entrained air within specified range, but not less than every 6th truck.
      3) When requested to do so by the Engineer.
      4) Test air entrainment in concrete in accordance with ASTM C173. If air entraining admixtures used for the Work require alternate testing procedures, advise the independent testing laboratory well in advance of the dates of testing, and confirm that appropriate equipment and personnel are provided for the test.
      5) Make air test at point of delivery (discharge from mixer). For pumped concrete, make air tests at point of delivery and at point where expelled after pumping for placement.
   f. Compressive strength in accordance with ASTM C39. Required number of cylinders is as follows:
      1) Not less than 6 cylinder specimens, 4 inches in diameter by 8 inches long, will be tested for each 150 cubic yards of each class of concrete, with minimum of 6 specimens for each class of concrete placed; not less than 6 specimens for each half day's placement; and not less than 2 sets of 6 specimens for each structure.
      2) 1 cylinder will be broken at 7 days, 1 at 14 days, and 3 at 28 days. The 6th cylinder may be used to evaluate strength after 28 days if requested by the Engineer.
      3) Retain and store "6th cylinders" (tested and untested) at testing laboratory until 56 days. Break "6th cylinder" when directed by the Engineer.
   g. Provide full access for Engineer to observe concrete sampling and testing at any time.

C. Test completed liquid containment structures listed in Section 01759 - Water Leakage Test for Concrete Structures for watertightness.

1.22 FIELD QUALITY CONTROL BY OWNER

A. Provide on-site inspection and field quality assurance for the Work of this Section.

B. Special tests and inspections: See Section 01455 - Regulatory Quality Assurance.

C. Field inspections:
   1. Required inspections:
      a. Observe construction for conformance to the Contract Documents and the accepted submittals.
   2. Records of inspections:
      a. Provide record of each inspection.
      b. Submit copies to Contractor upon request.

D. Field tests:
   1. Engineer may request, at any time, additional testing to confirm that materials being delivered and placed conform to the requirements of the Contract Documents.
      a. If such additional testing shows that the material do not conform to the specified requirements, Contractor shall pay the cost of these tests.
      b. If such additional testing shows that the materials do conform to the specified requirements, Owner will pay the cost of these tests.

1.23 NON-CONFORMING WORK

A. Remove and replace or repair non-conforming and defective work.
   1. Provide repairs having strength equal to or greater than specified concrete for areas involved.
   2. Provide replacement or repair of non-conforming work by means acceptable to the Engineer and at no additional cost to Owner.
   3. Project schedule will not be extended based on work to address non-conforming concrete.

B. Concrete not conforming to the specified requirements for properties of plastic concrete: Remove from the site and replace with conforming materials at no additional cost to Owner.
   1. Temperature: Do not use concrete having a temperature above or below the limits specified in this Section.
   2. Slump: Do not place concrete that does not conform to requirements for slump.
   3. Air entrainment: Do not use concrete that does not conform to requirements for percentage of entrained air.

C. Concrete not conforming to the specified requirements for compressive strength:
   1. Concrete is expected to reach a compressive strength equal to or greater than the minimum specified compressive strength f'c in Table 3 of this Section.
   2. Strength of concrete will be considered acceptable if following conditions are satisfied.
      a. Averages of all sets of 3 consecutive strength test results is greater than or equal to the specified compressive strength f'c.
      b. No individual strength test (average of 3 cylinders) falls below the strength specified in Table 6 of this Section.

c. Where relationships between 7-day and 28-day compressive strength, or between 28-day and 56-day compressive strength, have been provided as part of the mix design submittals:
   1) 7-day strength may be considered as an indication of 28 day strength provided effects of temperature and humidity between 7 day and 28 day are taken into account.
   2) 28-day strength may be considered as indication of 56 day strength provided effects of temperature and humidity between 28 days and 56 days are taken into account.

Table 6: Strength Compliance Requirements

Minimum Specified Compressive Strength, f'c (pounds per square inch)	Lower Bound of an Individual Compressive Strength Test, (pounds per square inch)
Less than 5,000	f'c – 500
Over 5,000	f'c – (0.10 x f'c)

3. Non-compliant strength tests.
   a. Mark non-compliant strength test reports to highlight the non-complying results, and immediately forward copies to all parties on the test report distribution list.
   b. Initial treatment may consist of additional curing of affected portion(s) followed by not less than 3 cores at each affected area, taken in accordance with ASTM C42 and ACI 318. Obtain Engineer's acceptance of proposed coring locations before proceeding with that work.
   c. Submit report of compressive strength testing for Engineer's review.
   d. If requested by the Engineer, provide additional cores and obtain petrographic testing in accordance with ASTM C856. Submit results for Engineer's review.
   e. If additional curing does not bring the average strength of 3 cores taken in affected area to at least specified compressive strength f'c, designate such concrete in affected area will be considered defective.
   f. Engineer may require the Contractor to strengthen defective concrete by means of additional concrete, additional reinforcing steel, or replacement of defective concrete, all of the Contractor's expense.

D. Concrete sections or surfaces with honeycombing and voids:
   1. Provide repairs having surface appearance and finish consistent with that of the surrounding work and acceptable to the Engineer.
   2. Do not patch, repair, or cover defective Work without prior inspection by the Engineer.
   3. Preparation of concrete for repair:
      a. Make no repair until Engineer has accepted methods for preparing surfaces and for making and curing repairs.
      b. Chip out and key-in imperfections in the Work to make them ready for repair.
      c. Coat bonding surfaces and edges of repair area with one of the following bonding agents as accepted by the Engineer.
         1) Epoxy bonding agent as specified in Section 03071 - Epoxies; or
         2) Epoxy resin/portland cement bonding agent as specified in Section 03072 - Epoxy Resin/Portland Cement Bonding Agent.

4. Methods of repair:
    a. Dry pack mortar method:
        1) Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt holes, and for narrow slots cut for repair.
        2) Smooth Holes: Clean and roughen by heavy sandblasting before repair.
        3) Install dry-pack mortar as specified in Section 03600 - Grouting.
    b. Cement mortar method:
        1) Use for holes too wide to dry pack and too shallow for concrete replacement; and for comparatively shallow depressions, large or small, that extend no deeper than nearest surface reinforcement.
        2) Install cement mortar as specified in Section 03600 - Grouting.
    c. Concrete replacement:
        1) Use when holes extend entirely through the concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.
        2) Form, place, consolidate, and cure concrete of same mix as the surrounding work.

E. Leaking construction joints and cracks in concrete walls and slabs:
    1. Repair cracks that develop in walls or slabs, and repair cracks that show any signs of leakage until all leakage is stopped.
    2. Pressure inject visible cracks in the following areas, other than hairline cracks and crazing, with repair products and methods acceptable to the Engineer.
        a. Floors and walls of water bearing structures.
        b. Walls and overhead slabs of passageways and occupied spaces where the opposite face of the member is exposed to weather or may be washed down and where the opposite face does not receive a separate waterproofing membrane.
        c. Other items not specified to receive separate waterproofing membrane including slabs over water channels, wet wells, reservoirs, and other similar surfaces.
    3. Continue pressure injection of cracks as specified until structure is watertight and remains watertight for not less than 1 year after date of Substantial Completion or date of final repair, whichever occurs later in time.

F. Leaking expansion joints in concrete walls or slabs that include waterstops:
    1. Repair any signs of leakage until all leakage is stopped.
    2. Pressure inject visible leaks with hydrophilic polyurethane foam resin as specified in Section 03933 - Hydrophilic and Hydrophobic Foam Polyurethane Resin Injection System.
    3. Continue pressure injection along joints lines as specified until structure is watertight and remains watertight for not less than 1 year after date of Substantial Completion or date of final repair, whichever occurs later in time.

G. Walls and slabs at overhead channels that leak or sweat because of porosity or cracks too small for successful pressure injection with epoxy.
    1. Seal on water or weather side by coating using surface-applied sealing system as specified in this Section.

2. Apply as recommended by manufacturer published instructions. Where concrete continues to sweat or leak, apply additional coats of surface-applied sealing system until the sweating or leaks stop.
3. Continue application of surface-applied sealing system until structure is watertight and remains watertight for not less than 1 year after date of Substantial Completion, or date of final repair, whichever occurs later in time.

403S.11, Measurement: **DELETE** the entire section

403S.12, Payment: **DELETE** the entire section

End

SPECIAL PROVISION To

Standard Specification to Item No. 405S
CONCRETE ADMIXTURES

For this project Item No. 405S Concrete Admixtures of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

405S.2 Submittals: **DELETE** subsection in its entirety and **INSERT** the following:

1.01 PRODUCT DATA:

A. Submit data completely describing products and demonstrating compliance with the requirements of this Section.

B. Admixtures:
   1. For each admixture included in concrete mixes, submit manufacturer's product data demonstrating compliance with standards specified.
   2. If air entraining admixture requires test method other than ASTM C173 to accurately determine air content, make special note of requirements in submittal.

405S.3 Materials: **DELETE** paragraphs (1) through (6) and **INSERT** the following:

A. Admixtures:
   1. General:
      a. Do not include admixtures, other than those specified, unless written acceptance has been obtained from the Engineer during submittal of mix designs.
      b. Admixtures shall be compatible with concrete constituents and with other admixtures.
         1) All admixtures in a given mix shall be products of the same manufacturer to ensure compatibility.
         2) Admixture manufacturers: One of the following, or equal.
            a) BASF Corp., Master Builders Solutions.
            b) Euclid Chemical.
            c) GCP Applied Technologies (formerly W.R. Grace).
            d) Sika Corp.
      c. Do not use admixtures containing chlorides, calculated as chloride ion, in excess of 0.5 percent by weight of cement.
      d. Use in accordance with manufacturer's recommendations. Add each admixture to concrete mix separately.
      e. Admixtures used shall be the same products used in concrete trial batches, or the same products used in concrete represented by submitted field test records.
   2. Air entraining admixture (AEA):

B. In accordance with ASTM C260, and dosed to provide entrained air percentages specified in this Section.

C. Provides entrained air as bubbles, evenly dispersed at the time of placement and during curing.
   1. Water reducing admixture(WRA):
      a. May be used at the Contractor's option.
      b. Conforming to ASTM C494, Type A (water-reducing).
         1) ASTM C494, Type D (water-reducing and retarding) may be used during periods of hot weather with prior acceptance by the Engineer.
      c. Not containing air-entraining agents.
      d. Liquid form before adding to the concrete mix.
   2. High range water reducing admixtures ("super-plasticizers") (HRWR):
      a. Not permitted without acceptance by Engineer.

   3. Shrinkage reducing admixture (SRA):
      a. May be used at Contractor's option.
         1) Provide shrinkage reducing admixture in sufficient dosage so as to produce shrinkage within the limits specified.
      b. Not containing expansive agents.
      c. In accordance with ASTM C494, Type S (specific performance).
      d. One of the following, or equal:
         1) BASF Corporation, Master Builders Solutions: SRA Series.
         2) Euclid Chemical: Eucon SRA Series.
         3) GCP Applied Technologies: Eclipse Series.

   4. Set-controlling admixtures:
      a. Shall not be used without prior acceptance from Engineer.
      b. Accelerating admixtures: not permitted.

D. Coloring admixtures:
   1. Conduit encasement coloring agent:
      a. Red color concrete used for encasement of electrical ducts, conduits, and similar type items.
      b. Manufacturers: One of the following or equal:
         1) Davis Co., #100 Utility Red.
         2) I. Reiss Co., Inc., equivalent product.
         3) Euclid Chemical Co., Increte Division, “Colorcrete Brick Red.”
      c. Conduit encasement concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

405S.6, Measurement and Payment: **DELETE** the entire section.

DELETE the entire section of SPECIFIC CROSS REFERENCE MATERIALS

DELETE the entire section of RELATED CROSS REFERENCE MATERIALS

End

SPECIAL PROVISION To

Standard Specification to Item No. 406S
REINFORCING STEEL

For this project Item No. 406S Reinforcing Steel of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

416S.2 Submittals: **DELETE** subsection in its entirety and **INSERT** the following:

1.01 GENERAL:

A. Submit in accordance with Section 01330 - Submittal Procedures.

B. Changes to reinforcement in Contract Documents:
   1. Indicate in a separate letter submitted with shop drawings any changes to reinforcement indicated on the Drawings or specified.
   2. Such changes will not be acceptable unless Engineer has accepted them in writing.

1.02 PRODUCT DATA:

A. Bar supports:
   1. Wire bar supports:
      a. Schedule of support materials to be provided and locations of use.
   2. Precast concrete bar supports ("dobies"):
      a. Manufacturer's data indicating compression strength of concrete and confirming dimensions and thickness(es).height(s) to be provided for each location where used.

B. Mechanical reinforcing bar couplers. For each type and/or series to be provided:
   1. Evaluation Report documenting compliance with the requirements of ICC-ES AC133.
   2. Details, properties, and dimensions of couplers. Include type or size identification, and bar size(s) and grade(s) for which the coupler is suitable.
   3. Manufacturer’s installation and testing instructions.
   4. Manufacturer's statement that products installed in accordance with manufacturer's recommended procedures will develop strengths and limit slip as specified in this Section.

C. Mechanical reinforcing bar end anchors (terminators).
   1. Evaluation Report documenting compliance with the requirements of ICC-ES AC307.
   2. Details, properties, and dimensions of end anchors. Include type or size identification, and bar size(s) and grade(s) for which the end anchor is suitable.
   3. Manufacturer’s installation and testing instructions.
   4. Manufacturer's statement that products installed in accordance with manufacturer's recommended procedures will develop strengths and limit slip as specified in this Section.

1.03 SHOP DRAWINGS:

A. Reinforcement shop drawings:
   1. Submit drawings showing bending and placement of reinforcement required by the Contract Documents.
   2. Clearly indicate structures or portions of structures covered by each submittal.
      a. Submit reinforcement shop drawings for each structure as a complete package. Submittals addressing only a portion of a structure will be rejected and returned without review, unless such presentation is accepted by Engineer in advance.
   3. Shop drawings shall conform to the recommendations of the CRSI Manual of Standard Practice and ACI SP-66.
   4. Use the same bar identification marks on bending detail drawings, placement drawings, and shipping tags.
   5. Submittals consisting solely of reinforcing bar schedules, without accompanying placement drawings, will not be accepted unless accepted under prior written agreement with Engineer.

B. Reinforcement placement drawings:
   1. Clearly show placement of each bar listed in the bill of materials, including additional reinforcement at corners and openings, and other reinforcement required by details in the Contract Documents.
   2. Clearly identify locations of reinforcement with coatings (e.g., galvanized or epoxy) and with yield strength other than ASTM A615, Grade 60.
   3. Show splice locations.
   4. Indicate locations of mechanical reinforcing couplers if used.
   5. Show locations of reinforcing bar end anchors, if used.

C. Reinforcement fabrication drawings:
   1. If bend types or nomenclature differs from that recommended in the CRSI Manual of Standard Practice, provide details showing bend types and dimensional designations.
   2. Clearly identify reinforcement with coatings and with yield strength other than ASTM A615, Grade 60.

1.04 SAMPLES (WHEN REQUESTED BY ENGINEER):

A. Bar supports/wire reinforcement supports: Samples of each type of chair and bolster proposed for use. Submit with letter stating where each type will be used.

B. Precast concrete bar supports: Samples of each type of precast support proposed for use. Submit with letter stating where each will be used.

1.05 TEST REPORTS:

A. Certified copy of mill test for each steel used. Show physical properties and chemical analysis.
   1. Mill test reports may be submitted as record documents at the time the reinforcement from that heat of steel is shipped to the site.
   2. In such cases, submit certificates under the shop drawing submittal number with the letter "R" (for record date) appended to the end (e.g., of the

reinforcement was submitted as 03200-002-1, deliver the associated mill certificate as submittal 03200-002-1R).

B. Mechanical reinforcing bar couplers:
   1. Current Evaluation Report confirming that couplers provide specified tension and compression strength and conform to specified limits on total slip within the coupler.
   2. Certified copy of mill tests for heat(s) of steel incorporated into the reinforcing bar couplers shipped.
   3. For threaded sleeve type couplers, heat treatment lot numbers for each shipment.

C. Reinforcing bar end anchors:
   1. Current Evaluation Report confirming that end anchors provide specified tension strength.
   2. Certified copy of mill tests for heat(s) of steel incorporated into the materials shipped.

1.06 MANUFACTURER'S INSTRUCTIONS:

A. Mechanical reinforcing bar couplers:
   1. Manufacturer's installation instructions.
   2. Manufacturer's instructions for confirmation testing of couplers after reinforcing bars have been inserted into the couplers.

B. Mechanical reinforcing bar end anchors:
   1. Manufacturer's installation instructions.
   2. Manufacturer's instructions for confirmation testing of end anchors.

1.07 SPECIAL PROCEDURES:

A. Welding procedures conforming to AWS D1.4 for reinforcement to be field welded.
   1. Procedures qualification record.

1.08 QUALIFICATIONS STATEMENTS:

A. Welder qualifications.

1.09 CLOSEOUT DOCUMENTS:

A. Field quality control and inspection reports.

B. Field quality assurance special inspection and testing reports.

406S.3 Materials:

DELETE Paragraph B. Deformed Bards and Wire Reinforcement, Sub-Paragraph 1 and **INSERT** the following:

B. Reinforcing bars:
   1. Provide reinforcement of the grades and quality specified, fabricated from new stock, free from excessive rust or scale, and free from unintended bends or other defects affecting its usefulness.

2. Reinforcing bars:
    a. ASTM A615 Grade 60 deformed bars, including the following requirements, or ASTM A706 Grade 60 deformed bars.
        1) Actual yield strength based on mil tests of reinforcement provided shall not exceed the minimum yield strength specified in this Section by more than 18,000 pounds per square inch.
        2) Ratio of actual ultimate tensile strength to actual tensile yield strength shall not be less than 1.25.
3. Reinforcing bars designated or required to be welded:
    a. Low-alloy, ASTM A706 Grade 60, deformed bars.
    b. ASTM A615 Grade 60 deformed bars may be used in lieu of ASTM A706 Grade 60 if following requirements are satisfied.
        1) Welding procedures conforming to AWS D1.4 are submitted to Engineer.
        2) The specific location for proposed substitution is acceptable to Engineer.

C. Thread bars:
1. Reinforcing bars conforming to ASTM A615, Grade [60][75][ ] unless otherwise indicated on the Drawings, and having a continuous rolled-in pattern of thread-like deformations along entire length.
    a. Substitution of shop-cut threads on regular ASTM A615 or A706 reinforcing bars is not permitted.
2. Thread bar hardware, including nuts (hex and jamb), couplers, and washers (flat, spherical, and beveled):
    a. Provided by same manufacturer as the threaded bars.
    b. Capable of developing a load equal to at least 125 percent of the yield strength of the threaded bar.
3. Manufacturers: One of the following or equal:
    a. DYWIDAG-Systems International (DSI), DYWIDAG Threadbar®:
        1) [Bar and accessories hot-dip galvanized in accordance with ASTM A123.]
    b. Williams Form Engineering Corp., Grade 75 all-thread rebar:
        1) [Bar and accessories hot-dip galvanized in accordance with ASTM A153 to minimum 3 mils coating thickness.]
    c. [ ].

D. Bar supports:
1. Wire supports:
    a. All stainless steel bar supports:
        1) Conforming to CRSI Manual of Standard Practice recommendations for types and details, but custom fabricated entirely from stainless steel wire conforming to ASTM A493, AISI Type 316.
    b. Stainless steel protected bar supports:
        1) Conforming to CRSI Manual of Standard Practice Class 2, Type B, and consisting of bright basic wire support fabricated from cold--drawn carbon steel wire with stainless steel ends attached at the bottom of each leg.
        2) Stainless steel wire ends shall conform to ASTM A493, AISI Type 316 and shall extend at least 3/4 inch inward from the formed surface of the concrete.

c. Bright basic wire bar supports.
1) Conforming to CRSI Manual if Standard Practice, Class 3.

2. Plastic supports:
a. Manufacturers: The following or equal:
1) Aztec Concrete Accessories.

3. Deformed steel reinforcing bar supports:
a. Fabricated of materials and to CRSI details recommended for typical reinforcement embedded in concrete and bent to dimensions required to provide specified clearances and concrete cover.

4. Precast concrete bar supports ("dobies"):
a. Pre-manufactured, precast concrete blocks with cast-in annealed steel wires, 16-gauge or heavier.
b. Compression strength of concrete: Equal to or exceeding the compression strength of the surrounding concrete.
c. Block dimensions:
1) Height to provide specified concrete cover.
2) Footprint not less than 3 inches by 3 inches, and adequate to support the weight of the reinforcement and maintain specified concrete cover without settling into the underlying surface.

5. Stainless steel wire supports on stainless steel plates:
a. Type 304 stainless steel wire bar support chairs or bolsters supported on Type 304 stainless steel plates resting on the ground surface.
1) Weld plates to at least 2 legs of wire support chairs.

E. Tie wires:
1. General use: Black annealed steel wire, 16-gauge or heavier.

DELETE Paragraph C. Smooth Bar and Spiral Reinforcement

DELETE Paragraph D. Weldable Reinforcing Steel in its entirety and **INSERT** the following

D. Welding reinforcing bars:
1. Weld reinforcing bars only where indicated on the Drawings or where acceptance is received from Engineer prior to welding.
2. Perform welding in accordance with AWS D1.4 and welding procedures accepted by Engineer.
a. Conform to requirements for minimum preheat and interpass temperatures.
3. Submit:
a. Welding procedures specification.
b. Procedures qualification record.
c. Welder qualification test record.
4. Do not tack weld reinforcing bars except where specifically indicated on the Drawings.

DELETE Paragraph E. Welded Wire Fabric in its entirety and **INSERT** the following:

E. Welded wire fabric reinforcement:
1. Material:
a. Carbon steel conforming to ASTM A1064.
2. Provide welded wire reinforcement in flat sheet form. Rolled wire fabric is not permitted.

3. Fabric may be used in place of reinforcing bars if accepted by Engineer:
    a. Provide welded wire fabric having cross-sectional area per linear foot not less than the cross-sectional area per linear foot of reinforcing bars indicated on the Drawings.

DELETE Paragraph F. Epoxy Coating.

DELETE Paragraph G. Mechanical Couplers in its entirety and **INSERT** the following:

G. Mechanical reinforcing bar couplers [and end anchors]:
    1. General:
        a. Only products conforming to the requirements of ACI 318 for mechanical splices, and holding a current Evaluation Report that documents the following performance characteristics, will be considered for use.
        b. Strength of coupler: Capable of developing tension and compression strength not lower than the lesser of the following:
            1) ACI 318 "Type 2" units: In static tension and compression:
                a) Minimum 125 percent of the ASTM-specified minimum yield strength of the reinforcement being spliced[or terminated].
                b) Minimum 100 percent of the ASTM-specified minimum ultimate strength of the reinforcement being spliced[or terminated].
        c. Slip of reinforcing bars within coupler: Total slip of the reinforcing bars within the splice sleeve limited as follows:
            1) For bar sizes #14 and smaller, elongation between gauge points measured clear of the splice sleeve not exceeding 0.010 inches after coupler has been loaded to a tension of 30,000 pounds per square inch and load relaxed to a tension of 3,000 pounds per square inch.
        d. Fabrication:
            1) Threaded joints:
                a) Provide threaded ends designed so that cross-threading of bars will not occur during assembly.
                b) Fabricate male ends for female couplers using coupler manufacturer’s bar threading equipment to ensure proper taper and thread engagement.
            2) Mark each sleeve with heat treatment lot number.
    2. Couplers: Threaded - Reinforcing bar splice at construction joints.
        a. Steel sleeve butt splice with tapered internal threads in forged or swaged head, and nailing flange for attaching to forms. Provide with matching, tapered male-threaded dowels for insertion and tightening into threaded sleeve after form removal.
            1) Provide sleeve with factory-installed plugs to prevent concrete mortar from entering internally threaded coupler.
            2) Provide optional clipped nailing flanges as required to maintain minimum specified concrete cover over surfaces of coupler.
        b. Holding current Evaluation Report demonstrating acceptance under ICC-ES AC133.
        c. Manufacturers: One of the following or equal:
            1) Dayton Superior, DBDI Splice System.
            2) ERICO-Pentair, Lenton Form Saver.
    3. Couplers: Threaded - reinforcing bar splice:
        a. Steel sleeve butt splice with tapered internal threads at each end for joining to matching tapered male threads on reinforcing bars.

b. Holding current Evaluation Report demonstrating acceptance under ICC-ES AC133.
c. Manufacturers: One of the following, or equal:
1) Dayton Superior: Taper-Lock System.
2) ERICO-Pentair: Lenton Taper Threaded Splicing System.

4. Couplers: Threaded - All thread rod to reinforcing bar:
a. Steel sleeve butt splice with tapered internal threads on one end for joining to matching tapered male threads on reinforcing bars, and straight internal threads at opposite end for joining to matching straight male threads on all-thread rods.
b. Holding current Evaluation Report demonstrating acceptance under ICC-ES AC133.
c. Manufacturers: The following or equal:
1) ERICO-Pentair, Lenton Bolt Coupler - S4 or S5 Series.

5. End anchors:
a. Headed steel disc with tapered internal female threads for joining to matching tapered male threads on reinforcing bars.
b. Holding current Evaluation Report demonstrating acceptance under ICC-ES AC347.
c. Manufacturers: One of the following or equal:
1) Dayton Superior, D350/351 Taper-Lock End Anchor Disc.
2) ERICO-Pentair, Inc., Lenton Terminator.

DELETE Paragraph H. Chairs and Supports

406S.7, Splices: **DELETE** subsection in its entirety and **INSERT** the following:

1.01 LAP SPLICES FOR BARS:

A. Lap splice locations and lap splice lengths: as indicated on the Drawings. Where lap lengths are not indicated, provide in accordance with ACI 318.

B. Unless otherwise specifically indicated on the Drawings (and noted as "non-contact lap splice"), install bars at lap splices in contact with each other and fasten together with tie wire.

C. Where bars are to be lap spliced at concrete joints, ensure that bars project from the first concrete placement a length equal to or greater than minimum lap splice length indicated on the Drawings.

D. Stagger lap splices where indicated on the Drawings.

E. Where lap splice lengths are not indicated on the Drawings, provide lap splice lengths in accordance with ACI 318.

406S.8, Placement:

DELETE the first paragraph and table in its entirety and **INSERT** the following:

A. Reinforcing bars: General:
1. Field-cutting of reinforcing bars is not permitted.

2. Field-bending of reinforcing bars, including straightening and rebending, is not permitted.

B. Placing reinforcing bars:
   1. Accurately place bars to meet position and cover requirements indicated on the Drawings and specified. Secure bars in position.
   2. Tolerances for placement and minimum concrete cover: As listed in Table 1.

Table 1 - Reinforcement Placing Tolerances

Member	Tolerance on Reinforcement Location (1)	Tolerance on Minimum Concrete Cover (1,2)
Slabs, beams, walls and columns except as noted below:		
10 inches thick and less	± 3/8 inch	- 3/8 inch
More than 10 inches thick	± 1/2 inch	- 1/2 inch
Formed soffits:	As noted above	- 1/4 inch
Longitudinal location of bends and ends of reinforcement:		
Conditions not listed below:	± 2 inches	- 1/2 inch
At discontinuous ends of brackets and corbels	± 1/2 inch	- 1/4 inch
At discontinuous ends of other members:	± 1 inch	- 1/2 inch

Notes:
(1) ± indicates "plus or minus;" - indicates "minus;" + indicates "plus."
(2) Tolerance on cover is limited as noted, but decrease in cover shall not exceed one third of the minimum cover indicated on the Drawings.

   3. Spacing between bars:
      a. Minimum clear spacing between bars in a layer:
         1) As indicated on the Drawings, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
      b. Minimum clear spacing between bars in 2 or more parallel layers:
         1) Place bars in upper layers directly above bars in lower layers.
         2) Minimum spacing between layers: As indicated on the Drawings, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
      c. Limits on minimum clear spacing between bars also applies to the clear spacing between a lap splice and the adjacent bars and/or lap splices.
   4. Lap splices for bars:
      a. Lap splice locations and lap splice lengths: as indicated on the Drawings. Where lap lengths are not indicated, provide in accordance with ACI 318.
      b. Unless otherwise specifically indicated on the Drawings (and noted as "non-contact lap splice"), install bars at lap splices in contact with each other and fasten together with tie wire.

c. Where bars are to be lap spliced at concrete joints, ensure that bars project from the first concrete placement a length equal to or greater than minimum lap splice length indicated on the Drawings.
d. Stagger lap splices where indicated on the Drawings.
e. Where lap splice lengths are not indicated on the Drawings, provide lap splice lengths in accordance with ACI 318.

C. Reinforcing supports:
1. Provide supports of sufficient numbers, sizes, and locations to maintain concrete cover, to prevent sagging and shifting, and to support loads during construction without displacement and without gouging or indentation into forming surfaces.
a. Quantities and locations of supports shall not be less than those indicated in ACI SP-66 and the CRSI Manual of Standard Practice.
2. Do not use brick, concrete masonry units, concrete spalls, rocks, wood, or similar materials for supporting reinforcement.
3. Do not use "give away bars" that have less cover than that required by the Contract Documents. Do not adjust the location of reinforcement required by the Contract Documents to provide cover for give away bars.
4. Provide bar supports of height required to maintain the clear concrete cover indicated on the Drawings.
5. Provide bar supports at formed vertical faces to maintain the clear concrete cover indicated on the Drawings.
6. Schedule of reinforcement support materials: Provide bar supports as indicated in Table 2.

Table 2 - Reinforcement Support Materials

Case	Location	Material
a.	Concrete placed over earth and concrete seal slabs ("mud mats"):	**[Precast concrete bar supports.][Stainless steel wire supports on stainless steel plates.]**
b.	Concrete placed against forms and exposed to water or wastewater process liquids (whether or not such concrete received additional linings or coatings):	All stainless steel bar supports.
c.	Concrete placed against forms and exposed to earth, weather, frequent washdown, or groundwater in the finished work	**[All stainless steel bar supports.]** **[Stainless steel protected bar supports.]**
d.	Concrete placed against forms and exposed to interior equipment/piping areas in the finished work	**[All stainless steel bar supports.]** **[Stainless steel protected bars supports.]**
e.	Between mats of reinforcement, and fully	Bright basic wire bars supports, or deformed steel reinforcing bars.

Table 2 - Reinforcement Support Materials		
Case	**Location**	**Material**
	embedded within a concrete member	

D. Tying of reinforcing:
   1. Fasten reinforcement securely in place with wire ties.
   2. Tie reinforcement at spacings sufficient to prevent shifting.
      a. Provide at least 3 ties in each bar length. (Does not apply to dowel lap splices or to bars shorter than 4 feet, unless necessary for rigidity).
   3. Tie slab bars at every intersection around perimeter of slab.
   4. Tie wall bars and slab bar intersections other than around perimeter at not less than every fourth intersection, but at not more than the spacing indicated in Table 3:

Table 3 - Maximum Spacing of Tie Wires for Reinforcement		
Bar Size	**Slab Bar Spacing (inches)**	**Wall Bar Spacing (inches)**
Bars Number 5 and Smaller	60	48
Bars Number 6 through Number 9	96	60
Bars Number 10 and Number 11	120	96

   5. After tying:
      a. Bend ends of wires inward towards the center of the concrete section. Minimum concrete cover for tie wires shall be the same as cover requirements for reinforcement.
      b. Remove tie wire clippings from inside forms before placing concrete.

DELETE the following text:

"The exposure of the ends of longitudinals, stirrups and spacers used to position the reinforcement in concrete pipe and in precast box culverts or storm drains Is not a cause for rejection. Reinforcing steel for bridge slabs, top slabs of direct traffic culverts, and top slabs of prestressed box beams at all intersections, except tie only alternate intersections where spacing is less than 1 ft. (300 mm) in each direction."

DELETE Paragraph 406S.9. Handling, Placement and Repair of Epoxy-coated Reinforcement steel.

406S.11, Payment: **DELETE** the entire section.

DELETE the entire section of SPECIFIC CROSS REFERENCE MATERIALS.

DELETE the entire section of RELATED CROSS REFERENCE MATERIALS.

End

SPECIAL PROVISION To

Standard Specification to Item No. 408S
CONCRETE JOINT MATERIALS

For this project Item No. 408S Concrete Joint Materials of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

408S.3 Material:

DELETE paragraph (1) (2) (3) (5) and (7) in its entirety and **INSERT** the following:

A. JOINT FILLERS
   1. General:
      a. Use specific type in applications as indicated on the Drawings.
      b. Do not use scrap or recycled materials to manufacture joint fillers.
   2. Expanded polystyrene joint filler:
      a. Commercially available polystyrene board:
      b. Minimum flexural strength: 35 pounds per square inch in accordance with ASTM C203.
      c. Compressive yield strength: Between 16 and 40 pounds per square inch at 5-percent compression.
   3. Hardboard:
      a. 1/8-inch minimum thickness.
      b. In accordance with ANSI A135.4 Class 2.
   4. Preformed expansion joint materials:
      a. Bituminous fiber expansion joint material:
         1) Properties:
            a) Thickness: To match joint width indicated on the Drawings.
            b) Asphalt-impregnated fiber in accordance with ASTM D1751.
         2) Manufacturers: One of the following or equal:
            a) Durajoint.
            b) W.R. Meadows, SealTight Fibre Expansion Joint.
      b. Synthetic sponge rubber expansion joint material:
         1) Properties:
            a) Thickness: As recommended for width indicated on the Drawings.
            b) Material in accordance with ASTM D1752, Type I.
         2) Manufacturers: One of the following or equal:
            a) Williams Products Inc., Everlastic 1300.
            b) W.R. Meadows, SealTight Sponge Rubber.

ADD the following section as 408S.6, Execution

1.01 408S.6 EXECUTION

A. Joints:
   1. Construct construction and expansion joints as indicated on the Drawings.

2. Preformed expansion joint material: Fasten expansion joint strips to concrete, masonry, or forms with adhesive. No nailing will be permitted, nor shall expansion joint strips be placed without fastening.

B. Expanded polystyrene joint filler:
   1. When filler is indicated on the Drawings or specified, place filler in correct position before concrete is placed against filler.
   2. Fill holes and joints in filler with caulking to prevent entry of mortar into joint or passage of mortar or concrete from one side of joint to other.

C. Hardboard:
   1. When indicated on the Drawings, face surface of joint filler with hardboard.
   2. Other facing materials may be used provided they furnish equivalent protection and material is acceptable to Engineer.
   3. Hold hardboards in place with nails, waterproof adhesive, or other means acceptable to Engineer.

D. Slip dowels at expansion joints:
   1. Where indicated on the Drawings, install smooth dowels at right angles to expansion joints.
      a. Align dowels with finished surface.
      b. Rigidly hold in place and support during concrete placement.
   2. Slip dowel sleeves:
      a. Locate slip dowel sleeves on expansion joints as indicated on the Drawings.
   3. Slip dowel end caps:
      a. Unless otherwise indicated on the Drawings, apply a bond breaker at one end of dowels through expansion joints.
      b. Provide slip dowel end caps on the lubricated end of expansion dowels.

END

SPECIAL PROVISION To

Standard Specification to Item No. 410S
CONCRETE STRUCTURES

For this project Item No. 410S Concrete Structures of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

410S.2 Submittals: **DELETE** subsection in its entirety and **INSERT** the following:

A. Information on proposed forming system:
   1. Submit in such detail as the Engineer may require to assure themselves that intent of the Specifications can be complied with by use of proposed system.
   2. Alternate combinations of plywood thickness and stud spacing may be submitted.

B. Form release agent. NSF 61 certification prepared by NSF, Underwriters Laboratories (UL) or other, similar, nationally recognized testing laboratory acceptable to the Engineer.

410S.3 Materials: **DELETE** paragraphs B through K in its entirety and **INSERT** the following

B. DESIGN AND PERFORMANCE CRITERIA
   1. Design requirements:
      a. Design of concrete forms, falsework, and shoring in accordance with local, state, and federal regulations.
      b. Design forms and ties to withstand concrete pressures without bulging, spreading, or lifting of forms.
   2. Performance requirements:
      a. Construct forms so that finished concrete conforms to shapes, lines, grades, and dimensions indicated on the Drawings.
      b. It is intended that surface of concrete after stripping presents smooth, hard, and dense finish that requires minimum amount of finishing.
      c. Provide sufficient number of forms so that the work may be performed rapidly and present uniform appearance in form patterns and finish.
      d. Use forms that are clean and free from dirt, concrete, and other debris.
         1) Coat with form release agent if required, prior to use or reuse.

C. MANUFACTURED UNITS
   1. Forms: Built-up plywood:
      a. Built-up plywood forms may be substituted for prefabricated forming system subject to following minimum requirements:
         1) Size and material:
            a) Use full size 4-foot by 8-foot plywood sheets, except where smaller pieces are able to cover entire area.
            b) Sheet construction: 5-ply plywood sheets, 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

2) Wales: Minimum 2-inch by 4-inch lumber.
3) Studding and wales: Contain no loose knots and be free of warps, cups, and bows.

2. Forms: Steel or steel framed:
   a. Steel forms:
      1) Rigidly constructed and capable of being braced for minimum deflection of finish surface.
      2) Capable of providing finish surfaces that are flat without bows, cups, or dents.
   b. Steel framed plywood forms:
      1) Provide forms that are rigidly constructed and capable of being braced.
      2) Plywood paneling: 5-ply, 5/8-inch nominal or 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.
3. Form release agent.
   a. Effective, non-staining, bond-breaking coating compatible with form surfaces and concrete mixes used.
4. Form ties:
   a. General:
      1) Provide form ties for forming system selected that are manufactured by recognized manufacturer of concrete forming equipment.
      2) Do not use wire ties or wood spreaders of any form.
      3) Provide ties of type that accurately tie, lock, and spread forms.
      4) Provide form ties of such design that when forms are removed, they locate no metal or other material within 1-1/2 inches of the surface of the concrete.
      5) Do not allow holes in forms for ties to allow leakage during placement of concrete.
   b. Cone-snap ties:
      1) Cone-snap ties shall form a cone shaped depression in the concrete with minimum diameter of 1 inch at the surface of the concrete and minimum depth of 1-1/2 inches.
      2) Provide neoprene waterseal washer that is located near the center of the concrete.
   c. Taper ties:
      1) Neoprene plugs for taper tie holes: Size so that after they are driven, plugs are located in center third of wall thickness.
5. Incidentals:
   a. External angles:
      1) Where not otherwise indicated on the Drawings, provide with 3/4-inch bevel, formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, slabs, walls, beams, columns, and openings.
      2) Provide 1/4-inch bevel formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, walls, and slabs at expansion, and construction joints.
   b. Keyways: Steel, plastic, or lumber treated with form release agent.

c. Dovetail anchor system: System consisting of dovetail slots cast into the concrete, dovetail anchors that tie the masonry veneer to dovetail slots, and continuous wires that are embedded in the masonry and connect to the dovetail anchors.
   1) Dovetail slot: 18 gauge, Type 304 stainless steel in accordance with ASTM A480, foam filled, and in 10-foot lengths.
      a) Manufacturers: One of the following or equal:
         (1) Hohmann and Barnard, Inc., Model No. 305.
         (2) Heckmann Building Products, Inc., Model No. 100.
   2) Dovetail anchors: 23 gauge, 1 inch wide, hot-dip galvanized after fabrication in accordance with ASTM A153, and with seismic notch for attachment to wire embedded in masonry.
      a) Manufacturers: One of the following or equal:
         (1) Hohmann and Barnard, Inc., Model No. 303SV.
         (2) Heckmann Building Products, Inc., Model No. 361.

410S.7, Construction Joints: in the seventh paragraph, **DELETE** references to “in accordance with TxDoT DMS-6100, “Epoxies and Adhesives””.

410S.10 Forms: **DELETE** the first paragraph “Forms for prestressed concrete members and for prestressed pilling shall be constructed conforming to item No. 425S, “Prestressed Concrete Structures”.

410S.12, Placing Concrete: **DELETE** the entire section.

410S.13, Placing Concrete in Cold Weather: **DELETE** the entire section.

410S.14, Placing Concrete in Hot Weather: **DELETE** the entire section.

410S.15, Placing Concrete in Water: **DELETE** the entire section.

410S.16, Placing Concrete in Superstructure: **DELETE** the entire section.

410S.17, Placing Concrete in Concrete Arches: **DELETE** the entire section.

410S.18, Placing Concrete in Box Culverts: **DELETE** the entire section.

410S.20, Treatment of Finishing Horizontal Surfaces Except Bridge Slabs: **DELETE** the entire section.

410S.21, Finish of Bridge Slabs: **DELETE** the entire section.

410S.23, Curing Concrete: **DELETE** the entire section.

410S.28, Measurement and Payment: **DELETE** the entire section.

DELETE the entire section of SPECIFIC CROSS REFERENCE MATERIALS.

DELETE the entire section of RELATED CROSS REFERENCE MATERIALS.

End

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SPECIAL PROVISION To

Standard Specification to Item No. 411S
SURFACE FINISHES FOR CONCRETE

For this project Item No. 411S Surface Finished for Concrete of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

411S.3 Materials: **DELETE** item (4) in its entirety and **INSERT** the following:

Membrane Curing
Membrane curing shall conform to Item No. 410S, "Concrete Structures".

411S.9 Measurement and Payment: **DELETE** the entire section.

DELETE the entire section of SPECIFIC CROSS REFERENCE MATERIALS.

DELETE the entire section of RELATED CROSS REFERENCE MATERIALS.

End

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SPECIAL PROVISION To

Standard Specification to Item No. 416S
WATERSTOPS

For this project Item No. 416S Waterstops of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

416S.2 Submittals: **DELETE** subsection in its entirety and **INSERT** the following:

A. Product data:
   1. Polyvinyl chloride waterstops: Complete physical characteristics.
   2. Preformed expansion joint material: Sufficient information on each type of material for review to determine conformance of material to requirements specified.

B. Samples:
   1. Polyvinyl chloride waterstop.

C. Laboratory test reports: Indicating that average properties of polyvinyl chloride waterstops material and finish conform to requirements specified in this Section.

D. Quality control submittals:
   1. Certificates of Compliance:
      a. Written certificates that polyvinyl chloride waterstops supplied on this Project meet or exceed physical property in accordance with USACE CRD-C-572 and the requirements of this Section.
   2. Manufacturer's instructions: For materials specified in this Section that are specified to be installed with such instructions.

E. Quality Assurance
   1. Mock-ups:
      a. Welding demonstration:
         1) Demonstrate ability to weld acceptable joints in polyvinyl chloride waterstops before installing waterstop in forms.
   2. Field joints:
      a. Polyvinyl chloride waterstops field joints: Free of misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of material to water pressure at any point. Replace defective joints. Remove faulty material from site and disposed of by Contractor at its own expense.
   3. Inspections:
      a. Quality of welded joints will be subject to acceptance of Engineer.
      b. Polyvinyl chloride waterstop: Following defects represent partial list that will be grounds for rejection:
         1) Offsets at joints greater than 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
         2) Exterior crack at joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness, at any point, whichever is less.

3) Any combination of offset or crack that will result in net reduction in cross section of waterstop in excess of 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
4) Misalignment of joint that will result in misalignment of waterstop in excess of 1/2 inch in 10 feet.
5) Porosity in welded joint as evidenced by visual inspection.
6) Bubbles or inadequate bonding.

416S.3, Materials:

DELETE the reference in Paragraph (1) " Either natural or synthetic rubber or from"

DELETE Sub-Paragraph (1)(a) in its entirety and **INSERT** the following:

A. Waterstops - polyvinyl chloride (PVC):
   1. Manufactured from prime virgin polyvinyl chloride plastic compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements as specified in this Section.
   2. Manufacturers: One of the following or equal:
      a. Vinylex Corp.
      b. Sika Corp., Greenstreak PVC Waterstop.
   3. Type: Ribbed waterstop:
      a. Construction joints: 6-inch wide ribbed type.
      b. Expansion joint for wall penetrations for concrete encased electrical duct banks: 6-inch ribbed type with hollow center bulb.
      c. Expansion joints: 9-inch wide ribbed type with hollow center bulb.
      d. Dumbbell-type waterstop will not be allowed unless otherwise specified or indicated on the Drawings.
      e. No scrap or reclaimed material shall be used.

DELETE Sub-Paragraph (1) (b)

DELETE Sub-Paragraph (1) (c)

DELETE the first paragraph of Paragraph (3) in its entirety and **INSERT** the following :

(3) Manufacturing Requirements: PVC water stops shall be manufactured with an integral cross section which shall be uniform within plus or minus 3/16 inch (4.8 mm) in width. The web thickness or bulb diameter cross section shall be within plus 1/32 (0.8 mm) and minus 1/32 inch (0.8 mm). No splices will be permitted in straight strips. Strips and special connection pieces shall be well cured so that any cross section shall be dense, homogeneous and free from all porosity. All junctions in the special connections shall be full-molded.

416S.4, Construction Methods: **DELETE** TABLE A in its entirety and **INSERT** the table below:

Physical Characteristics	Test Method	Required Results
Specific Gravity	ASTM D792	Not less than 1.3.
Hardness	ASTM D2240	70 to 90 Type A15 Shore durometer.
Tensile Strength	ASTM D638	Not less than 2,000 pounds per square inch.

Ultimate Elongation	ASTM D638	Not less than 300 percent.
Alkali Extraction	CRD-C-572	Change in weight after 7 days: Between minus 0.1 percent and plus 0.25 percent. Change in hardness after 7 days: Not more than plus 5 points.
Low Temperature Brittle Point	ASTM D746	No sign of cracking or chipping at -35 degrees Fahrenheit.
Water Absorption	ASTM D570	Not more than 0.15 percent after 24 hours.
Accelerated Extraction Test	CRD-C-572	Tensile strength: Not less than 1,600 pounds per square inch. Elongation: Not less than 280 percent.
Stiffness in Flexure	ASTM D747	Not less than 600 pounds per square inch.
Tear Resistance	ASTM D624	Not less than 225 pounds per inch.
Thickness	-	3/8 inch.
Center Bulb		
6-inch Waterstops	-	7/8 inch or 1-inch nominal outside diameter.
9-inch Waterstops	-	For expansion joints 1 inch and narrower: 1-inch nominal outside diameter. For expansion joints wider than 1 inch: 2-inch nominal outside diameter.
Allowable Tolerances		
Width	-	Plus or minus 3/16 inch.
Thickness	-	Plus or minus 1/32 inch.

ADD the following section as 416S.6, Execution:

1.01 416S.6 EXECUTION

A. Waterstops:
   1. General:
      a. Store waterstops so as to permit free circulation of air around waterstop material and prevent direct exposure to sunlight.
      b. Install waterstops in concrete joints where indicated on the Drawings.
      c. Carry waterstops in walls into lower slabs and join to waterstops in slabs with appropriate types of fittings.
      d. In waterbearing structures: Provide all joints with waterstops, whether indicated on the Drawings or not.
      e. Provide waterstops that are continuous.
      f. Set waterstops accurately to position and line as indicated on the Drawings.

g. Hold and securely fix edges in position at intervals of not more than 24 inches so that they do not move during placing of concrete.
h. Position the waterstop so that symmetrical halves of waterstop are equally divided between concrete pours. Center axis of waterstop shall be coincident with centerline of the joint.
i. Do not drive nails, screws, or other fasteners through waterstops in vicinity of construction joints.
j. Use wires at not more than 24 inches on centers near outer edge of waterstop to tie waterstops into position.
k. Special clips may be used in lieu of wires, at Contractor's option.
l. Terminate waterstops 3 inches from top of finish surfaces of walls and slabs unless otherwise specified or indicated on the Drawings.
m. When any waterstop is installed in concrete on one side of joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, take suitable precautions to shade and protect exposed waterstop from direct rays of sunlight during entire exposure and until exposed portion is embedded in concrete.
n. When placing concrete at waterstops in slabs, lift edge of waterstop while placing concrete below the waterstop. Manually force waterstop against and into concrete, and then cover waterstop with fresh concrete.

2. Polyvinyl chloride waterstop:
   a. Install waterstops so that joints are watertight.
   b. Weld joints such as unions, crosses, ells, and tees, with thermostatically controlled equipment recommended by waterstop manufacturer:
      1) Do not damage material by heat sealing.
      2) Make joints by overlapping, then simultaneously cut ends of sections to be spliced so they will form smooth even joint. Heat cut ends with splicing tool until the plastic melts. Press 2 ends together until plastic cools.
      3) Maintain continuity of waterstop ribs and tubular center axis.
      4) The splices shall have tensile strength of not less than 60 percent of unspliced materials tensile strength.
   c. Butt joints of ends of 2 identical waterstop sections may be made while material is in forms.
   d. Manufacturer shall factory prefabricate joints for crosses and tees.
   e. Split-type waterstops will not be permitted except where specifically indicated on the Drawings.

B. Joints:
   1. Construct construction and expansion joints as indicated on the Drawings.
   2. Preformed expansion joint material: Fasten expansion joint strips to concrete, masonry, or forms with adhesive. No nailing will be permitted, nor shall expansion joint strips be placed without fastening.

End

SPECIAL PROVISION To
Standard Specification Item 436S
P.C. Concrete Valley Gutters

For this project, Item No. 436S P.C. Concrete Valley Gutters dated 11/13/2007, of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

Paragraph 436S.1 Description

Delete the first sentence in its entirety and insert the following:

"This item shall govern the construction of Portland cement (p. c.) concrete valley gutters, *flumes, and slope paving* on an approved subgrade in conformity to the lines, grades, Standard Detail No. 436S-2 and details indicated on the Drawings or as established by the Engineer or DESIGNATED representative."

End

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SPECIAL PROVISION To

Standard Specification to Item No. 510
PIPE

For this project Item No. 510 Pipe dated 02/28/2022, of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

510.2 Materials: **DELETE** subsection (6) Select Backfill or Borrow in its entirety.

510.2 Materials: **ADD** the following to subsection (8)(b) after the line reading "-Linings and Coatings:":

A. Pipe linings:
   1. Cement-mortar lining:
      a. Type of cement: Type II. Use Type V for non-potable water (NPW).

B. Coatings:
   1. Asphalt varnish: Factory applied.
   2. Primer:
      a. Factory applied for field coating.
      b. Compatible with materials as specified in Section 09960.

510.2 Materials: **ADD** the following to subsection (8)(b)3 Polyethylene Film Wrap:

A. Polyethylene encasement:
   1. Polyethylene encasement shall be continuous and terminated neatly at connections to below grade equipment or structures.
   2. At wall penetrations, extend encasement to the wall and neatly terminate.
   3. At slab penetrations, extend encasement to 2 inches below the top of slab and neatly terminate.
   4. When rising vertically in unimproved areas, extend encasement 6 inches above existing grade and neatly terminate.
   5. All work shall be inspected prior to backfilling of pipe and associated items.

510.2, Materials: **INSERT** the following after subsection (8)(k)5 Tracer Tape:

6. Nuts and Bolts:
   a. Bolts and nuts for flanges on plastic pipe located indoors, outdoors above ground, or in dry vaults and structures shall be hot-dip galvanized carbon steel, in accordance with ASTM A307, Grade B for bolts and in accordance with ASTM A563, Grade A for nuts.

   b. Bolts and nuts for flanges on plastic pipe submerged in water or wastewater, buried, in wet vaults or structures, adjacent to wet walls, or above open water-containing structures and plastic pipe carrying corrosive chemicals shall be Type 316 stainless steel in accordance with ASTM A193, Grade B8M for bolts and in accordance with ASTM A194, Grade 8M for nuts.

c. Provide a washer for each nut. Washer shall be of the same material as the nut.

d. Nuts shall be Heavy hex-head.

e. Cut and finish flange bolts to project a maximum of 1/4 inch beyond outside face of nut after assembly.

f. Tap holes for cap screws or stud bolts when used."

510.2 Materials: **INSERT** the following to the end of subsection (8)(n)6 Flanges:

d. "Bolts and nuts for ASME B16.5 Class 150 flanges and AWWA C207 Class D flanges located indoors, outdoors above ground, or in dry vaults and structures shall be hot-dip galvanized carbon steel, ASTM A307, Grade B for bolts and in accordance with ASTM A563, Grade A for nuts.

e. Bolts and nuts for ASME B16.5 and B16.47 Class 300 flanges and AWWA C207 Class E and F flanges located indoors, outdoors above ground, or in dry vaults and structures in accordance with ASTM A193, Grade B7 for bolts and in accordance with ASTM A194, Grade 2H for nuts.

f. Bolts and nuts for flanges submerged in water or wastewater, buried, in wet vaults or structures, adjacent to wet walls, or above open water-containing structures shall be Type 316 stainless steel in accordance with ASTM A193, Grade B8M for bolts and in accordance with ASTM A194, Grade 8M for nuts.

g. Provide a washer for each nut. Washer shall be of the same material as the nut.

h. Nuts shall be Heavy hex-head.

i. Cut and finish flange bolts to project a maximum of 1/4 inch beyond outside face of nut after assembly.

j. Tap holes for cap screws or stud bolts when used."

510.2 Materials: **INSERT** the following after subsection (9) Geotextile Filter Fabric for Pipe Bedding Material:

10. Pipe Material Schedule:
    a. Pipe material usage shall be as per the Piping Schedule in Section 15052."

510.3 Construction Methods: **DELETE** subsection (3) Utility and Storm Sewer Crossings in its entirety.

510.3 Construction Methods: **DELETE** the paragraph under subsection (10) Blasting and **INSERT** the following:

"No blasting will be allowed on this project."

510.3 Construction Methods: **DELETE** the paragraph under subsection (22)(a) Concrete Thrust Blocking and **INSERT** the following:

"Concrete thrusting blocking shall not be used unless specifically shown on the Drawings."

510.3, Construction Methods: **DELETE** subsection (22)(b) Metal Thrust Restraint in its entirety and **ADD** the following:

1. Restrained mechanical joints:
    a. Application:
        1) Where designation RMJ is specified in the Piping Schedule provided in Section 15052, supply either an integrally restrained mechanical joint piping system or mechanical wedge action joint restraint piping system.
    b. Integrally restrained mechanical joint design:
        1) Integral retainer weldment type or lugged type joint with Type 304 stainless steel rods and nuts.
        2) Restrained mechanical joints of the configuration which utilizes a gripping or friction force for restraint will not be acceptable.
        3) Manufacturers: Where restrained mechanical joints are required, use one of the following or equal:
            a) American Cast Iron Pipe Company, MJ Coupled Joint.
            b) U.S. Pipe & Foundry Co., Mechanical Joint Pipe.
            c) Griffin Pipe Products Co., Bolt-Lok.
            d) Griffin Pipe Products Co., Mech-Lok.]
2. Mechanical wedge action joint restraints:
    a. Manufacturers: One of the following or equal:
        1) EBAA Iron, Inc., Megalug Series 1100.
        2) Star Pipe Products, Split Stargrip Series 3000.
    b. Materials:
        1) Gland body: Ductile iron in accordance with ASTM A 536.
        2) Wedges and wedge actuating components: Ductile iron in accordance with ASTM A 536.
            a) Wedges shall be heat treated to a minimum of 370 BHN.
        3) Actuating bolts and nuts: Ductile iron in accordance with ASTM A 536.
            a) Provide torque-limiting twist off components to ensure proper installation.
    c. Coatings:
        1) Provide manufacturer applied coating system.
        2) Manufacturers: One of the following or equal:
            a) EBAA Iron Inc., Mega-Bond.
            b) Star Pipe Products, Star-Bond.
    d. Working pressure:
        1) Shall include a minimum safety factor of 2:1.
        2) For sizes 3- through 16-inch: 350 pounds per square inch.
        3) For sizes 18- through 48-inch: 250 pounds per square inch.
    e. Restraint shall consist of multiple gripping wedges incorporated into a follower gland meeting the requirements of AWWA C111.

f. Restraint shall allow post assembly angular deflection that is a minimum of 50 percent of the angular deflection allowed by the mechanical joint.
g. Restraint must be in accordance with applicable requirements of AWWA C110 and AWWA C111 for mechanical joints.

3. Restrained push-on joints:
   a. Application:
      1) Where designation RPO is specified in the Piping Schedule provided in Section 15052, supply either an integrally restrained push-on joint piping system or push-on joint restraint harness piping system.
   b. Integrally restrained push-on joint design:
      1) Restrained push-on joints of the configuration which utilizes a gripping or friction force for restraint will not be acceptable.
      2) Suitable for the following working pressures:
         a) For 4- through 24-inch pipe: 350 pounds per square inch gauge.
         b) For 30- through 54-inch pipe: 250 pounds per square inch gauge.
   c. Manufacturers: One of the following or equal:
      1) United States Pipe and Foundry Company, TR Flex.
      2) American Cast Iron Pipe Company, Flex Ring or Lok-Ring.
      3) Griffin Pipe Products Co., Snap-Lok.
   d. Limit buried joints to half the manufacturer's published allowable angular joint deflection for purposes of pipeline alignment and elimination of fittings.
4. Push-on joint restraint harnesses:
   a. Manufacturers: One of the following or equal:
      1) EBAA Iron, Inc., Megalug Series 1700.
      2) Star Pipe Products, Split Stargrip Series 3100S.
   b. Materials:
      1) Restraint and backup ring: Ductile iron in accordance with ASTM A 536.
      2) Wedges and wedge actuating components: Ductile iron in accordance with ASTM A 536.
         a) Wedges shall be heat treated to a minimum of 370 BHN.
      3) Actuating bolts and nuts: Ductile iron in accordance with ASTM A 536.
         a) Provide torque-limiting twist off components to ensure proper installation.
      4) Tie rods: Low alloy steel in accordance with AWWA C111.

510.3, Construction Methods: **DELETE** subsection (27) Pressure Pipe Hydrostatic Testing in its entirety.

End

SPECIAL PROVISION To
Standard Specification to Item No. 511S
WATER VALVES

For this project Item No. 511 Water Valves of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

511S.3 Valves: **DELETE** the paragraph under subsection C) Ball Valves in its entirety and **ADD** the following:

"Ball valves shall be as specified in Section 15111."

511S.4, Construction Methods: **INSERT** the following after subsection K. Shutoffs:

"L. Acceptable butterfly valve types and body styles are listed in the Butterfly Valve Application Schedule attached. Furnish and install butterfly valves in accordance with this Schedule."

BUTTERFLY VALVE APPLICATION SCHEDULE	
Valve Type and Style	**Acceptable Applications**
General Purpose AWWA Butterfly Valves – Flanged Body Design	Aboveground or submerged in the following service applications only: - Acceptable in all service applications except oxygen and ozone service and high-pressure service. - May be used in buried applications when required by the specified piping system.
General Purpose AWWA Butterfly Valves – Mechanical Joint Body Design	Buried in the following service applications only: - Acceptable in all service applications except oxygen and ozone service and high-pressure service.
General Purpose AWWA Butterfly Valves – Lugged Body Design	Aboveground in the following service applications only: - Aeration Air Systems
General Purpose AWWA Butterfly Valves – Wafer (not lugged) Body Design	Not allowed.
General Purpose AWWA Butterfly Valves – Grooved End Body Design	Aboveground, in sizes 20-inch and less, with piping system test pressure less than 100 psi, and in the following service applications only: - Acceptable in all service applications, except oxygen and ozone service, where piping for that service is specified in the Piping Schedule to have grooved end joints.

BUTTERFLY VALVE APPLICATION SCHEDULE	
Valve Type and Style	**Acceptable Applications**
High Pressure Butterfly Valves – Flanged Body Design	Service applications with piping system test pressure greater than 250 psi. Acceptable in aboveground and buried installations.
High Pressure Butterfly Valves – Wafer or Lugged Wafer Body Design	Not allowed.
Industrial Class Butterfly Valves – Lugged Body Design	Aboveground in the following service applications only: - Aeration Air Systems - Natural Gas Systems - Digester Gas Systems - Chilled and Hot Water Systems
Industrial Class Butterfly Valves – Wafer (not lugged) Body Design	Not allowed.
Stainless Steel Butterfly Valves - Lugged Body Design	Aboveground in the following service applications only: - Oxygen Systems - Ozone Systems
Stainless Steel Butterfly Valves – Wafer (not lugged) Body Design	Not allowed.

End

SPECIAL PROVISION To

Standard Specification to Item No. 720S
METAL FOR STRUCTURES

For this project Item No. 720S Metal for Structure of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

720S.2 Submittals: **DELETE** subsection in its entirety and **INSERT** the following

1.01 PRODUCT DATA:

A. Compressible-washer-type direct tension indicators: Manufacturer's detailed installation instructions including:
   1. Requirements for type and frequency of pre-installation verification.
   2. Requirements for coordination with regular washers.
   3. Instructions for assembling and tightening the joint so that work progresses from the most rigid part until the connected plies are in firm contact.

B. Stainless steel: Fabricator name and qualifications, member dimensions and structural section properties, and specifications and procedures used for pickling and passivating members.

1.02 SHOP DRAWINGS:

A. Fabrication and erection drawings.

1.03 QUALITY CONTROL SUBMITTALS:

A. Welding procedure specifications (WPS) in accordance with AWS D1.1 and D1.6.
   1. Submit WPS for each type of welded joint used, whether prequalified or qualified by testing.
      a. State electrode manufacturer and specific electrodes used.
      b. Indicate required AWS qualification for joint.
   2. Submit WPS with shop drawings that indicate those welds.
   3. Submit Procedure Qualification Record (PQR) in accordance with AWS D1.1 and D1.6 for welding procedures qualified by testing.

B. Welder qualifications: For each welding process and position:
   1. Welder's qualification certificates.
   2. Contractor's statement that certificate will be "in effect" at the time(s) welding will be performed based on the "Period of Effectiveness" provisions of AWS D1.1 and D1.6.

C. Steel fabricator's AISC certification.

1.04 TEST REPORTS:

A. Certified copies of mill tests and analyses made in accordance with applicable ASTM standards, or reports from a recognized commercial laboratory, including

chemical and tensile properties of each shipment of structural steel or part thereof having common properties.

720S.3 Structural Steel for Main Members: **DELETE** subsection in its entirety and **INSERT** the following paragraphs:

A. Unless otherwise specified or indicated on the Drawings, materials shall conform to the following:

Item	ASTM Standard	Class, Grade, Type, or Alloy Number
Carbon Steel		
Plate, bars, rolled shapes (except W and WT shapes), and miscellaneous items	A36	--
Rolled W and WT shapes	A992	Grade 50
Hollow structural sections/HSS: Round, square, or rectangular (including “pipe” where indicated for structural members and supports)	A500	Grade C
Stainless steel		
Plate, sheet, and strip	A240	Type 304* or 316**
Bars and shapes	A276	Type 304* or 316**
* Use Type 304L (low-carbon stainless steel) if material will be welded.		
** Use Type 316L (low carbon stainless steel) if material will be welded.		

720S.4 Miscellaneous Steel: **DELETE** subsection in its entirety and **INSERT** the following paragraphs:

1.01 FASTENERS AND STRUCTURAL HARDWARE

A. General:
   1. Materials: Of domestic manufacture.
   2. Where fasteners and hardware are specified to be galvanized, hot-dip galvanize in accordance with ASTM A153 or ASTM F2329, unless otherwise specified.

B. All thread rods:
   1. Carbon steel:
      a. In accordance with ASTM A36 unless otherwise indicated on the Drawings.
      b. High strength all thread rods: In accordance with ASTM F1554, Grade 55.
      c. Nuts: ASTM A194.
      d. Washers: ASTM F436.
   2. Galvanized carbon steel:
      a. In accordance with ASTM A36 unless otherwise indicated on the Drawings, and hot dip galvanized in accordance with ASTM A153.
      b. High strength galvanized all thread rods: In accordance with ASTM F1554, Grade 55, and galvanized in accordance with ASTM F2329**.**

c. Nuts: ASTM A194, hot-dip galvanized in accordance with ASTM A153.
d. Washers: ASTM F436, hot-dip galvanized in accordance with ASTM A153.

3. Stainless steel:
a. Units descaled, pickled, and passivated as specified in “Fabrication” in this Section.
b. Threaded rods and nuts to be the products of a single manufacturer/fabricator to ensure proper fit without galling. Ship all thread rods with properly fitting nuts attached.
c. Alloy Type 304 or Type 316 as indicated on the Drawings.
d. Type 304:
1) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
2) Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
3) Washers: Type 304 stainless steel.
e. Type 316:
1) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
2) Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
3) Washers: Type 316 stainless steel.

C. Anchor bolts, anchor rods, and post-installed steel anchors: As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

D. High-strength bolts:
1. Provide high-strength bolt assembly, with nuts, hardened flat washers, and compressible-washer-type direct tension indicators. Carbon steel - Uncoated:
a. Bolts: Plain heavy hex structural bolts in accordance with ASTM F3125, Grade A325, Type 1.
b. Nuts: Heavy hex nuts in accordance with ASTM A563, Grade C.
c. Washers:
1) Adjacent to normal, oversized, and short-slotted holes: Circular, square or rectangular beveled, clipped, or extra thick washers in accordance with ASTM F436, Type 1. Flat circular washers unless otherwise indicated on the Drawings.
2) Adjacent to long slotted holes: Fabricated from 5/16-inch thick plate conforming to ASTM A36.
d. Load indicator devices: At slip critical connections, provide one of the following devices at each bolt:
1) Compressible washer type direct tension indicators (“DTI”): In accordance with ASTM F959, Type 325-1.
2) Twist-off type tension-control bolt assemblies: ASTM F3125, Grade F1852.

E. Stainless steel bolts (for use in stainless steel structures):
1. General:
a. Bolts and nuts shall be the products of a single manufacturer/fabricator to ensure proper fit without galling. Ship bolts with properly fitting nuts attached.
b. Units descaled, pickled and passivated as specified in “Fabrication."
2. Alloy: Type 304 or Type 316 to match alloy of structural members being connected.

3. Type 304:
    a. Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
    b. Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
    c. Washers: Type 304 stainless steel.
4. Type 316:
    a. Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
    b. Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
    c. Washers: Type 316 stainless steel.
5. Welded studs: As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

1.02 ISOLATING SLEEVES AND WASHERS

A. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

1.03 GALVANIZED SURFACE REPAIR

A. Manufacturers: The following or equal:
    1. Jelt, Galvinox.

1.04 THREAD COATING

A. Manufacturers: One of the following or equal:
    1. Bostik, Never-Seez.
    2. Oil Research, Inc., WLR No. 111.

720S.5 Miscellaneous Metals:

DELETE paragraph D, Aluminum, in its entirety and **INSERT** the following:

1. Structural sheet aluminum: ASTM B209, Alloy 6061-T6.
2. Structural aluminum: ASTM B308, Alloy 6061-T6.
3. Extruded aluminum: ASTM B221, Alloy 6063-T42.
4. Isolating sleeves and washers:
    a. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
5. Miscellaneous materials:
    a. Furnish supplementary parts necessary to complete each item even where such work is neither definitely indicated on the Drawings nor specified.
    b. Size, form, attachment, and location shall conform to the best of current practice.
    c. Conform to applicable ASTM Standards for materials not otherwise specified.

720S.6 Fabrication, Erection, and Painting: **DELETE** Paragraph (C)

720S.7 Galvanizing: **DELETE** the entire section.

720S.7 Measurement: **DELETE** the entire section.

720S.9 Payment: **DELETE** the entire section.

DELETE the entire section of SPECIFIC CROSS REFERENCE MATERIALS.

DELETE the entire section of RELATED CROSS REFERENCE MATERIALS.

END

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SPECIAL PROVISION To

Standard Specification to Item No. 721S
STEEL STRUCTURES

For this project Item No. 721S Steel Structure of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the City of Austin Standard Specifications are waived or changed.

721S.2 Submittals:

DELETE subsection (B) in its entirety.

INSERT subsection (D)(2) Quality Control with the following**:**

1.01 QUALITY ASSURANCE

A. Certification:
   1. Steel fabricators shall be certified by the AISC or other certification acceptable to the Engineer and the building official having jurisdiction.

B. Welding:
   1. Perform welding of structural metals in accordance with AWS D1.1 and D1.6 using welders who have current AWS qualification certificate for the process, position, and joint configuration to be welded.
   2. Make Welding Procedure Specifications available at the locations where welding is performed.
   3. Notify Engineer at least 24 hours before starting shop or field welding.
   4. Engineer may check materials, equipment, and qualifications of welders.
   5. Remove welders performing unsatisfactory Work, or require requalification.
   6. Engineer may use gamma ray, magnetic particle, dye penetrant, trepanning, or other aids to visual inspection to examine any part of welds or all welds.
   7. Contractor shall bear costs of retests on defective welds.
   8. Contractor shall also bear costs in connection with qualifying welders.

DELETE Paragraph (D) (4) Final payment for… in its entirety

721S.3 Delivery, Storage, and Handling: **DELETE** subsection in its entirety and **INSERT** the following paragraphs:

A. Packing and shipping: Deliver structural steel free from mill scale, rust, and pitting.

B. Storage and protection: Until erection and painting, protect from weather items not galvanized or protected by a shop coat of paint.

721S.4 Quality of Work: **DELETE** subsection in its entirety and **INSERT** the following paragraphs:

1.01 FABRICATION

A. Shop assembly:
   1. Fabricate structural steel in accordance with AISC 360 and AISC 303 unless otherwise specified or modified by applicable regulatory requirements.
   2. Where anchors, connections, or other details of structural steel are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.
   3. Round off sharp and hazardous projections and grind smooth.
   4. Take measurements necessary to properly fit work in the field. Take responsibility for and be governed by the measurements and proper working out of all the details.
   5. Take responsibility for correct fitting of metalwork.
   6. Welded connections:
      a. Comply with AWS requirements for the metals to be welded.
      b. Weld only in accordance with approved Welding Procedure Specifications.
      c. Keep Welding Procedure Specifications readily available for welders and inspectors during fabrication processes.

B. Stainless steel shapes and assemblies:
   1. For structural members such as W shapes, S shapes, channels, angles, and similar rolled shapes not available in quantity, size, and type of stainless steel specified or indicated on the Drawings:
      a. Fabricate shapes using laser-fused, full penetration welds between pieces of plate to attain same or higher section modulus and moment of inertia as that of members indicated on the Drawings.
      b. Fabricate shapes from dual grade stainless steel.
      c. Fabricate beams and channels to ASTM A6 tolerances.
      d. Manufacturers: The following or equal:
         1) Stainless Structural, LLC.
   2. Cleaning and passivation:
      a. Following shop fabrication of stainless steel members and bolts, clean and passivate fabrications at point of manufacture.
      b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a bright passive finished surface with no etching, pitting, frosting, or discoloration.
      c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated.
         1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
      d. Pre-clean, chemically de-scale (“pickle”), passivate, and final-clean fabrications in accordance with the requirements of ASTM A380.
         1) If degreasing is required before cleaning (pickling) to remove scale or iron oxide, cleaning with citric acid treatments is permissible; however, such treatments shall be followed inorganic cleaners.

2) Pickle and passivate stainless steel using a nitric acid solution in accordance with ASTM A380, Annex A2, Table A2.1, Part II.
3) Pickling by citric acid treatment or sulfuric acid treatment is not considered to satisfy the requirements of this Section.

e. Inspect after cleaning using methods specified for “gross inspection” in ASTM A380.
f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the site.

C. Galvanized carbon steel:
1. Where galvanizing is required, hot-dip structural steel after fabrication in accordance with ASTM A123:
2. Do not electro-galvanize or mechanically-galvanize unless specified or accepted by Engineer.
3. Re-straighten galvanized items that bend or twist during galvanizing.

721S.5 Execution: **DELETE** subsection in its entirety and **INSERT** the following paragraphs:

1.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

1.02 ERECTION

A. General:
1. Fabricate structural and foundry items to true dimensions without warp or twist.
2. Form welded closures neatly, and grind off smooth where weld material interferes with fit or is unsightly.
3. Install structural items accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.
4. Do not shift out of alignment, re-drill, re-shape, or force fit fabricated items.
5. Place anchor bolts or other anchoring devices accurately and make surfaces that bear against structural items smooth and level.
6. Rigidly support and brace structural items needing special alignment to preserve straight, level, even, and smooth lines. Keep structural items braced until concrete, grout, or dry pack mortar has hardened for 48 hours minimum.
7. Erect structural steel in accordance with AISC 303 unless otherwise specified or modified by applicable regulatory requirements.
8. Where anchors, connections, and other details of structural steel erection are not specifically indicated on the Drawings or specified, form, locate, and attach with equivalent in quality and workmanship to items specified.
9. Round off sharp or hazardous projections and grind smooth.
10. Paint or coat steel items as specified in Sections 09910 - Painting and 09960 - High-Performance Coatings.

B. Stainless steel. Take all necessary precautions to avoid iron contamination of stainless steel during delivery, storage, and handling.
1. Segregate stainless steel from iron.

2. Tools and handling devices.
    a. Do not use iron tools clamps, chokes, working surfaces, or brushes when fabricating, handling, and erecting stainless steel.
    b. Do not use tools that have been contaminated by contact with iron.
    c. Use stainless steel, polymer coated, or wood tools and handling equipment. Do not use tools that have been contaminated by contact with iron or steel.

C. Welding: General:
1. Make welds full penetration type, unless otherwise indicated on the Drawings.
2. Remove backing bars and weld tabs after completion of weld. Repair defective welds observed after removal of backing bars and weld tabs.

D. Welding: Carbon steel:
1. General: In accordance with AWS D1.1:
    a. Weld ASTM A36 and A992 structural steel, and ASTM A500 and A501 structural tubing with electrodes in accordance with AWS A5.1, using E70XX electrodes; AWS A5.17, using F7X-EXXX electrodes; or AWS A5.20, using E7XT-X electrodes:

E. Welding - stainless steel:
1. General: In accordance with AWS D1.6.
2. Field welding of stainless steel will not be permitted.
3. Passivation of field-welded surfaces:
    a. Provide cleaning, pickling and passivating as specified under “Fabrications” of this Section. Clean using Derustit Stainless Steel Cleaner, or equal.

F. Interface with other products:
1. Where steel members and fasteners come in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals with isolating sleeves and washers as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

G. Fasteners: General:
1. Install bolts to project 2 threads minimum, but 1/2 inch maximum beyond nut.
2. Anchor bolts and anchor rods: Install as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
    a. Unless otherwise specified, tighten nuts on anchor bolts and anchor rods specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry to the "snug-tight" condition.
3. All thread rods in drilled holes bonded to concrete with adhesive: Install as specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.
4. All thread rods in drilled holes bonded to masonry with adhesive: Install as specified in Section 04055 - Adhesive Bonding Reinforcing Bars and All Thread Rods in Masonry.

H. Fasteners: High-strength carbon steel bolts:
1. Connections with high-strength bolts shall in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts.

2. Provide pre-tensioned joints at bolted connections, except where slip-critical connections are indicated on the Drawings.
3. Joints: Slip-critical.
    a. Confirm that faying surfaces at connections are free of dirt and other foreign material, have been blast cleaned, and are free of coatings and inadvertent overspray in accordance with RCSC Specification.
    b. Furnish hardened flat washers in accordance with ASTM F436:
        1) On outer plies with slotted holes.
        2) When 1 or more plies of the connected material has a yield strength less than 40 ksi.
        3) Under element, nut, or bolt head, turned in tightening.
    c. Install tension indicator washers, placed in accordance with ASTM F959 Figure X1, to confirm adequate tightening of bolts.
    d. Tighten bolts to full pretension.
4. Joints: Pre-tensioned.
    a. Joint preparation, assembly, and tightening shalSP721Sl be as specified for slip-critical connections, except that the requirements for un-coated faying surfaces shall not apply.

I. Fasteners: Stainless steel bolts:
    1. Connections shall be snug-tight joints unless otherwise indicated on the Drawings.
    2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.
    3. Rotate nuts using a slow, smooth action without interruptions. Avoid over-tightening.

1.03 FIELD QUALITY CONTROL

A. Provide quality control as specified in Section 01450 - Quality Control.

1.04 FIELD QUALITY ASSURANCE

A. Provide quality assurance as specified in Section 01450 - Quality Control.

B. Special inspections, special tests, and structural observation:
    1. Provide as specified in Section 01455 - Regulatory Quality Assurance.

721S.6 Bolted Members: **DELETE** the entire section.

721S.7 Welded Members: **DELETE** the entire section.

721S.8 Field Erection: **DELETE** the entire section.

721S.9 Paint and Painting: **DELETE** the entire section.

721S.10 Measurement and Payment: **DELETE** the entire section.

DELETE the entire section of SPECIFIC CROSS REFERENCE MATERIALS.

DELETE the entire section of RELATED CROSS REFERENCE MATERIALS.

END