Texas Department of Transportation

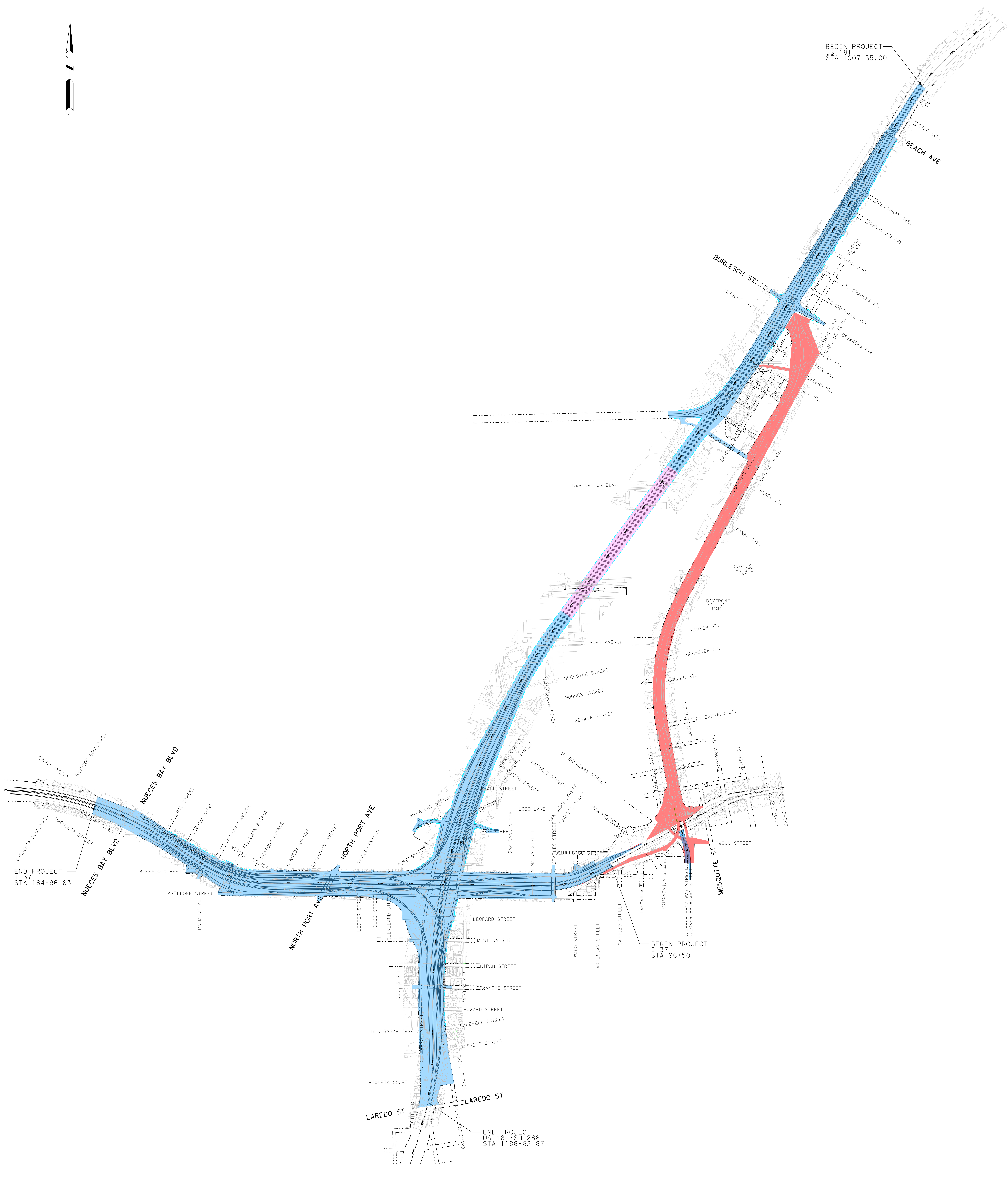
Book 2 – Technical Provisions

for

US 181 Harbor Bridge Project

Design-Build Project

Attachment 1-1
Project Limits



LEGEND

- NEW HARBOR BRIDGE LIMITS
- ROADWAY SECTION LIMITS
- REMOVAL LIMITS

PROJECT LIMITS

SCALE: 1" = 500'

Scale: 1:500
Plotted on: 1/27/2015
Model Name: PLNSHT-BASEWRK
Pen Table: TexasTwoStep=pentable=co.tbl
Design Filename: US181HB-E-RD-PRJ00.dgn

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 1-2
OPTION WORK BROADWAY BOULEVARD

LEGEND:

PROPOSED BROADWAY PAVE

PAVEMENT TO BE REMOVED

EXISTING ROW

US 181
HARBOR BRIDGE
OPTION WORK

BROADWAY

ROLL 1 OF 1

0 100

SCALE: 1" = 100'

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HNTB

HNTB Corporation
The HNTB Companies
Engineers Architects Planners

TBPE FIRM REGISTRATION NO.: 420

Scale: 1:100
Plotted on: 11/12/2014

Pen Table: TexasTwoStep*pentable*co.tbl
Design Filename: US181HB-A-RD-BRDWY.dgn

Texas Department of Transportation

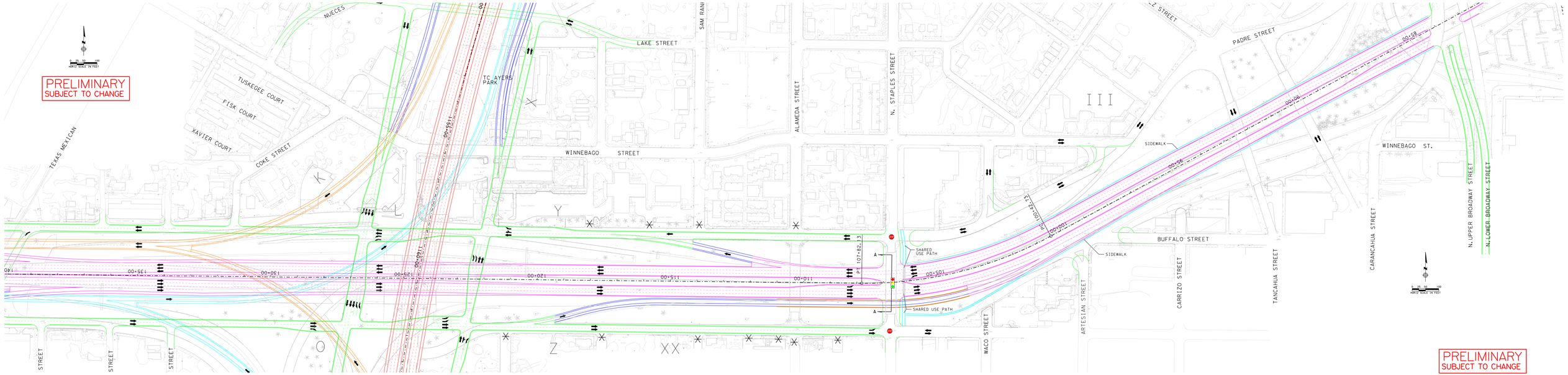
BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 1-3
OPTION 2 WORK
Concept Drawing



SECTION A-A

✳ ALL SIDESTREETS AND DRIVEWAYS SHALL BE CONNECTED TO FRONTAGE ROADS BETWEEN THE FRONTAGE ROAD BOX AND STAPLES STREET.

Texas Department of Transportation

US 181-HARBOR BRIDGE
ATTACHMENT 1-3
OPTION 2
CONCEPT DRAWING

Texas Department of Transportation

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US 181-HARBOR BRIDGE
ATTACHMENT 1-3
OPTION 2
CONCEPT DRAWING

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 2-1
PROJECT MANAGEMENT PLAN CONTENTS

Attachment 2-1 – Project Management Plan Contents

The Project Management Plan - Contents and Schedule for provision of the component parts

Legend

A = Submitted by Developer no later than 30 days after NTP1 and Approved by TxDOT prior to commencement of Design Work

A1 = Submitted by Developer no later than 30 days after NTP1 and concurrence by TxDOT prior to issuance of NTP2

B = Submitted by Developer no later than 90 days after NTP1 and Approved by TxDOT prior to commencement of Construction Work

Part	Ref	Section	Contents	Required by
1. Project Administration				
		Organization	Organization diagram	A
		Personnel	Names and contract details, titles, and job roles	A
		Subcontractors	Subcontracting Plan	A
		Schedule	Project Baseline Schedule in accordance with Section 2	A
		Quality Control	Procedures to establish and encourage continuous improvement	A
		Audit	Procedures to facilitate review and audit by TxDOT	A
		PMP Update	Procedures for preparation of amendments and submission of amendments to any part of the PMP (See Note 1)	A
		Document Management	The manner in which records will be maintained in compliance with the Technical Provisions, including any specific systems Developer will use.	A
			Document management procedures in compliance with the Technical Provisions Section 2.	A
2. Quality Management Plan				
2A. Professional Services Quality Management Plan				
		Organization	Developer's main contractual arrangements	A
			Organizational structure covering the activities to be performed in accordance with the Contract Documents	A
		Personnel	Resource Plan for the Developer and its Subcontractors	A
			Arrangements for coordinating and managing staff interaction with TxDOT and its consultants including collocation of Key Personnel and description of approach to coordinating work of off-site personnel	A

Part	Ref	Section	Contents	Required by
			Names and contact details, titles, job roles and specific experience required for the Key Personnel and for other principal personnel during design	A
		Personnel (continued)	Names and contact details, titles, job roles of principal personnel for Subcontractors and any third party with which Developer will coordinate activities.	A
		Offices and equipment	Description of the necessary offices and office equipment to be provided by Developer during design	A
		Subcontractors	Overall control procedures for Subcontractors, including consultants and subconsultants	A
			Responsibility of Subcontractors and affiliates	A
			Steps taken to ensure Subcontractors and Suppliers meet the obligations imposed by their respective Contracts	A
		Interfaces	Interfacing between the Developer, Subcontractors and the independent certifiers during design including interfaces between the structural design auditor, the safety auditor, and the quality reviewer	A
			Coordination with Utility Owners	A
		Environmental	Control of the interface between environmental requirements (including landscaping) and the design of the Project	A
		Procedures	Procedures describing how the principal activities will be performed during the design stage: to include geotechnical site investigation, surveys and mapping, environmental management, safety audit, structural audit, and checking	A
		Quality Control/Quality Assurance	Quality control and quality assurance including a resource table for monitoring and auditing all design services, design review and certification, verification of plans	A
			Procedures to establish Developer's hold points in the design process where checking and review will take place	A
			Procedures to ensure accuracy, completion, and quality in submittals to TxDOT and Governmental Entities	A
			Procedures to establish and encourage continuous improvement (corrective/preventive action)	A
		Audit	Name of Developer's representative(s) with defined authority for establishing, maintaining, auditing and reporting on the PSQMP	A
			Name, title, roles and responsibilities of supporting quality management staff reporting to the person with defined authority	A
			Procedures for scheduling and conducting audits of the Developer's compliance with the PSQMP, including subcontractors, with provision that auditors are independent of the activity being audited	A
		Document Management	The manner in which records will be maintained in compliance with the Technical Provisions, including any specific systems Developer will use	A

Part	Ref	Section	Contents	Required by
			Document management procedures in compliance with the Technical Provisions Section 2	A
2B. Construction Quality Management Plan				
		Organization	Developer's main contractual arrangements	A
			Organizational structure covering the activities to be performed in accordance with the Contract Documents	A
		Personnel	Resource Plan for the Developer and its Subcontractors	B
			Arrangements for coordinating and managing staff interaction with TxDOT and its consultants including collocation of Key Personnel and description of approach to coordinating work of off-site personnel	B
			Names and contact details, titles, job roles and specific experience required for the Key Personnel as related to construction	A
			Names and contact details, titles, job roles of principal personnel for Subcontractors and any third party with which Developer will coordinate his activities	B
		Offices and equipment	Description of the necessary offices and office equipment to be provided by Developer during construction	A
		Subcontractors	Overall control procedures for Subcontractors, including consultants and subconsultants	B
			Responsibility of Subcontractors and affiliates	A
			Steps taken to ensure Subcontractors and Suppliers meet the obligations imposed by their respective Contracts	B
		Interfaces	Interfacing between the Developer, Subcontractors, and independent certifiers during construction, including any testing contractor	A
		Procedures	Traffic Management Plan	B
		Quality Control/Quality Assurance	Procedures for construction quality control and quality assurance	B
			Control, identification and traceability of materials, including any material or samples temporarily or otherwise removed from site for testing or other reasons.	B
			Examinations and audit of Construction Work, review of examination and audit, issue of certificates	B
			Observation and reporting of all tests in compliance with Section 2	B
			Procedures for tests and inspections for the purpose of the Subcontractor certifying that prior to burying, each part of the Works is complete and conforms to the Contract Documents	B

Part	Ref	Section	Contents	Required by
		Quality Control/Quality Assurance	Quality control and quality acceptance procedures including a resource table for monitoring and auditing during construction any work and testing undertaken by Subcontractors and Suppliers both on and off Site	B
			Procedures to establish Developer's hold points in construction	B
			Procedures to ensure accuracy, completion, and quality in submittals to TxDOT and Governmental Entities	B
			Procedures to establish and encourage continuous improvement (Corrective/Preventive Action)	A
		Audit	Inspection and test plans that identify the performance and/or databases to be used for recording the inspection and test results and methodology for transmitting acceptance testing and inspection reports to TxDOT	B
			Name of Developer's representative with defined authority for establishing, maintaining, auditing and reporting on the CQMP	A
			Name, title, roles and responsibilities of supporting quality management staff reporting to the person with defined authority.	B
			Procedures for scheduling and conducting audits of the Developer's compliance with the CQMP, including subcontractors, with provision that auditors are independent of the activity being audited	B
		Document Management	The manner in which records will be maintained in compliance with the Technical Provisions, including any specific systems Developer will us	B
			Document management procedures in compliance with the Technical Provisions Section 2	A
2C. O&M Work Quality Management				
		Organization Personnel Offices and Equipment Subcontractors Interfaces Procedures Audit	Consistent with general quality management requirements in Section 2 of the Technical Provisions and addressing the items required by Section 19.7 of the Technical Provisions.	See TP Table 19-5
3. Comprehensive Environmental Protection Plan (CEPP)				
		Organization	Developer's main contractual arrangements	A
			Organizational structure covering the activities to be performed in accordance with the Contract Documents	A
			Environmental Contact Tree	A

Part	Ref	Section	Contents	Required by
		Personnel	Resource Plan for the Developer and its Subcontractors	B
			Arrangements for coordinating and managing staff interaction with TxDOT and its consultants, including collocation of Key Personnel and description of approach to coordinating work of off-site personnel	A
		Personnel	Names and contact details, titles, job roles and specific experience required for Key Personnel and for other environmental personnel	A
			Implement Environmental Protection Training Program for all employees in accordance with Section 4	A
		Subcontractors	Overall control procedures for Subcontractors, including consultants and subconsultants	A
			Responsibility of Subcontractors and Affiliates	A
		Environmental	Establishment of the component parts of the Environmental Compliance and Mitigation Plan (ECMP)	B
			Procedures for implementation of the Environmental Protection Training Program for all Developer employees and subcontractors	B
			Procedures for environmental compliance	B
		Quality Control and Quality Acceptance	Procedures to ensure accuracy, completion, and quality in submittals to TxDOT and Governmental Entities	A
			Procedures to establish and encourage continuous improvement (Corrective/Preventive Action)	A
		Audit	Name of Developer's representative(s) with defined authority for establishing, maintaining, auditing and reporting on the CEPP	A
			Procedures for scheduling and conducting audits of the Developer's compliance with the CEPP, including subcontractors, with provision that auditors are independent of the activity being audited	A
		Document Management	The manner in which records will be maintained in compliance with the Technical Provisions, including any specific systems Developer will use	A
			Identify environmental documentation and reporting requirements	A
4. Public Information and Communications Plan				
		Organization	Developer's main contractual arrangements	A
			Organizational structure covering the activities to be performed in accordance with the Contract Documents.	A
		Personnel	Resource Plan for the Developer and its Subcontractors	A
			Arrangements for coordinating and managing staff interaction with TxDOT and its consultants, including co-location of Key Personnel and description of approach to coordinating work of off-site personnel	A
			Names and contact details, titles, job roles and specific experience required for Key Personnel and for other principal personnel	A

Part	Ref	Section	Contents	Required by
		Personnel	Names and contact details, titles, job roles of principal personnel for Subcontractors and any third party with which Developer will coordinate his activities	A
		Offices and equipment	Description of the necessary offices and office equipment to be provided by Developer during design	A
		Subcontractors	Overall control procedures for Subcontractors, including consultants and subconsultants	A
			Responsibility of Subcontractors. and affiliates	A
		Subcontractors	Steps taken to ensure Subcontractors and Suppliers meet the obligations imposed by their respective Contracts	A
			Procedures for implementation of Environmental Protection Training Program for employees of Subcontractors	A
		Interfaces	Procedures for liaison with the public, the media and other Customer Groups in accordance with Section 3 and the press media policy of TxDOT	A
			Procedures to coordinate with Project Stakeholders such as municipalities, counties, MPOs, RMAs and other Customer Groups	A
		Procedures	Procedures describing how the principal activities will be performed	A
		Quality Control	Quality control procedures including a resource table for monitoring and auditing all public information and communication services	A
			Procedures to ensure accuracy, completion, and quality in submittals to TxDOT, Governmental Entities and Customer Groups	A
		Quality Control	Procedures to establish and encourage continuous improvement (Corrective/Preventive Action)	A
		Audit	Name of Developer's representative with defined authority for establishing, maintaining, auditing and reporting on the PICP	A
		Document Management	The manner in which records will be maintained in compliance with the Technical Provisions, including any specific systems Developer will use	A
			Document management procedures in compliance with the Technical Provisions Section 2	A
			Identify environmental documentation and reporting requirements	A
5. Health and Safety				
			Policies, plans, training programs, Work Site controls, and Incident response plans to ensure the health and safety of personnel involved in the Project and the general public affected by the Project	A1
			Procedures for immediately notifying TxDOT of all incidents arising out of or in connection with the performance of the Work	A1

Part	Ref	Section	Contents	Required by
6. TxDOT – Developer Communications Plan				
			The manner in which the Developer's organization will respond to unexpected requests for information, communicate changes or revisions to necessary Developer personnel, and notify affected stakeholders before and after changes are made	A
			Processes and procedures for communication of Project information between the Developer's organization and TxDOT	A
7. ROW Acquisition Plan				
		Organization	Developer's main contractual arrangements	A
			Organizational structure covering the activities to be performed in accordance with the Contract Documents	A
		Personnel	Resource plan for the Developer and its Subcontractors	A
			Arrangements for coordinating and managing staff interaction with TxDOT and its consultants, including collocation of Key Personnel and description of approach to coordinating work of off-site personnel	A
			Names and contact details, titles, job roles and specific experience required for the Key Personnel as related to ROW acquisition and Utility Adjustment activities.	A
			Names and contact details, titles, job roles of principal personnel for Subcontractors and any third party with which Developer will coordinate activities	A
		Subcontractors	Overall control procedures for Subcontractors, including consultants and subconsultants	A
			Responsibility of Subcontractors and affiliates	A
			Steps taken to ensure Subcontractors and Suppliers meet the obligations imposed by their respective Contracts	A
			Procedures for implementation of the Environmental Protection Training Program for employees of Subcontractors in accordance with Section 4	A
		Interfaces	Interfacing between the Developer, Subcontractors and independent certifiers during Project ROW acquisition including the interfaces between Project ROW acquisition, Project design, and any quality reviewer	A
			Coordination with Utility Owners	A
			Utility Adjustment Plan	B
		Relocation	Relocation Plan (Right of Way)	B
		Environmental	Control of the interface between environmental requirements (including Hazardous Materials and demolition) and Project ROW acquisition activities	A
			Applicable procedures for the Hazardous Materials Management Plan in accordance with Section 4	A

Part	Ref	Section	Contents	Required by
		Environmental	Applicable procedures to implement the Stormwater Pollution Prevention Plan (SW3P), recycling program and waste management in accordance with Section 4	A
			Address Project Environmental Mitigation Plan (PEMP) requirements	A
		Schedule Procedures	Logic linked ROW acquisition activities on a parcel-by-parcel basis as part of the Project Baseline Schedule, including adequate time periods for TxDOT review and condemnation activities in accordance with Section 7	A
			Procedures describing how the principal activities will be performed during the Project ROW acquisition, whether directly undertaken or subcontracted	A
		Quality Control	Procedures to ensure accuracy, completion, and quality in submittals to TxDOT and Governmental Entities	A
			Procedures to establish and encourage continuous improvement	A
			Quality control procedures and quality review standards for Project ROW acquisition in accordance with Section 7	A
			Procedures for environmental compliance	A
		Audit	Name, title, roles and responsibilities of supporting quality management staff reporting to the person with defined authority	A
		Document Management	The manner in which records will be maintained in compliance with the Technical Provisions, including any specific systems Developer will use	A
			Document management procedures in compliance with the Technical Provisions Section 2	A
			Identify environmental documentation and reporting requirements	A
8. Risk Management Plan				
			Procedures for identifying, assessing, analyzing, controlling and managing project risks to meet its obligations under the Agreement.	A
9. Corpus Christi Ship Channel Plan				
		Procedures	Consistent with requirements in Section 2.9.1 of the Technical Provisions.	A
		Requirements	Consistent with requirements in Section 2.9.2 of the Technical Provisions.	A
		Sweep and Sounding Surveys	Consistent with requirements in Section 2.9.3 of the Technical Provisions.	A
10. Sustainability Plan				

Part	Ref	Section	Contents	Required by
		Energy and Energy Efficiency	Describe plans for maximizing energy efficiency throughout the Project, including: • Minimizing energy and fuel usage during construction. • Innovative ideas for incorporation of energy generation and use of renewable energy sources.	A
		Community and Environmental Justice	Describe the commitment to environmental quality and enhancement above and beyond the requirements of the EIS, including: • Minimizing air quality degradation during construction. • Minimizing and mitigating for disproportionately high and adverse human health or environmental effects of construction activities on minority populations and low-income populations. • Commitment to sustainable storm water management, specifically the incorporation of permanent Best Management Practices for storm water management. • Commitment to providing durable permanent Best Management Practice features that minimize long term maintenance. • Proposals for quantifying and minimizing the project's carbon footprint.	A
		Green Building	Describe plans for locating the Project Management Office in existing, currently unused office space, and plans (if any)for the use of a LEED (Leadership in Energy and Environmental Design) certified Green Building for the Project Management Office.	A
		Waste Reduction and Recycling	Describe the approach to minimizing the amount of waste generated by the project. The plan shall also describe the Developer's plans for maximizing the re-use of materials, including construction material from structures and facilities demolished as part of this project. The Developer may also include plans to incorporate into the project recycled materials generated off site. Any such plan must be in conformance with Contract Documents.	A
		Green Project Administration	Describe the overall commitment to green project administration, including: • Tracking all environmental commitments and ensuring completion and appropriate documentation of those commitments. • Providing construction personnel with the opportunity for construction environmental training, including best practices for minimizing impacts to the human and natural environment.	A
		Materials and Resources	Describe the commitment to using materials produced in a manner that minimizes ecosystem degradation and reduces lifecycle impacts from extraction, production, and transport of virgin materials.	A
		Construction Practices	Describe the commitment to using construction practices that minimize impacts to the environment and community surrounding the project.	A

Part	Ref	Section	Contents	Required by
		Education and Demonstration of Energy Efficiency	Describe proposal to develop and implement at least one project feature that publically demonstrates energy efficiency. This feature shall be a visible element of the project that demonstrates the commitment to energy efficiency. The feature can also serve to educate the public on other sustainable project elements and practices. Potential features could include, but are not limited to, the following: • Use of solar panels to generate a portion of the energy needs of the project. • Use of wind turbine(s) to generate a portion of the energy needs of the project. • Use of light-emitting diode (LED) fixtures for bridge illumination.	A
		Sustainability Level	Identification of the number of points that the Project will score as determined in a joint Developer/Department/FHWA INVEST workshop following the INVEST 1.0 Project Development Module and using the Urban Extended scorecard. The Proposer shall indicate the number of points that the Project will score as follows: points scored that are attributable to previous Department work, points scored by the Developer executing the Project Scope, and points that will be provided by the actions of the Developer.	A
11	Maintenance Management Plan			
		General Requirements	Consistent with Section 19.6.2 of the Technical Provisions	See TP Table 19-5
		O&M Deliverable Schedule	Consistent with Section 19.6.3 of the Technical Provisions	See TP Table 19-5
		Document Management	Consistent with Section 19.6.4 of the Technical Provisions	See TP Table 19-5
		Communications	Consistent with Section 19.6.5 of the Technical Provisions	See TP Table 19-5
		Maintenance Safety	Consistent with Section 19.6.6 of the Technical Provisions	See TP Table 19-5
		Maintenance Hazmat	Consistent with Section 19.6.7 of the Technical Provisions	See TP Table 19-5
		Maintenance Environmental	Consistent with Section 19.6.8 of the Technical Provisions	See TP Table 19-5
		MMS	Consistent with Section 19.6.9 of the Technical Provisions	See TP Table 19-5
		Maintenance Transition	Consistent with Section 19.8 of the Technical Provisions	See TP Section 19.8
		Incident Management	Consistent with Section 19.10.5 of the Technical Provisions	See TP Table 19-5

Part	Ref	Section	Contents	Required by
		Snow and Ice Control	Consistent with Section 19.10.7 of the Technical Provisions	See TP Table 19-5
		Durability Plan	Consistent with Section 19.14.3 of the Technical Provisions	See TP Table 19-5
		Handback Plan	Consistent with Section 19.14.2 of the Technical Provisions	See TP Section 19.14

Notes to Attachment 2-1:

1) The PMP shall be updated via the submittal of a redline amendment and cover sheet identifying changes whenever any of the following conditions exist:

- A plan or procedure is required to be updated in accordance with Section 6.4 of the Agreement;
- A plan or procedure no longer adequately addresses the matters it was intended to address;
- An audit by the Developer or by TxDOT identifies a need for an update to the PMP;
- A plan or procedure no longer represents current or appropriate practice;
- Organizational structure changes require revision to a plan;
- Developer is undertaking, or plans to undertake, activities not covered within a current plan; or
- Scope or schedule changes require revision to a plan.

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

Design-Build Project

Attachment 2-2
Work Breakdown Structure Requirements

The following Work Breakdown Structure (WBS) shall be the basis for organizing all Work under the Contract Documents and shall be used to structure the baseline schedule and other cost control systems, including the Payment Progress Process if applicable.

Table 1 represents the minimum levels of the WBS that all cost and schedule information shall rollup to once the Project Baseline Schedule is fully developed.

The WBS shall conform to level structure as follows:

Table 1: WBS Minimum Requirements

1 [Name of Project]
- **1.1. Project Administration**
  - 1.1.1. Mobilization
    - 1.1.1.1. Developer
    - 1.1.1.2. DB Contractor
  - 1.1.2. Submittals and Permitting
    - 1.1.2.1. (By Governmental Agency)
      - 1.1.2.1.1. (By Specific Permit/Submittal Requirement)
- **1.2. Right-of Way Acquisition**
  - 1.2.1. Acquisition By TxDOT
    - 1.2.1.1. (By Parcel No.)
  - 1.2.2. Acquisition by Developer
    - 1.2.2.1. (By Parcel No.)
- **1.3. Utility Adjustments**
  - 1.3.1. Utility Coordination
    - 1.3.1.1. Administration and Planning
      - 1.3.1.1.1. Site Utility Engineering
      - 1.3.1.1.2. Conceptual Design
    - 1.3.1.2. (By Owner)
      - 1.3.1.2.1. Master Agreements
      - 1.3.1.2.2. Utility Assemblies
  - 1.3.2. Utility Relocations
    - 1.3.2.1. (By Owner)
      - 1.3.2.1.1. (By Line No.)
- **1.4. Design**
  - 1.4.1. General Activities and Field Work
    - 1.4.1.1. Design Mobilization
    - 1.4.1.2. Schematics
    - 1.4.1.3. Survey Work
    - 1.4.1.4. Geotechnical Investigations
    - 1.4.1.5. Additional Field Investigations
  - 1.4.2. Develop Specifications

1.4.2.1. (By Discipline)
1.4.3. Geotechnical Design
1.4.3.1. General
1.4.3.2. Earthwork Geotech
1.4.3.3. Bridge Geotech
1.4.3.4. Culvert Geotech
1.4.3.5. Wall Geotech

1.4. Design (Continued)

1.4.4. Pavement Design
1.4.4.1. Data Analysis and Draft Report
1.4.4.2. Final Design and Report
1.4.5. Drainage Design
1.4.5.1. Hydrologic and Hydraulic Design
1.4.5.2. Preliminary System Design
1.4.5.3. Detailed Drainage Design
1.4.6. Roadway Design
1.4.6.1. Alignments
1.4.6.2. Sections
1.4.6.3. Detailed Design
1.4.7. Bridge Design
1.4.7.1. Establish Criteria and Procedures
1.4.7.2. Bridge layouts
1.4.7.3. Substructure Design
1.4.7.4. Superstructure Design
1.4.8. Retaining Wall Design
1.4.8.1. Establish Criteria and Procedures
1.4.8.2. Fill Wall Design
1.4.8.3. Cut Wall Design
1.4.9. Traffic Management
1.4.9.1. (By Phase)
1.4.10. Environmental Design
1.4.10.1. Erosion Control/SWPPP
1.4.10.2. Noise Wall Design
1.4.10.3. Wetland and habitat Mitigation
1.4.10.4. TCEQ Best Management Practices
1.4.11. Landscape and Aesthetic Design
1.4.11.1. Landscape Design
1.4.11.2. Aesthetic Design
1.4.12. Electrical Design
1.4.12.1. Illumination
1.4.12.2. Traffic Signals
1.4.13. ITS & TCS Design
1.4.13.1. Duct Bank System & Power Supply
1.4.13.2. ITS/TCS Equipment & Structures
1.4.14. Signage and Marking Design
1.4.14.1. Overhead
1.4.14.2. Small signs and pavement markings
1.4.15. Design Packages
1.4.15.1. Package Preparation
1.4.15.2. QA/QC Review

1.4.15.3. Submittal
1.4.15.4. TxDOT/IE Reviews
1.4.15.5. Comment Resolution

1.5. Construction

1.5.1. General
1.5.1.1. Mobilization
1.5.1.2. Administration
1.5.1.3. Quality Control

1.5. Construction (Continued)

1.5.2. By Work Areas – NBFR, SBFR, NBGPL, SBGPL, ML, XR, etc.
1.5.2.1. Removals
1.5.2.1.1. Building Removals
1.5.2.1.2. ROW Preparation
1.5.2.1.3. Roadway Removals
1.5.2.1.4. Bridge Removals
1.5.2.2. Earthwork
1.5.2.2.1. Topsoil Stripping and Placing
1.5.2.2.2. Excavation
1.5.2.2.3. Embankment
1.5.2.2.4. Special Geotechnical Measures
1.5.2.3. Landscaping
1.5.2.3.1. Seeding and Sodding
1.5.2.3.2. Fertilizer and Watering
1.5.2.3.3. Special Aesthetic Landscaping (if applicable)
1.5.2.4. Subgrade Treatment and Base
1.5.2.4.1. Lime Treatment
1.5.2.4.2. Flexible Base
1.5.2.5. Pavement
1.5.2.5.1. Asphalt Pavement
1.5.2.5.2. Concrete Pavement
1.5.2.5.3. Curb & Gutter
1.5.2.5.4. Driveways
1.5.2.5.5. Sidewalks and Median Paving
1.5.2.6. Retaining Walls
1.5.2.6.1. (By Wall No.)
1.5.2.7. Bridges
1.5.2.7.1. (By Bridge No.)
1.5.2.8. Drainage
1.5.2.8.1. Culverts
1.5.2.8.2. Storm Sewer
1.5.2.8.3. Riprap
1.5.2.9. Traffic Control and Temporary Work
1.5.2.9.1. Barricades, Signs & Traffic Handling
1.5.2.9.2. Erosion Control
1.5.2.9.3. Detour Construction/Removal
1.5.2.9.4. Portable Traffic Barrier
1.5.2.9.5. Workzone Pavement Marking
1.5.2.9.6. Temporary Bridges
1.5.2.9.7. Temporary Walls/Shoring
1.5.2.9.8. Temporary Drainage

1.5.2.9.9. Temporary Illumination
1.5.2.10. Permanent Barriers
1.5.2.10.1. Permanent Concrete Barriers
1.5.2.10.2. Metal Beam Guard Fence
1.5.2.10.3. Crash Attenuators
1.5.2.11. Signals and Illumination
1.5.2.11.1. Roadway Illumination
1.5.2.11.2. High Mast Illumination
1.5.2.11.3. Electrical Services

1. 5. Construction (Continued)

1.5.2.11.4. Traffic Signals
1.5.2.12. ITS/TCS
1.5.2.12.1. Duct Bank System
1.5.2.12.2. Equipment Foundations
1.5.2.12.3. Support Structures and Equipment
1.5.2.13. Permanent Signing and Marking
1.5.2.13.1. Overhead Sign Structures
1.5.2.13.2. Small Signs
1.5.2.13.3. Pavement Markings
1.5.2.14. Environmental Mitigation
1.5.2.14.1. Noise Walls
1.5.2.14.2. Wetland and Habitat Mitigation
1.5.2.15. Hazardous Materials
1.5.2.15.1. Site Assessments
1.5.2.15.2. Remediation

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

Design-Build Project

Attachment 2-3
Organizational Structure for Cost Reporting

Organizational Structure for Cost Reporting

1 PROJECT DESCRIPTION

1.1. Project Administration

1.1.1. Mobilization

1.1.2. Submittals and Permitting

1.2. Right-of Way Acquisition

1.2.1. Acquisition by TxDOT

1.2.2. Acquisition by Developer

1.3. Utility Adjustments

1.3.1. Utility Coordination

1.3.2. Utility Relocations

1.4. Design

1.4.1. General Activities and Field Work

1.4.2. Develop Specifications

1.4.3. Geotechnical Design

1.4.4. Pavement Design

1.4.5. Drainage Design

1.4.6. Roadway Design

1.4.7. Bridge Design

1.4.8. Retaining Wall Design

1.4.9. Traffic Management

1.4.10. Environmental Design

1.4.11. Landscape and Aesthetic Design

1.4.12. Electrical Design

1.4.13. ITS & TCS Design

1.4.14. Signage and Marking Design

1.4.15. Design Packages

1.5. Construction

1.5.1. Traffic Control and Temporary Work

1.5.2. Environmental Mitigation

1.5.3. Hazardous Materials

1.5.4. Removals

1.5.5. Earthwork

1.5.6. Subgrade Treatment and Base

1.5.7. Drainage

1.5.8. Pavement

1.5.9. Retaining Walls

1.5.10. Bridges

1.5.11. Permanent Barriers

1.5.12. Signals and Illumination

1.5.13. ITS/TCS

1.5.14. Landscaping

1.5.15. Permanent Signing and Marking

1.6. Changes Modifications

1.6.1. Change Order #xx

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

Design-Build Project

Attachment 2-4
I2MS Test Form Fields

I2MS Test Field Report

File: I2MSFieldReport.xls

File Type: Microsoft Excel (spreadsheet)

File Description: Describes what fields are required to be submitted per test, including pertinent header and footer information. All fields are required to be submitted if possible.

I2MS Test Form Fields

Purpose

The purpose of this document is to provide information on the tables and fields within I2MS.

Material Test Forms

Material Test Forms are forms used to run tests for a sample. A test form contains header and footer information which all forms have in common. Each test form also has a form body containing fields specific to the test method(s) being performed.

Header Fields

The header information is the metadata of the form. It is vital for searching for and analyzing records. All of the test forms have similar header information.

Table Name: HEADER_VALUE_OVT **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Course Lift	course_lift	nvarchar	250		TRUE
Direction	direction	nvarchar	250	CVL	TRUE
Distance From CL	dist_from_cl	nvarchar	250		TRUE
Feature	feature	nvarchar	250	CVL	TRUE
Grade	grade	nvarchar	100	CVL	TRUE
Material	material	nvarchar	100	CVL	TRUE
Misc	misc	nvarchar	250		TRUE
Report Type	report_type	nvarchar	250	CVL	TRUE
Roadway	roadway	nvarchar	250	CVL	TRUE
Sample ID	sample_id	nvarchar	13		TRUE
Sample Location	sample_location	nvarchar	250		TRUE
Sample Type	sample_type	nvarchar	100	CVL	TRUE
Sampled By	sampled_by	nvarchar	250	CVL	TRUE
Sampled Date	sampled_date	datetime		MM/dd/yyyy	TRUE
Section	section	nvarchar	100	CVL	TRUE
Spec Item	spec_item	nvarchar	100	CVL	TRUE
Spec Year	spec_year	nvarchar	250		TRUE
Special Provision	special_provision	nvarchar	250	CVL	TRUE
Split Sample ID	split_sample_id	nvarchar	250		TRUE
Station	station	nvarchar	250	Pattern: [0-9]+\+[0-9][0-9](\.[0-9][0-9])?	TRUE
Structure Number	structure_number	nvarchar	250	CVL	TRUE
Supplier	supplier	nvarchar	100	CVL	TRUE

Footer Fields

The footer contains approval data and comments for each of the test forms.

Table Name: FOOTER_VALUE_OVT **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Authorized By	authorized_by	nvarchar	100	CVL	TRUE
Authorized Date	authorized_date	smalldatetime		MM/dd/yyyy	TRUE
Completed Date	completed_date	smalldatetime		MM/dd/yyyy	TRUE
Digital Signature ID 1	dig_sig_id1	int			FALSE
Digital Signature ID 2	dig_sig_id2	int			FALSE
Remarks	remarks	text			TRUE
Reviewed By	reviewed_by	nvarchar	100	CVL	TRUE

Body Fields

Moisture Content of Aggregates (DB-103-E)

Table Name: VALUE_DB103E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Dish No.	dish_no	nvarchar	100		FALSE
Mass of Dry Sample	dry_sample_tare	decimal	(19, 8)		FALSE
Moisture Content	moisture_content	decimal	(19, 8)		TRUE
Payable Weight of Class 2 Flex Base	payable_weight	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tare Mass	tare_mass	decimal	(19, 8)		FALSE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE
Mass of Wet Sample Tare	wet_sample_tare	decimal	(19, 8)		FALSE

Liquid Limit, Plastic Limit, Plastic Index (DB-104-6)

Table Name: VALUE_DB104E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Liquid Limit	liquid_limit_total	decimal	(19, 8)		TRUE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE

Table Name: VALUE_DB104E_SAMPLE **Maximum Rows: 6**

Field Description	Field Name	Datatype	Length	Values	Required
Dish No.	dish_no	nvarchar	100		FALSE
Liquid Limit (%)	liquid_limit	decimal	(19, 8)		FALSE
Mass of Dry Sample + Tare (g)	mass_dry_sample	decimal	(19, 8)		FALSE
Mass of Wet Sample + Tare (g)	mass_wet_sample	decimal	(19, 8)		FALSE
Moisture Content, %	moisture_content	decimal	(19, 8)		FALSE
Number of Blows	number_blows	int			FALSE
Tare Mass (g)	tare_mass	decimal	(19, 8)		FALSE

Table Name: VALUE_DB105E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Plastic Limit	plastic_limit_total	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE

Table Name: VALUE_DB105E_SAMPLE **Maximum Rows: 3**

Field Description	Field Name	Datatype	Length	Values	Required
Dish No.	dish_no	nvarchar	100		FALSE
Mass of Dry Sample + Tare (g)	mass_dry_sample	decimal	(19, 8)		FALSE
Mass of Wet Sample + Tare (g)	mass_wet_sample	decimal	(19, 8)		FALSE
Plastic Limit (%)	plastic_limit	decimal	(19, 8)		FALSE
Tare Mass (g)	tare_mass	decimal	(19, 8)		FALSE
Mass of Water (g)	water_mass	decimal	(19, 8)		FALSE

Table Name: VALUE_DB106E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Plastic Index	plasticity_index	int			TRUE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE
Use Bar Linear Shrinkage to Calculate Plasticity Index?	use_bar_linear	nvarchar	100	{Yes, No}	FALSE

Bar Linear Shrinkage (DB-107-E)

Table Name: VALUE_DB107E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Calculate Plasticity Index	calculate_plasticity_index	bit		{Yes, No}	FALSE
Final Length	final_length	decimal	(19, 8)		FALSE
Initial Length	initial_length	decimal	(19, 8)		FALSE
Linear Shrinkage	linear_shrinkage	decimal	(19, 8)		TRUE
Maximum By Specification	maximum_by_specification	decimal	(19, 8)		FALSE
Minimum By Specification	minimum_by_specification	decimal	(19, 8)		FALSE
Plasticity Index	plasticity_index	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE
Unit	unit	nvarchar	100		FALSE

Particle Size Analysis (DB-110-E)

Table Name: VALUE_DB110E_SIEVE **Maximum Rows: 6**

Field Description	Field Name	Datatype	Length	Values	Required
Cumulative Percent Retained	cumulative_pct_retained	decimal	(19, 8)		TRUE
Cumulative Weight Retained	cumulative_weight_retained	decimal	(19, 8)		FALSE
Lower Spec Limit	lower_spec_limit	decimal	(19, 8)		FALSE
Master Grading	master_grading	nvarchar	100		TRUE
Sieve Size	sieve_size	nvarchar	100	CVL	TRUE
Upper Spec Limit	upper_spec_limit	decimal	(19, 8)		FALSE
Weight Retained	weight_retained	decimal	(19, 8)		FALSE

Table Name: VALUE_DB110E_TEST **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Cumulative Method	individual_cumulative	nvarchar	100	{Cumulative, Individual}	FALSE
Negative No.40	negative_no_40	nvarchar	100		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE
Total	total	nvarchar	100		FALSE

Moisture-Density Work Sheet (DB-113-E)

Table Name: VALUE_DB113E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Dry Density Scale Max	dry_density_scale_max	decimal	(19, 8)		FALSE
Dry Density Scale Min	dry_density_scale_min	decimal	(19, 8)		FALSE
Dry Density Scale unit	dry_density_scale_unit	decimal	(19, 8)		FALSE
Hygroscopic Moisture	hygroscopic_moisture	decimal	(19, 8)		FALSE
Max Density(kg)	max_density_kg	decimal	(19, 8)		FALSE
Max Density (pcf)	max_density_pcf	decimal	(19, 8)		TRUE
Moisture scale max	moisture_scale_max	decimal	(19, 8)		FALSE
Moisture scale min	moisture_scale_min	decimal	(19, 8)		FALSE
Moisture scale unit	moisture_scale_unit	decimal	(19, 8)		FALSE
Optimum Moisture	optimum_moisture	decimal	(19, 8)		TRUE
Oven Dry Weight	oven_dry_weight	decimal	(19, 8)		FALSE
Soil Description	soil_desc	nvarchar	100		TRUE
Specific Gravity (Apparent)	specific_gravity	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE
Weight of Aggr., Pycn. & Water	weight_of_aggr	decimal	(19, 8)		FALSE
Weight of Pycnometer & Water	weight_of_pycnometer	decimal	(19, 8)		FALSE

Table Name: VALUE_DB113E_SPECIMEN **Maximum Rows: 4**

Field Description	Field Name	Datatype	Length	Values	Required
Dry Density	dry_density	decimal	(19, 8)		FALSE
Dry Mass Material	dry_mass_material	decimal	(19, 8)		FALSE
Dry Mass Pan & Specimen	dry_mass_pan_specimen	decimal	(19, 8)		FALSE
Estimated Dry Density	est_dry_density	decimal	(19, 8)		FALSE
Height of Specimen	height_specimen	decimal	(19, 8)		FALSE
Mass Material	mass_material	decimal	(19, 8)		FALSE
Mass Water	mass_water	decimal	(19, 8)		FALSE
Mass Water Added	mass_water_added	decimal	(19, 8)		FALSE
Percent Water Content	pct_water_content	decimal	(19, 8)		FALSE
Percent Water On Total	pct_water_total	decimal	(19, 8)		FALSE
Tare Mass Mold	tare_mass_mold	decimal	(19, 8)		FALSE
Tare Mass Pan	tare_mass_pan	decimal	(19, 8)		FALSE
Volume Per Linear	volume_per_linear	decimal	(19, 8)		FALSE
Volume of Specimen	volume_specimen	decimal	(19, 8)		FALSE
Wet Density of Specimen	wet_density_specimen	decimal	(19, 8)		FALSE
Wet Mass Of Pan & Specimen	wet_mass_pan_specimen	decimal	(19, 8)		FALSE
Wet Mass Specimen	wet_mass_specimen	decimal	(19, 8)		FALSE
Wet Mass Specimen & Mold	wet_mass_specimen_mold	decimal	(19, 8)		FALSE

Moisture-Density Relationship of Subgrade and Embankment Soils (DB-114-E)

Table Name: VALUE_DB114E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Dry Density Scale Max	dry_density_scale_max	decimal	(19, 8)		FALSE
Dry Density Scale Min	dry_density_scale_min	decimal	(19, 8)		FALSE
Dry Density Scale unit	dry_density_scale_unit	decimal	(19, 8)		FALSE
Hygroscopic Moisture	hygroscopic_moisture	decimal	(19, 8)		FALSE
Max Density (kg)	max_density_kg	decimal	(19, 8)		FALSE
Max Density (pcf)	max_density_pcf	decimal	(19, 8)		TRUE
Moisture scale max	moisture_scale_max	decimal	(19, 8)		FALSE
Moisture scale min	moisture_scale_min	decimal	(19, 8)		FALSE
Moisture scale unit	moisture_scale_unit	decimal	(19, 8)		FALSE
Optimum Moisture	optimum_moisture	decimal	(19, 8)		TRUE
Oven Dry Weight	oven_dry_weight	decimal	(19, 8)		FALSE
Soil Descript	soil_description	nvarchar	100		TRUE
Specific Gravity	specific_gravity	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE
Weight of Aggr., Pycn. & Water	weight_of_aggr	decimal	(19, 8)		FALSE
Weight of Pycnometer & Water	weight_of_pycnometer	decimal	(19, 8)		FALSE

Table Name: VALUE_DB114E_SPECIMEN **Maximum Rows: 4**

Field Description	Field Name	Datatype	Length	Values	Required
Dry Density	dry_density	decimal	(19, 8)		FALSE
Dry Mass Material	dry_mass_material	decimal	(19, 8)		FALSE
Dry Mass Pan & Specimen	dry_mass_pan_specimen	decimal	(19, 8)		FALSE
Estimated Dry Density	est_dry_density	decimal	(19, 8)		FALSE
Height of Specimen	height_specimen	decimal	(19, 8)		FALSE
Mass Material	mass_material	decimal	(19, 8)		FALSE
Mass Water	mass_water	decimal	(19, 8)		FALSE
Mass Water Added	mass_water_added	decimal	(19, 8)		FALSE
Percent Water Content	pct_water_content	decimal	(19, 8)		FALSE
Percent Water Total	pct_water_total	decimal	(19, 8)		FALSE
Tare Mass Mold	tare_mass_mold	decimal	(19, 8)		FALSE
Tare Mass Pan	tare_mass_pan	decimal	(19, 8)		FALSE
Volume Per Linear mm	volume_per_linear	decimal	(19, 8)		FALSE
Volume of Specimen	volume_specimen	decimal	(19, 8)		FALSE
Wet Density of Specimen	wet_density_specimen	decimal	(19, 8)		FALSE
Wet Mass of Pan & Specimen	wet_mass_pan_specimen	decimal	(19, 8)		FALSE
Wet Mass Specimen	wet_mass_specimen	decimal	(19, 8)		FALSE
Wet Mass Specimen & Mold	wet_mass_specimen_mold	decimal	(19, 8)		FALSE

Nuclear Density and Moisture Determination (DB-115-1)

Table Name: VALUE_DB115_1 **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Density Count	density_count	int			FALSE
Density, %	density_pct	decimal	(19, 8)		TRUE
Pass/Fail	density_pct_pass_fail	nvarchar	100		FALSE
Max Density Specification Requirement	density_specification_req_max	decimal	(19, 8)		FALSE
Low Density Specification Req	density_specification_req_min	decimal	(19, 8)		FALSE
density_standard	density_standard	int			FALSE
Determined By Test Method	determined_by_test_method	nvarchar	100	{DB-113-E, DB-114-E}	FALSE
Dry Density, pcf	dry_density_pcf	decimal	(19, 8)		TRUE
Gauge No.	gauge_no	nvarchar	100		TRUE
Maximum Dry Density	max_dry_density_pcf	decimal	(19, 8)		TRUE
Moisture Content, %	moisture_content_pct	decimal	(19, 8)		TRUE
Moisture Content Pct Pass or Fail	moisture_content_pct_pass_fail	nvarchar	100	{Pass, Fail}	FALSE
Moisture Count	moisture_count	int			FALSE
Max Moisture Specification Requirement	moisture_specification_req_max	decimal	(19, 8)		FALSE
Low Moisture Specification Req	moisture_specification_req_min	decimal	(19, 8)		FALSE
Moisture Standard	moisture_standard	int			FALSE
Optimum Moisture Content	optimum_moisture_content_pct	decimal	(19, 8)		TRUE
Probe Depth	probe_depth	decimal	(19, 8)		TRUE
Soil Description	soil_desc	nvarchar	100		TRUE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE
Wet Density , pcf	wet_density_pcf	decimal	(19, 8)		FALSE

Soil /Aggregate Field Unit Weight Tests (DB-115-2)

Table Name: VALUE_DB115_2 **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Compaction, %	compaction_pct	decimal	(19, 8)		FALSE
Compaction Required	compaction_req_pct	decimal	(19, 8)		FALSE
Dry unit weight	dry_unit_weight	decimal	(19, 8)		FALSE
Dry Weight Total Moisture Sample	dry_weight_total_moisture	decimal	(19, 8)		FALSE
Final Weight Apparatus & Sand	final_weight_apparatus	decimal	(19, 8)		FALSE
Final Weight of Sand	final_weight_sand	decimal	(19, 8)		FALSE
Initial Weight Apparatus & Sand	initial_weight_apparatus	decimal	(19, 8)		FALSE
Initial Weight of Sand	initial_weight_sand	decimal	(19, 8)		FALSE
Maximum dry unit weight	max_dry_unit_weight	decimal	(19, 8)		FALSE
Moisture Required	moisture_req_pct	decimal	(19, 8)		FALSE
Optium Moisture (% if of dry unit weight)	optimum_moisture	decimal	(19, 8)		FALSE
Pass/Fail % Density	pass_fail_pct_density	nvarchar	100		FALSE
Pass/Fail % Moisture	pass_fail_pct_moisture	nvarchar	100		FALSE
% Moisture	pct_moisture	decimal	(19, 8)		FALSE
Sand bulk unit weight	sand_bulk_unit_weight	decimal	(19, 8)		FALSE
Soil Descript	soil_desc	nvarchar	100		FALSE
Stamp Code	stamp_code	int		CVL	FALSE
Tested By	tested_by	nvarchar	100	CVL	FALSE
Tested Date	tested_date	datetime		MM/dd/yyyy	FALSE
Total Volume-Sand Userd	total_volume	decimal	(19, 8)		FALSE
Volume of Hole	volume_hole	decimal	(19, 8)		FALSE
Volume of Surface	volume_surface	decimal	(19, 8)		FALSE
Weight of Material From Hole	weight_material_hole	decimal	(19, 8)		FALSE
Wet Unit Weight	wet_unit_weight	decimal	(19, 8)		FALSE
Wet Weight Total Moisture Sample	wet_weight_total_moisture	decimal	(19, 8)		FALSE

Test Resistance to Degradation By Wet Ball Mill Method (DB-116-E)

Table Name: VALUE_DB116E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Cumulative Method	cumulative_method	nvarchar	50	{Cumulative, Individual}	FALSE
Total of 3000g weight retained	individual_weight_retained_3000g_total	decimal	(19, 8)		FALSE
Total of 3500g weight retained	individual_weight_retained_3500g_total	decimal	(19, 8)		FALSE
Percent Soil Binder	pct_soil_binder	decimal	(19, 8)		FALSE
Percent Soil Binder Increase	pct_soil_binder_increase	decimal	(19, 8)		TRUE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE
Wet Ball Mill -No.40 Individual Percent Retained	wbm_individual_pct_retained_minusno40	decimal	(19, 8)		FALSE
Wet Ball Mill No.40 Individual Percent Retained	wbm_individual_pct_retained_no40	decimal	(19, 8)		FALSE
Wet Ball Mill Initial Weight	wbm_initial_weight	decimal	(19, 8)		FALSE
Wet Ball Mill Value	wbm_value	decimal	(19, 8)		TRUE
Wet Ball Mill -No.40 Weight Retained	wbm_weight_retained_minusno40	decimal	(19, 8)		FALSE
Wet Ball Mill No.40 Weight Retained	wbm_weight_retained_no40	decimal	(19, 8)		FALSE
Total of weight retained	weight_retained_total	decimal	(19, 8)		FALSE
Washed Sieve Analysis No.40 Individual Percent Retained	wsa_individual_pct_retained_no40	decimal	(19, 8)		FALSE
Washed Sieve Analysis -No.40 Individual Percent Retained	wsa_inidividual_pct_retained_minusno40	decimal	(19, 8)		FALSE
Washed Sieve Analysis Initial Weight	wsa_initial_weight	decimal	(19, 8)		FALSE
Washed Sieve Analysis -No.40 Weight Retained	wsa_weight_retained_minusno40	decimal	(19, 8)		FALSE
Washed Sieve Analysis No.40 Weight Retained	wsa_weight_retained_no40	decimal	(19, 8)		FALSE

Table Name: VALUE_DB116E_SIEVE **Maximum Rows: 7**

Field Description	Field Name	Datatype	Length	Values	Required
Cumulative Percent Retained	cumulative_pct_retained	decimal	(19, 8)		FALSE
3000g Cumulative Weight Retained	cumulative_weight_retained_3000g	decimal	(19, 8)		FALSE
3500g Cumulative Weight Retained	cumulative_weight_retained_3500g	decimal	(19, 8)		FALSE
Individual Percent Retained	individual_pct_retained	decimal	(19, 8)		FALSE
3000g Individual Weight Retained	individual_weight_retained_3000g	decimal	(19, 8)		FALSE
3500g Individual Weight Retained	individual_weight_retained_3500g	decimal	(19, 8)		FALSE
Sieve Size	sieve_size	nvarchar	100		FALSE
Weight Retained	weight_retained	decimal	(19, 8)		FALSE

Triaxial Compression Tests (DB-117-E)

Table Name: VALUE_DB117E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Average Corrected Strength, 00 psi	average_corrected_strength_0psi	decimal	(19, 8)		TRUE
Average Corrected Strength, 15 psi	average_corrected_strength_15psi	decimal	(19, 8)		TRUE
Classification	classification	nvarchar	100		FALSE
Cohesion, psi	cohesion_psi	decimal	(19, 8)		FALSE
Correlation Factor	correlation_factor	decimal	(19, 8)		FALSE
Grade, 00 psi	grade_0psi	nvarchar	100		FALSE
Grade, 15 psi	grade_15psi	nvarchar	100		FALSE
Internal Angle of Friction	internal_angle_friction	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE

Table Name: VALUE_DB117E_SPECIMEN **Maximum Rows: 8**

Field Description	Field Name	Datatype	Length	Values	Required
Area, in.^2	area	decimal	(19, 8)		FALSE
Avg. Cross Sectional Area, in^2	avg_cross_sectional_area	decimal	(19, 8)		FALSE
Average Diameter, in.	avg_diameter	decimal	(19, 8)		FALSE
Corrected Stress, psi.	corrected_stress_psi	decimal	(19, 8)		FALSE
Dry Density of Specimen, pcf	dry_density_specimen_pcf	decimal	(19, 8)		FALSE
Final Weight of Stones	final_weight_stones	decimal	(19, 8)		FALSE
Height of Stone 1, in.	height_stone1	decimal	(19, 8)		FALSE
Height of Stone 2, in.	height_stone2	decimal	(19, 8)		FALSE
I-Strain, in./in.	i_strain	decimal	(19, 8)		FALSE
Initial Height of Specimen, in.	initial_height	decimal	(19, 8)		FALSE
Lateral Pressure, psi.	lateral_pressure_psi	decimal	(19, 8)		FALSE
New Height of Specimen, in.	new_height	decimal	(19, 8)		FALSE
Moisture of Specimen, %	pct_moisture_specimen	decimal	(19, 8)		FALSE
% Strain , in./in.	pct_strain	decimal	(19, 8)		FALSE
Uncorrected Stress, psi.	uncorrected_stress_psi	decimal	(19, 8)		FALSE
Weight of Specimen	weight_specimen	decimal	(19, 8)		FALSE
Weight of Stones and Specimen	weight_stones_specimen	decimal	(19, 8)		FALSE

Determining Soil pH (DB-128-E)

Table Name: VALUE_DB128E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Soil pH	soil_ph	decimal	(19, 8)		TRUE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE

Measuring Resistivity of Soil Materials (DB-129-E)

Table Name: VALUE_DB129E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Resistance using resistivity meter	resistance_using_meter	decimal	(19, 8)		FALSE
Resistivity	resistivity_result	decimal	(19, 8)		TRUE
A= Area of one electrode	sbf_area	decimal	(19, 8)		FALSE
Distance between electrodes	sbf_distance	decimal	(19, 8)		FALSE
Soil Box Factor	sbf_factor	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE

Measuring Thickness of Pavement Layer (DB-140-E)

Table Name: VALUE_DB140E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Average Depth:	avg_depth	decimal	(19, 8)		TRUE
Depth 1:	depth_1	decimal	(19, 8)		FALSE
Depth 2:	depth_2	decimal	(19, 8)		FALSE
Depth 3:	depth_3	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE

OVF HMAC Test Data: DB-200-F, DB-207-FPR, DB-227-F, DB-236-F, DB-207-F (DB-200/07/36)

Table Name: VALUE_DB207F **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Specific Gravity of Asphalt Binder	specific_gravity	decimal	(19, 3)		FALSE
Stamp Code	stamp_code	int		CVL	FALSE
Tested By	tested_by	nvarchar	100	CVL	FALSE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	FALSE
Voids in Mineral Aggregate (VMA)	vma	decimal	(19, 1)		TRUE

Table Name: VALUE_DB207FPR **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Average Actual Specific Gravity (Ga):	GA	nvarchar	100		TRUE
Lab Molded Density, %:	LMD	decimal	(19, 8)		TRUE
Stamp Code	stamp_code	nvarchar	100	CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE

Table Name: VALUE_DB227F **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Rice Specific Gravity (Gr):	rice_specific_gravity	decimal	(19, 8)		TRUE
Stamp Code	stamp_code	nvarchar	100	CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE

Table Name: VALUE_DB229F **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Stamp Code	stamp_code	nvarchar	100	CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE

Table Name: VALUE_DB229F_SIEVE **Maximum Rows: 10**

Field Description	Field Name	Datatype	Length	Values	Required
Current JMF	Current_JMF	nvarchar	100		FALSE
Design JMF	Design_JMF	nvarchar	100		FALSE
Adjusted Individual % Retained	pct	decimal	(19, 8)		TRUE
Sieve Size	sieve_size	nvarchar	100	CVL	TRUE

Table Name: VALUE_DB236F **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Asphalt Content, %:	AC	decimal	(19, 8)		TRUE
Stamp Code	stamp_code	nvarchar	100	CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE

Sieve Analysis of Non-Surface Treatment Aggregates (DB-200-F)

Table Name: VALUE_DB200F **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Cumulative Weight Retained Minusno14	cumulative_weight_retained_minusno14	decimal	(19, 8)		FALSE
Dry Weight After Washing	dry_weight_after_washing	decimal	(19, 8)		FALSE
Limit As Percent	limit_as_percent	nvarchar	100	{Passing, Retained}	FALSE
Original Dry Weight	original_dry_weight	decimal	(19, 8)		FALSE
Sieve Analysis Result 1	sieve_analysis_result1	nvarchar	100		FALSE
Sieve Analysis Result 2	sieve_analysis_result2	decimal	(19, 8)		FALSE
Sieve Analysis Result 3	sieve_analysis_result3	decimal	(19, 8)		FALSE
Sieve Analysis Result 4	sieve_analysis_result4	decimal	(19, 8)		FALSE
Sieving Loss	sieving_loss	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE
Total Weight	total_weight	decimal	(19, 8)		FALSE
Washing Loss	washing_loss	decimal	(19, 8)		FALSE

Table Name: VALUE_DB200F_SIEVE **Maximum Rows: 12**

Field Description	Field Name	Datatype	Length	Values	Required
Cumulative Percent Passing	cumulative_pct_passing	decimal	(19, 8)		TRUE
Cumulative Percent Retained	cumulative_pct_retained	decimal	(19, 8)		FALSE
Cumulative Weight Retained	cumulative_weight_retained	decimal	(19, 8)		FALSE
Individual Weight Retained	individual_weight_retained	decimal	(19, 8)		FALSE
Lower Limit Grading	lower_limit_grading	decimal	(19, 8)		FALSE
Sieve Size	sieve_size	nvarchar	100	{2", 1-3/4", 1-1/2", 1-1/4", 1", 7/8", 3/4", 5/8", 1/2", 7/16", 3/8", 5/16", 1/4", No. 4, No. 6, No. 8, No. 10, No. 14, No. 16, No. 20, No. 30, No. 40, No. 50, No. 80, No. 100, No. 200 }	TRUE
Upper Limit Grading	upper_limit_grading	decimal	(19, 8)		FALSE
Within Grading Limits	within_grading_limits	bit			TRUE

Sand Equivalent (DB-203-F)

Table Name: VALUE_DB203F **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Average Sand Equivalent	average_sand_equivalent	decimal	(19, 8)		TRUE
Clay No.1 Reading	clay1_reading	decimal	(19, 8)		FALSE
Clay No.2 Reading	clay2_reading	decimal	(19, 8)		FALSE
Sand No.1 Calculated	sand1_calculated	decimal	(19, 8)		FALSE
Sand No.1 Reading	sand1_reading	decimal	(19, 8)		FALSE
Sand No.1 Reported	sand1_reported	decimal	(19, 8)		FALSE
Sand No.2 Calculated	sand2_calculated	decimal	(19, 8)		FALSE
Sand No.2 Reading	sand2_reading	decimal	(19, 8)		FALSE
Sand No.2 Reported	sand2_reported	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE

QC/QA Test Data (DB-207-FPL)

Table Name: VALUE_DB207FPL **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
In Place Air Void, %	air_void	decimal	(19, 8)		TRUE
Stamp Code	stamp_code	nvarchar	100	CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE

Deleterious Material & Decantation For Coarse Aggr (DB-217-F)

Table Name: VALUE_DB217F **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Original Weight Retained	part1_orig_weight_retained	decimal	(19, 8)		FALSE
Percent Deterious Material	part1_pct_deleterious_material	decimal	(19, 8)		TRUE
Sieve Size	part1_sieve_size	nvarchar	100		FALSE
Weight Deleterious Material	part1_weight_deleterious_material	decimal	(19, 8)		FALSE
Dry Weight after Washing	part2_dry_weight_after_washing	decimal	(19, 8)		FALSE
Percent Loss By Decantation	part2_loss_by_decantation	decimal	(19, 8)		TRUE
Original Weight Retained	part2_orig_weight_retained	decimal	(19, 8)		FALSE
Sieve Size	part2_sieve_size	nvarchar	53		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE

Sieve Analysis for Fine & Coarse Aggregate (DB-401-A)

Table Name: VALUE_DB401A **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Equivalent Exceed 85	equivalent_exceed_85	bit			FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE
Total	total	decimal	(19, 8)		FALSE

Table Name: VALUE_DB401A_SIEVE **Maximum Rows: 8**

Field Description	Field Name	Datatype	Length	Values	Required
Cumulative Percent Passing	cumulative_pct_passing	decimal	(19, 8)		FALSE
Cumulative Percent Retained	cumulative_pct_retained	decimal	(19, 8)		TRUE
Cumulative Weight Retained	cumulative_weight_retained	decimal	(19, 8)		FALSE
Individual Weight Retained	individual_weight_retained	decimal	(19, 8)		FALSE
Lower Spec Limit	lower_retained_spec_limit	decimal	(19, 8)		FALSE
Sieve Size	sieve_size	nvarchar	100		TRUE
Upper Spec Limit	upper_retained_spec_limit	decimal	(19, 8)		FALSE
Within Master Grading	within_master_grading	varchar	20		TRUE

Table Name: VALUE_DB402A **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Fineness Modulus	fineness_modulus	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	FALSE
Tested By	tested_by	nvarchar	100	CVL	FALSE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	FALSE

Decantation Test For Concrete Aggregates (DB-406-A)

Table Name: VALUE_DB406A **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Dry Mass After Washing	dry_mass_after_washing	decimal	(19, 8)		FALSE
Mass of Pycnometer Containing Sample and Water To Fill After Washing	mass_of_pycnometer_after_washing	decimal	(19, 8)		FALSE
Mass of Pycnometer Containing Sample and Water To Fill Before Washing	mass_of_pycnometer_before_washing	decimal	(19, 8)		FALSE
Mass of Pycnometer Filled With Water at Approx. Same Temperature as above	mass_of_pycnometer_with_water	decimal	(19, 8)		FALSE
Original Dry Mass of Sample	original_dry_mass	decimal	(19, 8)		FALSE
% Loss	percent_loss_part1	decimal	(19, 8)		TRUE
Percent Loss	percent_loss_part2	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Test By:	test_by	nvarchar	100	{Part I - Lab Method, Part II - Field Method}	FALSE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested By - Part II	tested_by_part2	nvarchar	100	CVL	FALSE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE
Tested Date - Part II	tested_date_part2	datetime		MM/dd/yyyy	FALSE

Organic Impurities in Fine Aggregate for Concrete (DB-408-A)

Table Name: VALUE_DB408A **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Color of the Supernatant Liquid	color_of_supernatant_liquid	nvarchar	100	{LIGHTER THAN STANDARD, EQUAL TO STANDARD, DARKER THAN STANDARD}	TRUE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE

Deleterious Material (DB-413-A)

Table Name: VALUE_DB413A **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Clay	clay_value1	decimal	(19, 8)		FALSE
Clay Percentage	clay_value2	decimal	(19, 8)		TRUE
Friable	friable_value1	decimal	(19, 8)		FALSE
Friable Percentage	friable_value2	decimal	(19, 8)		TRUE
Laminated	laminated_value1	decimal	(19, 8)		FALSE
Laminated Percentage	laminated_value2	decimal	(19, 8)		TRUE
Other	other_value1	decimal	(19, 8)		FALSE
Othesr Percentage	other_value2	decimal	(19, 8)		FALSE
Deleterious Material Retained	percent_deleterious_material_retained	decimal	(19, 8)		TRUE
Shale	shale_value1	decimal	(19, 8)		FALSE
Shale Percentage	shale_value2	decimal	(19, 8)		TRUE
Sieve Size	sieve_size	nvarchar	100		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE
Total	total	decimal	(19, 8)		FALSE
Total Weight Sample	total_weight_sample	decimal	(19, 8)		FALSE

Field Form Concrete Sample - Cylinders (DB-418-A)

Table Name: VALUE_DB418A **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Actual Water	actual_water	nvarchar	100		TRUE
Agg. Correction Factor	agg_correction_factor	nvarchar	100	CVL	TRUE
Agg. Size	agg_size	nvarchar	100	CVL	TRUE
Air Temperature	air_temperature	nvarchar	100		TRUE
Batch Size	batch_size	nvarchar	100		TRUE
Batch Time	batch_time	nvarchar	100		TRUE
Class of Concrete	class_of_concrete	nvarchar	100	CVL	TRUE
Concrete Temperature	concrete_temperature	nvarchar	100		TRUE
Corrected Air Content	corrected_air_content	decimal	(19, 8)		TRUE
Design Water	design_water	nvarchar	100		TRUE
Mix ID	mix_id	nvarchar	100		TRUE
Placement Air	placement_air	decimal	(19, 8)		TRUE
Placement Slump	placement_slump	decimal	(19, 8)	CVL	TRUE
Pump Air Loss	pump_air_loss	decimal	(19, 8)		TRUE
Pump Slump Loss	pump_slump_loss	decimal	(19, 8)		TRUE
Req. Strength	req_strength	nvarchar	100		TRUE
Sample Time	sample_time	nvarchar	100		TRUE
Average 7 Day Compressive Strength	seven_day_average	decimal	(19, 8)		FALSE
Slump	slump	decimal	(19, 8)		TRUE
Specimen Size	specimen_size	nvarchar	100	{4x8, 6x12}	TRUE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE
Ticket #	ticket_number	nvarchar	100		TRUE
Total Water	total_water	nvarchar	100		TRUE
Truck #	truck_number	nvarchar	100		TRUE
Average 28 Day Compressive Strength	twenty_eight_day_average	decimal	(19, 8)		FALSE
Unit Wt.	unit_weight	nvarchar	100		TRUE
Water Added	water_added	nvarchar	100		TRUE

Table Name: VALUE_DB418A_AVERAGE **Maximum Rows: 3**

Field Description	Field Name	Datatype	Length	Values	Required
Average Age	average_age	nvarchar	100		TRUE
Average Strength	average_strength	decimal	(19, 8)		TRUE

Table Name: VALUE_DB418A_SPECIMEN **Maximum Rows: 7**

Field Description	Field Name	Datatype	Length	Values	Required
Age(days)	age	nvarchar	100	CVL	TRUE
Area	area	decimal	(19, 8)		TRUE
Load(lbs)	load_lbs	decimal	(19, 8)		TRUE
Pass/Fail	pass_fail	nvarchar	5		FALSE
Specimen	specimen	nvarchar	100		FALSE
Strength	strength	decimal	(19, 8)		TRUE
Test Date	test_date	smalldatetime		MM/dd/yyyy	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Type Fracture	type_fracture	varchar	50	{A, B, C, D, E}	TRUE

Determining Pavement Thickness By Direct Measurement (DB-423-A)

Table Name: VALUE_DB423A **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Measure Unit	measure_unit	nvarchar	100	{Inches, Millimeters}	FALSE
Pavement Depth	pavement_depth	decimal	(19, 8)		TRUE
Stamp Code	stamp_code	int		CVL	FALSE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE

Table Name: VALUE_DB423A_LOCATION **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Average	average	decimal	(19, 8)		TRUE
Measurement 1	measurement_1	decimal	(19, 8)		FALSE
Measurement 2	measurement_2	decimal	(19, 8)		FALSE
Measurement 3	measurement_3	decimal	(19, 8)		FALSE
Measurement Identification / Location	measurement_id_location	nvarchar	100		FALSE

Soil-Cement, Soil-Lime Testing (DB-120-E) ** INACTIVE **

Table Name: VALUE_DB120E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Avg. Corrected Stress, psi:	avg_corrected_stress_psi	decimal	(19, 8)		FALSE
Percent Cement, (%)	percent_cement	decimal	(19, 8)		TRUE
Performed By DB-120-E:	performed_by	nvarchar	200		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Target Percent Cement, %:	target_percent_cement	decimal	(19, 8)		FALSE
Target Stress, psi:	target_stress_psi	decimal	(19, 8)		FALSE
Tested By	tested_by	nvarchar	200	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE

Table Name: VALUE_DB120E_SPECIMEN **Maximum Rows: 3**

Field Description	Field Name	Datatype	Length	Values	Required
Area, in.^2:	area	decimal	(19, 8)		FALSE
Avg. Corrected Stress, psi:	avg_corrected_stress	decimal	(19, 8)		FALSE
Avg. Cross Sectional Area, in^2:	avg_cross_section_area	decimal	(19, 8)		FALSE
Average Diameter, in.:	avg_diameter	decimal	(19, 8)		FALSE
Circumference, in.:	circumference	decimal	(19, 8)		FALSE
Corrected Stress, psi.:	corrected_stress	decimal	(19, 8)		FALSE
Dead Load, lbs.:	dead_load	decimal	(19, 8)		FALSE
Deformation at Max Load, in.	deformation_at_max_load	decimal	(19, 8)		FALSE
Height of Stone 1, in.	height_stone1	decimal	(19, 8)		FALSE
Height of Stone 2, in.	height_stone2	decimal	(19, 8)		FALSE
I-Strain, in./in.:	i_strain	decimal	(19, 8)		FALSE
Initial Height of Specimen, in.:	initial_height_specimen	decimal	(19, 8)		FALSE
Lateral Pressure, psi.:	lateral_pressure	decimal	(19, 8)		FALSE
Max. Load Reading, div.	max_load_reading	decimal	(19, 8)		FALSE
New Height of Specimen, in.:	new_height_specimen	decimal	(19, 8)		FALSE
% Strain , in./in.:	pct_strain	decimal	(19, 8)		FALSE
Percent Cement, (%)	percent_cement	decimal	(19, 8)		FALSE
Ring Factor, lbs./div	ring_factor	decimal	(19, 8)		FALSE
Specimen Number:	specimen_no	int			FALSE
Uncorr'd Stress, psi.:	uncorrected_stress	decimal	(19, 8)		FALSE

Soil-Lime Testing: DB-121-E (DB-121-E) ** INACTIVE **

Table Name: VALUE_DB121E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Average Corrected Strength, 00 psi	average_corrected_strength_0psi	decimal	(19, 8)		TRUE
Average Corrected Strength, 15 psi	average_corrected_strength_15psi	decimal	(19, 8)		FALSE
Classification	classification	nvarchar	100		FALSE
Cohesion, psi	cohesion_psi	decimal	(19, 8)		FALSE
Correlation Factor	correlation_factor	decimal	(19, 8)		FALSE
Grade, 00 psi	grade_0psi	nvarchar	100		FALSE
Grade, 15 psi	grade_15psi	nvarchar	100		FALSE
Internal Angle of Friction	internal_angle_friction	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE

Table Name: VALUE_DB121E_SPECIMEN **Maximum Rows: 8**

Field Description	Field Name	Datatype	Length	Values	Required
Area, in.^2	area	decimal	(19, 8)		FALSE
Avg. Cross Sectional Area, in^2	avg_cross_sectional_area	decimal	(19, 8)		FALSE
Average Diameter, in.	avg_diameter	decimal	(19, 8)		FALSE
Corrected Stress, psi.	corrected_stress_psi	decimal	(19, 8)		FALSE
Dry Density of Specimen, pcf	dry_density_specimen_pcf	decimal	(19, 8)		FALSE
Final Weight of Stones	final_weight_stones	decimal	(19, 8)		FALSE
Height of Stone 1, in.	height_stone1	decimal	(19, 8)		FALSE
Height of Stone 2, in.	height_stone2	decimal	(19, 8)		FALSE
I-Strain, in./in.	i_strain	decimal	(19, 8)		FALSE
Initial Height of Specimen, in.	initial_height	decimal	(19, 8)		FALSE
Lateral Pressure, psi.	lateral_pressure_psi	decimal	(19, 8)		FALSE
New Height of Specimen, in.	new_height	decimal	(19, 8)		FALSE
Moisture of Specimen, %	pct_moisture_specimen	decimal	(19, 8)		FALSE
% Strain , in./in.	pct_strain	decimal	(19, 8)		FALSE
Uncorrected Stress, psi.	uncorrected_stress_psi	decimal	(19, 8)		FALSE
Weight of Specimen	weight_specimen	decimal	(19, 8)		FALSE
Weight of Stones and Specimen	weight_stones_specimen	decimal	(19, 8)		FALSE

Density of Asphalt Stabilized Base (DB-126-E) ** INACTIVE **

Table Name: VALUE_DB126E **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Percent Asphalt in Mix(max)	asphalt_pct_max	decimal	(19, 8)		FALSE
Percent Asphalt in Mix(min)	asphalt_pct_min	decimal	(19, 8)		FALSE
Broken Method	broken_method	nvarchar	20	{Fast Break, Slow Break}	FALSE
Date Broken(max)(max)	date_broken_max	smalldatetime		MM/dd/yyyy	FALSE
Date Broken(min)	date_broken_min	smalldatetime		MM/dd/yyyy	FALSE
Density of Specimen(max)	density_of_specimen_max	decimal	(19, 8)		FALSE
Density of Specimen(min)	density_of_specimen_min	decimal	(19, 8)		FALSE
Gauge Reading(max)	gague_reading_psi_max	decimal	(19, 8)		FALSE
Gauge Reading (min)	gague_reading_psi_min	decimal	(19, 8)		FALSE
Height of Specimen(max)	height_max	decimal	(19, 8)		FALSE
Height of Specimen(min)	height_min	decimal	(19, 8)		FALSE
Measured Weight(max)	measured_weight_max	decimal	(19, 8)		FALSE
Measured Weight(min)	measured_weight_min	decimal	(19, 8)		FALSE
Minimum Allowable Density	min_allowable_density	decimal	(19, 8)		FALSE
Minimum Percent Density	min_pct_density	decimal	(19, 8)		FALSE
Minimum Specimen Unconfined Compressive Strength	min_specimen_UCS	decimal	(19, 8)		FALSE
Mold Number(max)	mold_number_max	nvarchar	100		FALSE
Mold Number(min)	mold_number_min	nvarchar	100		FALSE
Date Molded(max)	molded_date_max	smalldatetime		MM/dd/yyyy	FALSE
Date Molded(min)	molded_date_min	smalldatetime		MM/dd/yyyy	FALSE
Stamp Code	stamp_code	int		CVL	FALSE
Tested By	tested_by	nvarchar	100	CVL	FALSE
Tested Date	tested_date	datetime		MM/dd/yyyy	FALSE
Unconfined Compressive Strength (max)	UCS_max	nvarchar	100		FALSE
Unconfined Compressive Strength (min)	UCS_min	nvarchar	100		FALSE
Volume of Mold(max)	volume_of_mold_max	decimal	(19, 8)		FALSE
Volume of Mold(min)	volume_of_mold_min	decimal	(19, 8)		FALSE
Volume of Specimen(max)	volume_of_specimen_max	decimal	(19, 8)		FALSE
Volume of Specimen(min)	volume_of_specimen_min	decimal	(19, 8)		FALSE
Weight of Filters(max)	weight_of_filters_max	decimal	(19, 8)		FALSE
Weight of Filters(min)	weight_of_filters_min	decimal	(19, 8)		FALSE
Weight of Material(max)	weight_of_mat_max	decimal	(19, 8)		FALSE
Weight of Material(min)	weight_of_mat_min	decimal	(19, 8)		FALSE
Weight of Plates(max)	weight_of_plates_max	decimal	(19, 8)		FALSE
Weight of Plates(min)	weight_of_plates_min	decimal	(19, 8)		FALSE
Weight of Specimen(max)	weight_of_specimen_max	decimal	(19, 8)		FALSE
Weight of Specimen(min)	weight_of_specimen_min	decimal	(19, 8)		FALSE

Sieve Analysis of Surface Treatment Aggregate (DB-200-ST) ** INACTIVE **

Table Name: VALUE_DB200ST **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Sphalt	asphalt_pct	decimal	(19, 8)		FALSE
Dry Weight After Washing	dry_weight_after_washing	decimal	(19, 8)		FALSE
Moisture	moisture_pct	decimal	(19, 8)		FALSE
Original Dry Weight	orig_dry_weight	decimal	(19, 8)		FALSE
Total	pan_weight	decimal	(19, 8)		FALSE
Percent Difference	percent_difference	decimal	(19, 8)		FALSE
Sieving Loss	sieving_loss	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	FALSE
Tested By	tested_by	nvarchar	100	CVL	FALSE
Tested Date	tested_date	datetime		MM/dd/yyyy	FALSE
Total Weight	total_weight	decimal	(19, 8)		FALSE
Type	type	nvarchar	100	{A, B, C, D, E, L, PA, PB, PC, PD, PE, PL}	FALSE
Washing Loss	washing_loss	decimal	(19, 8)		FALSE
Weight Difference	weight_difference	decimal	(19, 8)		FALSE
PrePan	weight_retained	decimal	(19, 8)		FALSE

Table Name: VALUE_DB200ST_SIEVE **Maximum Rows: 8**

Field Description	Field Name	Datatype	Length	Values	Required
Cumulative Percent Passing	cumulative_percent_passing	decimal	(19, 8)		FALSE
Lower Retained Limit	lower_retained_limit	decimal	(19, 8)		FALSE
Cumulative Percent Retained	percent_retained_cumulative	decimal	(19, 8)		FALSE
Individual Percent Retained	percent_retained_individual	decimal	(19, 8)		FALSE
Sieve Size	sieve_size	nvarchar	100		FALSE
Upper Retained Limit	upper_retained_limit	decimal	(19, 8)		FALSE
Cumulative Weight Retained	weight_retained_cumulative	decimal	(19, 8)		FALSE
Individual weight Retained	weight_retained_individual	decimal	(19, 8)		FALSE
Within Master Grading	within_master_grading	nvarchar	100		FALSE

Determining Flakiness Index (DB-224-F) ** INACTIVE **

Table Name: VALUE_DB224F **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Flakiness Index	flakiness_index	decimal	(19, 8)		TRUE
Number of Particles	num_particles_1	decimal	(19, 8)		FALSE
Number of Particles	num_particles_2	decimal	(19, 8)		FALSE
Number of Particles	num_particles_3	decimal	(19, 8)		FALSE
Number of Particles Passing for 1/4" slot	slot_1_4	decimal	(19, 8)		FALSE
Number of Particles Passing for 3/8" slot	slot_3_8	decimal	(19, 8)		FALSE
Number of Particles Passing for 5/32" slot	slot_5_32	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE
Total Particles	total_particles	decimal	(19, 8)		FALSE
Total Passing Particles	total_passing_particles	decimal	(19, 8)		FALSE

Determining Draindown Characteristics in Bituminous Materials (DB-235-F) ** INACTIVE **

Table Name: VALUE_DB235F **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Average Percent of Draindown for Two Samples	avg_pct_draindown	decimal	(19, 8)		FALSE
Final Weight Plate	final_weight_plate_1	decimal	(19, 8)		FALSE
Final Weight Plate	final_weight_plate_2	decimal	(19, 8)		FALSE
Initial Sample Weight	init_sample_weight_1	decimal	(19, 8)		FALSE
Initial Sample Weight	init_sample_weight_2	decimal	(19, 8)		FALSE
Initial Weight Plate	init_weight_plate_1	decimal	(19, 8)		FALSE
Initial Weight Plate	init_weight_plate_2	decimal	(19, 8)		FALSE
Percent Of Draindown	pct_draindown_1	decimal	(19, 8)		FALSE
Percent Of Draindown	pct_draindown_2	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	datetime		MM/dd/yyyy	TRUE

Resistance To Degradation By Abrasion & Impact in Los Angeles Machine (DB-410-A) ** INACTIVE **

Table Name: VALUE_DB410A **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Final Weight	final_weight	decimal	(19, 8)		FALSE
Initial Weight	initial_weight	decimal	(19, 8)		FALSE
La Abrasion Type	la_abrasion_type	nvarchar	100	CVL	FALSE
La Abrasion Value	la_abrasion_value	decimal	(19, 8)		FALSE
Loss of Weight	loss_of_weight	decimal	(19, 8)		FALSE
Number of Spheres	number_of_spheres	int			FALSE
Percent Loss	percent_loss	decimal	(19, 8)		FALSE
Sieve	sieve	nvarchar	100		FALSE
Stamp Code	stamp_code	int		CVL	FALSE
Tested By	tested_by	nvarchar	100	CVL	FALSE
Tested Date	tested_date	datetime		MM/dd/yyyy	FALSE
Weight of Charge	weight_of_charge	nvarchar	100		FALSE

Table Name: VALUE_DB410A_SAMPLE **Maximum Rows: 4**

Field Description	Field Name	Datatype	Length	Values	Required
Actual Weight	actual_weight	decimal	(19, 8)		FALSE
Passing Sieve	passing_sieve	nvarchar	100		FALSE
Projected Weight	projected_weight	nvarchar	100		FALSE
Retained Sieve	retained_sieve	nvarchar	100		FALSE
Within Range	within_range	bit			FALSE

Magnesium Sulfate Soundness (DB-411-M) ** INACTIVE **

Table Name: VALUE_DB411M — **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Normalized Individual Percent Retained Total	ni_pct_retained_total	decimal	(19, 8)		FALSE
% Loss Total	pct_loss_total	decimal	(19, 8)		FALSE
Soundness Loss	soundness_loss	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE
Weighted Average % Loss Total	weighted_avg_pct_loss_total	decimal	(19, 8)		FALSE

Table Name: VALUE_DB411M_CYCLE — **Maximum Rows: 5**

Field Description	Field Name	Datatype	Length	Values	Required
Cycle	cycle	nvarchar	5		FALSE
In Oven Date	in_oven_date	smalldatetime		MM/dd/yyyy	FALSE
In Oven Time In	in_oven_time_in	smalldatetime		MM/dd/yyyy	FALSE
In Oven Time Out	in_oven_time_out	smalldatetime		MM/dd/yyyy	FALSE
In Solution Date	in_solution_date	smalldatetime		MM/dd/yyyy	FALSE
In Solution Time In	in_solution_time_in	smalldatetime		MM/dd/yyyy	FALSE
In Solution Time Out	in_solution_time_out	smalldatetime		MM/dd/yyyy	FALSE
Out Oven Date	out_oven_date	smalldatetime		MM/dd/yyyy	FALSE
Out Oven Time In	out_oven_time_in	smalldatetime		MM/dd/yyyy	FALSE
Out Oven Time Out	out_oven_time_out	smalldatetime		MM/dd/yyyy	FALSE
Out Solution Date	out_solution_date	smalldatetime		MM/dd/yyyy	FALSE
Out Solution Time In	out_solution_time_in	smalldatetime		MM/dd/yyyy	FALSE
Out Solution Time Out	out_solution_time_out	smalldatetime		MM/dd/yyyy	FALSE
Remarks	remarks	nvarchar	250		FALSE

Table Name: VALUE_DB411M_PARTICLE — **Maximum Rows: 8**

Field Description	Field Name	Datatype	Length	Values	Required
Final Weight (g)	final_weight	decimal	(19, 8)		FALSE
Initial Weight (g)	initial_weight	decimal	(19, 8)		FALSE
Loss of Weight (g)	loss_of_weight	decimal	(19, 8)		FALSE
Normalized Individual Percent Retained	ni_pct_retained	decimal	(19, 8)		FALSE
% Loss	pct_loss	decimal	(19, 8)		FALSE
Particle Size Range Passing	size_range_passing	nvarchar	100		FALSE
Particle Size Range Retained	size_range_retained	nvarchar	100		FALSE
Weighted Average % Loss	weighted_avg_pct_loss	decimal	(19, 8)		FALSE

Testing Of Drilled Cores Of Portland Cement Concrete (DB-424-A, Part III) ** INACTIVE **

Table Name: VALUE_DB424A **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Stamp Code	stamp_code	int		CVL	FALSE
Tested By	tested_by	nvarchar	100	CVL	FALSE
Tested By - Part II	tested_by_part2	nvarchar	100	CVL	FALSE
Tested By - Part III	tested_by_part3	nvarchar	100	CVL	FALSE
Tested Date	tested_date	datetime		MM/dd/yyyy	FALSE
Tested Date - Part II	tested_date_part2	datetime		MM/dd/yyyy	FALSE
Tested Date - Part III	tested_date_part3	datetime		MM/dd/yyyy	FALSE

Table Name: VALUE_DB424A_CORE **Maximum Rows: 4**

Field Description	Field Name	Datatype	Length	Values	Required
Age (Days)	age	int			FALSE
Compressive Strength	compressive_strength1	decimal	(19, 8)		FALSE
Compressive Strength	compressive_strength2	decimal	(19, 8)		FALSE
Diameter of Core (inches)	core_diameter1	decimal	(19, 8)		FALSE
Diameter of Core (inches)	core_diameter2	decimal	(19, 8)		FALSE
Length of Core (inches)	core_length1	decimal	(19, 8)		FALSE
Length of Core (inches)	core_length2	decimal	(19, 8)		FALSE
Core Number	core_number1	nvarchar	100		FALSE
Core Number	core_number2	nvarchar	100		FALSE
Failure Type	failure_type1	nvarchar	100		FALSE
Failure Type	failure_type2	nvarchar	100		FALSE
Max Load (Lbs)	max_load1	decimal	(19, 8)		FALSE
Max Load (Lbs)	max_load2	decimal	(19, 8)		FALSE

Texture Depth By Sand Patch Method (DB-436-A) ** INACTIVE **

Table Name: VALUE_DB436A **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Average Diameter	avg_diameter	decimal	(19, 8)		FALSE
Diameter 1	measurement_1	decimal	(19, 8)		FALSE
Diameter 2	measurement_2	decimal	(19, 8)		FALSE
Diameter 3	measurement_3	decimal	(19, 8)		FALSE
Diameter 4	measurement_4	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	FALSE
Tested By	tested_by	varchar	200	CVL	FALSE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	FALSE
Thickness	thickness	decimal	(19, 8)		FALSE
Volume of Cylinder	vol_cylinder	decimal	(19, 8)		FALSE

Concrete Sample - Beams (DB-448-A) ** INACTIVE **

Table Name: VALUE_DB448A **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Actual Water	act_water	decimal	(19, 8)		FALSE
Added Gal	added_gal	decimal	(19, 8)		FALSE
Agg. Correction Factor	agg_corr_factor	decimal	(19, 8)	CVL	FALSE
Agg Size	agg_size	nvarchar	100	CVL	FALSE
Air Temperature	air_temp	decimal	(19, 8)		FALSE
Batch Size	batch_size	decimal	(19, 8)		FALSE
Batch Time	batch_time	smalldatetime		MM/dd/yyyy	FALSE
Class of Concrete	class_concrete	nvarchar	100	CVL	FALSE
Concrete Temperature	concrete_temp	decimal	(19, 8)		FALSE
Corrected Air Content	corrected_air_content	decimal	(19, 8)	CVL	FALSE
Design Water	des_water	decimal	(19, 8)		FALSE
Mix ID	mix_id	nvarchar	100	CVL	FALSE
Qty Load	qty_load	decimal	(19, 8)		FALSE
Req. Strength, psi	req_strength	decimal	(19, 8)		FALSE
Sample Time	sample_time	smalldatetime		MM/dd/yyyy	FALSE
Slump	slump	decimal	(19, 8)	CVL	FALSE
Specimen Dimensions	spec_dimensions	nvarchar	100	CVL	FALSE
Stamp Code	stamp_code	int		CVL	FALSE
Tested By	tested_by	nvarchar	100	CVL	FALSE
Tested Date	tested_date	datetime		MM/dd/yyyy	FALSE
Ticket Number	ticket_num	decimal	(19, 8)		FALSE
Total Water	total_water	decimal	(19, 8)		FALSE
Truck Number	truck_num	decimal	(19, 8)		FALSE
Unit Weight	unit_weight	decimal	(19, 8)		FALSE

Table Name: VALUE_DB448A_SPECIMEN **Maximum Rows: 6**

Field Description	Field Name	Datatype	Length	Values	Required
Age	age	nvarchar	100	CVL	FALSE
Avg Depth	avg_depth	decimal	(19, 8)		FALSE
Avg. Width	avg_width	decimal	(19, 8)		FALSE
Correction Factor	corr_factor	decimal	(19, 8)		FALSE
Max Load, lbs	max_load_psi	decimal	(19, 8)		FALSE
Mod Rupture	mod_rupture	decimal	(19, 8)		FALSE
Pass Fail	pass_fail	nvarchar	100		FALSE
Specimen	specimen	nvarchar	100		FALSE
Test Date	test_date	smalldatetime		MM/dd/yyyy	FALSE
Tested By	tested_by	nvarchar	100	CVL	FALSE

Coarse Aggregate Angularity By Fractured Faces Count (DB-460-A) ** INACTIVE **

Table Name: VALUE_DB460A **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Number of Particles w/ one or no FF	number_of_particles_with_one	int			FALSE
Number of Particles w/ 2 or more FF	number_of_particles_with_two	int			FALSE
Number of Questionable Particles	number_of_questionable_particles	int			FALSE
Percent Crushed Particles	percent_crushed_particles	decimal	(19, 8)		FALSE
Percent Crushed Particles	percent_crushed_particles_result	decimal	(19, 8)		TRUE
Sieve Size	sieve_size	nvarchar	100		FALSE
Stamp Code	stamp_code	int		CVL	TRUE
Tested By	tested_by	nvarchar	100	CVL	TRUE
Tested Date	tested_date	smalldatetime		MM/dd/yyyy	TRUE
Total Number of Particles	total_number_of_particles	int			FALSE

Effect of Water On Bituminous Paving Mixtures (DB-530-C) ** INACTIVE **

Table Name: VALUE_DB530C **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Estimated Percent of Stripping	est_pct_stripping	nvarchar	100		FALSE
Stamp Code	stamp_code	int		CVL	FALSE
Tested By	tested_by	nvarchar	100	CVL	FALSE
Tested Date	tested_date	datetime		MM/dd/yyyy	FALSE

Determining Chloride and Sulfate Content in Soils (DB-620-J) ** INACTIVE **

Table Name: VALUE_DB620J **Maximum Rows: 1**

Field Description	Field Name	Datatype	Length	Values	Required
Chloride (CL) (PPM)	chloride_ppm	decimal	(19, 8)		FALSE
Crucible + Residue Weight	crucible_residue_weight	decimal	(19, 8)		FALSE
Crucible Weight	crucible_weight	decimal	(19, 8)		FALSE
Ending	ending	decimal	(19, 8)		FALSE
Normality of AgNO3	normality_of_agno3	decimal	(19, 8)		FALSE
Residue Weight	residue_weight	decimal	(19, 8)		FALSE
Sample Weight	sample_weight_chloride	decimal	(19, 8)		FALSE
Sample Weight	sample_weight_sulfate	decimal	(19, 8)		FALSE
Stamp Code	stamp_code	int		CVL	FALSE
Starting	starting	decimal	(19, 8)		FALSE
Sulfate (SO4) (PPM)	sulfate_ppm	decimal	(19, 8)		FALSE
Tested By	tested_by	nvarchar	100	CVL	FALSE
Tested Date	tested_date	nvarchar	100		FALSE
Total	total	decimal	(19, 8)		FALSE

CQAF Sample

File: CQAFSample.xml

File Type: XML (Extensible Markup Language). The de facto standard for transferring data.

File Description: An example of an electronic submission that can be read into I2MS. The example provided was used for a previous project and passed the verification process for that particular project's inputs. This file can be submitted to I2MS via a web service run on I2MS using SOAP (Simple Object Access Protocol), which is a standard programming protocol by which software developers send data between systems.

CQAF Sample


```
<?xml version='1.0' encoding='UTF-8'?>
<form name="DB-115-1" version_no="1.0" key="0020905270501151" date="2009-05-27T00:00:00" display_key="00209052705">
    <owner_name value="CQAF" />
    <security username="CQAFDataXfer" password="as9-3958$h@" />
    <header>
        <column name="sample_id" value="00209052705" />
        <column name="sampled_date" value="5/27/2009 12:00:00 AM" />
        <column name="sample_type" value="Random-Independent" />
        <column name="split_sample_id" />
        <column name="report_type" value="Original" />
        <column name="section" value="5.1" />
        <column name="sampled_by" value="Al Jones" />
        <column name="spec_year" value="2004" />
        <column name="material" value="14" />
        <column name="spec_item" value="247" />
        <column name="supplier" value="Pit" />
        <column name="special_provision" />
        <column name="structure_number" />
        <column name="grade" value="1" />
        <column name="sample_location" />
        <column name="feature" value="Mainlane" />
        <column name="course_lift" value="2" />
        <column name="station" value="342+49" />
        <column name="dist_from_cl" value="5' LT" />
        <column name="misc" />
```

```
        <column name="roadway" value="Loop 375" />
        <column name="direction" value="NB" />
</header>
<test name="DB-115-1"> <!-- This can be the same value as the form name. -->
        <table name="VALUE_DB115_1">
                <row>
                        <column name="determined_by_test_method" value="DB-113-E" />
                        <column name="max_dry_density_pcf" value="132.5" />
                        <column name="optimum_moisture_content_pct" value="7.7" />
                        <column name="density_standard" value="4200" />
                        <column name="moisture_standard" value="420" />
                        <column name="density_count" value="1045" />
                        <column name="moisture_count" value="231" />
                        <column name="probe_depth" value="10" />
                        <column name="wet_density_pcf" value="140.5" />
                        <column name="dry_density_pcf" value="133.5" />
                        <column name="moisture_content_pct" value="5.2" />
                        <column name="gauge_no" value="3242" />
                        <column name="moisture_content_pct_pass_fail" />
                        <column name="density_pct" value="100.7" />
                        <column name="density_pct_pass_fail" />
```

CQAF Sample

```
                        <column name="density_specification_req_max" />
                        <column name="moisture_specification_req_max" />
                        <column name="soil_desc" />
                        <column name="density_specification_req_min" value="100" />
                        <column name="moisture_specification_req_min" value="5.2" />
```

```
                    <column name="tested_by" value="Al Jones" />
                    <column name="tested_date" value="5/27/2009 12:00:00 AM" />
                    <column name="stamp_code" value="1" />
                </row>
            </table>
        </test>
        <footer>
            <column name="remarks" />
            <column name="reviewed_by" />
            <column name="completed_date" />
            <column name="authorized_by" />
            <column name="authorized_date" />
        </footer>
</form>
```

Web Form Validation

File: WebFormValidation.xsd

File Type: XSD (XML Schema Document). Describes a schema used for an XML document.

File Description: Describes elements, annotations, and documentation used in the aforementioned XML. XSD files are the standard used to describe XML file formats and are often used to assist in developing XML files with added features such as intellisense (which is an added type ahead feature used by developers).

Web Form Validation

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema id="FormValidation" xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="form">
    <xs:complexType>
      <xs:sequence>
        <xs:choice minOccurs="1" maxOccurs="1" id="owner">
            <xs:annotation>
                <xs:documentation>
                    The owner of the record must be supplied to upload successfully.  The user login provided in the security element
                    must have permission to add a record for the owner as part of the validation process.

                    The record owner can be identified by a variety of properties.  In general, when submitting XML from an external source,
                    the owner_name attribute is the preferred method.
                </xs:documentation>
            </xs:annotation>
          <xs:element name="owner_name" minOccurs="1" maxOccurs="1">
            <xs:annotation>
                <xs:documentation>
                    The name of the owner of this record.  For example, "OVF" or "CQAF".
                </xs:documentation>
            </xs:annotation>
            <xs:complexType>
              <xs:attribute name="value" type="xs:string" use="required" />
            </xs:complexType>
```

```
    </xs:element>
    <xs:element name="owner_guid" minOccurs="1" maxOccurs="1">
      <xs:complexType>
        <xs:attribute name="value" type="xs:string" use="required" />
      </xs:complexType>
    </xs:element>
    <xs:element name="owner_id" minOccurs="1" maxOccurs="1">
      <xs:complexType>
        <xs:attribute name="value" type="xs:int" use="required" />
      </xs:complexType>
    </xs:element>
  </xs:choice>
  <xs:element name="security" minOccurs="1" maxOccurs="1">
      <xs:annotation>
          <xs:documentation>
              User login credentials must be provided to upload a record.  Supply a username and password.
          </xs:documentation>
      </xs:annotation>
    <xs:complexType>
```

Web Form Validation

```
      <xs:attribute name="user_guid" type="xs:string" />
      <xs:attribute name="username" type="xs:string" />
      <xs:attribute name="password" type="xs:string" />
    </xs:complexType>
  </xs:element>
  <xs:element name="header" minOccurs="0" maxOccurs="1">
```

```
            <xs:annotation>
                <xs:documentation>
                    The collection of header column values common to multiple forms.
                </xs:documentation>
            </xs:annotation>
          <xs:complexType>
            <xs:sequence>
              <xs:element name="column" type="ColumnType" maxOccurs="unbounded" />
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element name="test" minOccurs="0" maxOccurs="unbounded">
            <xs:annotation>
                <xs:documentation>
                    Container element for Body Table elements, which contain the data specific to the form type being uploaded.
                    This element can be used to logically group the body tables by the test method they represent, but it is not required to do so.
                    All body table elements can be placed under one test element, and the test name attribute is inconsequential.
                </xs:documentation>
            </xs:annotation>
          <xs:complexType>
            <xs:sequence>
              <xs:element name="table" minOccurs="1" maxOccurs="unbounded">
                <xs:annotation>
                    <xs:documentation>
                        A collection of rows of form data for a specific table.
```

The number of rows permitted for each table depends on the form and table name. For testing forms, the number of rows allowed for each table can be found in the I2MS Test Form Fields report.

```
                    </xs:documentation>
                </xs:annotation>
                  <xs:complexType>
                    <xs:sequence>
                      <xs:element name="row" minOccurs="0" maxOccurs="unbounded">
                        <xs:annotation>
                            <xs:documentation>
                                A collection of body column values.
                            </xs:documentation>
                        </xs:annotation>
```

Web Form Validation

```
                            <xs:complexType>
                          <xs:sequence>
                            <xs:element name="column" type="ColumnType" minOccurs="0"
maxOccurs="unbounded" />
                          </xs:sequence>
                        </xs:complexType>
                      </xs:element>
                    </xs:sequence>
                    <xs:attribute name="name" type="xs:string" use="required">
                        <xs:annotation>
                            <xs:documentation>
                                The name of the body table.
```

For testing forms, the list of supported table names can be found in the I2MS Test Form Fields report.

```
                    </xs:documentation>
                </xs:annotation>
            </xs:attribute>
        </xs:complexType>
    </xs:element>
    </xs:sequence>
    <xs:attribute name="name" type="xs:string" use="required" />
  </xs:complexType>
</xs:element>
<xs:element name="footer" minOccurs="0" maxOccurs="1">
    <xs:annotation>
        <xs:documentation>
            The collection of footer column values common to multiple forms.
        </xs:documentation>
    </xs:annotation>
  <xs:complexType>
    <xs:sequence>
      <xs:element name="column" type="ColumnType" minOccurs="0"
maxOccurs="unbounded" />
    </xs:sequence>
  </xs:complexType>
</xs:element>
</xs:sequence>
<xs:attribute name="name" form="unqualified" type="xs:string" use="required" >
  <xs:annotation>
    <xs:documentation>
        The short name of the I2MS form for which data is being submitted.  This value
determines the data columns that are supported and required
```

for the header, body, and footer elements.

For testing forms, the list of supported form names can be found in the I2MS Test Form Fields report.

Web Form Validation

The form name is the value in parentheses for each subheading under the Body Fields section.

</xs:documentation>

</xs:annotation>

</xs:attribute>

<xs:attribute name="key" form="unqualified" use="required">

<xs:annotation>

<xs:documentation>

A value representing the test record in I2MS. This value is required to be unique for each owner (OVF/CQAF).

The same key is used for all revisions of the record. To add a new revision, supply the same key with the new form data and a

new value for the version_no attribute.

</xs:documentation>

</xs:annotation>

<xs:simpleType>

<xs:restriction base="xs:string">

<xs:maxLength value="100"></xs:maxLength>

</xs:restriction>

</xs:simpleType>

</xs:attribute>

<xs:attribute name="version_no" use="required">

<xs:annotation>

<xs:documentation>

The version number of this revision within the series of revisions identified by the key attribute.

The revision in the series with the greatest version number will be considered the latest revision regardless of the order in which revisions were submitted to I2MS.

Submitting a record with the same key and version number as another record in the system is an error.

</xs:documentation>

</xs:annotation>

<xs:simpleType>

<xs:restriction base="xs:decimal">

<xs:totalDigits value="19" />

<xs:fractionDigits value="9" />

</xs:restriction>

</xs:simpleType>

</xs:attribute>

<xs:attribute name="display_key">

<xs:annotation>

<xs:documentation>

The value displayed to users as the ID value of the record (for example, Sample ID for testing forms).

This value is not required to be unique.

</xs:documentation>

</xs:annotation>

<xs:simpleType>

<xs:restriction base="xs:string">

Web Form Validation

<xs:maxLength value="100"></xs:maxLength>

```
            </xs:restriction>
        </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="version_key">
        <xs:annotation>
            <xs:documentation>
                An optional identifier for this revision.  For example, when submitting XML to I2MS from an external source,
                this could be the Version ID of the record in the external system.
            </xs:documentation>
        </xs:annotation>
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="100"></xs:maxLength>
            </xs:restriction>
        </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="action_name" type="xs:string">
        <xs:annotation>
            <xs:documentation>
                The name of a custom workflow action to execute when submitting the form. The user login submitting the form
                must have permissions in I2MS for the action and validation rules must pass before allowing the action.

                When submitting XML to I2MS from an external source, this attribute should generally be omitted unless other
                instructions have been provided.
            </xs:documentation>
        </xs:annotation>
```

```
        </xs:attribute>
        <xs:attribute name="date" type="xs:dateTime">
          <xs:annotation>
                <xs:documentation>
                      The value displayed to users as the date of the record (for example, Sampled Date for testing forms).
                </xs:documentation>
          </xs:annotation>
        </xs:attribute>
      </xs:complexType>
    </xs:element>

        <xs:complexType name="ColumnType">
        <xs:attribute name="name" type="xs:string" use="required">
                <xs:annotation>
                      <xs:documentation>
                            The name of the column for which a value is being provided.
```

Web Form Validation

```
                      For testing forms, the list of supported data columns can be found in the I2MS Test Form Fields report.
                      </xs:documentation>
                </xs:annotation>
        </xs:attribute>
      <xs:attribute name="value" type="xs:string" use="optional">
        <xs:annotation>
                <xs:documentation>
                      The value of the column.
                </xs:documentation>
```

```
        </xs:annotation>
    </xs:attribute>
        </xs:complexType>

</xs:schema>
```

Form Submission Service

File: FormSubmissionService.wsdl

File Type: WSDL (Web Services Description Language). Describes a web service and its respective protocols in XML format.

File Description: Describes the web service used by I2MS for submitting data electronically for the purposes of Validation (i.e. Verification) and Submission. The I2MS system takes in data electronically via a web service (often via the SOAP protocol), for the purposes of verifying or submitting a test (submitted in XML format).

Form Submission Service

```
<?xml version="1.0" encoding="utf-8"?>

<wsdl:definitions xmlns:s="http://www.w3.org/2001/XMLSchema"
xmlns:soap12="http://schemas.xmlsoap.org/wsdl/soap12/"
xmlns:mime="http://schemas.xmlsoap.org/wsdl/mime/" xmlns:tns="http://tempuri.org/"
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
xmlns:tm="http://microsoft.com/wsdl/mime/textMatching/"
xmlns:http="http://schemas.xmlsoap.org/wsdl/http/"
xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/" targetNamespace="http://tempuri.org/"
xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/">

  <wsdl:types>

    <s:schema elementFormDefault="qualified" targetNamespace="http://tempuri.org/">
```

```
    <s:element name="SubmitForm">
     <s:complexType>
      <s:sequence>
       <s:element minOccurs="0" maxOccurs="1" name="xmlForm" type="s:string" />
      </s:sequence>
     </s:complexType>
    </s:element>
    <s:element name="SubmitFormResponse">
     <s:complexType>
      <s:sequence>
       <s:element minOccurs="1" maxOccurs="1" name="SubmitFormResult" type="s:int" />
      </s:sequence>
     </s:complexType>
    </s:element>
    <s:element name="ValidateForm">
     <s:complexType>
      <s:sequence>
       <s:element minOccurs="0" maxOccurs="1" name="xmlForm" type="s:string" />
      </s:sequence>
     </s:complexType>
    </s:element>
    <s:element name="ValidateFormResponse">
     <s:complexType>
      <s:sequence>
       <s:element minOccurs="0" maxOccurs="1" name="ValidateFormResult" type="s:string" />
      </s:sequence>
     </s:complexType>
    </s:element>
   </s:schema>
```

```
 </wsdl:types>
 <wsdl:message name="SubmitFormSoapIn">
  <wsdl:part name="parameters" element="tns:SubmitForm" />
 </wsdl:message>
 <wsdl:message name="SubmitFormSoapOut">
  <wsdl:part name="parameters" element="tns:SubmitFormResponse" />
 </wsdl:message>
```

Form Submission Service

```
<wsdl:message name="ValidateFormSoapIn">
  <wsdl:part name="parameters" element="tns:ValidateForm" />
 </wsdl:message>
 <wsdl:message name="ValidateFormSoapOut">
  <wsdl:part name="parameters" element="tns:ValidateFormResponse" />
 </wsdl:message>
 <wsdl:portType name="FormSubmissionServiceSoap">
  <wsdl:operation name="SubmitForm">
   <wsdl:input message="tns:SubmitFormSoapIn" />
   <wsdl:output message="tns:SubmitFormSoapOut" />
  </wsdl:operation>
  <wsdl:operation name="ValidateForm">
   <wsdl:input message="tns:ValidateFormSoapIn" />
   <wsdl:output message="tns:ValidateFormSoapOut" />
  </wsdl:operation>
 </wsdl:portType>
 <wsdl:binding name="FormSubmissionServiceSoap" type="tns:FormSubmissionServiceSoap">
  <soap:binding transport="http://schemas.xmlsoap.org/soap/http" />
  <wsdl:operation name="SubmitForm">
```

```
    <soap:operation soapAction="http://tempuri.org/SubmitForm" style="document" />
    <wsdl:input>
      <soap:body use="literal" />
    </wsdl:input>
    <wsdl:output>
      <soap:body use="literal" />
    </wsdl:output>
  </wsdl:operation>
  <wsdl:operation name="ValidateForm">
    <soap:operation soapAction="http://tempuri.org/ValidateForm" style="document" />
    <wsdl:input>
      <soap:body use="literal" />
    </wsdl:input>
    <wsdl:output>
      <soap:body use="literal" />
    </wsdl:output>
  </wsdl:operation>
 </wsdl:binding>
 <wsdl:binding name="FormSubmissionServiceSoap12" type="tns:FormSubmissionServiceSoap">
  <soap12:binding transport="http://schemas.xmlsoap.org/soap/http" />
  <wsdl:operation name="SubmitForm">
    <soap12:operation soapAction="http://tempuri.org/SubmitForm" style="document" />
    <wsdl:input>
      <soap12:body use="literal" />
    </wsdl:input>
    <wsdl:output>
      <soap12:body use="literal" />
```

Form Submission Service

```
 </wsdl:output>
  </wsdl:operation>
  <wsdl:operation name="ValidateForm">
   <soap12:operation soapAction="http://tempuri.org/ValidateForm" style="document" />
   <wsdl:input>
    <soap12:body use="literal" />
   </wsdl:input>
   <wsdl:output>
    <soap12:body use="literal" />
   </wsdl:output>
  </wsdl:operation>
 </wsdl:binding>
 <wsdl:service name="FormSubmissionService">
  <wsdl:port name="FormSubmissionServiceSoap" binding="tns:FormSubmissionServiceSoap">
   <soap:address location="https://i2ms-sh130.txdot.gov/i2ms/i2ms/formsubmissionservice.asmx" />
  </wsdl:port>
  <wsdl:port name="FormSubmissionServiceSoap12" binding="tns:FormSubmissionServiceSoap12">
   <soap12:address location="https://i2ms-sh130.txdot.gov/i2ms/i2ms/formsubmissionservice.asmx"
/>
  </wsdl:port>
 </wsdl:service>
</wsdl:definitions>
```

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 5-1
TEXAS DEPARTMENT OF TRANSPORTATION MUNICIPAL MAINTENANCE AGREEMENT

2012-110

Form 1038
(Rev. 12/08)
Page 1 of 6

Texas Department of Transportation

MUNICIPAL MAINTENANCE AGREEMENT

STATE OF TEXAS §

COUNTY OF TRAVIS §

THIS AGREEMENT made this 10th day of April, 2012, by and between the State of Texas, hereinafter referred to as the "State," party of the first part, and the City of Corpus Christi (population 305,215, 2000, latest Federal Census) acting by and through its duly authorized officers, hereinafter called the "City," party of the second part.

WITNESSETH

WHEREAS, Chapter 311 of the Transportation Code gives the City exclusive dominion, control, and jurisdiction over and under the public streets within its corporate limits and authorizes the City to enter agreements with the State to fix responsibilities for maintenance, control, supervision, and regulation of State highways within and through its corporate limits; and

WHEREAS, Section 221.002 of the Transportation Code authorizes the State, at its discretion, to enter agreements with cities to fix responsibilities for maintenance, control, supervision, and regulation of State highways within and through the corporate limits of such cities; and

WHEREAS, the Executive Director, acting for and in behalf of the Texas Transportation Commission, has made it known to the City that the State will assist the City in the maintenance and operation of State highways within such City, conditioned that the City will enter into agreements with the State for the purpose of determining the responsibilities of the parties thereto; and

WHEREAS, the City has requested the State to assist in the maintenance and operation of State highways within such City:

AGREEMENT

NOW, THEREFORE, in consideration of the premises and of the mutual covenants and agreements of the parties hereto to be by them respectively kept and performed, it is agreed as follows:

For this agreement, the use of the words "State Highway" shall be construed to mean all numbered highways that are part of the State's Highway System.

2012-110
Res029442
4/10/12

TxDOT

INDEXED

COVERAGE

1. This agreement is intended to cover and provide for State participation in the maintenance and operation of the following classifications of State Highways within the City:

   A. Non-Controlled Access highways or portions thereof which are described and/or graphically shown as "State Maintained and Operated" highways in Exhibit "A," which is attached hereto and made a part hereof.

   B. All State highways or portions thereof which have been designated by the Texas Transportation Commission or maintained and operated as Controlled Access Highways and which are described and/or graphically shown in Exhibit "B," which is attached hereto and made a part hereof.

2. In the event that the present system of State highways within the City is changed by cancellation, modified routing, or new routes, the State will terminate maintenance and operation and this agreement will become null and void on those portions of the highways which are no longer on the State Highway System; and the full effect and all conditions of this agreement will apply to the changed highways or new highways on the State Highway System within the City; and they shall be classified as "State Maintained and Operated" under paragraph 1 above, unless the execution of a new agreement on the changed or new portions of the highways is requested by either the City or the State.

3. Exhibits that are a part of this agreement may be exchanged with both parties' written concurrence. Additional exhibits may also be added with both parties' written concurrence.

GENERAL CONDITIONS

1. The City authorizes the State to maintain and operate the State highways covered by this agreement in the manner set out herein.

2. This agreement is between the State and the City only. No person or entity may claim third party beneficiary status under this contract or any of its provisions, nor may any non-party sue for personal injuries or property damage under this contract.

3. This agreement is for the purpose of defining the authority and responsibility of both parties for maintenance and operation of State highways through the City. This agreement shall supplement any special agreements between the State and the City for the maintenance, operation, and/or construction of the State highways covered herein, and this agreement shall supersede any existing Municipal Maintenance Agreements.

4. Traffic regulations, including speed limits, will be established only after traffic and engineering studies have been completed by the State and/or City and approved by the State.

5. The State will erect and maintain all traffic signs and associated pavement markings necessary to regulate, warn, and guide traffic on State highways within the State right-of-way except as mentioned in this paragraph and elsewhere in this agreement. At the intersections of off-system approaches to State highways, the City shall install and maintain all stop signs, yield signs, and one-way signs and any necessary stop or yield bars and pedestrian crosswalks outside the main lanes or outside the frontage roads, if such exist. The City shall install and maintain all street name signs except for those mounted on State maintained traffic signal poles or arms or special advance street name signs on State right-of-way. All new signs installed by the City on State right-of-way shall meet or exceed the latest State breakaway standards and be in accordance with the *Texas Manual on Uniform Traffic Control Devices*, latest edition and revision. All existing signs shall be upgraded on a maintenance replacement basis to meet these requirements.

6. Subject to approval by the State, any State highway lighting system may be installed by the City provided the City shall pay or otherwise provide for all cost of installation, maintenance, and operation except in those installations specifically covered by separate agreements between the City and State.

7. The City shall enforce the State laws governing the movement of loads which exceed the legal limits for weight, length, height, or width as prescribed by Chapters 621, 622, and 623 of the Transportation Code for public highways outside corporate limits of cities. The City shall also, by ordinance/resolution and enforcement, prescribe and enforce lower weight limits when mutually agreed by the City and the State that such restrictions are needed to avoid damage to the highway and/or for traffic safety.

8. The City shall prevent future encroachments within the right-of-way of the State highways and assist in removal of any present encroachments when requested by the State except where specifically authorized by separate agreement; and prohibit the planting of trees or shrubbery or the creation or construction of any other obstruction within the right-of-way without prior approval in writing from the State.

9. Traffic control devices such as signs, traffic signals, and pavement markings, with respect to type of device, points of installation and necessity, will be determined by traffic and engineering studies. The City shall not install, maintain, or permit the installation of any type of traffic control device which will affect or influence the use of State highways unless approved in writing by the State. Traffic control devices installed prior to the date of this agreement are hereby made subject to the terms of this agreement and the City agrees to the removal of such devices which affect or influence the use of State highways unless their continued use is approved in writing by the State. It is understood that basic approval for future installations of traffic control signals by the State or as a joint project with the City, will be indicated by the proper City official's signature on the title sheet of the plans. Both parties should retain a copy of the signed title sheet or a letter signed by both parties acknowledging which signalized intersections are covered by this agreement. Any special requirements not covered within this agreement will be covered under a separate agreement.

10. New construction of sidewalks, ramps or other accessibility related items shall comply with current ADA standards. The city is responsible for the maintenance of these items.

11. If the City has a driveway permit process that has been submitted to and approved by the State, the City will issue permits for access driveways on State highway routes and will assure the grantee's conformance, for proper installation and maintenance of access driveway facilities, with either a Local Access Management Plan that the City has adopted by ordinance and submitted to the State or, if the City has not adopted by ordinance and submitted to the State a Local Access Management Plan, the State's "Regulations for Access Driveways to State Highways" and the State's Access Management Manual. If the City does not have an approved city-wide driveway permit process, the State will issue access driveway permits on State highway routes in accordance with the City's Local Access Management Plan, adopted by city ordinance and submitted to the State or, if the City has not adopted by ordinance and submitted a Local Access Management Plan, the State's "Regulations for Access Driveways to State Highways" and the State's Access Management Manual.

12. The use of unused right-of-way and areas beneath structures will be determined by a separate agreement.

NON-CONTROLLED ACCESS HIGHWAYS

The following specific conditions and responsibilities shall be applicable to non-controlled access State highways in addition to the "General Conditions" contained herein above. Non-controlled access State highways or portions thereof covered by this section are those listed and/or graphically shown in Exhibit "A."

State's Responsibilities (Non-Controlled Access)

1. Maintain the traveled surface and foundation beneath such traveled surface necessary for the proper support of same under vehicular loads encountered and maintain the shoulders.

2. Assist in mowing and litter pickup to supplement City resources when requested by the City and if State resources are available.

3. Assist in sweeping and otherwise cleaning the pavement to supplement City resources when requested by the City and if State resources are available.

4. Assist in snow and ice control to supplement City resources when requested by the City and if State resources are available.

5. Maintain drainage facilities within the limits of the right-of-way and State drainage easements. This does not relieve the City of its responsibility for drainage of the State highway facility within its corporate limits.

6. Install, maintain, and operate, when required, normal regulatory, warning and guide signs and normal markings (except as provided under "General Conditions" in paragraph 5). In cities with less than 50,000 population, this also includes school safety devices, school crosswalks, and crosswalks installed in conjunction with pedestrian signal heads. This does not include other pedestrian crosswalks. Any other traffic striping desired by the City may be placed and maintained by the City subject to written State approval.

7. Install, operate, and maintain traffic signals in cities with less than 50,000 population.

8. In cities equal to or greater than 50,000 population, the State may provide for installation of traffic signals when the installation is financed in whole or in part with federal-aid funds if the City agrees to enter into an agreement setting forth the responsibilities of each party.

City's Responsibilities (Non-Controlled Access)

1. Prohibit angle parking, except upon written approval by the State after traffic and engineering studies have been conducted to determine if the State highway is of sufficient width to permit angle parking without interfering with the free and safe movement of traffic.

2. Install and maintain all parking restriction signs, pedestrian crosswalks [except as provided in paragraph 6 under "State's Responsibilities (Non-Controlled Access)"], parking stripes, and special guide signs when agreed to in writing by the State. Cities greater than or equal to 50,000 population will also install, operate, and maintain all school safety devices and school crosswalks.

3. Signing and marking of intersecting city streets with State highways will be the full responsibility of the City (except as provided under "General Conditions" in paragraph 5).

4. Require installations, repairs, removals, or adjustments of publicly or privately owned utilities or services to be performed in accordance with Texas Department of Transportation specifications and subject to approval of the State in writing.

5. Retain all functions and responsibilities for maintenance and operations which are not specifically described as the responsibility of the State. The assistance by the State in maintenance of drainage facilities does not relieve the City of its responsibility for drainage of the State highway facility within its corporate limits except where participation by the State is specifically covered in a separate agreement between the City and the State.

6. Install, maintain, and operate all traffic signals in cities equal to or greater than 50,000 population. Any variations will be handled by a separate agreement.

7. Perform mowing and litter pickup.

8. Sweep and otherwise clean the pavement.

9. Perform snow and ice control.

CONTROLLED ACCESS HIGHWAYS

The following specific conditions and responsibilities shall be applicable to controlled access highways in addition to the "General Conditions" contained herein above. Controlled access State highways or portions thereof covered by this section are those listed and/or graphically shown in Exhibit "B."

State's Responsibilities (Controlled Access)

1. Maintain the traveled surface of the through lanes, ramps, and frontage roads and foundations beneath such traveled surface necessary for the proper support of same under vehicular loads encountered.

2. Mow and clean up litter within the outermost curbs of the frontage roads or the entire right-of-way width where no frontage roads exist, and assist in performing these operations between the right-of-way line and the outermost curb or crown line of the frontage roads in undeveloped areas.

3. Sweep and otherwise clean the through lanes, ramps, separation structures or roadways and frontage roads.

4. Remove snow and control ice on the through lanes and ramps and assist in these operations as the availability of equipment and labor will allow on the frontage roads and grade separation structures or roadways.

5. Except as provided under "General Conditions" in paragraph 5, the State will install and maintain all normal markings and signs, including sign operation if applicable, on the main lanes and frontage roads. This includes school safety devices, school crosswalks and crosswalks installed on frontage roads in conjunction with pedestrian signal heads. It does not include other pedestrian crosswalks.

6. Install, operate, and maintain traffic signals at ramps and frontage road intersections unless covered by a separate agreement.

7. Maintain all drainage facilities within the limits of the right-of-way and State drainage easements. This does not relieve the City of its responsibility for drainage of the highway facility within its corporate limits.

City's Responsibilities (Controlled Access)

1. Prohibit, by ordinance or resolution and through enforcement, all parking on frontage roads except when parallel parking on one side is approved by the State in writing. Prohibit all parking on main lanes and ramps and at such other places where such restriction is necessary for satisfactory operation of traffic, by passing and enforcing ordinances/resolutions and taking other appropriate action in addition to full compliance with current laws on parking.

2. When considered necessary and desirable by both the City and the State, the City shall pass and enforce an ordinance/resolution providing for one-way traffic on the frontage roads except as may be otherwise agreed to by separate agreements with the State.

3. Secure or cause to be secured the approval of the State before any utility installation, repair, removal, or adjustment is undertaken, crossing over or under the highway facility or entering the right-of-way. In the event of an emergency, it being evident that immediate action is necessary for protection of the public and to minimize property damage and loss of investment, the City, without the necessity of approval by the State, may at its own responsibility and risk make necessary emergency utility repairs, notifying the State of this action as soon as practical.

4. Pass necessary ordinances/resolutions and retain its responsibility for enforcing the control of access to the expressway/freeway facility.

5. Install and maintain all parking restriction signs, pedestrian crosswalks (except as mentioned above in paragraph 5 under "State's Responsibilities"), and parking stripes when agreed to by the State in writing. Signing and marking of intersecting city streets to State highways shall be the full responsibility of the City (except as discussed under "General Conditions" in paragraph 5).

6. Mow and clean up litter between the right-of-way line and the outermost curb or crown line of the frontage roads in undeveloped areas, defined as the real property identified in a plat or replat of a subdivision properly recorded in the county clerk's office in accordance with Property Code, §12.002, on which development has not commenced. The city may assist at the city's discretion, in performing these

operations within the outermost curbs of the frontage roads or the entire right-of-way width where no frontage roads exist.

TERMINATION

All obligations of the State created herein to maintain and operate the State highways covered by this agreement shall terminate if and when such highways cease to be officially on the State highway system; and further, should either party fail to properly fulfill its obligations as herein outlined, the other party may terminate this agreement upon 30 days written notice. Upon termination, all maintenance and operation duties on non-controlled access State highways shall revert to City responsibilities, in accordance with Chapter 311 of the Texas Transportation Code. The State shall retain all maintenance responsibilities on controlled access State highways in accordance with the provisions of Chapter 203 of the Texas Transportation Code, 23 United States Code § 116.

Said State assumption of maintenance and operations shall be effective the date of execution of this agreement by the Texas Department of Transportation.

IN WITNESS WHEREOF, the parties have hereunto affixed their signatures, the City of Corpus Christi, 10th day of, 2012, and the Texas Department of Transportation, on the 26th day of April, 2012.

ATTEST:
Maria Orduna, Asst. City Secretary
CITY OF Corpus Christi
BY Ora M Mantt
(Title of Signing Official)

Res 029442 AUTHORIZED
BY COUNCIL 4/10/12
AC
SECRETARY TM

THE STATE OF TEXAS

Executed and approved for the Texas Transportation Commission for the purpose and effect of activating and/or carrying out the orders, and established policies or work programs heretofore approved and authorized by the Texas Transportation Commission

BY [signature] PE 4-26-12
District Engineer
Corpus Christi District

The Texas Department of Transportation maintains the information collected through this form. With few exceptions, you are entitled on request to be informed about the information that we collect about you. Under Sections 552.021 and 552.023 of the Texas Government Code, you also are entitled to receive and review this information. Under Section 559.004 of the Government Code, you are also entitled to have us correct information about you that is incorrect. For more information, call 512/416-3048.

NOTE: To be executed in duplicate and supported by Municipal Maintenance Ordinance/Resolution and City Secretary Certificate.

Resolution approving and authorizing the City Manager or designee to execute a Municipal Maintenance Agreement with the State of Texas, acting by and through the Texas Department of Transportation ("State" or "TxDOT") for the maintenance, control, supervision, and regulation of certain state highways and/or portions of state highways in the City of Corpus Christi.

WHEREAS, the public convenience, safety, and necessity of the City, and the people of the City require that state highway routes within the City be adequately maintained; and

WHEREAS, the City and the State of Texas, acting by and through its Department of Transportation ("State" or "TxDOT"), agree that the State will enter upon and contribute financially to the maintenance of said project; and

WHEREAS, the State has made it known to the City that it will, with its own forces and equipment and at its sole expense enter upon and maintain said project, conditioned upon the provisions concerning responsibilities for maintenance, control, supervision, and regulation which are set out in the document titled "Municipal Maintenance Agreement" or "MMA"; and

WHEREAS, said project consists of those state highways and/or portions thereof which are described in the MMA.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF CORPUS CHRISTI, TEXAS:

Section 1. The City Manager or designee is authorized to execute the Municipal Maintenance Agreement with the State of Texas, acting by and through the Texas Department of Transportation ("State" or "TxDOT") for the maintenance, control, supervision, and regulation of certain State Highways and/or portions of state highways in the City of Corpus Christi.

ATTEST:

Armando Chapa
City Secretary

THE CITY OF CORPUS CHRISTI

Joe Adame
Mayor

APPROVED AS TO FORM: 14-Mar-12

Veronica Ocanas
Assistant City Attorney
for City Attorney

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029442

INDEXED

Corpus Christi, Texas

10th of April, 2012

The above resolution was passed by the following vote:

Joe Adame	Aye
Chris N. Adler	Absent
Kelley Allen	Aye
Larry Elizondo, Sr.	Aye
Priscilla G. Leal	Aye
David Loeb	Aye
John E. Marez	Aye
Nelda Martinez	Aye
Mark Scott	Aye

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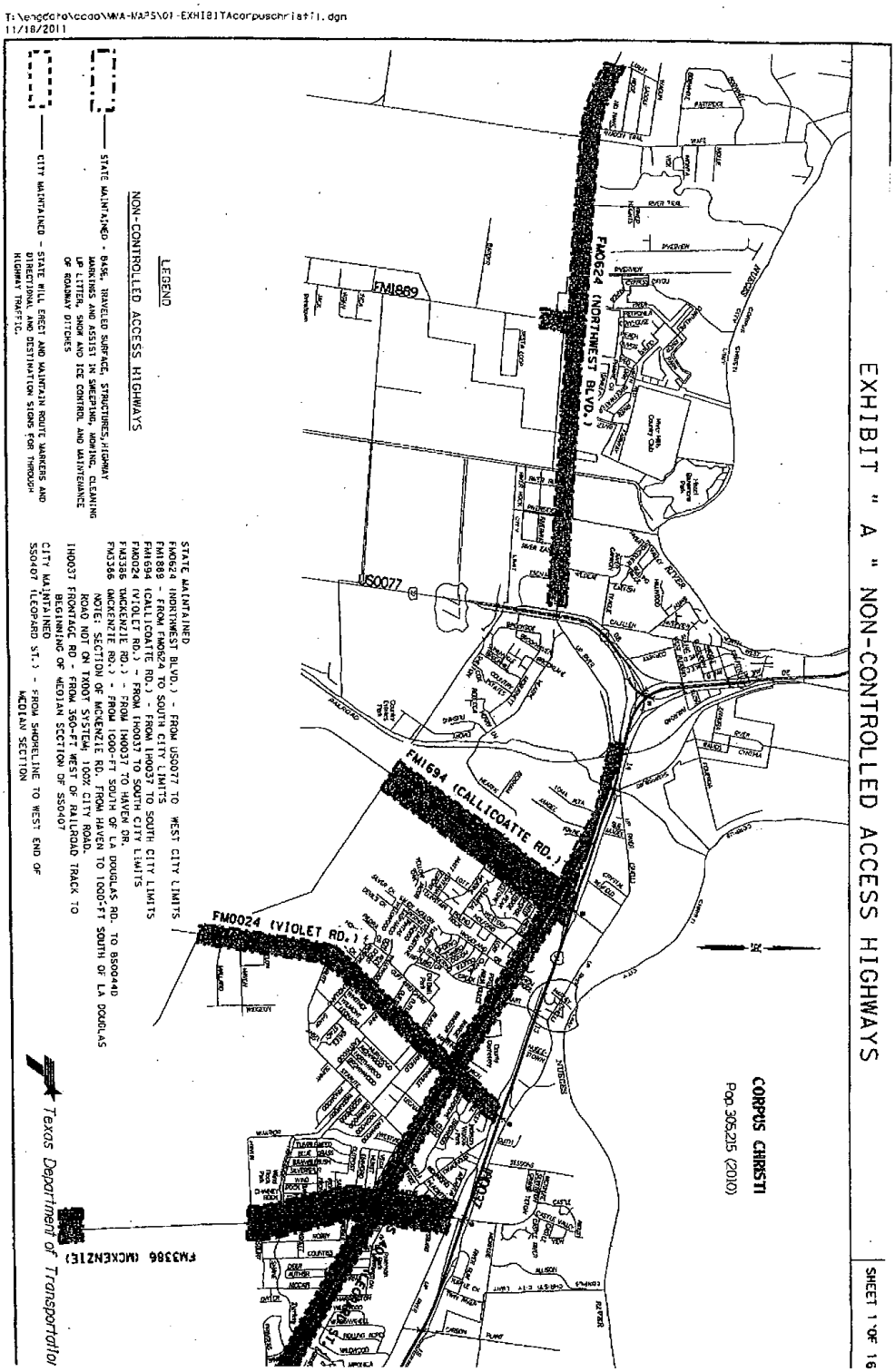
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11/18/2011
EXHIBIT " A " NON-CONTROLLED ACCESS HIGHWAYS
SHEET 1 OF 16
CORPUS CHRISTI
Pop 305,215 (2010)
FM0624 (NORTHWEST BLVD.)
FM1889
US0077
FM1694 (CALLICOATTE RD.)
FM0024 (VIOLET RD.)
FM3386 (MCKENZIE)
LEGEND
NON-CONTROLLED ACCESS HIGHWAYS
STATE MAINTAINED - BASE, TRAVELED SURFACE, STRUCTURES, HIGHWAY MARKINGS AND ASSIST IN SWEEPING, MOWING, CLEANING UP LITTER, SNOW AND ICE CONTROL AND MAINTENANCE OF ROADWAY DITCHES
CITY MAINTAINED - STATE WILL ERECT AND MAINTAIN ROUTE MARKERS AND DIRECTIONAL AND DESTINATION SIGNS FOR THROUGH HIGHWAY TRAFFIC.
STATE MAINTAINED
FM0624 (NORTHWEST BLVD.) - FROM US0077 TO WEST CITY LIMITS
FM1889 - FROM FM0624 TO SOUTH CITY LIMITS
FM1694 (CALLICOATTE RD.) - FROM IH0037 TO SOUTH CITY LIMITS
FM0024 (VIOLET RD.) - FROM IH0037 TO SOUTH CITY LIMITS
FM3386 (MCKENZIE RD.) - FROM IH0037 TO HAVEN DR.
(MCKENZIE RD.) - FROM 1000-FT SOUTH OF LA DOUGLAS RD. TO 850@40
NOTE: SECTION OF MCKENZIE RD. FROM HAVEN TO 1000-FT SOUTH OF LA DOUGLAS ROAD NOT ON TXDOT SYSTEM; 100% CITY ROAD.
IH0037 FRONTAGE RD - FROM 350-FT WEST OF RAILROAD TRACK TO BEGINNING OF MEDIAN SECTION OF SS0407
CITY MAINTAINED
SS0407 (LEOPARD ST.) - FROM SHORELINE TO WEST END OF MEDIAN SECTION
Texas Department of Transportation

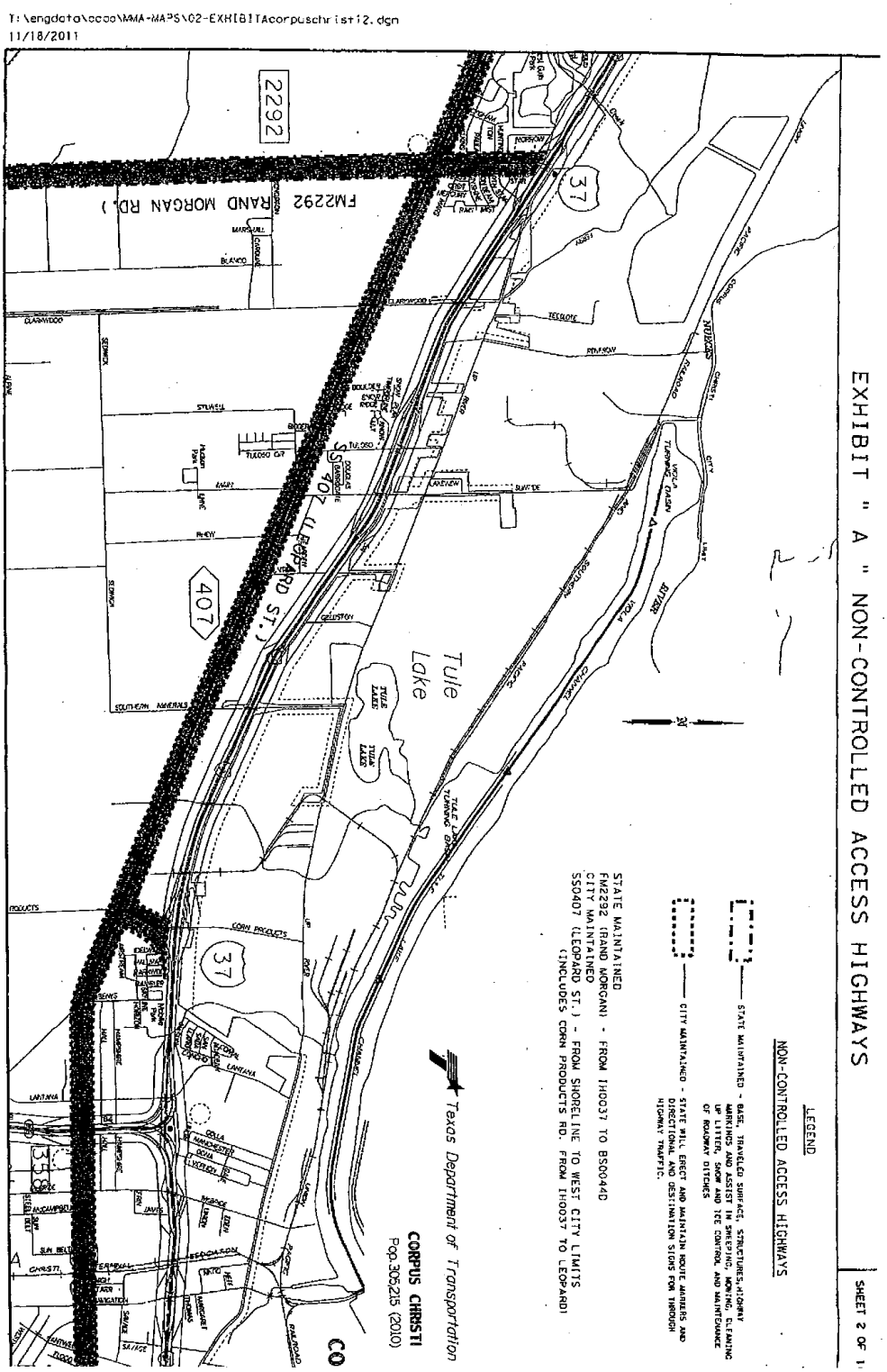
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EXHIBIT " A " NON-CONTROLLED ACCESS HIGHWAYS
SHEET 2 OF 1
LEGEND
NON-CONTROLLED ACCESS HIGHWAYS
STATE MAINTAINED - BASIL, TRAVELED SURFACE, STRUCTURES, HIGHWAY MARKINGS AND ASSIST IN SWEEPING, MOWING, CLEANING UP LITTER, SNOW AND ICE CONTROL AND MAINTENANCE OF ROADWAY DITCHES
CITY MAINTAINED - STATE WILL ERECT AND MAINTAIN ROUTE MARKERS AND DIRECTIONAL AND DESTINATION SIGNS FOR THROUGH HIGHWAY TRAFFIC.
STATE MAINTAINED
FM2292 (RAND MORGAN) - FROM IH0037 TO BS0044D
CITY MAINTAINED
SS0407 (LEOPARD ST.) - FROM SHORELINE TO WEST CITY LIMITS
(INCLUDES CORN PRODUCTS RD. FROM IH0037 TO LEOPARD)
Texas Department of Transportation
CORPUS CHRISTI
Pop.305,215 (2010)
FM2292 RAND MORGAN RD.)
2292
37
407
Leopard St.
Tule Lake
CORN PRODUCTS
CO

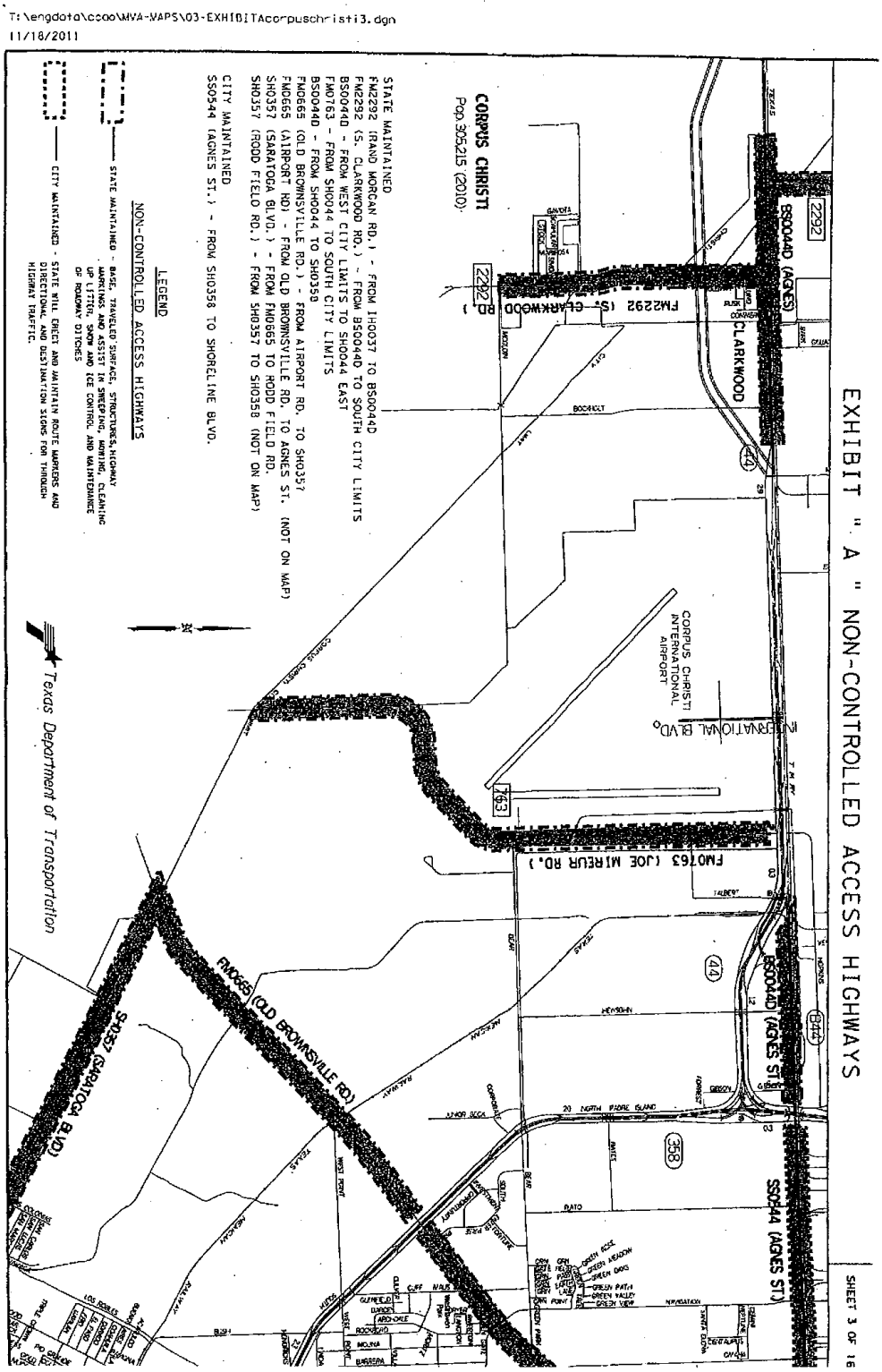
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EXHIBIT "A" NON-CONTROLLED ACCESS HIGHWAYS
CORPUS CHRISTI
Pop 305215 (2010)
STATE MAINTAINED
FM2292 (RAND MORGAN RD.) - FROM IH0037 TO BS0044D
FM2292 (S. CLARKWOOD RD.) - FROM BS0044D TO SOUTH CITY LIMITS
BS0044D - FROM WEST CITY LIMITS TO SH0044 EAST
FM0763 - FROM SH0044 TO SOUTH CITY LIMITS
BS0044D - FROM SH0044 TO SH0358
FM0665 (OLD BROWNSVILLE RD.) - FROM AIRPORT RD. TO SH0357
FM0665 (AIRPORT RD) - FROM OLD BROWNSVILLE RD. TO AGNES ST. (NOT ON MAP)
SH0357 (SARATOGA BLVD.) - FROM FM0665 TO HODD FIELD RD.
SH0357 (HODD FIELD RD.) - FROM SH0357 TO SH0358 (NOT ON MAP)
CITY MAINTAINED
SS0544 (AGNES ST.) - FROM SH0358 TO SHORELINE BLVD.
LEGEND
NON-CONTROLLED ACCESS HIGHWAYS
STATE MAINTAINED - BASE, TRAVELED SURFACE, STRUCTURES, HIGHWAY MARKINGS AND ASSIST IN SWEEPING, MOWING, CLEANING UP LITTER, SNOW AND ICE CONTROL AND MAINTENANCE OF ROADWAY DITCHES
CITY MAINTAINED - STATE WILL ERECT AND MAINTAIN ROUTE MARKERS AND DIRECTIONAL AND DESTINATION SIGNS FOR THROUGH HIGHWAY TRAFFIC.
Texas Department of Transportation
BS0044D (AGNES)
FM2292 (S. CLARKWOOD)
CLARKWOOD
BOCANOT
CORPUS CHRISTI INTERNATIONAL AIRPORT
INTERNATIONAL BLVD.
FM0763 (JOE MIRELR RD.)
SH357 (SARATOGA BLVD)
FM0665 (OLD BROWNSVILLE RD)
SS0544 (AGNES ST.)
SHEET 3 OF 16

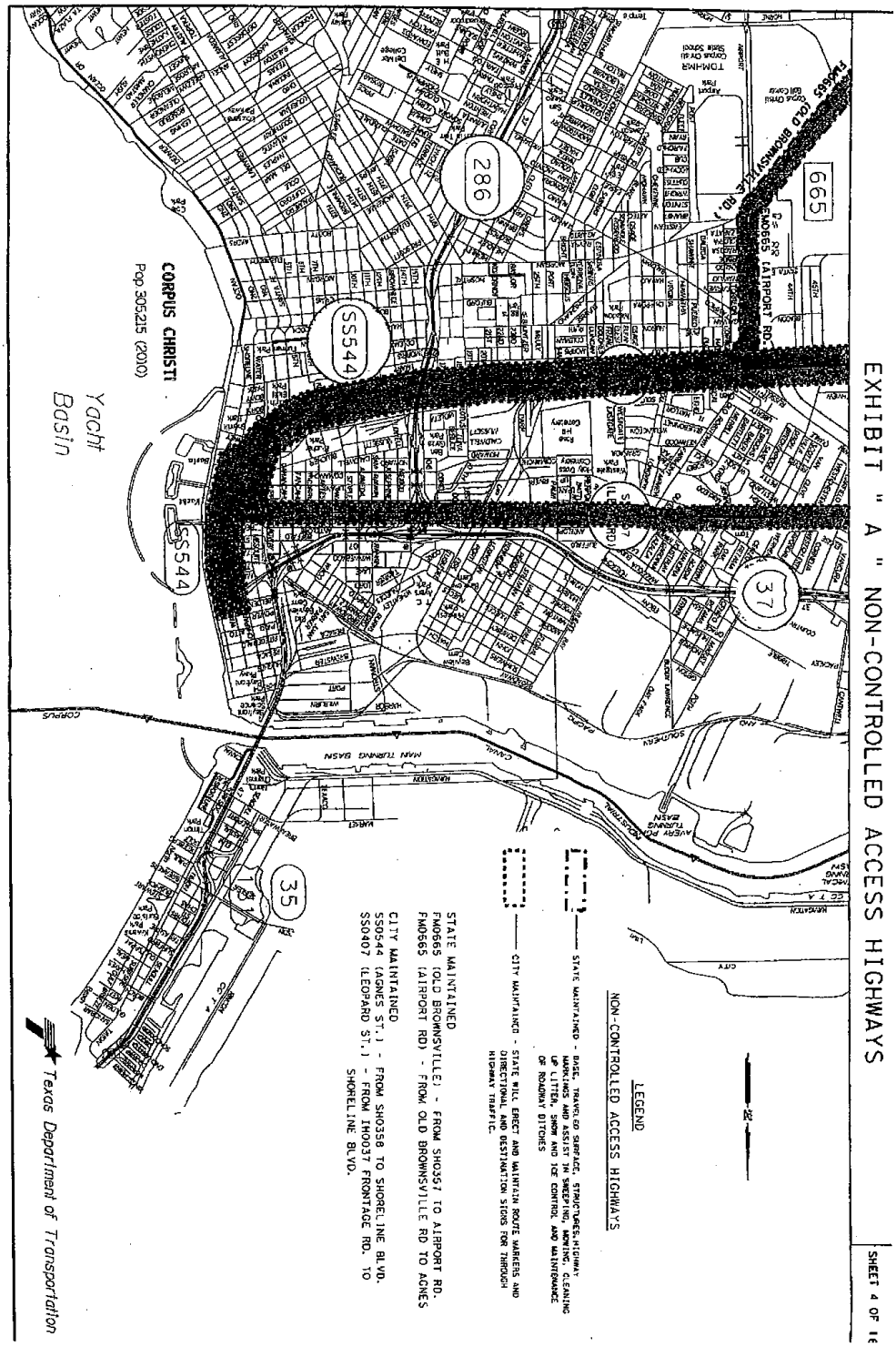
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EXHIBIT " A " NON-CONTROLLED ACCESS HIGHWAYS
CORPUS CHRISTI
Pop 305215 (2010)
Yacht Basin
Texas Department of Transportation
LEGEND
NON-CONTROLLED ACCESS HIGHWAYS
STATE MAINTAINED - BASE, TRAVELED SURFACE, STRUCTURES, HIGHWAY MARKINGS AND ASSIST IN SWEEPING, MOWING, CLEANING UP LITTER, SNOW AND ICE CONTROL AND MAINTENANCE OF ROADWAY DITCHES
CITY MAINTAINED - STATE WILL ERECT AND MAINTAIN ROUTE MARKERS AND DIRECTIONAL AND DESTINATION SIGNS FOR THROUGH HIGHWAY TRAFFIC.
STATE MAINTAINED
FM0665 (OLD BROWNSVILLE) - FROM SH0357 TO AIRPORT RD.
FM0665 (AIRPORT RD) - FROM OLD BROWNSVILLE RD TO AGNES
CITY MAINTAINED
SS0544 (AGNES ST.) - FROM SH0358 TO SHORELINE BLVD.
SS0407 (LEOPARD ST.) - FROM IH0037 FRONTAGE RD. TO SHORELINE BLVD.
SHEET 4 OF 16

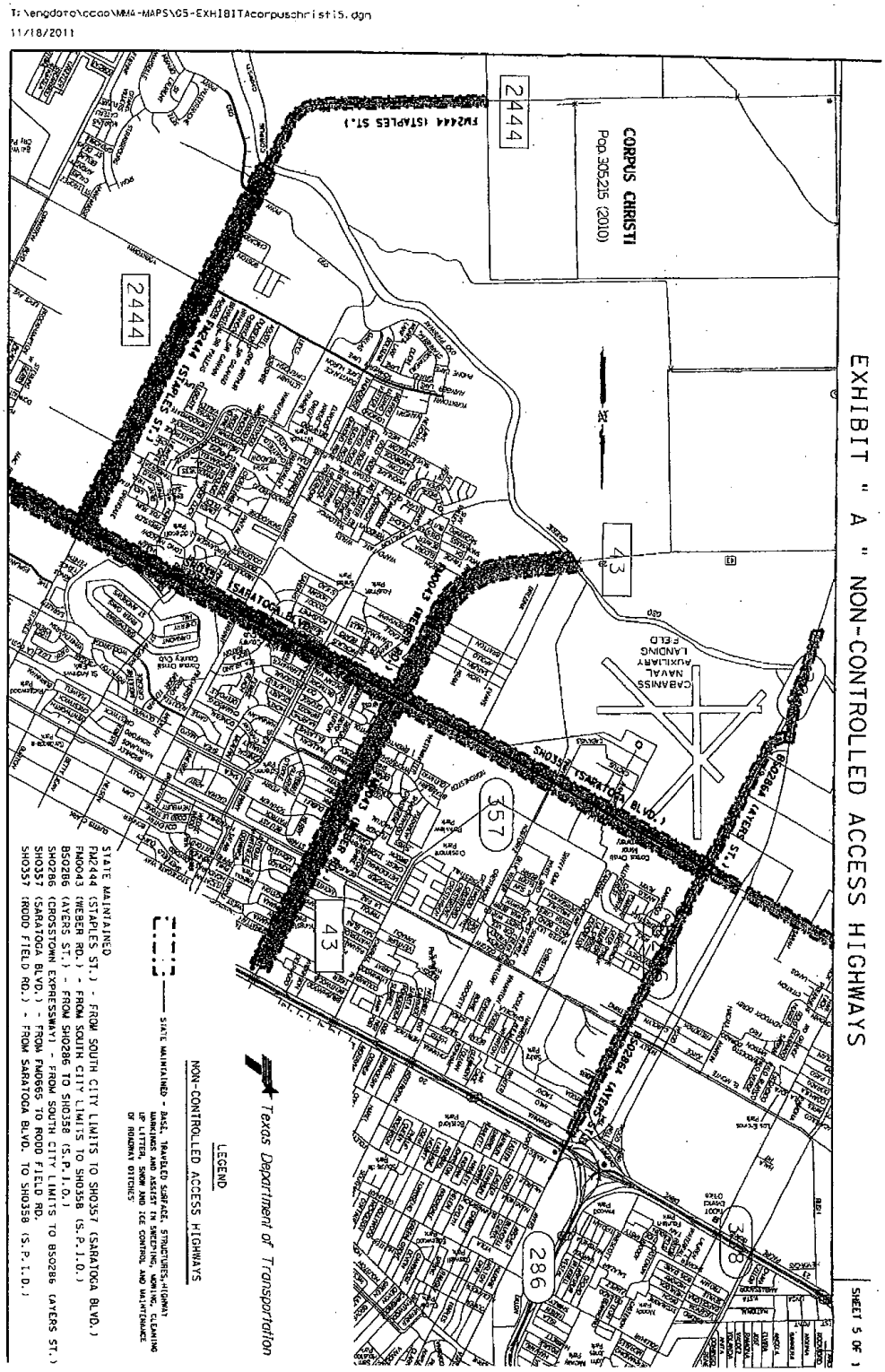
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EXHIBIT " A " NON-CONTROLLED ACCESS HIGHWAYS
CORPUS CHRISTI
Pop.305,215 (2010)
2444
FM2444 (STAPLES ST.)
SARATOGA BLVD.
CRANE AERO
NAVAL AUXILIARY LANDING FIELD
SHOWALTER
SHORELINE
Texas Department of Transportation
LEGEND
NON-CONTROLLED ACCESS HIGHWAYS
STATE MAINTAINED - BASE, TREATED SUBBASE, STRUCTURES, HIGHWAY LIGHTING, CLEANING, MAINTENANCE AND ASSIST IN SWEEPING, MOWING, ICE CONTROL, AND MAINTENANCE OF ROADWAY DITCHES
STATE MAINTAINED
FM2444 (STAPLES ST.) - FROM SOUTH CITY LIMITS TO SH0357 (SARATOGA BLVD.)
FM0043 (WEBER RD.) - FROM SOUTH CITY LIMITS TO SH035B (S.P.I.D.)
BS0286 (AYERS ST.) - FROM SH0286 TO SH035B (S.P.I.D.)
SH0286 (CROSSTOWN EXPRESSWAY) - FROM SOUTH CITY LIMITS TO BS0286 (AYERS ST.)
SH0357 (SARATOGA BLVD.) - FROM FM0665 TO RODD FIELD RD.
SH0357 (RODD FIELD RD.) - FROM SARATOGA BLVD. TO SH035B (S.P.I.D.)
SHEET 5 OF 7

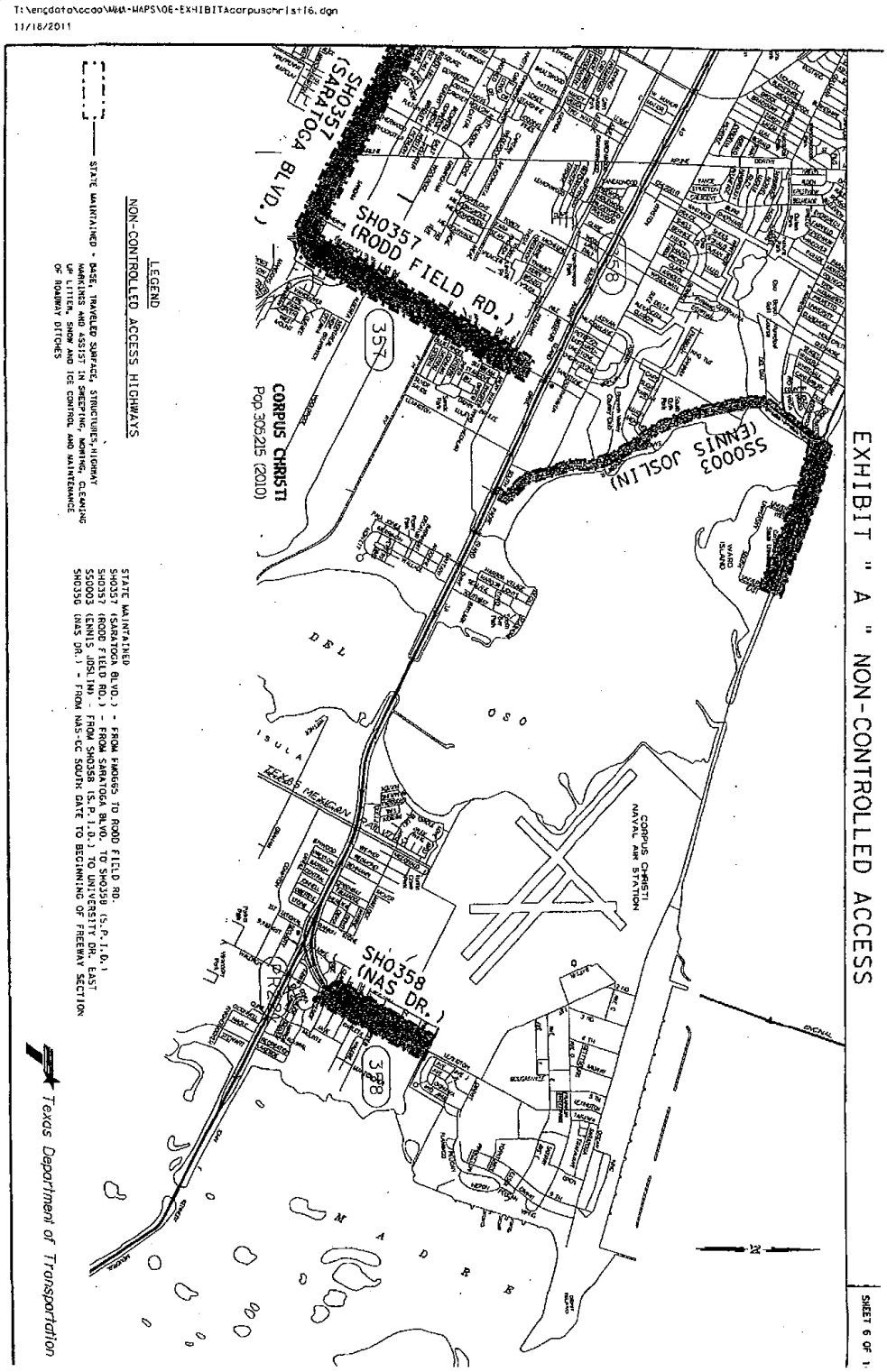
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EXHIBIT " A " NON-CONTROLLED ACCESS
LEGEND
NON-CONTROLLED ACCESS HIGHWAYS
STATE MAINTAINED - BASE, TRAVELED SURFACE, STRUCTURES, HIGHWAY MARKINGS AND ASSIST IN SWEEPING, MOWING, CLEANING UP LITTER, SNOW AND ICE CONTROL AND MAINTENANCE OF ROADWAY DITCHES
STATE MAINTAINED
SH0357 (SARATOGA BLVD.) - FROM FM0665 TO RODD FIELD RD.
SH0357 (RODD FIELD RD.) - FROM SARATOGA BLVD. TO SH0358 (S.P.I.D.)
SS0003 (ENNIS JOSLIN) - FROM SH0358 (S.P.I.D.) TO UNIVERSITY DR. EAST
SH0358 (NAS DR.) - FROM NAS-CC SOUTH GATE TO BEGINNING OF FREEWAY SECTION
SH0357 (SARATOGA BLVD.)
SH0357 (RODD FIELD RD.)
CORPUS CHRISTI
Pop. 305,215 (2010)
SS0003 (ENNIS JOSLIN)
SH0358 (NAS DR.)
CORPUS CHRISTI NAVAL AIR STATION
TEXAS MEXICAN
Texas Department of Transportation
SHEET 6 OF

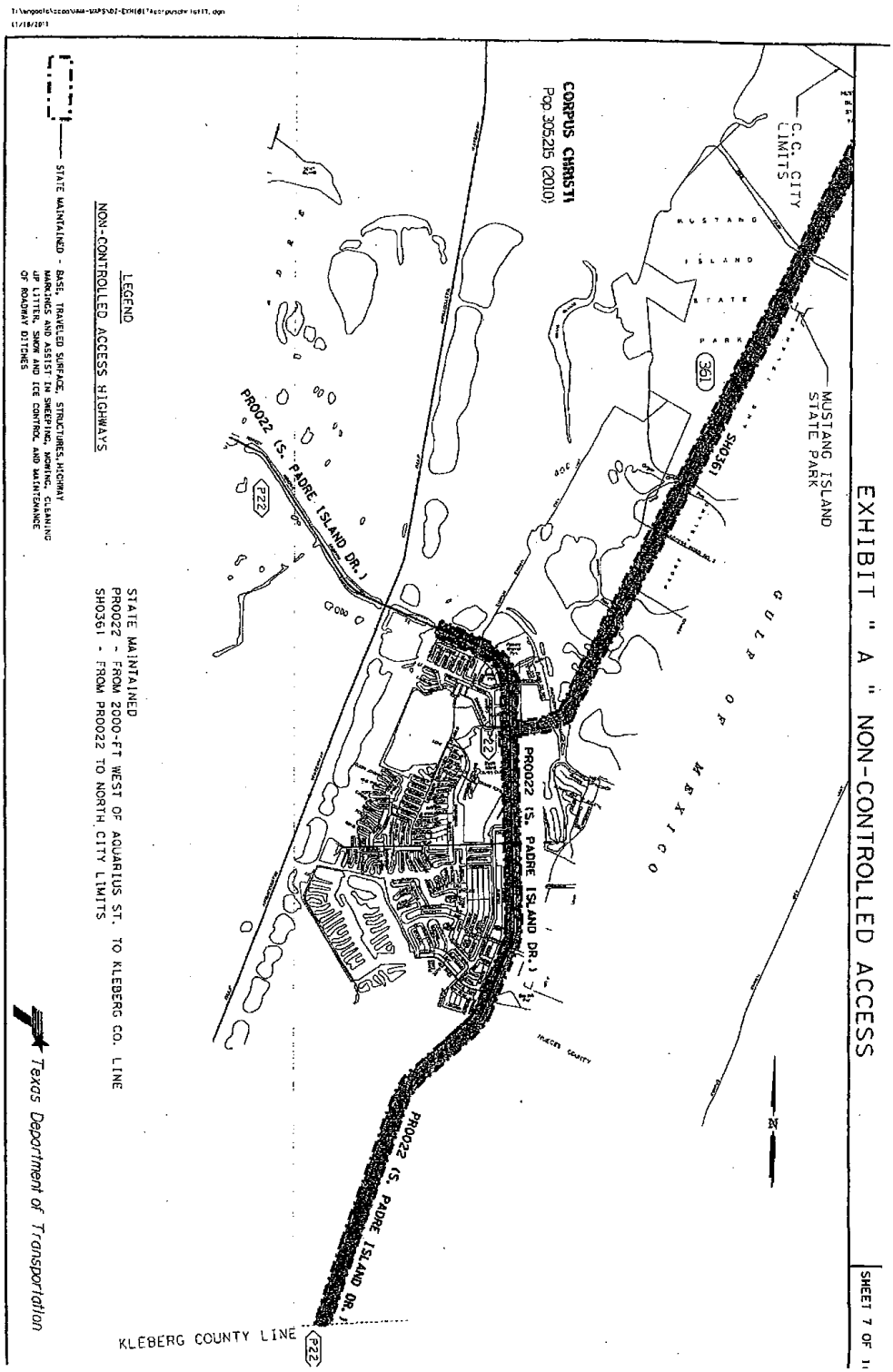
EXHIBIT " A " NON-CONTROLLED ACCESS
SHEET 7 OF 11
CORPUS CHRISTI
Pop 305215 (2010)
C.C. CITY LIMITS
MUSTANG ISLAND STATE PARK
SH0361
PR0022 (S. PADRE ISLAND DR.)
GULF OF MEXICO
KLEBERG COUNTY LINE
LEGEND
NON-CONTROLLED ACCESS HIGHWAYS
STATE MAINTAINED - BASE, TRAVELED SURFACE, STRUCTURES, HIGHWAY MARKINGS AND ASSIST IN SWEEPING, MOWING, CLEANING UP LITTER, SNOW AND ICE CONTROL AND MAINTENANCE OF ROADWAY DITCHES
STATE MAINTAINED
PR0022 - FROM 2000-FT WEST OF AQUARIUS ST. TO KLEBERG CO. LINE
SH0361 - FROM PR0022 TO NORTH CITY LIMITS
Texas Department of Transportation

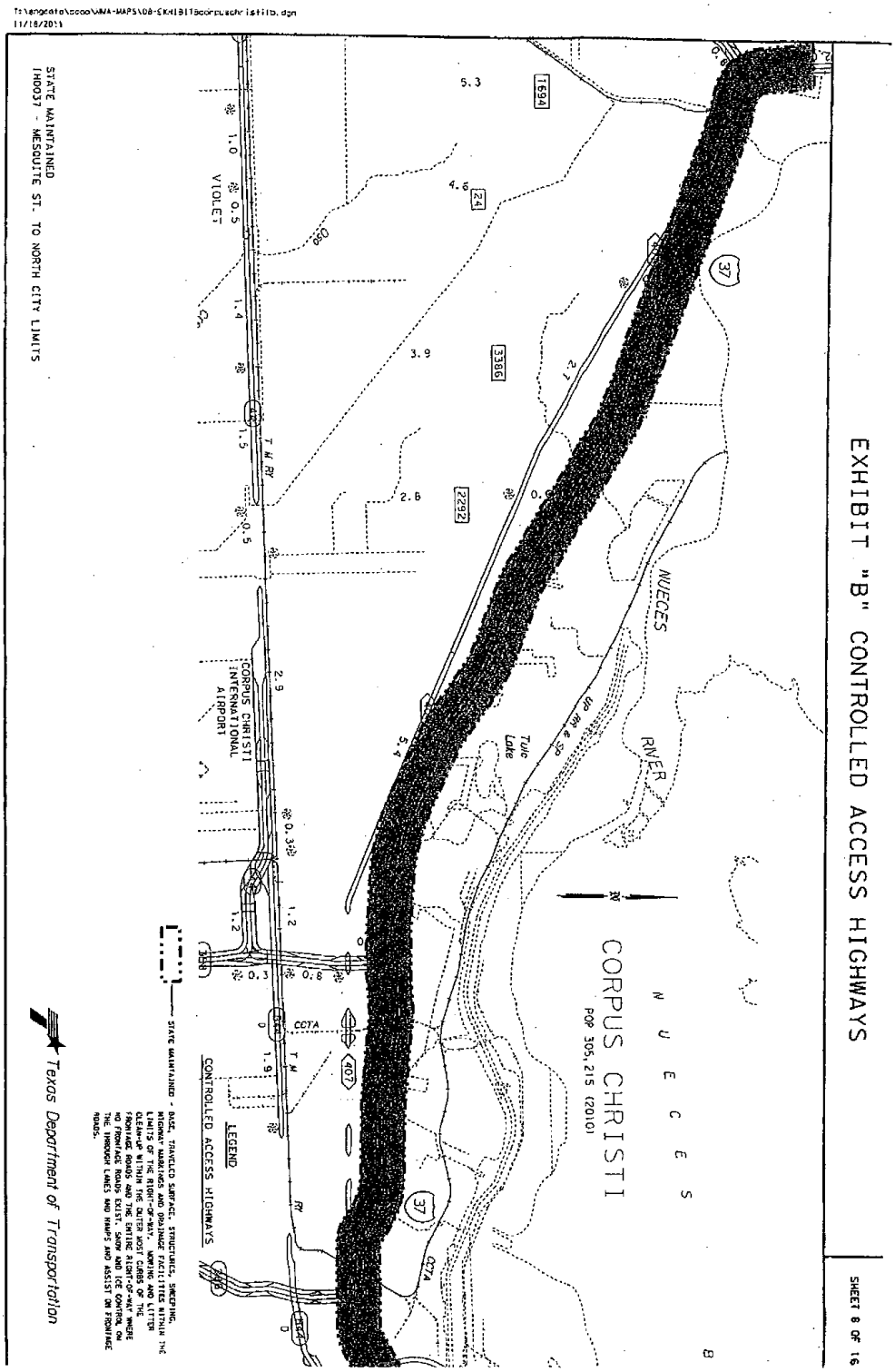
EXHIBIT "B" CONTROLLED ACCESS HIGHWAYS
SHEET 8 OF 16
CORPUS CHRISTI
POP 305,215 (2010)
NUECES
NUECES RIVER
Tule Lake
CORPUS CHRISTI INTERNATIONAL AIRPORT
VIOLET
LEGEND
CONTROLLED ACCESS HIGHWAYS
STATE MAINTAINED - BASE, TRAVELED SURFACE, STRUCTURES, SWEEPING, HIGHWAY MARKINGS AND DRAINAGE FACILITIES WITHIN THE LIMITS OF THE RIGHT-OF-WAY. MOWING AND LITTER CLEAN-UP WITHIN THE OUTER MOST CURBS OF THE FRONTAGE ROADS AND THE ENTIRE RIGHT-OF-WAY WHERE NO FRONTAGE ROADS EXIST. TRAFFIC CONTROL ON THE THROUGH LANES AND RAMPS AND ASSIST ON FRONTAGE ROADS.
STATE MAINTAINED
IH0037 - MESQUITE ST. TO NORTH CITY LIMITS
Texas Department of Transportation

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11/18/2011

EXHIBIT "B" CONTROLLED ACCESS HIGHWAYS

CORPUS CHRISTI

Pop 305215 (2010)

STATE MAINTAINED
SH0286 (CROSSTOWN EXPRESSWAY) FROM IH0037 TO SS0286 (AYERS ST.)

STATE MAINTAINED - BASE, TRAVELED SURFACE, STRUCTURES, SHEETING, SIGNAGE, GUARDRAIL, LANDSCAPING, UTILITIES WITHIN LIMITS OF THE RIGHT-OF-WAY, MOWING AND LITTER CLEAN-UP WITHIN THE OUTER MOST CURBS OF THE FRONTAGE ROADS AND THE ENTIRE RIGHT-OF-WAY WHERE NO FRONTAGE ROADS EXIST. SNOW AND ICE CONTROL ON THE THROUGH LANES AND RAMPS AND ASSIST ON FRONTAGE ROADS.

CONTROLLED ACCESS HIGHWAYS

Texas Department of Transportation

SHEET 9 OF 11

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11/15/2011

EXHIBIT "B" CONTROLLED ACCESS HIGHWAYS

LEGEND

CONTROLLED ACCESS HIGHWAYS

STATE MAINTAINED - BASE, TRAVELED SURFACE, STRUCTURES, SHOULDING, HIGHWAY MARKINGS AND DRAINAGE FACILITIES WITHIN THE LIMITS OF THE RIGHT-OF-WAY. MOWING AND LITTER CLEAN-UP WITHIN THE OUTER MOST BOUNDS OF THE CONTROLLED ACCESS HIGHWAYS. ALSO WHERE FRONTAGE ROADS EXIST, SWEEPING AND ICE CONTROL ON THE THROUGH LANES AND RAMPS AND ASSIST ON FRONTAGE ROADS.

STATE MAINTAINED

SH0286 (CROSSTOWN EXPRESSWAY) - FROM IH0037 TO BS0286A (AYERS ST.)

SH035B (PADRE ISLAND DR.) - FROM IH0037 TO END OF EXPRESSWAY LANES AT CLAIRE DR.

Texas Department of Transportation

SHEET 10 OF 1

EXHIBIT "B" CONTROLLED ACCESS HIGHWAYS
CORPUS CHRISTI
Pop 305215 (2010)
LEGEND
CONTROLLED ACCESS HIGHWAYS
STATE MAINTAINED
SH0358 (PADRE ISLAND DR.) - FROM IH0037 TO END OF FREEWAY SECTION AT CLARIE DR.
Texas Department of Transportation
SHEET 11 OF 16

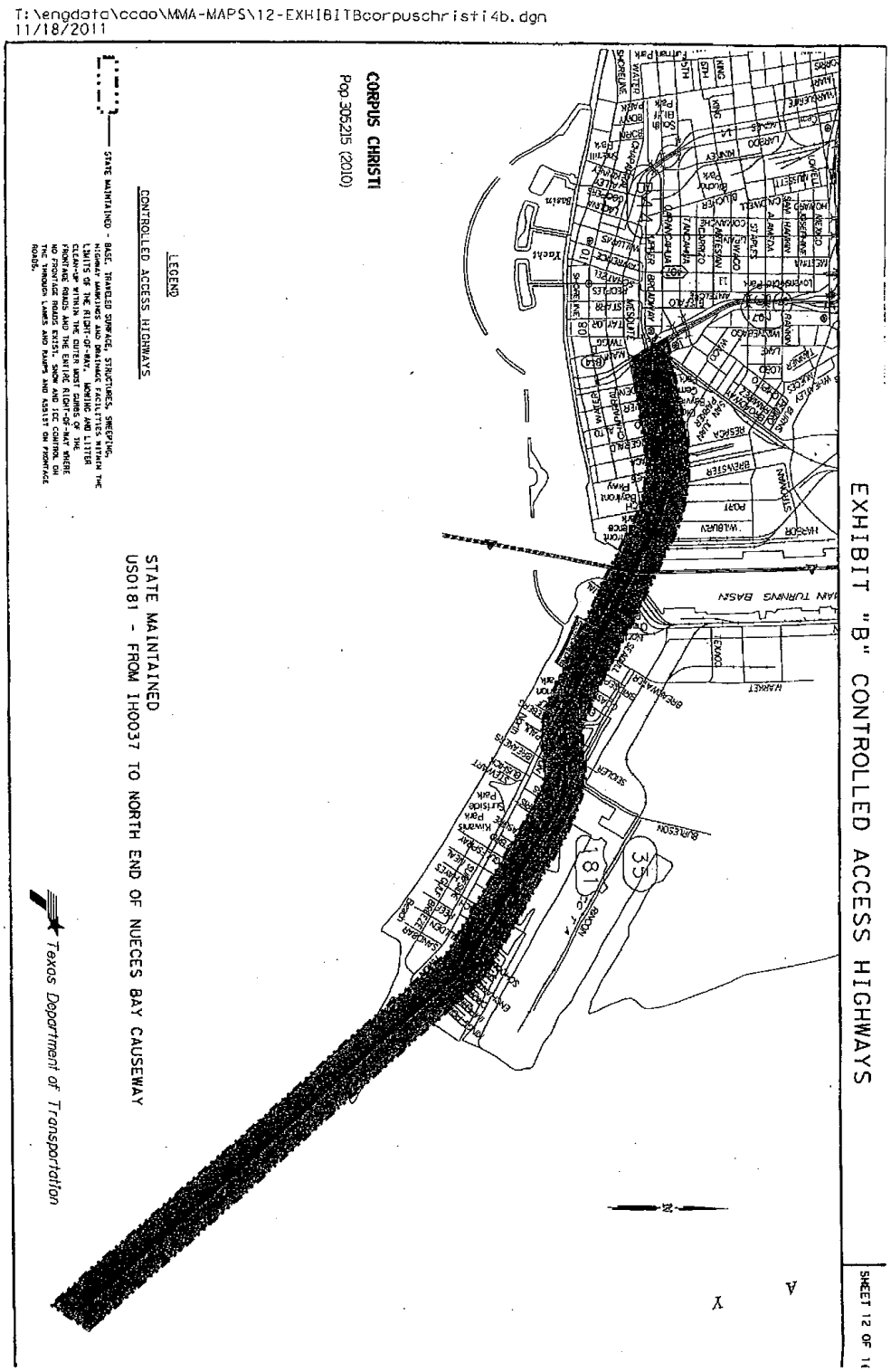
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EXHIBIT "B" CONTROLLED ACCESS HIGHWAYS
CORPUS CHRISTI
Pop 305215 (2010)
LEGEND
CONTROLLED ACCESS HIGHWAYS
STATE MAINTAINED - BASE, TRAVELED SURFACES, STRUCTURES, SWEEPING, HIGHWAY MARKINGS AND DRAINAGE FACILITIES WITHIN THE LIMITS OF THE RIGHT-OF-WAY. MOWING AND LITTER CONTROL WITHIN THE RIGHT-OF-WAY LIMITS ON THE FRONTAGE ROADS AND THE ENTIRE RIGHT-OF-WAY WHERE NO FRONTAGE ROADS EXIST. SNOW AND ICE CONTROL ON THE THROUGH LANES AND RAMPS AND ASSIST ON FRONTAGE ROADS.
STATE MAINTAINED
US0181 - FROM IH0037 TO NORTH END OF NUECES BAY CAUSEWAY
Texas Department of Transportation
SHEET 12 OF 14

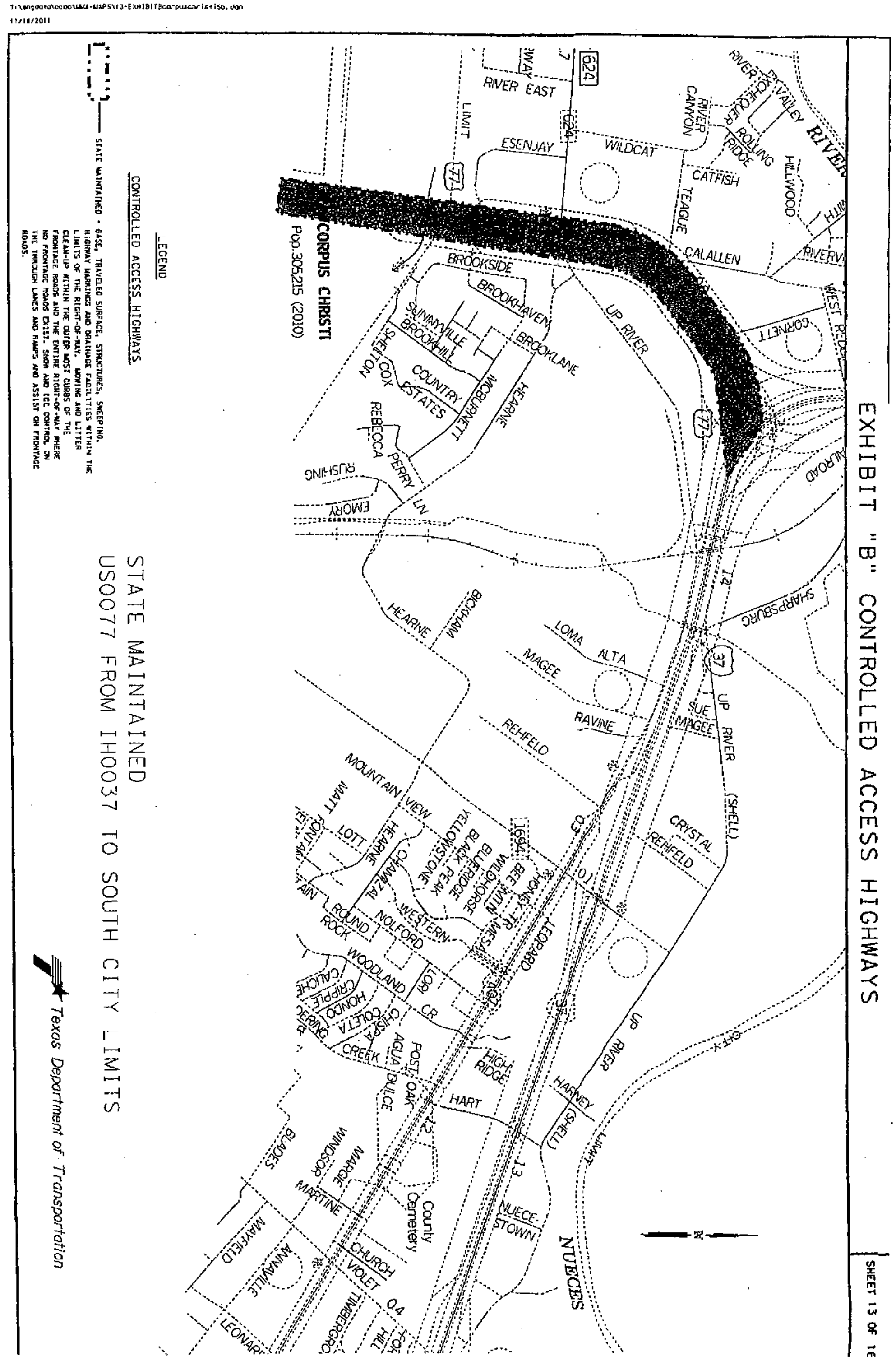
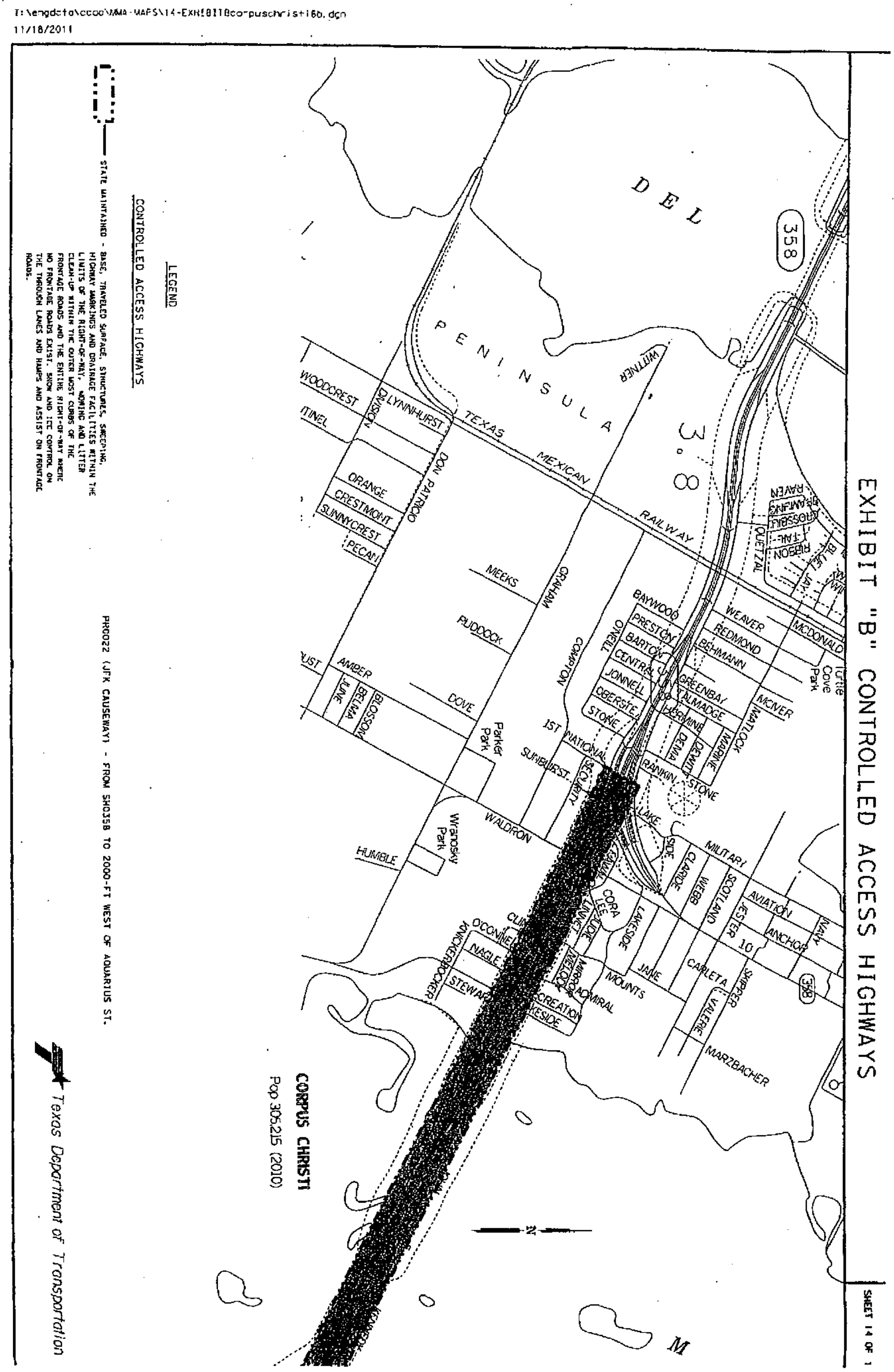


EXHIBIT "B" CONTROLLED ACCESS HIGHWAYS
STATE MAINTAINED
US0077 FROM IH0037 TO SOUTH CITY LIMITS
LEGEND
CONTROLLED ACCESS HIGHWAYS
CORPUS CHRISTI
Pop. 305,215 (2010)
Texas Department of Transportation
NUECES


11/18/2011
EXHIBIT "B" CONTROLLED ACCESS HIGHWAYS
LEGEND
CONTROLLED ACCESS HIGHWAYS
PR0022 (JFK CAUSEWAY) - FROM SH035B TO 2000-FT WEST OF AQUARIUS ST.
DEL
PENINSULA
TEXAS MEXICAN RAILWAY
358
CORPUS CHRISTI
Pop 305,215 (2010)
Texas Department of Transportation

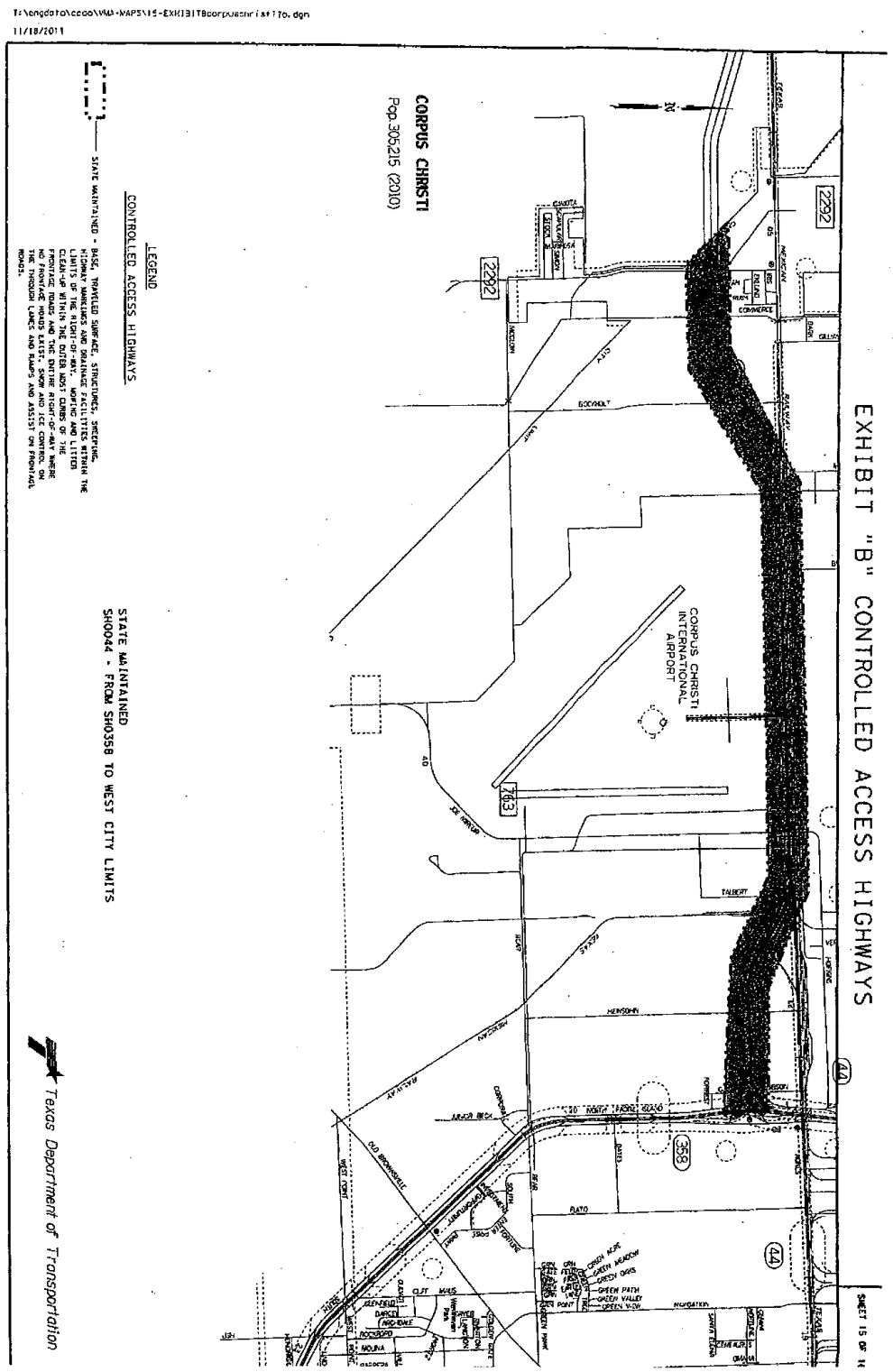


EXHIBIT "B" CONTROLLED ACCESS HIGHWAYS
CORPUS CHRISTI
Pop 305215 (2010)
CORPUS CHRISTI INTERNATIONAL AIRPORT
LEGEND
CONTROLLED ACCESS HIGHWAYS
STATE MAINTAINED - BASE, TRAVELED SURFACE, STRUCTURES, SWEEPING, STRIPING, MAINTENANCE AND OPERATIONS WITHIN THE LIMITS OF THE RIGHT-OF-WAY. MOWING AND LITTER CLEAN-UP WITHIN THE OUTER MOST CURBS OF THE FRONTAGE ROADS AND THE ENTIRE RIGHT-OF-WAY WHERE NO FRONTAGE ROADS EXIST. SNOW AND ICE CONTROL ON THE THROUGH LANES AND RAMPS AND ASSIST ON FRONTAGE ROADS.
STATE MAINTAINED
SH0044 - FROM SH0358 TO WEST CITY LIMITS
Texas Department of Transportation
11/18/2011

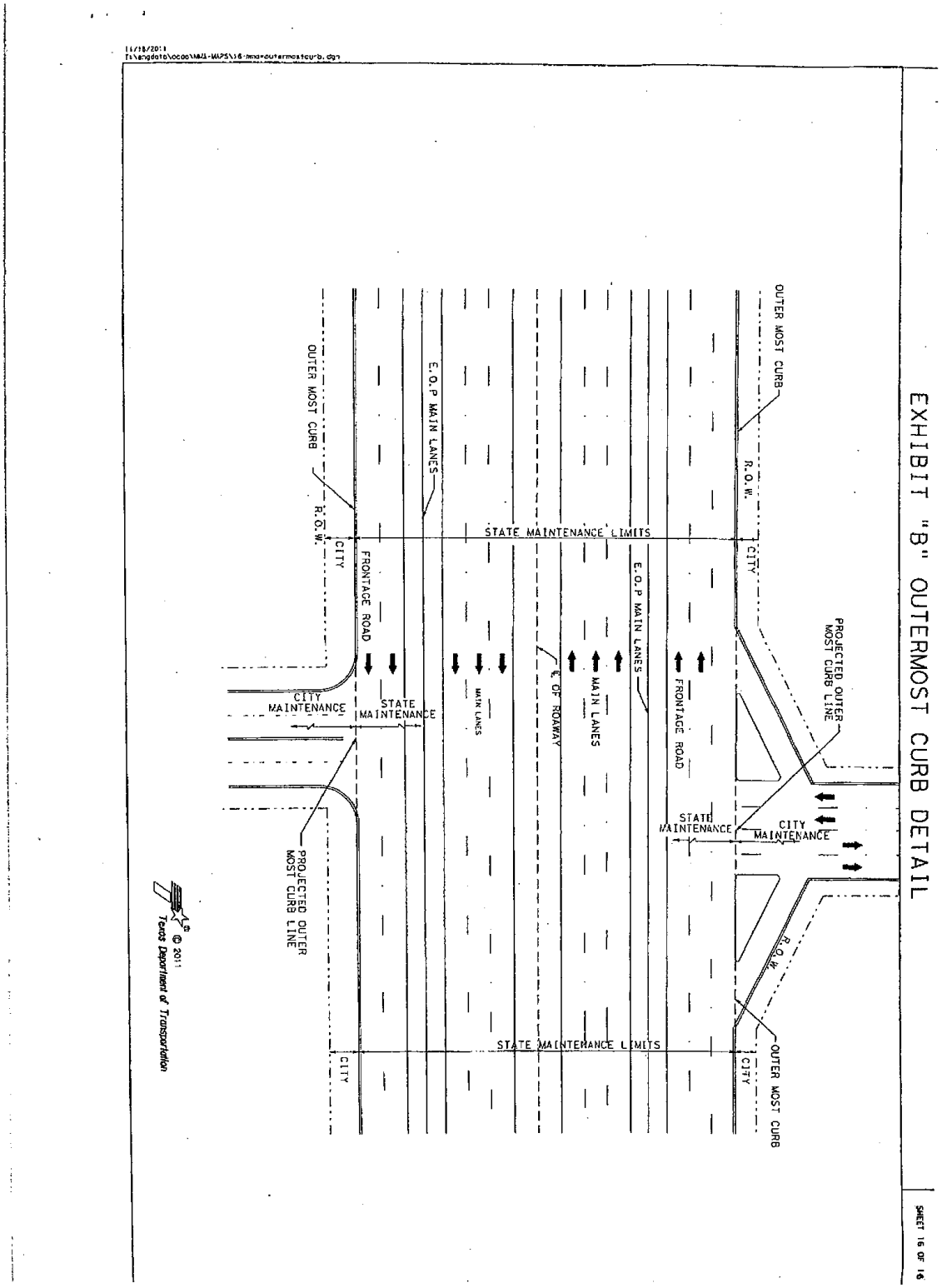


EXHIBIT "B" OUTERMOST CURB DETAIL
OUTER MOST CURB
R.O.W.
CITY
STATE MAINTENANCE LIMITS
E.O.P MAIN LANES
FRONTAGE ROAD
MAIN LANES
PROJECTED OUTER MOST CURB LINE
STATE MAINTENANCE
CITY MAINTENANCE
℄ OF ROADWAY
SHEET 16 OF 16
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Texas Department of Transportation

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 5-2
NPDES PERMIT

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
P. O. Box 13087
Austin, Texas 78711-3087

TPDES PERMIT NO. WQ0004200000
[For TCEQ office use only – EPA I.D. No. TXS000601]

This is a renewal of NPDES Permit No. TXS000601, issued on April 21, 1995.

PERMIT TO DISCHARGE UNDER THE TEXAS
POLLUTANT DISCHARGE ELIMINATION SYSTEM
under provisions of
Section 402 of the Clean Water Act
and Chapter 26 of the Texas Water Code

PART I: AUTHORIZATION

City of Corpus Christi
P.O. Box 9277
Corpus Christi, Texas 78469

Del Mar College District
101 Baldwin
Corpus Christi, Texas 78404

Port of Corpus Christi Authority
P.O. Box 1541
Corpus Christi, Texas 78403

Texas Department of Transportation
P.O. Box 9907
Corpus Christi, Texas 78469

Texas A&M University - Corpus Christi
6300 Ocean Drive
Corpus Christi, Texas 78412

are authorized to discharge from the City of Corpus Christi Municipal Separate Storm Sewer System (MS4) (SIC 9111)

including all areas, except for any agricultural lands, located within the corporate boundary of the City of Corpus Christi served by, or otherwise contributing to discharges to the MS4(s) owned or operated by the permittees, located in Nueces, Kleberg, San Patricio, and Aransas Counties, Texas

via the MS4 to Corpus Christi Bay, Nueces Bay, Oso Bay, Laguna Madre, and the Gulf of Mexico, Segment Nos. 2481, 2482, 2485, 2491, and 2501 of the Bays and Estuaries, and to various ditches and tributaries that eventually reach Corpus Christi Bay, Nueces Bay, Oso Bay, Laguna Madre, and the Gulf of Mexico

only according to conditions set forth in this permit, as well as the rules of the Texas Commission on Environmental Quality (TCEQ), the laws of the State of Texas, and other orders of the TCEQ. The issuance of this permit does not grant to the permittee(s) the right to use private or public property for conveyance of storm water and certain non storm water discharges along the discharge route described in this permit. This includes, but is not limited to, property belonging to any individual, partnership, corporation or other entity. Neither does this permit authorize any invasion of personal rights nor any violation of federal, state, or local laws or regulations. It is the responsibility of the permittee(s) to acquire property rights as may be necessary to use the discharge route.

This permit shall expire at midnight, five years from date of issuance.

ISSUED DATE: AUG 11 2008

For the Commission

PART II: DISCHARGES AUTHORIZED BY THIS PERMIT

A This permit authorizes existing or new storm water point source discharges to surface water in the state from those portions of the Municipal Separate Storm Sewer System (MS4) owned or operated by the copermittees, except as follows:

1. The following discharges, whether discharged separately or commingled with municipal storm water, are not authorized by this permit:

   a. Unauthorized non-storm water and industrial storm water: Discharges of unauthorized non-storm water; any storm water discharges associated with industrial activity; or other storm water discharges required by either the TCEQ or the EPA to obtain a TPDES or a National Pollutant Discharge Elimination System (NPDES) permit;

   b. Discharges of materials resulting from a spill, except when necessary to prevent loss of life, personal injury, or severe property damage;

   c. However, nothing in subsections a. and b. is intended to negate any person's ability to assert the *force majeure* (Act of God, war, strike, riot, or other catastrophe) defenses found in 30 TAC Section (§) 70.7.

This permit does not transfer liability for the act of discharging without, or in violation of, an NPDES or a TPDES permit from the party(ies) responsible for a spill to the permittees. Also see Part III, Item B.7. of this permit.

B Responsibilities of the Permittees:

1. Each permittee is individually responsible for:

   a. Compliance with permit conditions relating to discharges from portions of the MS4 for which they are the operator;

   b. Storm Water Management Program (SWMP) implementation on portions of the MS4 for which they are the operator;

   c. Compliance with annual reporting requirements;

   d. Collection of representative wet weather monitoring data, according to such agreements established between permittees; and

   e. A plan of action to assume responsibility for implementation of the storm water management and monitoring programs on their portions of the MS4 should inter-jurisdictional agreements allocating responsibility between permittees be dissolved or in default.

2. Permittees are jointly responsible for permit compliance on portions of the MS4 where operational or SWMP implementation authority over portions of the MS4 is shared or has been transferred from one permittee to another in accordance with legally binding agreements that do not specify responsibility for the portion of such MS4 so transferred.

PART III: STORM WATER MANAGEMENT PROGRAM

A. Each permittee shall contribute to the development, implementation and revision of a comprehensive Storm Water Management Program (SWMP) which includes pollution prevention measures, treatment or pollutant removal techniques, storm water monitoring, use of legal authority, and other appropriate means to control the quality of storm water discharged from the MS4 that reach Waters of the United States (U.S.). Each element of the plan must be developed to include measurable goals, to the maximum extent practicable.

The SWMP shall identify the areas of permittees' jurisdiction for each program element, control, and activity. Implementation of the SWMP may be achieved through participation with other permittees, public agencies, or private entities in cooperative efforts to satisfy the requirements of Part III of this permit in lieu of creating duplicate program elements for each individual permittee. The SWMP, taken as a whole, must include controls necessary to effectively prohibit the discharge of non-storm water into the MS4 (except as described in Part III.B.6. of this permit), and reduce the discharge of pollutants from the MS4 to the Maximum Extent Practicable (MEP).

The SWMP shall cover the term of the permit and shall be updated as necessary or as required by the TCEQ, to ensure compliance with Section 402 of the Clean Water Act, Chapter 26 of the Texas Water Code, applicable EPA and TCEQ regulations, and the requirements of this TPDES permit. Any modifications to the SWMP shall be made in accordance with Part III.G.2. and Part III.G.3. of this permit. Compliance with the SWMP is defined as compliance with Part III.B. The SWMP, and all approved updates are incorporated by reference.

The Best Management Practices (BMPs) included in the SWMP which relate to the discharge of hazardous metals constitute effluent limitations for the purposes of compliance with the requirements of 30 TAC Chapter 319, Subchapter B, related to Hazardous Metals.

B. The SWMP shall, at a minimum, contain the following elements:

1. Structural Controls: The MS4 and any storm water structural controls shall be operated in manner to reduce the discharge of pollutants to the Maximum Extent Practicable (MEP).

2. Areas of New Development and Significant Redevelopment: The permittees shall implement a comprehensive master planning process (or equivalent) to develop, implement, and enforce controls to minimize the discharge of pollutants from areas of new development and significant redevelopment after construction is completed. The goals of such controls shall include:

   a. New development - limiting increases in the discharge of pollutants in storm water as a result of development; and

b. Redevelopment - minimizing the discharge of pollutants in storm water.

3. Roadways: Public streets, roads, and highways shall be operated and maintained in a manner to minimize discharge of pollutants, including those pollutants related to deicing or sanding activities.

4. Flood Control Projects: Impacts on receiving water quality shall be assessed for all flood control projects. To the MEP, new flood control projects must be designed and constructed to provide pollutant removal from storm water. If applicable, the retrofitting of existing structural flood control devices to provide additional pollutant removal from storm water shall be implemented, to the MEP.

5. Pesticide, Herbicide, and Fertilizer Application: The permittees shall develop and implement controls to reduce the discharge of pollutants related to the storage and application of pesticides, herbicides, and fertilizers applied, by the permittees' employees or contractors, to public right-of-ways, parks, or other municipal property. The permittees, if they have jurisdiction over lands they do not directly own (e.g. incorporated city), shall implement programs to reduce the discharge of pollutants related to the application and distribution of pesticides, herbicides, and fertilizers.

6. Illicit Discharges and Improper Disposal:

   a. Illicit non-storm water discharges to the MS4 shall be prohibited. For the purposes of this permit, the following discharges need not be addressed as illicit discharges by the permittees nor prohibited from entering the MS4:

      (1) Discharges authorized by a separate NPDES or TPDES permit, subject to the approval by an authorized permittee;

      (2) Discharges for which an NPDES or TPDES permit application has been submitted; and

      (3) Other non-storm water discharges, as described below, that are not prohibited by the permittees in the SWMP. The SWMP shall identify any categories of non-storm water discharges that are not prohibited from being discharged into the MS4, in accordance with the following conditions:

         (a) Categories of non-storm water discharges that the permittees may exempt from the prohibition on non-storm water entering the MS4 include the following: water line flushing; landscape irrigation; diverted stream flows; rising ground waters; uncontaminated ground water infiltration (*); uncontaminated pumped ground water; discharges from potable water sources; foundation drains; air conditioning condensation; irrigation water; springs; water from crawl space pumps; footing drains; lawn watering; street wash water; individual residential vehicle washing; charitable car washes; wash waters using only potable water, and which are similar in quality and character to street wash water or individual residential vehicle washing but without the use of detergents or surfactants; flows from riparian habitats and wetlands; dechlorinated swimming pool discharges; other allowable non-storm water discharges as listed in the TPDES Construction General Permit No. TXR150000 and TPDES Multi-Sector General Permit No. TXR050000; additional sources of non-storm water that may be listed in 40 CFR

Section 122.26(d)(2)(iv)(B)(1); as well as other similar occasional incidental non-storm water discharges, unless the TCEQ develops permits or regulations addressing these discharges. Program descriptions shall address discharges or flows from fire fighting only where such discharges or flows are identified as significant sources of pollutants to surface waters.

(*) For the purposes of this permit, "ground water infiltration" means uncontaminated ground water that enters an MS4 (including storm sewer service connection and foundation drains) from the ground through such means as defective pipes, pipe joints, connections, or manholes. This does not include, and is distinguished from, "inflow." For the purpose of this permit, "inflow" is defined as water that enters the MS4 (including storm sewer service connections) from sources such as, but not limited to, roof leaders, cellar drains, yard drains, area drains, drains from springs and swampy areas, manhole covers, cross connections between storm sewers and sanitary sewers, catch basins, cooling towers, storm waters, surface runoff, street wash waters, or drainage.

(b) The non-storm water discharges exempted from the prohibition on non-storm water must be reasonably expected not to be significant sources of pollutants based on either the nature of the discharges, or conditions placed on the discharges by the permittees.

(c) The SWMP shall describe any local controls or conditions placed on discharges exempted from the prohibition on non-storm water. Permittees shall prohibit any individual non-storm water discharge otherwise exempted under this paragraph from the prohibition on non-storm water that is determined by the permittee to be contributing significant amounts of pollutants to the MS4.

b. Overflows and Infiltration: Each permittee shall implement controls to the MEP, to prevent dry weather and wet weather overflows from sanitary sewers into the MS4, and shall limit the infiltration of seepage from municipal sanitary sewers into the MS4.

Within 180 days of permit issuance, Texas A&M University - Corpus Christi and Del Mar College District shall submit a discussion on how they have addressed this permit requirement.

c. Floatables: The permittees shall ensure the implementation of a program to reduce the discharge of floatables (e.g. litter and other human generated solid refuse) into the MS4, which shall include source controls and, where necessary, structural controls and other appropriate controls.

d. Household Hazardous Waste and Used Motor Vehicle Fluids: The discharge or disposal of used motor vehicle fluids, household hazardous wastes, and the intentional disposal of grass clippings, leaf litter, and animal wastes into the MS4 shall be prohibited. The permittees shall ensure the implementation of programs to collect used motor vehicle fluids (including, at a minimum, oil and antifreeze) for recycle, reuse, or proper disposal and to collect household hazardous waste materials (including paint, solvents, pesticides, herbicides, and other

hazardous materials) for recycle, reuse, or proper disposal. Such programs shall be readily available to all private residents and shall be publicized and promoted on a regular basis. Household hazardous waste collection centers which are operated by the permittees as a SWMP element are not considered an industrial activity requiring a separate TPDES authorization for the discharge of storm water.

e. MS4 Screening and Illicit Discharge Inspections: The permittees shall implement the Dry Weather Screening Program described in Part III.B.11.a (Monitoring and Screening) of this permit, to locate portions of the MS4 with suspected illicit discharges and improper disposals.

Follow-up activities to eliminate illicit discharges and improper disposals may be prioritized on the basis of magnitude and the nature of the suspected discharge; sensitivity of the receiving water; or other relevant factors. The entire MS4, but not necessarily each individual outfall, shall be screened at least once per five years.

f. Elimination of Illicit Discharges and Improper Disposal: Each permittee shall require the elimination of illicit discharges and improper disposal practices as expeditiously as reasonably possible. Where elimination of an illicit discharge within 30 days is not possible, the permittees shall require an expeditious schedule for removal of the discharge. In the interim, the permittees shall require the operator of the illicit discharge to take all reasonable and prudent measures to minimize the discharge of pollutants to the MS4.

g. The permittees shall maintain, and update as necessary, a list of discharges directly to the MS4 that have been issued an NPDES or a TPDES permit. The list shall include the name, location and permit number (if known) of the discharger.

7. Spill Prevention and Response: The permittees shall continue and improve as necessary existing programs which prevent, contain, and respond to spills that may discharge into the MS4. The spill response programs may include a combination of spill response actions by the permittees (and/or another public or private entity), and legal requirements for private entities within the jurisdiction of the permittees. This permit does not transfer liability for the act of discharging without, or in violation of, an NPDES or a TPDES permit from the operator of the discharge to the permittees.

8. Industrial & High Risk Runoff: The permittees shall continue and improve as necessary the existing programs to identify and control pollutants in storm water discharges to the MS4 from municipal landfills; other treatment, storage, or disposal facilities for municipal waste (e.g. transfer stations, incinerators, etc.); hazardous waste treatment, storage, disposal and recovery facilities and facilities that are subject to Emergency Planning and Community Right-to-Know Act (EPCRA) Title III, Section 313; and any other industrial or commercial discharge the permittees determine are contributing a substantial pollutant loading to the MS4. The program shall include:

a. Priorities and procedures for inspections and for establishing and implementing control measures for such discharges; and

b. An Industrial and High Risk Monitoring Program as described in Part III.B.11.c. of this permit (Monitoring and Screening).

9. Construction Site Runoff: The permittees shall implement a program to reduce the discharge of pollutants into the MS4 from constructions sites. This program shall include:

   a. Requirements for the use and maintenance of appropriate structural and nonstructural control measures to reduce pollutants discharged to the MS4 from construction sites;

   b. Inspection of construction sites and enforcement of control measure requirements;

   c. Appropriate education and training measures for construction site operators; and

   d. Notification, as appropriate, to building permit applicants of their potential responsibilities under the NPDES/TPDES permitting regulations and permits for construction site runoff.

10. Public Education: The permittees shall implement a public education program component with the following:

   a. A program element to promote and publicize public reporting of illicit discharges or improper disposal of materials, including floatables, into the MS4;

   b. A program element to promote and publicize the proper management and disposal of used oil and household hazardous wastes; and

   c. A program element to promote and publicize the proper use, application, and disposal of pesticides, herbicides, and fertilizers by public, commercial, and private applicators and distributors.

11. Monitoring and Screening Programs: The permittees shall implement the following monitoring and screening programs:

   a. Dry Weather Screening Program: This program shall continue ongoing efforts to detect the presence of illicit connections and improper discharges to the MS4. All areas of the MS4, but not necessarily each individual outfall, must be screened a least once during the permit term.

      Screening methodology may be modified based on experience gained during the actual field screening activities, and is not required to conform to the protocol for field screening at 40 CFR § 122.26(d)(1)(iv)(D). Sample collection and analysis is not required to conform to the requirements of Part V.B.2. of this permit, "Test Procedures."

   b. Wet Weather Screening Program: The permittees shall identify, investigate, and address areas within their jurisdiction that may be contributing excessive levels of pollutants to the MS4. The program shall:

      (1) Screen the MS4, as specified in the SWMP; and

(2) Specify the sampling and non-sampling techniques to be used for current screening and also for follow-up screening. Sample collection and analysis for this Wet Weather Screening Program is not required to conform to the requirements of Part V.B.2. of this permit, "Test Procedures."

Within 180 days of permit issuance, each permittee shall submit a proposal for meeting this requirement to perform wet weather screening over its portion of the MS4. This information shall be submitted to the TCEQ's Storm Water & Pretreatment Team (MC-148), and to the TCEQ Region 14 Office.

c. Industrial and High Risk Runoff Monitoring Program: This program shall include monitoring for pollutants in storm water discharges to the MS4 from Type 1 facilities and Type 2 facilities.

Type 1 facilities include: municipal landfills; hazardous waste treatment, storage, disposal, and recovery facilities; facilities that are subject to Emergency Planning and Community Right-to-Know Act (EPCRA) Title III, Section 313; and industrial facilities that the permittees determine are contributing a substantial pollutant loading to the MS4.

Type 2 facilities include: other treatment, storage, or disposal facilities for municipal waste (e.g., publicly owned treatment works, transfer stations, incinerators, etc.), and other industrial or commercial facilities that the permittees believe are contributing pollutants to the MS4.

(1) For Type 1 facilities, this program shall include the collection or review of available quantitative data on those parameters which have been identified by the permittees as a pollutant of concern for that facility, and shall either:

(a) coincide with the corresponding industrial sector-specific requirements of the TPDES Multi-Sector General Permit (MSGP) or any applicable general permit issued after September 29, 1995. This exception is not contingent on whether a particular facility is actually covered by the general permit; or

(b) coincide with the monitoring requirements of any individual permit for the storm water discharges from that facility.

To avoid the duplication of efforts, the permittees may review available data collected by a facility as required by any individual or general permit for that facility rather than performing an additional sample collection and analysis.

(2) For Type 2 facilities, appropriate monitoring shall be conducted as determined by the permittees to be necessary. This monitoring may include, but is not limited to, analytical monitoring and/or visual monitoring.

(3) In lieu of the monitoring discussed above, the permittees may accept a certification from a facility that raw and waste materials, final and intermediate products, by-products, material handling equipment or activities, industrial machinery or operations, or significant materials from past industrial activity are not presently exposed to storm

water and are not expected to be exposed to storm water for the certification period. Where the permittees accept a "no exposure" certification, the permittees shall conduct site inspections of the facility not less than once per permit term to verify the "no exposure" exemption; the permittees may waive this inspection for those facilities which participate in the TCEQ's Small Business and Local Government Assistance Compliance Commitment (C2) Program.

The permittees may also waive monitoring requirements under this permit for facilities that they determine are compliant with the TPDES Multi-Sector General Permit No. TXR050000.

C. Deadlines for SWMP Compliance: Full implementation of all new items required in the SWMP must be accomplished within 180 days of permit issuance, unless a compliance schedule is provided in the permit for a portion of the SWMP.

D. Roles and Responsibilities of Permittees: For shared programs, the SWMP shall clearly identify the roles and responsibilities of each permittee.

E. Legal Authority: Each permittee shall ensure legal authority to control discharges to and from those portions the MS4 over which it has jurisdiction. This legal authority may be a combination of statute, ordinance, permit, contract, order or inter-jurisdictional agreements with permittees with existing legal authority to:

1. Control the contribution of pollutants to the MS4 by storm water discharges associated with industrial activity and the quality of storm water discharged from sites of industrial activity;

2. Prohibit illicit discharges to the MS4;

3. Control the discharge of spills and the dumping or disposal of materials other than storm water (e.g. industrial and commercial wastes, trash, used motor vehicle fluids, leaf litter, grass clippings, animal wastes, etc.) into the MS4;

4. Control through interagency agreements among permittees the contribution of pollutants from one portion of the MS4 to another;

5. Require compliance with conditions in ordinances, permits, contracts or orders; and

6. Carry out all inspection, surveillance and monitoring procedures necessary to determine compliance with permit conditions.

F. SWMP Resources: Each permittee shall provide adequate finances, staff, equipment, and support capabilities to implement their activities under the SWMP.

G. SWMP Review and Updates:

1. SWMP Review: The permittees shall participate in an annual review of the current SWMP in conjunction with the preparation of the annual report required under this permit.

2. SWMP Updates: The SWMP shall not be revised by the permittees without the prior written approval of the TCEQ, except as follows:

   a. Adding components, controls, or requirements to the SWMP may be made by the permittees at any time upon written notification to the TCEQ.

   b. Changes to the SWMP that are made to replace less effective or infeasible Best Management Practices (BMPs) or other components, controls, or requirements specifically identified in the SWMP, may be requested at any time. Unless denied in writing by the TCEQ, the changes shall be considered approved and may be implemented 60 days from submittal of the request. Such requests must include the following:

      (1) an explanation of why the permittee(s) propose to eliminate the BMP, component, control, or requirement;

      (2) a discussion on the effectiveness of the proposed replacement BMP, component, control, or requirement; and

      (3) an explanation of why the permittee(s) expect the proposed replacement BMP, component, control, or requirement to achieve the goals of the BMP, component, control, or requirement that is proposed to be eliminated.

   c. Changes resulting from any compliance schedules contained in this permit may be requested following completion of an interim task or final deadline. Unless denied in writing by the TCEQ, proposed changes meeting the criteria contained in the applicable schedule shall be considered approved and may be implemented by the permittees 60 days from submittal date.

   d. Change requests or notifications must be made in writing to the TCEQ's Storm Water & Pretreatment Team (MC-148), signed by all directly affected permittees in accordance with Part V.B.8. of the permit, and must include a certification that all permittees were given an opportunity to comment on the proposed changes prior to submittal to the TCEQ.

3. SWMP Updates Required by the TCEQ: The TCEQ may require changes to the SWMP through a permit amendment or modification as needed to:

   a. address impacts on receiving water quality either caused or contributed to by discharges from the MS4;

   b. include more stringent requirements necessary to comply with new state or federal statutory or regulatory requirements; or

   c. include such other conditions deemed necessary to comply with the goals and requirements of the Texas Water Code.

If the TCEQ requires changes to the SWMP, the TCEQ will notify the permittees in writing of the required changes; will provide an explanation of the required changes; will set forth the time schedule for the permittees to develop these changes; and will allow the permittees an opportunity to propose alternative program changes to meet the objective of the request. The TCEQ will make changes through a permit amendment, which will be conducted in accordance with 30 TAC § 305.62.

4. Transfer of Ownership, Operational Authority, or Responsibility for SWMP Implementation: The permittees shall implement the SWMP on all new areas added to their portion of the MS4 (or for which they become responsible for implementation of storm water quality controls) as expeditiously as practicable, but not later than three years from the addition or annexation of the new areas. Implementation may be accomplished in a phased manner to allow additional time for controls that can not be implemented immediately.

   Within 90 days of a transfer of ownership, operational authority, or responsibility for SWMP implementation, the permittees shall have a plan for implementing the SWMP on all affected areas. The plan may include schedules for implementation. Information on all new annexed areas and any resulting updates required to the SWMP shall be included in the annual report.

H. Retention of SWMP Records: The permittees shall retain the SWMP and all associated records for at least three years after coverage under this permit terminates.

PART IV. MONITORING AND REPORTING REQUIREMENTS

A. Beginning upon permit issuance (unless stated otherwise), the permittees shall implement a Wet Weather Characterization sampling program in accordance with either Provision IV.A.1 or IV.A.2. as follows:

1. *Representative Storm Event Monitoring:* Monitoring shall be conducted on representative outfalls, internal sampling stations, and/or instream monitoring locations to characterize the quality of storm water discharges from the Municipal Separate Storm Sewer System (MS4).

a. Monitoring Requirements and Locations: During the period beginning upon date of issuance and lasting through date of expiration, the permittees are authorized to discharge from the Corpus Christi MS4 subject to the following monitoring requirements:

(1)

Discharge Characteristics	Discharge Requirements	Minimum Self-Monitoring Requirements	
	Daily Maximum mg/l	Measurement Frequency	Sample Type
Biochemical Oxygen Demand, 5-day	Report	2/Season (*1)	Composite
Chemical Oxygen Demand (COD)	Report	2/Season (*1)	Composite
Oil and Grease	Report	2/Season (*1)	Grab
Total Suspended Solids (TSS)	Report	2/Season (*1)	Composite
Total Dissolved Solids (TDS)	Report	2/Season (*1)	Composite
Total Nitrogen	Report	2/Season (*1)	Composite
Total Kjeldahl Nitrogen (TKN)	Report	2/Season (*1)	Composite
Nitrate-Nitrogen	Report	2/Season (*1)	Composite
Ammonia-Nitrogen	Report	2/Season (*1)	Composite
Total Phosphorus	Report	2/Season (*1)	Composite
Dissolved Phosphorus	Report	2/Season (*1)	Composite
Total Cadmium (μg/l)	(Report)	2/Season (*1)	Composite
Total Chromium (μg/l)	(Report)	2/Season (*1)	Composite
Total Copper (μg/l)	(Report)	2/Season (*1)	Composite
Total Cyanide (μg/l)	(Report)	2/Season (*1)	Grab
Total Lead (μg/l)	(Report)	2/Season (*1)	Composite
Total Nickel (μg/l)	(Report)	2/Season (*1)	Composite
Total Zinc (μg/l)	(Report)	2/Season (*1)	Composite
E. coli (MPN/100 ml) (*2)	(Report)	2/Season (*1)	Grab
Enterococci (MPN/100 ml) (*2)	(Report)	2/Season (*1)	Grab
Fecal streptococcus (MPN/100 ml)	(Report)	2/Season (*1)	Grab
Hardness (as $CaCO_3$)	(Report)	2/Season (*1)	Grab

(1)

	Discharge Requirements	Minimum Self-Monitoring Requirements	
Temperature (°C)	(Report)	2/Season (*1)	Grab
Diazinon (μg/l)	(Report)	2/Season (*1)	Composite

(*1) Monitoring frequency for each reporting year unless monitoring under Alternative Rapid Bioassessment Option (See Part IV.A.2.). Seasonal monitoring periods are:

May 1 through October 31 (wet); and
November 1 through April 30 (dry)

(*2) Beginning upon permit issuance and lasting for a period of up to one year, the permittees may substitute sampling for E. Coli and Enterococci with sampling for fecal coliform. Beginning no later than one year from permit issuance and lasting until permit expiration, sampling for E. Coli and Enterococci is required.

(2) The pH shall be monitored 2/Season (*1) by grab sample, and the permittees shall report the minimum and maximum values in standard units.

(3) Discharge monitoring samples shall be taken at the following locations:

Outfall 001 ("Carmel - Gollihar"), located between Staples Street and Fort Worth Street along the Carmel Parkway ditch, prior to discharge into Corpus Christi Bay;

Outfall 002 ("Rodd Field Road"), located between Saratoga and Wooldridge in a box culvert under Rodd Field Road, prior to discharge into Oso Bay; and

Outfall 003 ("Schanen"), located between Cedar Pass and Yorktown Boulevard, along Schanen ditch, prior to discharge into Oso Creek.

b. Alternate representative monitoring locations may be substituted for just cause during the term of the permit. Requests for approval of alternate monitoring locations shall be made to the TCEQ's Storm Water & Pretreatment Team (MC-148) in writing and include the rationale for the requested monitoring station relocation. Unless disapproved by the TCEQ, or unless the outfall contains numeric effluent limitations, use of an alternate monitoring location may commence 30 days from the date of the request. For outfalls where numeric effluent limitations have been established, the permit must be modified prior to substitution of alternate monitoring locations. Six samples shall be collected during the first year of monitoring at substitute outfalls.

2. *Representative Rapid Bioassessment Monitoring:* The permittees have the option of developing and implementing a rapid bioassessment monitoring program.

a. The permittees shall obtain all necessary aquatic wildlife collection permits from appropriate State and/or Federal agencies.

b. Permittees utilizing the rapid bioassessment monitoring option shall conduct monitoring of the MS4 as described in Part IV.A.1. of this permit, except the monitoring for Years Two, Three, and Five are no longer required. All other requirements of Part IV.A.1., A.3., and A.5. remain unchanged.

c. If the permittees elect to develop and implement a rapid bioassessment monitoring program, the permittees shall submit a monitoring program to the TCEQ's Storm Water & Pretreatment Team (MC-148) for approval no later than one year from the effective date of this permit. An approvable program must include:

(1) monitoring of at least two water bodies receiving storm water discharges from the MS4 plus a reference site located within the same ecological region as the MS4, but that does not receive discharges from the MS4;

(2) monitoring of each station at least twice per year, with monitoring conducted at essentially the same time periods each year; and

(3) monitoring of the reference site within a day or two each time a station located in the receiving waters of the MS4 is monitored.

Unless contacted by the TCEQ within 60 days, a proposed rapid bioassessment monitoring plan meeting the criteria herein shall be deemed approved and the permittees may implement the alternate rapid bioassessment program.

d. The permittees shall provide written notification to the TCEQ's Storm Water & Pretreatment Team (MC-148) at least 14 days prior to commencing an alternate rapid bioassessment monitoring program.

3. *Storm Event Data:* For sampling conducted for Part IV.A.1. of this permit and any additional sampling conducted for Part IV.A.4., quantitative data shall be collected to estimate pollutant loadings and event mean concentrations for each parameter sampled. In addition to the parameters listed in Part IV.A.1.a. of this permit, the permittees shall maintain records of the storm events which generated the sampled runoff: date and duration (in hours); rainfall measurements or estimates (in inches); the duration (in hours) between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event; and an estimate of the total volume (in gallons) of the discharge sampled.

4. *Seasonal Loadings and Event Mean Concentrations.* All necessary sampling data shall be collected to provide estimates for each of the selected monitoring locations (Outfalls 001 through 003 in this permit) of seasonal pollutant loadings and event mean concentrations for a representative storm event for the parameters listed in Part IV.A.1.a. of this permit. This information may be estimated from the representative monitoring locations and shall take into consideration land uses and drainage areas for the outfall. The estimates of seasonal loadings and event mean concentrations shall be included in the Annual Report for Year Four of this permit term.

5. *Sample Type, Collection, and Analysis:* The following requirements apply only to samples collected for Parts IV.A.1 and A.4. of this permit.

a. For discharges from holding ponds or other impoundments with a retention period greater than 24 hours, (estimated by dividing the volume of the detention pond by the estimated volume of water discharged during the 24 hours previous to the time that the sample is collected) a minimum of one grab sample must be taken.

b. Grab samples taken during the first two hours of discharge shall be used for the analyses (if required) of pH, temperature, cyanide, oil & grease, E. coli (colonies/100 ml), Enterococci (MPN/100 ml), and fecal streptococcus. For all other parameters, data shall be reported for flow-weighted composite samples of the entire event or, at a minimum, the first three hours of discharge.

c. Samples of a discharge resulting from a storm event that is greater than 0.1 inches and that occurs at least 72 hours from the previously measurable (greater than 0.1 inch rainfall) storm event shall be collected. Composite samples may be taken with a continuous sampler or as a combination of a minimum of three sample aliquots taken in each hour of discharge for the entire discharge or for the first three hours of the discharge, with each aliquot being separated by at least fifteen minutes.

The required 72 hour storm event interval is waived if the preceding storm event did not result in a measurable discharge. The required 72 hour storm event interval is also waived if the permittees document that less than a 72 hour interval is representative for local storm events during the season when sampling is being conducted.

6. *Temporary Suspension and Waivers:* Requirements to conduct representative monitoring as described in Part IV.A.1.a.(1) within a prescribed monitoring period may be temporarily suspended for adverse weather conditions. Adverse weather conditions are conditions that are either dangerous to personnel (e.g. high wind, excessive lightning) or weather conditions that prohibit access to a discharge (e.g. flooding, freezing conditions, extended period of drought). Adverse weather conditions that result in the temporary suspension of a permit requirement to conduct seasonal monitoring must be documented and included as part of the Annual Report. Documentation shall include the date, time, names of personnel that witnessed the adverse condition, and the nature of the adverse condition.

When seasonal monitoring is temporarily suspended, that monitoring must be conducted in the same season of the following year, in addition to any monitoring required for that season. If the temporarily suspended monitoring requirement cannot be fulfilled during the same season of the following year, then it is permanently waived.

B. Floatables Monitoring

Permittees shall maintain two monitoring locations for removal of floatable material in discharges to or from the MS4. Floatable material shall be collected at the frequency necessary for maintenance of the removal devices, but not less than twice per year. The amount of material collected shall be estimated by weight, volume, or by other practical means. Results shall be included in the Annual Report required in this permit.

C. Annual Report

Each permittee shall contribute to the preparation of an annual system-wide report to be submitted by no later than March 1 of each year. The report shall cover the previous reporting year (November 1 through October 31) and shall include the following separate sections, with an overview for the entire MS4:

1. The status of implementing the SWMP (status of compliance with any schedules established under this permit);

2. Any known proposed changes to the SWMP;

3. Revisions, if necessary, to the assessments of controls and the fiscal analysis reported in the permit application or the most recent annual report;

4. A summary of the data, including monitoring data, that is accumulated during the reporting year;

5. A summary of the number of the NPDES and TPDES Notices of Intent actually received for each general permit, the number of site notices received from small construction site operators seeking coverage for storm water discharges, and the number of inspections conducted at industrial facilities and construction sites;

6. Annual expenditures for the prior fiscal year, with a breakdown for the major elements of the SWMP, and the budget for the current fiscal year;

7. A summary describing the number and nature of enforcement actions, inspections, and public education programs; and

8. Identification of any water quality improvements, degradations, and progress toward any measurable goals or measured reductions in pollutants.

Preparation and submittal of a system-wide annual report shall be coordinated by the City of Corpus Christi. The report shall indicate which, if any, permittees have failed to provide required information on the portions of the MS4 for which they are responsible to the City of Corpus Christi no later than 45 days prior to report due date. Joint responsibility for report submission shall be limited to participation in preparation of the overview for the entire system and inclusion of the identity of any permittee who failed to provide input to the annual report. Each permittee shall be individually responsible for content of the report relating to the portions of the MS4 for which they are responsible and for failure to provide information for the system-wide annual report in a timely manner. Each permittee shall sign and certify the annual report in accordance with Part V.B.8. of this permit and include a statement or resolution that the permittee's governing body or agency (or delegated representative) has reviewed or been apprised of the content of the Annual Report.

D Certification and Signature of Reports

All reports required by the permit and other information requested by the TCEQ shall be signed and certified in accordance with Part V.B.8. of this permit.

F Reporting, Where and When to Submit

1. Representative monitoring results (Part IV.A.1) obtained during the reporting year running from November 1 to October 31 shall be submitted on Discharge Monitoring Report Forms along with the Annual Report required by Part IV.C. of this permit. A separate Discharge Monitoring Report Form is required for each monitoring period (season) specified in Part IV.A.1

2. Signed copies of the Annual Report required by Part IV.C., and all other reports required by this permit, shall be submitted to the TCEQ's Wastewater Permitting Section, Storm Water & Pretreatment Team (MC-148) and the TCEQ Region 14 Office.

PART V: DEFINITIONS AND STANDARD PERMIT CONDITIONS

A. Definitions:

As required by Title 30 Texas Administrative Code (TAC) Chapter 305, certain regulations appear as standard conditions in discharge permits. 30 TAC §§ 305.121 - 305.129, Subchapter F, "Permit Characteristics and Conditions" as promulgated under the Texas Water Code §§ 5.103 and 5.105, and the Texas Health and Safety Code §§ 361.017 and 361.024(a), establish the characteristics and standards for discharge permits, including sewage sludge, and those sections of 40 Code of Federal Regulations (CFR) 122 adopted by reference by the Commission. The following text includes these conditions and incorporates them into this permit.

All definitions contained in Section 26.001 of the Texas Water Code and 30 TAC Chapter 305 shall apply to this permit and are incorporated herein by reference. Unless otherwise specified, additional definitions of words or phrases used in this permit are as follows:

1. **Best Management Practices (BMPs)** - schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution in discharges that reach waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control facility site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

2. **CWA** - the Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972) Pub. L. 92-500, as amended Pub. L. 95-217, Pub. L. 95-576, Pub. L. (6-483 and Pub. L. 97-117, 33 U.S.C. 1251 et.seq.

3. **Copermittee** - one of several entities authorized under a single individual permit that is only responsible for permit conditions relating to the discharge for which it is the operator.

4. **Core Municipality** - the municipality whose corporate boundary (unincorporated area for counties and parishes) defines the municipal separate storm sewer system. (ex. City of Dallas for the Dallas Municipal Separate Storm Sewer System, Harris County for unincorporated Harris County).

5. **Daily average concentration** - the arithmetic average of all discharge samples, composite or grab as required by this permit, within a period of one calendar month, consisting of at least four separate representative measurements. When four samples are not available in a calendar month, the arithmetic average of the four most recent measurements or the arithmetic average (weighted by flow) of all values taken during the month shall be used as the daily average concentration.

6. **Daily maximum concentration** - the maximum concentration measured on a single day, by composite sample unless otherwise specified elsewhere in this permit, within a period of one calender month.

7. **Discharge** - unless indicated otherwise, refers to discharges from the Municipal Separate Storm Sewer System (MS4).

8. **Fecal coliform concentration, or fecal coliform bacteria concentration** - the number of colonies of fecal coliform bacteria per 100 milliliters of sample analyzed. The fecal coliform bacteria daily average is a geometric mean of the values for the discharge samples collected in a calendar month. The geometric mean shall be determined by calculating the nth root of the product of all measurements made in a calendar month, where n equals the number of measurements made; or, computed as the antilogarithm of the arithmetic mean of the logarithms of all measurements made in a calendar month. For any measurement of fecal coliform bacteria equaling zero (0), a substituted value of one (1) shall be made for input into either computation method.

9. **Flow-weighted composite sample** - a composite sample consisting of a mixture of aliquots collected at either: 1) a constant time interval, where the volume of each aliquot is proportional to the flow rate of the discharge; or 2) a constant volume at varying time intervals, proportional to the discharge flow rate.

10. **Grab sample** - an individual sample collected in less than 15 minutes.

11. **Illicit connection** - any man-made conveyance connecting an illicit discharge directly to a municipal separate storm sewer.

12. **Illicit discharge** - any discharge to a municipal separate storm sewer that is not composed entirely of storm water except discharges pursuant to a NPDES or TPDES permit (other than the NPDES or TPDES permit for certain discharges from the municipal separate storm sewer), discharges resulting from fire fighting activities, and other allowable non-storm water discharges described in Part III.B.6. of this permit.

13. **Landfill** - an area of land or an excavation in which wastes are placed for permanent disposal, and which is not a land application unit, surface impoundment, injection well, or waste pile.

14. **Large or medium municipal separate storm sewer system (MS4)** - all MS4s that are either:

    (a) located in an incorporated place (city) with a population of 100,000 or more as determined by the 1990 Decennial Census by the Bureau of Census (these cities are listed in Appendices F and G of 40 CFR Part 122); or

    (b) located in the counties with unincorporated urbanized populations of 100,000 or more, except municipal separate storm sewers that are located in the incorporated places, townships or towns within such counties (these counties are listed in Appendices H and I of 40 CFR Part 122); or

    (c) owned or operated by a municipality other than those described in paragraph (a) or (b) and that are designated by the EPA as part of the large or medium municipal separate storm sewer system.

15. **Major Outfall** - an outfall that discharges from a single pipe with an inside diameter of 36 inches or more or its equivalent (discharge from a single conveyance other than circular pipe which is associated with a drainage area of more than 50 acres); or for municipal separate storm sewers that receive storm water from lands zoned for industrial activity (based on comprehensive zoning plans or the equivalent), an outfall that discharges from a single pipe with an inside diameter of 12 inches or more or from its equivalent (discharge from other than a circular pipe associated with a drainage area of 2 acres or more).

16. **MEP, or "Maximum Extent Practicable"** - the technology-based discharge standard for MS4 established by Section 402(p) of the Federal Clean Water Act.

17. **Municipal separate storm sewer system, or MS4** - a conveyance, or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State Law) having jurisdiction over disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under State Law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian Tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the CWA that discharges to waters of the United States; (ii) designed or used for collecting or conveying storm water; (iii) which is not a combined sewer; and (iv) which is not part of a Publicly Owned Treatment Works (POTW) as defined at 30 TAC § 305.2

18. **Outfall** -a *point source* as defined by 40 CFR § 122.2 at the point where a municipal separate storm sewer discharges to surface water in the state and does not include open conveyances connecting two municipal separate storm sewers, or pipes, tunnels or other conveyances which connect segments of the same stream or other surface water in the state and are used to convey surface water in the state.

19. **Permittee** - any entity authorized by this permit to discharge to surface water in the state.

20. **Point source** - any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

21. **Storm sewer** - unless otherwise indicated, a municipal separate storm sewer (MS4).

22. **Storm water** - storm water runoff, snow melt runoff, and surface runoff and drainage.

23. **Storm water associated with industrial activity** - defined in TPDES General Permit No. TXR050000.

24. **Storm Water Management Program, or SWMP** - a comprehensive program to manage the quality of discharges from the municipal separate storm sewer system. For the purposes of this permit, the SWMP is considered a single document, but may actually consist of separate components (e.g. "chapters") for each permittee.

25. **Structural Control (or Practice)** - A pollution prevention practice that requires the construction of a device, or the use of a device, to capture or prevent pollution in storm water runoff. Structural controls and practices may include but are not limited to: silt fences, earthen dikes, drainage swales, sediment traps, check dams, subsurface drains, storm drain inlet protection, rock outlet protection, reinforced soil retaining systems, gabions, and temporary or permanent sediment basins.

26. **Surface Water in the State** - Lakes, bays, ponds, impounding reservoirs, springs, rivers, streams, creeks, estuaries, wetlands, marshes, inlets, canals, the Gulf of Mexico inside the territorial limits of the state (from the mean high water mark (MHWM) out 10.36 miles into the Gulf), and all other bodies of surface water, natural or artificial, inland or coastal, fresh or salt, navigable or nonnavigable, and including the beds and banks of all water-courses and bodies of surface water, that are wholly or partially inside or bordering the state or subject to the jurisdiction of the state; except that waters in treatment systems which are authorized by state or federal law, regulation, or permit, and which are created for the purpose of waste treatment are not considered to be water in the state.

27. **Time-weighted composite** - a composite sample consisting of a mixture of equal volume aliquots collected at a constant time interval.

28. **Waters of the United States** - For the purposes of this permit, waters of the United States or waters of the U.S. means:

    (a) all waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;

    (b) all interstate waters, including interstate wetlands;

    (c) all other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters:

(1) which are or could be used by interstate or foreign travelers for recreational or other purposes;

(2) from which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or

(3) which are used or could be used for industrial purposes by industries in interstate commerce;

(d) all impoundments of waters otherwise defined as waters of the United States under this definition;

(e) tributaries of waters identified in paragraphs (a) through (d) of this definition;

(f) the territorial sea; and

(g) wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a) through (f) of this definition.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR § 423.11(m) which also meet the criteria of this definition) are not waters of the United States. This exclusion applies only to manmade bodies of water which neither were originally created in waters of the United States (such as disposal area in wetlands) nor resulted from the impoundment of waters of the United States. Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with the EPA.

B. Monitoring And Reporting Requirements

1. Self-Reporting

Monitoring results shall be provided at the intervals specified in the permit. Unless otherwise specified in this permit or otherwise ordered by the Commission, the permittee shall conduct discharge sampling and reporting in accordance with 30 TAC §§ 319.4 - 319.12. Unless otherwise specified, a seasonal discharge report shall be submitted each monitoring period, to the Enforcement Division (MC 224), by the 20th day of the following monitoring period for each discharge which is described by this permit whether or not a discharge is made for that period.

As provided by state law, the permittee is subject to administrative, civil and criminal penalties, as applicable, for negligently or knowingly violating the Federal Clean Water Act, the Texas Water Code, Chapters 26, 27, and 28, and Texas Health and Safety Code, Chapter 361, including but not limited to knowingly making any false statement, representation, or certification on any report, record, or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance, or falsifying, tampering with or knowingly rendering inaccurate any monitoring device or method required by this permit or violating any other requirement imposed by state or federal regulations.

2. Test Procedures

Unless otherwise specified in this permit, analytical procedures shall comply with procedures specified in 30 TAC §§ 319.11 - 319.12. Measurements, tests and calculations shall be accurately accomplished in a representative manner.

3. Records of Results

a. Monitoring samples and measurements shall be taken at times and in a manner so as to be representative of the monitored activity.

b. Monitoring and reporting records, including the SWMP, requests for SWMP changes, reports, strip charts and records of calibration and maintenance, copies of all records required by this permit, and records of all data used to complete the application for this permit shall be retained by the permittee and/or shall be readily available for review by a TCEQ representative for a period of three years from the date of the original record or sample, measurement, report, application, or the latest revisions, whichever is later. This period shall be extended at the request of the Executive Director.

c. Records of monitoring activities shall include the following:

1. date, time and place of sample or measurement;
2. identity of individual who collected the sample or made the measurement.
3. date and time of analysis;
4. identity of the individual and laboratory who performed the analysis;
5. the technique or method of analysis; and
6. the results of the analysis or measurement and quality assurance/quality control records.

The period during which records are required to be kept shall be automatically extended to the date of the final disposition of any administrative or judicial enforcement action that maybe instituted against the permittee.

4. Additional Monitoring by Permittee

If the permittee performs additional monitoring for any parameter at the outfall(s) included in Part IV of this permit using approved analytical methods as specified above, then all results of such monitoring shall be included in the calculation and reporting of the values submitted in the annual or other reports describing these discharges. Increased frequency of sampling shall be indicated on the reports.

5. Calibration of Instruments

All automatic flow measuring and/or recording devices and/or totalizing meters for measuring flows shall be accurately calibrated by a trained person prior to use and as often as necessary to ensure accuracy, but not less often than annually. Such person shall verify in writing that the device is operating properly and giving accurate results. Copies of the verification shall be retained by the permittee(s) and/or shall be readily available for review by a TCEQ representative for a period of three years.

6. Compliance Schedule Reports

If a compliance schedule is included in this permit, reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in the compliance schedule shall be submitted no later than 14 days following each schedule date to the TCEQ Regional Office and to the Enforcement Division (MC-224).

7. Noncompliance Notification

a. In accordance with 30 TAC § 305.125(9) any noncompliance with this permit which may endanger human health or safety, or the environment shall be reported by the permittee to the TCEQ. Report of such information shall be provided orally or by facsimile transmission (FAX) to the TCEQ Regional Office within 24 hours of becoming aware of the noncompliance. A written submission of such information shall also be provided by the permittee to the TCEQ Regional Office and to the Enforcement Division (MC-224) within five working days of becoming aware of the noncompliance. The written submission shall contain a description of the noncompliance and its cause; the potential danger to human health or safety, or the environment; the period of noncompliance, including exact dates and times; if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance, and to mitigate its adverse effects.

b. Unauthorized discharges of wastewater or any other waste from the MS4 which results from noncompliance with the SWMP shall be reported under Item V.B 7.a. above.

c. In addition to 7.a. and b. above, and if the permit contains numeric limitations, any violation which deviates from a permitted numeric limitation by more than 40% shall be reported by the permittee in writing to the TCEQ Regional Office and to the Enforcement Division (MC-224) within 5 working days of becoming aware of the noncompliance.

d. Any noncompliance other than that specified in this section, or any required information not submitted or submitted incorrectly, shall be reported to the Enforcement Division (MC-224) as promptly as possible.

e. Duty to Mitigate

The permittee(s) shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

8. Signatories to Reports

All reports and other information requested by the Executive Director shall be signed by the person and in the manner required by 30 TAC § 305.128 (relating to Signatories to Reports).

C. **PERMIT CONDITIONS**

1. General

a. When the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in an application or in any report to the Executive Director, it shall promptly submit such facts or information.

b. This permit is granted on the basis of the information supplied and representations made by the permittee during action on an application in accordance with 30 TAC Chapter 50 and the application process in accordance with 30 TAC Chapter 281, and relying upon the accuracy and completeness of that information and those representations in accordance with 30 TAC Chapter 305. After notice in accordance with 30 TAC Chapter 39 and opportunity for a hearing in accordance with 30 TAC §§ 55.21 - 55.31, Subchapter B, "Hearing Requests, Public Comment", this permit may be modified, suspended, or revoked, in whole or in part in accordance with 30 TAC Chapter 305 Subchapter D, during its term for cause including but not limited to, the following:

1. Violation of any terms or conditions of this permit, or

2. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts.

c. The permittee shall furnish to the Executive Director, upon request and within a reasonable time, any information to determine whether cause exists for amending, revoking, suspending or terminating the permit. The permittee shall also furnish to the Executive Director, upon request, copies of records required to be maintained as a provision of the permit.

2. Compliance

a. Acceptance of the permit by the permittee to whom it is issued constitutes acknowledgment and agreement that the permittee will comply with all the terms and conditions embodied in the permit, and the rules and other orders of the Commission.

b. The permittee has a duty to comply with all conditions of the permit. Failure to comply with any permit condition constitutes a violation of the permit and the Texas Water Code or the Texas Health and Safety Code, and is grounds for enforcement action, for permit amendment, revocation or suspension, or for denial of a permit renewal application or of an application for a permit for another facility.

c. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of the permit.

d. Before beginning any change in the permitted activity that may result in noncompliance with any permit requirements, authorization from the Commission must be obtained.

e. A permit may be amended, suspended and reissued, or revoked for cause in accordance with 30 TAC §§ 305.62 and 305.66 and the Texas Water Code Section 7.302. The filing of a request by the permittee for a permit amendment, suspension and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

f. The permittee is subject to administrative, civil, and criminal penalties, as applicable, under Texas Water Code §§7.051 - 7.075 (relating to Administrative Penalties), 7.101 - 7.111 (relating to Civil Penalties), and 7.141 - 7.202 (relating to Criminal Offenses and Penalties) for violations including, but not limited to, negligently or knowingly violating the federal Clean Water Act, §§ 301, 302, 306, 307, or 308, or any condition or limitation implementing any sections in a permit issued under the CWA § 402, or any requirement imposed in a pretreatment program approved under the CWA §§ 402 (a)(3) or 402 (b)(8).

3. Inspections and Entry

a. Inspection and entry shall be allowed as prescribed in the Texas Water Code Chapters 26, 27, and 28, and Texas Health and Safety Code Chapter 361.

b. The members of the Commission and employees and agents of the Commission are entitled to enter any public or private property at any reasonable time for the purpose of inspecting and investigating conditions relating to the quality of water in the state or the compliance with any rule, regulation, permit or other order of the Commission. Members, employees, or agents of the Commission and Commission contractors are entitled to enter public or private property at any reasonable time to investigate or monitor or, if the responsible party is not responsive or there is an immediate danger to public health or the environment, to remove or remediate a condition related to the quality of water in the state. Members, employees, Commission contractors, or agents acting under this authority who enter private property shall observe the establishment's rules and regulations concerning safety, internal security, and fire protection, and if the property has management in residence, shall notify management or the person then in charge of his presence and shall exhibit proper credentials. If any member, employee,

Commission contractor, or agent is refused the right to enter in or on public or private property under this authority, the Executive Director may invoke the remedies authorized in Texas Water Code Section 7.002.

4. Permit Amendment and/or Renewal

   a. The permittee shall give notice to the Executive Director as soon as possible of any planned revisions to the SWMP that would require amendment of the permit.

   b. The permittee must apply for an amendment or renewal at least 180 days prior to expiration of the existing permit unless permission for a later date has been granted by the executive director. The executive director shall not grant permission for applications to be submitted later than the expiration date of the existing permit. The permittee(s) must apply for an amendment or renewal prior to the expiration of the existing permit in order to continue a permitted activity after the expiration date of the permit. Authorization to continue such activity will terminate upon the effective denial of said application.

   c. In accordance with the Texas Water Code § 26.029(b), after a public hearing, notice of which shall be given to the permittee, the Commission may require the permittee, from time to time, for good cause, in accordance with applicable laws, to conform to new or additional conditions.

   d. If any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under Section 307(a) of the Clean Water Act for a toxic pollutant which is present in the discharge, and that standard or prohibition is more stringent than a numeric limitation that was established for that pollutant in this permit, then this permit shall be modified or revoked and reissued to conform to the toxic effluent standard or prohibition. The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that established those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

5. Permit Transfer

   a. Prior to any transfer of this permit, Commission approval must be obtained. The Commission shall be notified in writing of any change in control or ownership of a system authorized by this permit. Such notification should be sent to the Water Quality Applications Team (MC-161) of the Registration, Review & Reporting Division.

   b. A permit may be transferred only according to the provisions of 30 TAC § 305.64 (relating to Transfer of Permits) and 30 TAC § 50.33 (relating to Executive Director Action on Application for Transfer).

6. Relationship to Hazardous Waste Activities

   This permit does not authorize any activity of hazardous waste storage, processing, or disposal which requires a permit or other authorization pursuant to the Texas Health and Safety Code.

7. Property Rights

   A permit does not convey any property rights of any sort, or any exclusive privilege.

8. Permit Enforceability

   The conditions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstances, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

D. OPERATIONAL REQUIREMENTS

1. Upon request by the Executive Director, the permittee shall take appropriate samples and provide proper analysis in order to demonstrate compliance with Commission rules.

2. The permittee(s) shall provide a readily accessible sampling point and, where required by the permit, a flow measuring device or other acceptable means by which discharge flow may be determined, at point sources and outfalls with discharge monitoring requirements.

3. The permittee shall remit an annual water quality fee to the Commission as required by 30 TAC Chapter 21. Failure to pay the fee may result in revocation of this permit under Texas Water Code § 7.302(b)(6).

4. Documentation

   For all written notifications to the Commission required of the permittee by this permit, the permittee shall keep and make available a copy of each such notification under the same conditions as self-monitoring data are required to be kept and made available. Except for applications, effluent data, permits, and other data specified in 30 TAC § 305.46, any information submitted pursuant to this permit may be claimed as confidential by the submitter. Any such claim must be asserted in the manner prescribed in the application form or by stamping the words "confidential business information" on each page containing such information. If no claim is made at the time of submission, information may be made available to the public without further notice.

5. Facilities which generate industrial solid waste as defined in 30 TAC § 335.1 shall comply with provisions of 30 TAC Chapter 335, relating to Industrial Solid Waste Management.

6. Proper Operation and Maintenance

   The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit and with the requirements of storm water management programs. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance requires the operation of backup or auxiliary facilities or similar systems, installed by a permittee only when necessary to achieve compliance with the conditions of the permit.

PART VI: OTHER REQUIREMENTS

A. The Executive Director has reviewed this action for consistency with the goals and policies of the Texas Coastal Management Program (CMP) in accordance with the regulations of the Coastal Coordination Council (CCC) and has determined that the action is consistent with the applicable CMP goals and policies.

B. Test methods utilized shall be sensitive enough to detect the following parameters at the minimum analytical level (MAL) specified below:

POLLUTANTS	MAL (mg/L)
Cadmium, total	0.001
Chromium, total	0.010
Copper, total	0.010
Cyanide, amenable	0.020
Lead, total	0.005
Nickel, total	0.010
Zinc, total	0.005
Diazinon	0.0005

When an analysis of an effluent sample for any of the parameters listed above indicates no detectable levels above the MAL and the test method detection level is as sensitive as the specified MAL, a value of zero (0) shall be used for that measurement when determining calculations and reporting requirements for the self-reporting form. This applies to determinations of daily maximum concentration, calculations of loading and daily averages, and other reportable results.

When an analysis of an effluent sample for a parameter indicates no detectable levels and the test method detection level is not as sensitive as the MAL specified in the permit, or an MAL is not specified in the permit for that parameter, the level of detection achieved shall be used for that measurement when determining calculations and reporting requirements for the self-reporting form. A zero (0) may not be used.

C. Monitoring results shall be provided at the intervals specified in the permit.

D. For the purposes of this permit, the following definitions apply to this permit term:

Reporting Year - The period beginning on November 1 and ending on October 31.

Year One: The period beginning upon date of issuance and lasting until October 31, 2008.
Year Two: The period beginning November 1, 2008 and lasting until October 31, 2009.
Year Three: The period beginning November 1, 2009 and lasting until October 31, 2010.
Year Four: The period beginning November 1, 2010 and lasting until October 31, 2011.
Year Five: The period beginning November 1, 2011 and lasting until October 31, 2012.

E. Permit coverage may be terminated for a single permittee, in accordance with TCEQ rules, without terminating coverage for other permittees. If a copermittee applies for its own separate individual permit with the same terms and conditions as the current permit, then a renewal application is required for the separate permit and an application for a new permit or major amendment is not required. If a copermittee applies for an individual permit along with different copermittees, then a major amendment application is required.

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 5-3
PORT CONSTRUCTION ACCESS AGREEMENT
DRAFT – TO BE REVISED WITH EXECUTED VERSION

CONSTRUCTION ACCESS AGREEMENT
BETWEEN
TEXAS DEPARTMENT OF TRANSPORTATION
AND
PORT OF CORPUS CHRISTI AUTHORITY
FOR THE
US 181 HARBOR BRIDGE REPLACEMENT PROJECT

THIS AGREEMENT is made by and between the State of Texas, acting through the Texas Department of Transportation ("TxDOT"), and the Port of Corpus Christi Authority ("Port").

WITNESSETH

WHEREAS, Texas Transportation Commission Minute Order Number 113853 authorizes TxDOT to undertake and complete a highway improvement generally described as the US 181 Harbor Bridge Replacement Project, which extends north-south along US 181 and the Crosstown Expressway and east-west along I-37 and includes: US 181 at Beach Avenue on the north; Crosstown Expressway at Laredo Street on the south; I-37 and Nueces Bay Boulevard on the west; and I-37 and Mesquite Street on the east side (the "Project," a map of which is attached hereto and made a part of this agreement as Attachment "A");

WHEREAS, on October 2, 2014, TxDOT issued a Request for Proposals to Develop, Design, Construct, and Maintain the US 181 Harbor Bridge Replacement Project, which consists of Instructions to Proposers, a Comprehensive Development Agreement, and Technical Provisions (which, as it may be amended, is referred to as the "RFP");

WHEREAS, after receiving and evaluating responses to the RFP, TxDOT intends to execute a contract with a developer to design, construct, operate, and maintain the Project (the "Developer");

WHEREAS, the scope of work for the Developer includes, among other things, the construction of the New Harbor Bridge as shown on Attachment A (the "New Harbor Bridge"), and the demolition and removal of the existing Harbor Bridge (the "Existing Harbor Bridge");

WHEREAS, the Port will benefit from the Project, in particular, from the construction of the New Harbor Bridge, in that the construction of the Project will provide for increased traffic in the Port facilities, among other benefits to the Port;

WHEREAS, a portion of the Project will be located on and above property owned by the Port;

WHEREAS, this agreement is necessary to provide for coordination and cooperation between the Port and TxDOT, including TxDOT's Developer, in connection with the design, development, construction, operation, and maintenance of the Project; and

WHEREAS, the governing body of the Port has approved entering into this agreement by resolution or ordinance dated _____, 2014, which is attached to and made a part of this agreement as Attachment "B."

NOW, THEREFORE, in consideration of the premises and of the mutual covenants and agreements of the parties hereto, to be by them respectively kept and performed as hereinafter set forth, TxDOT and the Port do agree as follows:

AGREEMENT

1. Period of the Agreement

This agreement becomes effective when signed by the last party whose signing makes the agreement fully executed. This agreement shall remain in effect until terminated in accordance with Section 8.

2. Conveyance of Easement

The Port agrees to convey to TxDOT, via a separate instrument and at no additional charge to TxDOT, a permanent easement, as more particularly described in Attachment "C" attached hereto (the "Easement"). The purpose of the easement will be for the construction, operation, and maintenance of the Project on the property of the Port.

3. Temporary Construction Easement

The Port acknowledges that TxDOT and/or the Developer may need access to areas on Port property outside of the Easement for the storage of equipment, material, and supplies used by the Developer in the construction of the Project, and for additional temporary workspace as may be needed by the Developer and/or TxDOT in completing the Project, including the demolition and removal of the Existing Harbor Bridge (the "Temporary Construction Easement" or "TCE"). The Port agrees to provide such Temporary Construction Easement as may be reasonably needed by the Developer and/or TxDOT, and may charge the Developer a reasonable fee for such TCE.

4. Access to Work Areas

A. Secured Areas

TxDOT and the Port agree to the provisions regarding access to Port property contained in Attachment D attached hereto, as it may be amended from time to time by the parties. The areas of Port property subject to the security requirements are shown on Attachments "E-1" and "E-2," which are incorporated herein.

B. Fencing

TxDOT will require the Developer to construct security fencing, or to modify existing fencing, with gates, access points, and other features as shown in Attachments E-1 and E-2. Gates will be manned by a TWIC certified guard at all times when Developer is conducting construction activities on Port property. At all other times, the gates will be locked, and the Port and TxDOT

will be provided with keys to the locks. The construction of the security fencing will be in accordance with the fencing specifications contained in Attachment F-1, which is incorporated herein, and the gate and fence standards shown in Attachment F-2, which is also incorporated herein.

The security fencing installed by Developer will remain in place and be maintained until final acceptance of the Project, at which point the Developer will remove the security fencing and restore the fencing to its original configuration.

5. Construction

A. Security Cameras

TxDOT and the Port agree that the Port will be permitted to provide and install, at its expense, security cameras on the New Harbor Bridge at the locations shown in Attachments "G-1" and "G-2," attached hereto and incorporated herein. TxDOT will require the Developer to install, at no expense to the Port, all conduit and other equipment necessary to support the security cameras, which will be consistent with Attachment "G-3," attached hereto and incorporated herein. Upon substantial completion of the New Harbor Bridge portion of the Project, the Developer shall notify the Port that the structure is ready for the Port to install the security cameras. Thereafter, the Port shall be permitted access to the Project as needed to install the cameras.

Operation and maintenance of the security cameras will be the responsibility of the Port, including paying the electrical costs for the cameras, and TxDOT will provide the Port such access to the New Harbor Bridge as is necessary to operate and maintain the cameras. The Port agrees to comply with TxDOT's reasonable safety, security, and insurance requirements in performing that work.

B. Removal of Existing Structures

~~The Developer will be required to demolish and remove the following~~Certain existing structures located on the Port property will be removed as follows:

~~i. Cold Storage Facility~~

i. Cold Storage Facility

The Port will remove, at its expense, the refrigerated warehouse (the "Cold Storage Facility" or "CSF") located at 701 E. Navigation Boulevard on the Port's property, to the foundation and/or floor slabs. For the avoidance of doubt, the Port will not remove the foundation and/or floor slabs. The Port agrees that the removal of the CSF will be complete by July 31, 2015.

~~The cold storage facility shall be removed by the Developer at the Developer's cost in accordance with the requirements of Attachment "H," attached hereto and incorporated herein.~~

ii. ~~-~~Gulf Stream Marine Building on East Port Ave

The east end of the building falls within the Easement. If the structure will be impacted by construction or operation, the entire building may be removed to ground level, or alternatively only that portion contained within the Easement may be removed, upon a showing satisfactory to the Port that the remaining portion of the building is structurally sound and can be adequately enclosed. This work will be done by the Developer.

iii. Cargo Storage Buildings 26 and 27

These buildings shall be removed by the Developer to ground level. The fencing around those buildings shall also be removed.

iv. H&S Constructors, Inc. Building

This building shall be removed by the Developer to ground level.

v. Three Accutrans, Inc. Mobile Buildings

The Port agrees to remove these three mobile buildings. At least 45 days before TxDOT issues Notice to Proceed 2 ("NTP2") to the Developer, TxDOT shall notify the Port of the date that TxDOT plans to issue NTP2. The Port shall remove the buildings before TxDOT issues NTP2.

With regard to the structures described in (ii), (iii), and (i~~i~~iv)~~ and (iv)~~ above, all structure removal shall be at the Developer's cost. The Developer is responsible for the removal and disposal of all materials and waste in connection with the removal of those structures. To the extent permitted by any applicable lease agreement, the Developer is permitted to retain any and all materials, equipment, fixtures, and other items of value located in, on, or attached to those structures which have not been disposed of by the Port prior to the beginning of the demolition of the structures. The Port agrees to execute and deliver to the Developer a bill of sale or other sufficient documentation evidencing the transfer of the ownership of the structures and the associated materials, equipment, fixtures, and other items of value located in, on, or attached to those structures. TxDOT will require the Developer to be responsible for the management, treatment, handling, storage, remediation, removal, transportation (where applicable) and/or disposal of all hazardous materials encountered in connection with the demolition of those structures.

With regard to the structures described in (v) above, all structure removal shall be at the Port's cost. The Port is responsible for the removal and disposal of all materials and waste in connection with the removal of those structures.

One or more of these existing structures may be the subject of a lease to a third party. No demolition or removal of the structures shall take place except in accordance with the terms of any such lease, or unless the consent of the lessee is obtained.

TxDOT acknowledges that the buildings are provided "AS IS" with all faults, including but not limited to any and all pollutants, asbestos, underground storage tanks and/or any other hazardous materials, and that the Port has not made any representations or warranties as to the condition of the buildings. The Port will provide to TXDOT information the Port may have concerning the

environmental status of the buildings. TxDOT agrees to include similar disclaimer of warranty language regarding these buildings in its contract with the Developer.

C. Railroads

The Port owns and operates certain railroad tracks on Port property, as shown in Attachments "I-1" and "I-2," which are attached hereto and included in this agreement, including the notes on those attachments. The Developer is permitted to construct the temporary connection and to relocate existing tracks on the south side of the channel as shown on Attachment I-1, and in accordance with the notes thereon. On the north side of the channel, the Developer is required to locate all structures placed thereon so as to permit the future construction by the Port of either or both of the proposed rail loops shown on Attachment I-2. All costs related to such work shall be borne by the Developer. The Port agrees to be responsible for making arrangements with the operator of railroad using those tracks to accommodate the work to be done the Developer contemplated herein.

The Developer is permitted to provide its own flaggers for crossing the rail lines located on Port property, so long as the Developer complies with the Roadway Worker Protection & On Track Safety Rules contained in Attachment I-3, which is attached hereto and incorporated herein.

D. Utility Relocation

The Port owns utility facilities and appurtenances that are or may be in locational conflict with the Project (the "Port Utilities"). The Developer will be responsible for paying all costs associated with the relocation and/or adjustment of the Port Utilities. The Port agrees that, subject to the terms of this agreement, the Developer and subcontractors selected by Developer, will effect the adjustment or relocation of the Port Utilities that are in locational conflict with the Project, as such are determined by TxDOT and/or Developer. It is expected that the Developer and the Port will execute an agreement describing in more detail their respective obligations with regard to the relocation and/or adjustment of the Port Utilities.

E. Channel Closure and Access to Channel

i. The Developer shall submit for approval by the Port the Corpus Christi Ship Channel Plan which shall contain the information required by section 2.9 of the Technical Provisions for US 181 Harbor Bridge Project Comprehensive Development Agreement.

~~i.~~ii. The Port agrees to close the channel as needed for the construction and operation of the Project on the terms and conditions described in Attachment "J," which is attached hereto and incorporated herein.

~~ii.~~iii. Structures associated with the new bridge shall be constructed so as to provide for the clearances shown in Attachment "K," which is attached hereto and incorporated herein.

~~iii.~~iv. Access to the channel will be provided as shown in Attachment "L," which is attached hereto and incorporated herein. The "In Water Work Areas" may be used by

Developer at all times, without any additional charges. No permanent structures may be placed on the channel side of the Bulkhead Lines. Temporary structures may be located beyond the Bulkhead Lines, but not within the Federal Channel Limits, as approved by the Port and the United State Coast Guard ("USCG"). Developer may not operate any vessel within the Federal Channel Limits without the approval of the Port, the Harbormaster, and the USCG.

~~iv.~~v. The Port, with assistance as needed from TxDOT and/or the Developer, will coordinate with the USCG, the Harbormaster, and pilots regarding any such closure.

~~v.~~vi. During such periods of closure, the Developer will be permitted access to the Port channel as needed for the construction of the Project and/or the demolition of the Existing Harbor Bridge. During a full closure, all other traffic in the channel will be prohibited; during a partial closure, other traffic will be prohibited in that part of the channel subject to the partial closure.

F. Miscellaneous

i. Developer shall ensure ~~C~~construction illumination ~~must be~~is directional and does not spill outside the construction zone ~~and~~or impede visibility of travelling vessels or vehicles on nearby travel ways.

ii. Prior to hanging any bridge beams on or above Port property, TxDOT will require the Developer to provide fifteen (15) calendar days written or email notice to the Port, and the Developer shall coordinate with the Port regarding issues arising from the placement of such beams.

iii. TxDOT shall require that any damage done by the Developer to Harbor Drive will be promptly repaired by the Developer to the Port's reasonable satisfaction. Any damage to Port property caused by the Developer shall be promptly repaired by the Developer to the Port's reasonable satisfaction.

iv. The design loading in the areas around the bridge support structures should be up to 1500 pounds per square foot. The storage yard loading will vary over a wide range and will be transient.

v. The mooring structure on the south side of the channel near the proposed location for the bridge pylon may be relocated by the Developer to the west of the existing location. The final location and the final design will be as approved by the Port. The design of the relocated mooring structure shall be in accordance with the Port's Project Manual in effect at that time. For matters not covered by the Project Manual, standard marine design practice should be followed. All costs of the removal, relocation, and reconstruction of the mooring structure will be borne by the Developer.

6. Third Party Leases

The Port is a party, as lessor, to certain leases granting leasehold interests in Port property to third parties, which leasehold interests are, or may be, expected to interfere with the construction, operation, and/or maintenance of the Project (the "Leases"). The Leases which have been identified to date are shown on Attachment "M" which is attached hereto and incorporated herein. If, subsequent to the date of this agreement, other leasehold interests are determined, in the sole discretion of TxDOT and/or the Developer, to interfere with or potentially interfere with, the construction, operation, and/or maintenance of the Project, then the leases pertaining to those leasehold interests shall be added to Attachment M and shall be a "Lease" subject to the terms of this agreement.

With regard to each such Lease, the Port agrees as follows:

i. To provide TxDOT a copy of all such Leases, including all amendments, extensions, and/or renewals of such leases.

ii. To not renew or extend any Lease without the consent of TxDOT.

iii. To not amend any Lease to enlarge the area covered by the Lease, or to otherwise increase the leasehold burden in such a fashion as to interfere with, or potentially interfere with, the construction, operation, and/or maintenance of the Project, without the consent of TxDOT.

iv. If requested by TxDOT or the Developer, and if permitted by the terms of the Lease, to terminate the Lease, or to modify the Lease as necessary to accommodate the construction, operation, and/or maintenance of the Project, according to the terms of the Lease. TxDOT, either itself or by causing the Developer to pay, will pay to the Port all costs, fees, charges, and other expenses incurred by the Port in connection with the termination or modification of any Lease.

v. If TxDOT and/or Developer determine, in their sole discretion, that a leasehold interest provided for in a Lease will interfere with the timely construction, operation, and/or maintenance of the Project, and such Lease is not, according to its terms, able to be modified or terminated so as to accommodate the construction, operation, and/or maintenance of the Project, then the Port, in consultation with TxDOT, agrees to negotiate with the lessee in an attempt to obtain a modification or early termination of the Lease as may be needed. The Port agrees not to enter into any such modification or termination without the consent of TxDOT. TxDOT, either itself or by causing the Developer to pay, will pay to the Port all costs, fees, charges, and other expenses incurred by the Port in connection with any such modification or termination of any Lease.

The Port agrees not to enter into any new lease covering any portion of the property owned by the Port without the consent of TxDOT if such new lease would, or may, interfere with the construction, operation, and/or maintenance of the Project.

7. Insurance

TxDOT shall require the Developer to provide, or cause to be provided, watercraft liability insurance, including protection and indemnity and water pollution liability with minimum limits of $15,000,000 per occurrence, whenever watercraft are utilized. Coverage shall include bodily injury (including death and mental anguish), property damage, defense costs, and cleanup costs. Coverage shall apply on a primary non-contributing basis in relation to any other insurance or self-insurance, primary or excess, available to TxDOT or any employee or agent of TxDOT.

8. Termination

This agreement shall remain in effect until final acceptance of the Project by TxDOT, unless:

i. The agreement is terminated in writing with the mutual consent of the parties;

ii. The agreement is terminated by one party because of a material breach which is not timely cured, as provided for below; or

iii. The Project does not proceed because of insufficient funds or other reason in the discretion of TxDOT.

In the event of a breach or claimed breach by one party to this agreement, the non-breaching party shall deliver written notice of default to the other party. Upon receipt of the notice of default, the breaching party shall have thirty (30) days to cure the default, provided that if the default is of such a nature that the cure cannot with diligence be completed within such time period and the breaching party has commenced meaningful steps to cure promptly after receiving the default notice, the breaching party shall have such additional period of time, up to a maximum cure period of one hundred twenty (120) days, as is reasonably necessary to diligently effect cure.

In the event the breaching party fails to cure the default within the cure period provided, then the non-breaching party may terminate this agreement by providing written notice of such termination to the breaching party. This remedy is not exclusive, and the non-breaching party retains all other remedies at law and in equity, including but not limited to the right to enforce this agreement and seek damages for its breach.

9. Amendments

This agreement may only be amended through a mutually agreed upon, written amendment executed by TxDOT and the Port.

10. Remedies

This agreement shall not be considered as specifying the exclusive remedy for any agreement default, but all remedies existing at law and in equity may be availed of by either party to this agreement and shall be cumulative.

11. Notices

All notices to either party shall be delivered personally or sent by certified or U.S. mail, postage prepaid, addressed to that party at the following address:

Port:	**State:**
John P. LaRue Executive Director Port of Corpus Christi Authority P.O. Box 1541 Corpus Christi, Texas 78403 Physical Address: 222 Power Street Corpus Christi, Texas 78401	[Title] Texas Department of Transportation 125 E. 11th Street Austin, Texas 78701

All notices shall be deemed given on the date delivered in person or deposited in the mail, unless otherwise provided by this agreement. Either party may change the above address by sending written notice of the change to the other party. Either party may request in writing that notices shall be delivered personally or by certified U.S. mail, and that request shall be carried out by the other party.

12. Legal Construction

If one or more of the provisions contained in this agreement shall for any reason be held invalid, illegal, or unenforceable in any respect, such invalidity, illegality, or unenforceability shall not affect any other provisions and this agreement shall be construed as if it did not contain the invalid, illegal, or unenforceable provision.

13. Responsibilities of the Parties

TxDOT and the Port agree that neither party is an agent, servant, or employee of the other party. Further, TxDOT and the Port agree that the Developer is an independent contractor of TxDOT, and as such, TxDOT is not responsible for any acts, errors, or omissions of the Developer. Further, the Port releases TxDOT from, and waives any claim against TxDOT for, any and all claims, damages, judgments, losses, penalties, costs, expenses, and any other loss, arising from, relating to, or caused by, any act or omission of the Developer in connection with the Developer's work on the Project.

14. Severability

If any provision of this agreement, or the application thereof to any person or circumstance, is rendered or declared illegal for any reason and shall be invalid or unenforceable, the remainder of this agreement and the application of such provision to other persons or circumstances shall not be affected thereby but shall be enforced to the greatest extent permitted by applicable law.

15. Ownership of Documents

Upon completion or termination of this agreement, all documents prepared by TxDOT shall remain the property of TxDOT. All data prepared under this agreement shall be made available to TxDOT without restriction or limitation on their further use. All documents produced or approved or otherwise created by the Port shall be transmitted to TxDOT in electronic form or photocopy reproduction, at TxDOT's election, on a monthly basis as required by TxDOT. The originals shall remain the property of the Port.

16. Compliance with Laws

The parties shall comply with all federal, state, and local laws, statutes, ordinances, rules and regulations, and the orders and decrees of any courts or administrative bodies or tribunals in any manner affecting the performance of this agreement.

17. Sole Agreement

This agreement constitutes the sole and only agreement between the parties and supersedes any prior understandings or written or oral agreements respecting the agreement's subject matter.

18. Successors and Assigns

TxDOT and the Port each binds itself, its successors, executors, assigns, and administrators to the other party to this agreement and to the successors, executors, assigns, and administrators of such other party in respect to all covenants of this agreement.

19. Signatory Warranty

Each signatory warrants that the signatory has necessary authority to execute this agreement on behalf of the entity represented.

THIS AGREEMENT IS EXECUTED by TxDOT and the Port in duplicate.

THE PORT OF CORPUS CHRISTI AUTHORITY

_____
John P. LaRue
Executive Director
Port of Corpus Christi Authority

_____
Date

THE TEXAS DEPARTMENT OF TRANSPORTATION

_____
[Name]
[Title]

_____
Date

LIST OF ATTACHMENTS

ATTACHMENT NO.	ATTACHMENT DESCRIPTION	INCLUDED?
A	Project Map	y
B	Port Resolution	n
C	Legal Description of Easement	y
D	Item 669(C)(R) 04-15-2009 Access to Port Authority Property	y
E-1	North Side Fence Construction and Secured Areas	y
E-2	South Side Fence Construction and Secured Areas	y
F-1	Fencing Specifications	y
F-2	Port Gate and Fence Standard	y
G-1	North Side Security Cameras and Lighting	y
G-2	South Side Security Cameras and Lighting	y
G-3	Bridge Column Conduits	y
H	~~Cold Storage Facility Requirements~~Not Used	y
I-1	South Side Rail and Storage Yard Operations	y
I-2	North Side Proposed Rail Loops	y
I-3	Roadway Worker Protection & On Track Safety Rules	y
J	Channel Closure Restrictions	y
K	Bridge Structure Clearance Diagrams	y
L	Profile Along New Bridge ROW Construction Horizontal & Vertical Clearances	y
M	Third Party Leases	y

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 6-1
UTILITY FORMS

County:
ROW CSJ No.:
Const. CSJ No.:
Highway:
Limits:
Fed. Proj. No.:

PROJECT UTILITY ADJUSTMENT AGREEMENT
(Developer Managed)

Agreement No.: _____-U-_____

THIS AGREEMENT, by and between _____, hereinafter identified as the "**Developer**" and _____, hereinafter identified as the "**Owner**", is as follows:

WITNESSETH

WHEREAS, the STATE OF TEXAS, acting by and through the Texas Department of Transportation, hereinafter identified as "TxDOT", is authorized to design, construct, operate, maintain, and improve projects as part of the state highway system throughout the State of Texas, all in conformance with the applicable provisions of Chapters 201, 203, 222, 223, 224 and 228 of the Texas Transportation Code, as amended; and

WHEREAS, the TxDOT proposes to construct a project identified as _____ (the "Project") and classified as either Interstate, Toll or Traditional (meaning eligibility based on existing compensable interest in the land occupied by the facility to be relocated within the proposed highway right of way limits) as indicated below (*check <u>one</u> (1) box*). Reimbursement will be authorized by the type of project selected below in conformance with §203.092 of the Transportation Code,

☐ Interstate

☐ Toll

☐ Traditional

; and

WHEREAS, pursuant to that certain Comprehensive Development Agreement (the "CDA") by and between TxDOT and the Developer with respect to the Project, the Developer has undertaken the obligation to design, construct, finance, operate and maintain the Project and adhere to all requirements in the CDA; and

WHEREAS, the Developer's duties pursuant to the CDA include causing the relocation, removal or other necessary adjustment of existing Utilities impacted by the Project (collectively, "Adjustment"), subject to the provisions herein; and

WHEREAS, the Project may receive Federal funding, financing and/or credit assistance; and

WHEREAS, the Developer has notified the Owner that certain of its facilities and appurtenances (the "Owner Utilities") are in locational conflict with the Project (and/or with the "Ultimate Configuration") of

the Project), and the Owner has requested that the Developer undertake the Adjustment of the Owner Utilities as necessary to accommodate the Project (and the Ultimate Configuration) and the Owner agrees that the "Project" will be constructed in accordance with §203.092 of the Texas Transportation Code, as amended, and 23 CFR 645 Subpart A (Utility Relocations, Adjustments and Reimbursement); and

WHEREAS, the Owner Utilities and the proposed Adjustment of the Owner Utilities are described as follows *[insert below a description of the affected facilities (by type, size and location) as well as a brief description of the nature of the Adjustment work to be performed (e.g., "adjust 12" waterline from approximately Highway Station 100+00 to approximately Highway Station 200+00)]*:

_____; and

WHEREAS, the Owner recognizes that time is of the essence in completing the work contemplated herein; and

WHEREAS, the Developer and the Owner desire to implement the Adjustment of the Owner Utilities by entering into this Agreement.

AGREEMENT

NOW, THEREFORE, in consideration of these premises and of the mutual covenants and agreements of the parties hereto and other good and valuable consideration, the receipt and sufficiency of which being hereby acknowledged, the Developer and the Owner agree as follows:

1. **Preparation of Plans.** [*Check one (1) box that applies:*]

☐ The Developer has hired engineering firm(s) acceptable to the Owner to perform all engineering services needed for the preparation of plans, required specifications, and cost estimates, attached hereto as Exhibit A (collectively, the "Plans"), for the proposed Adjustment of the Owner Utilities. The Developer represents and warrants tha the Plans conform to the most recent Utility Accommodation Rules issued by the Texas Department of Transportation ("TxDOT"), as set forth in 43 Tex. Admin. Code Part 1, Chapter 21, Subchapter C, *et seq.* (the "UAR"). By its execution of this Agreement or by the signing of the Plans, the Owner hereby approves and confirms that the Plans are in compliance with the "standards" described in Paragraph 3(a)(4).

☐ The Owner has provided plans, required specifications and cost estimates, attached hereto as Exhibit A (collectively, the "Plans"), for the proposed Adjustment of the Owner Utilities. The Owner represents and warrants that the Plans conform to the most recent Utility Accommodation Rules issued by the Texas Department of Transportation ("TxDOT"), as set forth in 43 Tex. Admin. Code Part 1, Chapter 21, Subchapter C, *et seq.* (the "UAR"). By its execution of this Agreement, the Developer and the Owner hereby approve the Plans. The Owner also has provided to the Developer a Utility plan view map illustrating the location of existing and proposed Utility facilities on the Developer's right of way map of the Project. With regard to its preparation of the Plans, the Owner represents as follows *[check one (1) box that applies]*:

☐ The Owner's employees were utilized to prepare the Plans, and the charges therefore do not exceed the Owner's typical costs for such work.

☐ The Owner utilized consulting engineers to prepare the Plans, and the fees for such work are not based upon a percentage of construction costs. Further, such fees encompass only the work necessary to prepare the Plans for Adjustment of the Owner Utilities described herein, and do not include fees for work done on any other project. The fees of the consulting engineers are reasonable and are comparable to the fees typically charged by consulting engineers in the locale of the Project for comparable work for the Owner.

2. **Review by TxDOT.** The parties hereto acknowledge and agree as follows:

(a) Upon execution of this Agreement by the Developer and the Owner, the Developer will submit this Agreement, together with the attached Plans, to TxDOT for its review and approval as part of a package referred to as a "Utility Assembly". The parties agree to cooperate in good faith to modify this Agreement and/or the Plans, as necessary and mutually acceptable to all parties, to respond to any comments made by TxDOT thereon. Without limiting the generality of the foregoing:

(i) The Owner agrees to respond (with comment and/or acceptance) to any modified Plans and/or Agreement prepared by the Developer in response to TxDOT comments within **14 Business Days** after receipt of such modifications; and

(ii) If the Owner originally prepared the Plans, the Owner agrees to modify the Plans in response to TxDOT comments and to submit such modified Plans to the Developer for its comment and/or approval (and re-submittal to TxDOT for its comment and/or approval) within **14 Business Days** after receipt of TxDOT's comments.

The Owner's failure to timely respond to any modified Plans submitted by the Developer pursuant to this paragraph shall be deemed the Owner's approval of same. If the Owner fails to timely prepare modified Plans which are its responsibility hereunder, then the Developer shall have the right to modify the Plans for the Owner's approval as if the Developer had originally prepared the Plans. The process set forth in this paragraph will be repeated until the Owner, the Developer and TxDOT have all approved this Agreement and the Plans.

(b) The parties hereto acknowledge and agree that TxDOT's review, comments and approval of a Utility Assembly or any component thereof shall constitute TxDOT's approval of the location and manner in which a Utility Assembly will be installed, adjusted, or relocated within the State Highway right of way (the "ROW"), subject to the Developer and the Owner's satisfactory performance of the Adjustment work in accordance with the approved Plans. TxDOT has no duty to review Owner Utilities or components for their quality or adequacy to provide the intended Utility service.

3. **Design and Construction Standards.**

(a) All design and construction performed for the Adjustment work which is the subject of this Agreement shall comply with and conform to the following:

(1) All applicable local and State Laws, regulations, decrees, ordinances and policies, including the UAR, the *Utility Manual* issued by TxDOT (to the extent its requirements are mandatory for the Utility Adjustment necessitated by the

Project, as communicated to the Owner by the Developer or TxDOT), the requirements of the CDA, and the policies of TxDOT;

(2) All Federal Laws, regulations, decrees, ordinances and policies applicable to projects receiving Federal funding, financing and/or credit assistance, including without limitation, 23 CFR 645 Subpart A and B; and the Buy America provisions of 23 U.S.C. §313 and 23 CFR 635.410. The Utility Owner shall supply, upon request by the Developer or TxDOT, proof of compliance with the aforementioned Laws, rules and regulations prior to the commencement of construction;

(3) The terms of all governmental permits or other approvals, as well as any private approvals of third parties necessary for such work;

(4) The standard specifications, standards of practice, and construction methods (collectively, "standards") which the Owner customarily applies to Utility facilities comparable to the Owner Utilities that are constructed by the Owner or for the Owner by its contractors at the Owner's expense, which standards are current at the time this Agreement is signed by the Owner, and which the Owner has submitted to the Developer in writing; and

(5) Owner agrees that all service matters must be placed outside of the State ROW.

(b) Such design and construction also shall be consistent and compatible with:

(i) The Developer's current design and construction of the Project;

(ii) The "Ultimate Configuration" for the Project; and

(iii) Any other Utilities being installed in the same vicinity.

The Owner acknowledges receipt of Project plans and Ultimate Configuration documents from the Developer as necessary to comply with the foregoing. In case of any inconsistency among any of the standards reference in this Agreement, the most stringent standard shall apply.

(c) The plans, specifications, and cost estimates contained in Exhibit A shall identify and detail all Utility facilities that the Owner intends to abandon in place rather than remove, including material type, quantity, size, age and condition. No facilities containing hazardous or contaminated materials may be abandoned, but shall be specifically identified and removed in accordance with the requirements of subparagraph (a). It is understood and agreed that the Developer shall not pay for the assessment and remediation or other corrective action relating to soil and ground water contamination caused by the Utility facility prior to the removal.

4. **Responsibility for Costs of Adjustment Work.** With the exception of any Betterment (hereinafter defined), the parties shall allocate the cost of any Adjustment between themselves as identified in Exhibit A and in accordance with §203.092 of the Texas Transportation Code. An allocation percentage may be determined by application of an eligibility ratio, if appropriate, as detailed in Exhibit A.

5. **Construction by the Developer.**

(a) The Owner hereby requests that the Developer perform the construction necessary to adjust the Owner Utilities and the Developer hereby agrees to perform such construction. All construction work hereunder shall be performed in a good and workmanlike manner, and in accordance with the Plans (except as modified pursuant to Paragraph 16).

(b) The Developer shall retain such contractor or contractors as are necessary to adjust the Owner Utilities.

(c) The Developer shall obtain all permits necessary for the construction to be performed by the Developer hereunder, and the Owner shall cooperate in that process as needed.

6. **Reimbursement of Owner's Indirect Costs.**

(a) Developer agrees to reimburse the Owner its share, if applicable, of the Owner's indirect costs (e.g., engineering, inspection, testing, ROW) as identified in Exhibit A. When requested by the Owner, monthly progress payments will be made. The monthly payment will not exceed 80% of the estimated indirect work done to date. Once the indirect work is complete, final payment of the eligible indirect costs will be made. Intermediate payments shall not be construed as final payment for any items included in the intermediate payment.

(b) The Owner's indirect costs associated with Adjustment of the Owner Utilities shall be developed pursuant to the method checked and described below [*check only one (1) box*]:

☐ (1) Actual related indirect costs accumulated in accordance with:

(i) A work order accounting procedure prescribed by the applicable Federal or State regulatory body, or

(ii) Established accounting procedure developed by the Owner and which the Owner uses in its regular operations

*(either (i) or (ii) referred to as "**Actual Cost**")*, OR

☐ (2) The agreed sum of $_____ ("**Agreed Sum**") as supported by the analysis of the Owner's estimated costs attached hereto as part of Exhibit A.

(c) All indirect costs charged to the Developer by the Owner shall be reasonable and shall be computed using rates and schedule not exceeding those applicable to similar work performed by or for the Owner at the Owner's expense. The Developer's performance of the Adjustment work hereunder and payment of the Developer's share of the Owner's costs pursuant to this Agreement, if applicable, shall be full compensation to the Owner for all costs incurred by the Owner in adjusting the Owner Utilities (including without limitation, costs of relinquishing and/or acquiring right of way).

7. **Advancement of Funds by Owner for Construction Costs.**

(a) Advancement of Owner's share, if any, of estimated costs, Exhibit A shall identify all estimated engineering and construction-related costs, including labor, material, equipment and other miscellaneous construction items. Exhibit A shall also identify the Owner's and Developer's respective shares of the estimated costs. The Owner shall advance to the Developer its allocated share, if any, of the estimated costs for construction and engineering work to be performed by the Developer, in accordance with the following terms:

☐ The adjustment of the Owner's Utilities does not require advancement of funds.

☐ The adjustment of the Owner's Utilities does not require advancement of funds and the terms agreed to between the Developer and the Owner are listed below.

[Insert terms of advance funding to be agreed between Developer and Owner]

(b) Adjustment Based on Actual Costs or Agreed Sum

[*Check the one (1) appropriate provision, if advancement of funds is required*]:

☐ The Owner is responsible for its share of the Developer's actual cost for the Adjustment, including the identified Betterment. Accordingly, upon completion of all Adjustment work to be performed by both parties pursuant to this Agreement, (i) the Owner shall pay to the Developer the amount, if any, by which the actual cost of the Betterment (as determined in Paragraph 9(b)) *plus* the actual cost of Owner's share of the Adjustment (based on the allocation set forth in Exhibit A) exceeds the estimated cost advanced by the Owner, or (ii) the Developer shall refund to the Owner the amount, if any, by which such advance exceeds such actual cost, as applicable.

☐ The Agreed Sum is the agreed and final amount due for the Adjustment, including any Betterment, under this Agreement. Accordingly, no adjustment (either up or down) of such amount shall be made based on actual costs.

8. **Invoices.** On invoices prepared by either the Owner or the Developer, all costs developed using the "**Actual Cost**" method described in Paragraph 6(b)(1) shall be itemized in a format allowing for comparisons to the approved estimates, including listing each of the service performed, the amount of time spent and the date on which the service was performed. The original and three (3) copies of each invoice, together with (i) such supporting information to substantiate all invoices as reasonably requested, and (ii) such waivers and releases of liens as the other party may reasonably require, shall be submitted to the other party at the address for notices stated in Paragraph 21, unless otherwise directed pursuant to Paragraph 22.

The Owner and the Developer shall make commercially reasonable efforts to submit final invoices no later than 120 days after completion of work. The Owner and the Developer hereby acknowledge and agree that any costs submitted to the other party within 12 months following completion of all Adjustment work to be performed by the parties pursuant to this Agreement shall be deemed to have been abandoned and waived.

9. **Betterment and Salvage.**

(a) For purposes of this Agreement, the term "Betterment" means any upgrading of an Owner Utility being adjusted that is not attributable to the construction of the Project and is made solely for the benefit of and at the election of the Owner, including but not limited to an increase in the capacity, capability, efficiency or function of the adjusted Utility over that provided by the existing Utility or an expansion of the existing Utility; *provided, however*, that the following are not considered Betterments:

(i) Any upgrading which is required for accommodation of the Project;

(ii) Replacement devices or materials that are of equivalent standards although not identical;

(iii) Replacement of devices or materials no longer regularly manufactured with the next highest grade or size;

(iv) Any upgrading required by applicable Laws, regulations or ordinances;

(v) Replacement devices or materials which are used for reasons of economy (e.g., non-stocked items that may be uneconomical to purchase); or

(vi) Any upgrading required by the Owner's written "standards" meeting the requirements of Paragraph 3(a)(4).

[*Include the following for fiber optic Owner Utilities only:*] Extension of an adjustment to the nearest splice boxes shall not be considered a Betterment if required by the Owner in order to maintain its written telephony standards.

Any upgrading required by the Owner's written "standards" meeting the requirements of Paragraph 3(a)(4) shall be deemed to be direct benefit to the Project.

(b) It is understood and agreed that the Developer shall not pay for any Betterments and that the Owner shall be solely responsible therefor. NO Betterment may be performed hereunder which is incompatible with the Project or the Ultimate Configuration or which cannot be performed within the other constraints of applicable Law, any applicable governmental approvals, including without limitation the scheduling requirements thereunder.

Accordingly, the parties agree as follows [*check the <u>one</u> (1) box that applies, and complete if appropriate*]:

☐ The Adjustment of the Owner Utilities pursuant to the Plans does not include any Betterment.

☐ The Adjustment of the Owner Utilities pursuant to the Plans includes a Betterment to the Owner Utilities by reason of *[Insert explanation, e.g. "replacing 12" pipe with 24" pipe]*: _____.

The Developer has provided to the Owner comparative estimates for (i) all work to be performed by the Developer pursuant to this Agreement, including work attributable to the Betterment, and (ii) the cost to perform such work without the Betterment, which estimates are hereby approved by the Owner. The estimated cost of the Developer's work hereunder which is attributable to Betterment is $_____, calculated by *subtracting* (ii) from (i). The percentage of the total cost of the Developer's work hereunder which is attributable to Betterment is _____%, calculated by *subtracting* (ii) from (i), which remainder is *divided* by (i).

(c) If Paragraph 9(b) identifies Betterment, the Owner shall advance to the Developer, at least **14 Business Days** prior to the date scheduled for commencement of construction for Adjustment of the Owner Utilities, the estimated cost attributable to Betterment as set forth in Paragraph 9(b). Should the Owner fail to advance payment to the Developer **14 Business Days** prior to commencement of the Adjustment construction, the Developer shall have the option of commencing and completing (without delay) the Adjustment work without installation of the applicable Betterment. *[If Paragraph 9(b) identifies Betterment, check the <u>one</u> (1) appropriate provision]*:

☐ The estimated cost stated in Paragraph 9(b) is the agreed and final amount due for Betterment hereunder, and accordingly no adjustment (either up or down) of such amount shall be made based on actual costs.

☐ The Owner is responsible for the Developer's actual cost for the identified Betterment. Accordingly, upon completion of all Adjustment work to be performed by both parties pursuant to this Agreement, (i) the Owner shall pay to the Developer the amount, if any, by which the actual cost of the Betterment (determined as provided below in this paragraph) exceeds the estimated cost advanced by the Owner, or (ii) the Developer shall refund to the Owner the amount, if any, by which such advance exceeds such actual cost, as applicable. Any additional payment by the Owner shall be due within **60 calendar days** after the Owner's receipt of the Developer's invoice therefor, together with supporting documentation; and refund shall be due within **60 calendar days** after completion of the Adjustment work hereunder. The actual cost of Betterment incurred by the Developer shall be calculated by *multiplying* (i) the Betterment percentage stated in Paragraph 9(b), by (ii) the actual cost of all work performed by the Developer pursuant to this Agreement (including work attributable to the Betterment), as invoiced by the Developer to the Owner.

(d) If Paragraph 9(b) identifies Betterment, the amount allocable to Betterment in the Owner's indirect costs shall be determined by applying the percentage of the Betterment calculated in Paragraph 9(b) to the Owner's indirect costs. The Owner's invoice to the Developer for the Developer's share of the Owner's indirect costs, shall credit the Developer with any Betterment amount determined pursuant to this Paragraph 9(d).

(e) For any Adjustment from which the Owner recovers any materials and/or parts and retains or sells the same, after application of any applicable Betterment credit, the Owner's invoice to the Developer for its costs shall credit the Developer with the salvage value for such materials and/or parts.

(f) The determination and calculations of Betterment described in this Paragraph 9 shall exclude right of way acquisition costs. Betterment in connection with right of way acquisition is addressed in Paragraph 15.

10. **Management of the Adjustment Work.** The Developer will provide project management during the Adjustment of the Owner Utilities.

11. **Utility Investigations.** At the Developer's request, the Owner shall assist the Developer in locating any Utilities (including appurtenances) which are owned and/or operated by the Owner and may be impacted by the Project. Without limiting the generality of the foregoing, in order to help assure that neither the adjusted Owner Utilities nor existing, unadjusted Utilities owned or operated by the Utility Owner are damaged during construction of the Project, the Owner shall mark in the field the location of all such Utilities horizontally on the ground in advance of Project construction in the immediate area of such Utilities.

12. **Inspection and Acceptance by the Owner.**

(a) Throughout the Adjustment construction hereunder, the Owner shall provide adequate inspectors for such construction. The work shall be inspected by the Owner's inspector(s) at least once each working day, and more often if such inspections are deemed necessary by Owner. Further, upon request by the Developer or its Subcontractors, the Owner shall furnish an inspector at any reasonable time in which construction is underway pursuant to this Agreement, including occasions when construction is underway in excess of the usual 40 hour work week and at such other times as reasonably required. The Owner agrees to promptly notify the Developer of any concerns resulting from any such inspection.

(b) The Owner shall perform a final inspection of the adjusted Owner Utilities, including conducting any test as are necessary or appropriate, within **five (5) Business Days** after completion of construction hereunder. The Owner shall accept such construction if it is consistent with the performance standards described in Paragraph 3, by giving written notice of such acceptance to the Developer within said **five (5) day** period. If the Owner does not accept the construction, then the Owner shall, not later than the expiration of said **five (5) day** period, notify the Developer in writing of its grounds for non-acceptance and suggestions for correcting the problem, and if the suggested corrections are justified, the Developer will comply. The Owner shall re-inspect any revised construction (and retest if appropriate) and give notice of acceptance, no later than **five (5) Business Days** after completion of corrective work. The Owner's failure to inspect and to give any required notice of acceptance or non-acceptance within the specified time period shall be deemed accepted.

(c) From and after the Owner's acceptance (or deemed acceptance) of an adjusted Owner Utility, the Owner agrees to accept ownership of, and full operation and maintenance responsibility for, such Owner Utility.

13. **Design Changes.** The Developer will be responsible for additional Adjustment design and construction costs necessitated by design changes to the Project, upon the terms specified herein.

14. **Field Modifications.** The Developer shall provide the Owner with documentation of any field modifications, including Utility Adjustment Field Modifications as well as minor changes described in Paragraph 16(b), occurring in the Adjustment of the Owner Utilities.

15. **Real Property Interests.**

(a) The Owner has provided, or upon execution of this Agreement shall promptly provide to the Developer, documentation acceptable to TxDOT indicating any right, title or interest in real property claimed by the Owner with respect to the Owner Utilities in their existing location(s). Such claims are subject to TxDOT's approval as part of its review of the Developer Utility Assembly as described in Paragraph 2. Claims approved by TxDOT as to rights or interests are referred to herein as "**Existing Utility Property Interests**".

(b) If acquisition of any new easement or other interest in real property ("**Replacement Utility Property Interest**") is necessary for the Adjustment of any Owner Utilities, then the Owner shall be responsible for undertaking such acquisition. The Owner shall implement each acquisition hereunder expeditiously so that related Adjustment construction can proceed in accordance with the Developer's Project schedules. The Developer shall be responsible for its share (as specified in Paragraph 4) of the actual and reasonable acquisition costs of any such Replacement Utility Property Interest (including without limitation the Owner's reasonable overhead charges and reasonable legal costs as well as compensation paid to the landowner), excluding any costs attributable to Betterment as described in Paragraph 15(c), and subject to the provisions of Paragraph 15(e); *provided, however*, that all acquisition costs shall be subject to the Developer's prior written approval. Eligible acquisition costs shall be segregated from other costs on the Owner's estimates and invoices. Any such Replacement Utility Property Interest shall have a written valuation and shall be acquired in accordance with applicable Law.

(c) The Developer shall pay its share only for a replacement in kind of an Existing Utility Property Interest (e.g., in width and type), unless a Replacement Utility Property Interest exceeding such standard:

(i) Is required in order to accommodate the Project or by compliance with applicable Law; or

(ii) Is called for by the Developer in the interest of overall Project economy.

Any Replacement Utility Property Interest which is not the Developer's responsibility pursuant to the preceding sentence shall be considered a Betterment to the extent that it upgrades the Existing Utility Property Interest which it replaces, or in its entirety if the related Owner Utility was not installed pursuant to an Existing Utility Property Interest. Betterment costs shall be solely the Owner's responsibility.

(d) For each Existing Utility Property Interest located within the Project right of way, upon completion of the related Adjustment work and its acceptance by the Owner, the Owner agrees to execute a quitclaim deed or other appropriate documentation relinquishing such Existing Utility Property Interest to TxDOT, unless the affected Owner Utility is remaining in its original location or is being reinstalled in a new location within the area subject to such Existing Utility Property Interest. If the Owner's facilities are remaining within the existing property interest, a Utility Joint Use Acknowledgement will be required. All quitclaim deeds or other relinquishment documents shall be subject to

TxDOT's approval as part of its review of the Utility Assembly as described in Paragraph 2. For each such Existing Utility Property Interest relinquished by the Owner, the Developer shall do one (1) of the following to compensate the Owner for such Existing Utility Property Interest, as appropriate:

(i) If the Owner acquires a Replacement Utility Property Interest for the affected Owner Utility, the Developer shall reimburse the Owner for the Developer's share of the Owner's actual and reasonable acquisition costs in accordance with Paragraph 15(b), subject to Paragraph 15(c); or

(ii) If the Owner does not acquire a Replacement Utility Property Interest for the affected Owner Utility, the Developer shall compensate the Owner for the Developer's share of the market value of such relinquished Existing Utility Property Interest, as mutually agreed between the Owner and the Developer and supported by a written valuation.

The compensation, if any, provided to the Owner pursuant to either subparagraph (i) or (ii) above shall constitute complete compensation to the Owner for the relinquished Existing Utility Property Interest and any Replacement Utility Property Interest, and not further compensation shall be due to the Owner from the Developer or TxDOT on account of such Existing Utility Property Interest or Replacement Utility Property Interest.

(e) All Utility Joint Use Acknowledgments (UJUA) or Utility Installation Requests, Form 1082 shall be subject to TxDOT approval as part of its review of the Utility Assembly as described in Paragraph 2. A Utility Joint Use Acknowledgment is required where an Existing Utility Property Interest exists and the existing or proposed Utility will remain or be adjusted within the boundaries of the Existing Utility Property Interest. All other accommodations not located on Existing Utility Property Interests will require a Utility Installation Request, Form 1082.

16. **Amendments and Modifications.** This Agreement may be amended or modified only by a written instrument executed by the parties hereto, in accordance with Paragraph 16(a) or Paragraph 16(b) below:

(a) Except as otherwise provided in Paragraph 16(b), any amendment or modification to this Agreement or the Plans attached hereto shall be implemented by a Utility Adjustment Agreement Amendment ("**UAAA**") in the form of Exhibit B hereto (SPD ROW-CDA-U-UAAA-DM). The UAAA form can be used for a new scope of work with concurrence of the Developer and TxDOT as long as the design and construction responsibilities have not changed. Each UAAA is subject to the review and approval of TxDOT, prior to its becoming effective for any purpose and prior to any work being initiated thereunder. The Owner agrees to keep and track costs for each UAAA separately from other work being performed.

(b) For purposes of this Paragraph 16(b), "**Utility Adjustment Field Modification**" shall mean any horizontal or vertical design change from the Plans included in a Utility Assembly previously approved by TxDOT, due either to design of the Project or to conditions not accurately reflected in the approved Utility Assembly (e.g., shifting the alignment of an 8 inch water line to miss a modified or new roadway drainage structure). A Utility Adjustment Field Modification agreed upon by the Developer and the Owner

does not require a UAAA, provided that the modified Plans have been submitted to TxDOT for its review and comment. A minor change (e.g., an additional water valve, an added Utility marker at a ROW line, a change in vertical bend, etc.) will not be considered a Utility Adjustment Field Modification and will not require a UAAA, but shall be shown in the documentation required pursuant to Paragraph 14.

(c) This Agreement does not alter and shall not be construed in any way to alter the obligations, responsibilities, benefits, rights, remedies, and claims between the Developer and TxDOT to design and construct the Project, including the Adjustment.

17. **Entire Agreement.** This Agreement embodies the entire agreement between the parties and there are no oral or written agreements between the parties or any representation made which are not expressly set forth herein.

18. **Assignment; Binding Effect; TxDOT as Third-Party Beneficiary.** Neither the Owner nor the Developer may assign any of its rights or delegate any of its duties under this Agreement without the prior written consent of the other party and of TxDOT, which consent may not be unreasonably withheld or delayed; *provided, however*, that the Developer may assign any of its rights and/or delegate any of its duties to TxDOT or to any other entity engaged by TxDOT to fulfill the Developer's obligations, at any time without the prior consent of the Owner.

This Agreement shall bind the Owner, the Developer and their successors and permitted assigns, and nothing in this Agreement nor in any approval subsequently provided by any party hereto shall be construed as giving any benefits, rights, remedies, or claims to any other person, firm, corporation or other entity, including, without limitation, any contractor or other party retained for the Adjustment work or the public in general; *provided, however*, that the Owner and the Developer agree that although TxDOT is not a party to this Agreement, TxDOT is intended to be a third-party beneficiary to this Agreement.

19. **Breach by the Parties.**

(a) If the Owner claims that the Developer has breached any of its obligations under this Agreement, the Owner will notify the Developer and TxDOT in writing of such breach, and the Developer shall have **30 days** following receipt of such notice in which to cure such breach, before the Owner may invoke any remedies which may be available to it as a result of such breach; *provided, however*, that both during and after such period TxDOT shall have the right, but not the obligation, to cure any breach by the Developer. Without limiting the generality of the foregoing:

(i) TxDOT shall have no liability to the Owner for any act or omission committed by the Developer in connection with this Agreement, including without limitation any claimed defect in any design or construction work supplied by the Developer or by its Subcontractors; and

(ii) In no event shall TxDOT be responsible for any repairs or maintenance to the Owner Utilities adjusted pursuant to this Agreement.

(b) If the Developer claims that the Owner has breached any of its obligations under this Agreement, the Developer will notify the Owner and TxDOT in writing of such breach, and the Owner shall have **30 days** following receipt of such notice in which to cure such

breach, before the Developer may invoke any remedies which may be available to it as a result of such breach.

20. **Traffic Control.** The Developer shall provide traffic control or shall reimburse the Owner for the Developer's share (if any, as specified in Paragraph 4) of the costs for traffic control made necessary by the Adjustment work performed by either the Developer or the Owner pursuant to this Agreement, in compliance with the requirements of the Texas *Manual on Uniform Traffic Control Devices*. Betterment percentages calculated in Paragraph 9 shall also apply to traffic control costs.

21. **Notices.** Except as otherwise expressly provided in this Agreement, all notices or communications pursuant to this Agreement shall be sent or delivered to the following:

Owner: [Address Line #1]
[Address Line #2]
[City, State Zip]
Phone: ( ) -
Fax: ( ) -

Developer: [Address Line #1]
[Address Line #2]
[City, State Zip]
Phone: ( ) -
Fax: ( ) -

A party sending notice of default of this Agreement to another party shall also send a copy of such notice to TxDOT and the CDA Utility Manager at the following addresses:

TxDOT: Texas Department of Transportation
Attention: Strategic Projects Division – ROW Office
125 E 11th Street
Austin, TX 78701-2483

TxDOT CDA Utility Manager: [Insert project address and contact]

Any notice or demand required herein shall be given (a) personally, (b) by certified or registered mail, postage prepaid, return receipt requested, or (c) by reliable messenger or overnight courier to the appropriate address set forth above. Any notice served personally shall be deemed delivered upon receipt, and any notice served by certified or registered mail or by reliable messenger or overnight courier shall be deemed delivered on the date of receipt as shown on the addressee's registry or certification of receipt or on the date receipt is refused as shown on the records or manifest of the U.S. Postal Service or such courier. Any party may designate any other address for this purpose by written notice to all other parties; TxDOT may designate another address by written notice to all parties.

22. **Approvals.** Any acceptance, approval, or any other like action (collectively "**Approval**") required or permitted to be given by the Developer, the Owner or TxDOT pursuant to this Agreement:

    (a) Must be in writing to be effective (except if deemed granted pursuant hereto);

    (b) Shall not be unreasonably withheld or delayed; and if Approval is withheld, such withholding shall be in writing and shall state with specificity the reason for withholding such Approval, and every effort shall be made to identify with as much detail as possible what changes are required for Approval; and

    (c) Except for approvals by TxDOT, and except as may be specifically provided otherwise in this Agreement, shall be deemed granted if no response is provided to the party requesting an Approval within the time period prescribed by this Agreement (or if no time period is prescribed, then **14 calendar days**), commencing upon actual receipt by the party from which an Approval is requested or required, of a request for Approval form the requesting party. All requests for Approval shall be sent out by the requesting party to the other party in accordance with Paragraph 21.

23. **Time.**

    (a) Time is of the essence in the performance of this Agreement.

    (b) All references to "days" herein shall be construed to refer to calendar days, unless otherwise stated.

    (c) No party shall be liable to another party for any delay in performance under this Agreement from any cause beyond its control and without its fault or negligence ("**Force Majeure**"), such as acts of God, acts of civil or military authority, fire, earthquake, strike, unusually severe weather, floods or power blackouts.

24. **Continuing Performance.** In the event of a dispute, the Owner and the Developer agree to continue their respective performance hereunder to the extent feasible in light of the dispute, including paying billings, and such continuation of efforts and payment of billings shall not be construed as a waiver of any legal right.

25. **Equitable Relief.** The Developer and the Owner acknowledge and agree that delays in Adjustment of the Owner Utilities will impact the public convenience, safety and welfare, and that (without limiting the parties' remedies hereunder) monetary damages would be inadequate to compensate for delays in the construction of the Project. Consequently, the parties hereto (and TxDOT as well, as a third-party beneficiary) shall be entitled to specific performance or other equitable relief in the event of any breach of this Agreement which threatens to delay construction of the Project; *provided, however*, that the fact that specific performance or other equitable relief may be granted shall not prejudice any claims for payment or otherwise related to performance of the Adjustment work hereunder.

26. **Authority.** The Owner and the Developer each represent and warrant to the other party that the warranting party possesses the legal authority to enter into this Agreement and that it has taken all actions necessary to exercise that authority and to lawfully authorize its undersigned signatory to execute this Agreement and to bind such party to its terms. Each person executing this Agreement

on behalf of a party warrants that he or she is duly authorized to enter into this Agreement on behalf of such party and to bind it to the terms hereof.

27. **Cooperation.** The parties acknowledge that the timely completion of the Project will be influenced by the ability of the Owner (and its contractors) and the Developer to coordinate their activities, communicate with each other, and respond promptly to reasonable requests. Subject to the terms and conditions of this Agreement, the Owner and the Developer agree to take all steps reasonably required to coordinate their respective duties hereunder in a manner consistent with the Developer's current and future construction schedules for the Project.

28. **Termination.** If the Project is canceled or modified so as to eliminate the necessity of the Adjustment work described herein, then the Developer shall notify the Owner in writing and the Developer reserves the right to thereupon terminate this Agreement. Upon such termination, the parties shall negotiate in good faith an amendment that shall provide mutually acceptable terms and conditions for handling the respective rights and liabilities of the parties relating to such termination.

29. **Nondiscrimination.** Each party hereto agrees, with respect to the work performed by such party pursuant to this Agreement that such party shall not discriminate on the grounds of race, color, sex, national origin or disability in the selection and/or retention of contractors and consultants, including procurement of materials and lease of equipment.

30. **Applicable Law, Jurisdiction and Venue.** This Agreement shall be governed by the Laws of the State of Texas, without regard to the Conflict of Laws principles thereof. Venue for any action brought to enforce this Agreement or relating to the relationship between any of the parties shall be the District Court of County, Texas [or the United States District Court for the Western District of Texas (Austin)].

31. **Relationship of the Parties.** This Agreement does not in any way, and shall not be construed to, create a principal/agent or joint venture relationship between the parties hereto and under no circumstances shall the Owner or the Developer be considered as or represent itself to be an agent of the other.

32. **Waiver of Consequential Damages.** No party hereto shall be liable to any other party to this Agreement, whether in contract, tort, equity, or otherwise (including negligence, warranty, indemnity, strict liability, or otherwise) for any punitive, exemplary, special, indirect, incidental, or consequential damages, including, without limitation, loss of profits or revenues, loss of use, claims of customers, or loss of business opportunity.

33. **Captions.** The captions and headings of the various paragraphs of this Agreement are for convenience and identification only, and shall not be deemed to limit or define the content of their respective paragraphs.

34. **Counterparts.** This Agreement may be executed in any number of counterparts. Each such counterpart hereof shall be deemed to be an original instrument but all such counterparts together shall constitute one (1) and the same instrument.

35. **Effective Date.** This Agreement shall become effective upon the later of (a) the date of signing by the last party (either the Owner or Developer) signing this Agreement, and (b) the date of TxDOT's approval as indicated by the signature of TxDOT's representative below.

APPROVED BY:

TEXAS DEPARTMENT OF TRANSPORTATION

By: Donald C. Toner, Jr., SR/WA
[Printed Name]

By: _____
Authorized Signature

_____ [*Title*]
Strategic Projects Division

Date: _____

OWNER

By: _____
[Print Owner Name]

By: _____
Duly Authorized Representative

_____ [*Title*]
_____ [*Company*]

Date: _____

DEVELOPER

By: _____
[Print Name]

By: _____
Duly Authorized Representative

_____ [*Title*]
_____ [*Company*]

Date: _____

County:
ROW CSJ No.:
Const. CSJ No.:
Highway:
Limits:
Fed. Proj. No.:

EXHIBIT A

PLANS, SPECIFICATIONS, COST ESTIMATES AND ALLOCATION

County:
ROW CSJ No.:
Const. CSJ No.:
Highway:
Limits:
Fed. Proj. No.:

EXHIBIT B

UTILITY ADJUSTMENT AGREEMENT AMENDMENT
(SPD ROW-CDA-U-UAAA-DM)

County:
ROW CSJ No.:
Const. CSJ No.:
Highway:
Limits:
Fed. Proj. No.:

PROJECT UTILITY ADJUSTMENT AGREEMENT
(Owner Managed)

Agreement No.: _____-U-_____

THIS AGREEMENT, by and between _____, hereinafter identified as the "**Developer**" and _____, hereinafter identified as the "**Owner**", is as follows:

WITNESSETH

WHEREAS, the STATE OF TEXAS, acting by and through the Texas Department of Transportation, hereinafter identified as "TxDOT", is authorized to design, construct, operate, maintain, and improve projects as part of the state highway system throughout the State of Texas, all in conformance with the applicable provisions of Chapters 201, 203, 222, 223, 224 and 228 of the Texas Transportation Code, as amended; and

WHEREAS, TxDOT proposes to construct a project identified as the _____ (the "Project") and classified as either Interstate, Toll or Traditional (meaning eligibility based on existing compensable interest in the land occupied by the facility to be relocated within the proposed highway right of way limits) as indicated below (*check one (1) box*). Reimbursement will be authorized by the type of project selected below in conformance with Transportation Code 203.092,

☐ Interstate

☐ Toll

☐ Traditional

;and

WHEREAS, pursuant to that certain Comprehensive Development Agreement (the "CDA") by and between TxDOT and the Developer with respect to the Project, the Developer has undertaken the obligation to design, construct, finance, operate and maintain the Project and adhere to all requirements in the CDA; and

WHEREAS, the Developer's duties pursuant to the CDA include causing the relocation, removal, or other necessary adjustment of existing Utilities impacted by the Project (collectively, "Adjustment"), subject to the provisions herein; and

WHEREAS, the Project may receive Federal funding, financing and/or credit assistance; and

WHEREAS, the Developer has notified the Owner that certain of its facilities and appurtenances (the "Owner Utilities") are in locational conflict with the Project (and/or the "Ultimate Configuration" of the Project), and the Owner has decided to undertake the Adjustment of the Owner Utilities and agrees that

the "Project" will be constructed in accordance with §203.092 of the Texas Transportation Code, as amended, and 23 CFR 645 Subpart A (Utility Relocations, Adjustments and Reimbursement); and

WHEREAS, the Owner Utilities and the proposed Adjustment of the Owner Utilities are described as follows *[insert below a description of the affected facilities (by type, size and location) as well as a brief description of the nature of the Adjustment work to be performed (e.g., "adjust 12" waterline from approximately Highway Station 100+00 to approximately Highway Station 200+00")]:*

_____; and

WHEREAS, the Owner recognizes that time is of the essence in completing the work contemplated herein; and

WHEREAS, the Developer and the Owner desire to implement the Adjustment of the Owner Utilities by entering into this Agreement.

AGREEMENT

NOW, THEREFORE, in consideration of these premises and of the mutual covenants and agreements of the parties hereto and other good and valuable consideration, the receipt and sufficiency of which being hereby acknowledged, the Developer and the Owner agree as follows:

1. **Preparation of Plans**. *[Check one (1) box that applies:]*

☐ The Developer has hired engineering firm(s) acceptable to the Owner to perform all engineering services needed for the preparation of plans, required specifications, and cost estimates, attached hereto as Exhibit A (collectively, the "Plans"), for the proposed Adjustment of the Owner Utilities. The Developer represents and warrants that the Plans conform to the most recent Utility Accommodation Rules issued by the Texas Department of Transportation ("TxDOT"), set forth in 43 Tex. Admin. Code, Part 1, Chapter 21, Subchapter C, *et seq*. (the "UAR"). By its execution of this Agreement or by the signing of the Plans, the Owner hereby approves and confirms that the Plans are in compliance with the "standards" described in Paragraph 3(a)(4).

☐ The Owner has provided plans, required specifications and cost estimates, attached hereto as Exhibit A (collectively, the "Plans"), for the proposed Adjustment of the Owner Utilities. The Owner represents and warrants that the Plans conform to the UAR. By its execution of this Agreement, the Developer and the Owner hereby approve the Plans. The Owner also has provided to the Developer a Utility plan view map illustrating the location of existing and proposed Utility facilities on the Developer's right of way map of the Project. With regard to its preparation of the Plans, the Owner represents as follows *[check one (1) box that applies]*:

☐ The Owner's employees were utilized to prepare the Plans, and the charges therefore do not exceed the Owner's typical costs for such work.

☐ The Owner utilized consulting engineers to prepare the Plans, and the fees for such work are not based upon a percentage of construction costs. Further, such fees encompass only the work necessary to prepare the Plans for Adjustment of the Owner Utilities described herein, and do not include fees for work done on any other project. The fees of the consulting engineers are reasonable and are

comparable to the fees typically charged by consulting engineers in the locale of the Project for comparable work for the Owner.

2. **Review by TxDOT**. The parties hereto acknowledge and agree as follows:

(a) Upon execution of this Agreement by the Developer and the Owner, the Developer will submit this Agreement, together with the attached Plans, to TxDOT for its review and approval as part of a package referred to as a "Utility Assembly". The parties agree to cooperate in good faith to modify this Agreement and/or the Plans, as necessary and mutually acceptable to all parties, to respond to any comments made by TxDOT thereon. Without limiting the generality of the foregoing:

(i) The Owner agrees to respond (with comment and/or acceptance) to any modified Plans and/or Agreement prepared by the Developer in response to TxDOT comments within **14 business days** after receipt of such modifications; and

(ii) If the Owner originally prepared the Plans, the Owner agrees to modify the Plans in response to TxDOT comments and to submit such modified Plans to the Developer for its comment and/or approval (and resubmit to TxDOT for its comment and/or approval) within **14 business days** after receipt of TxDOT's comments.

The Owner's failure to timely respond to any modified Plans submitted by the Developer pursuant to this paragraph shall be deemed the Owner's approval of same. If the Owner fails to timely prepare modified Plans which are its responsibility hereunder, then the Developer shall have the right to modify the Plans for the Owner's approval as if the Developer had originally prepared the Plans. The Developer shall be responsible for providing Plans to and obtaining comments on and approval of the Plans from the Developer. The process set forth in this paragraph will be repeated until the Owner, the Developer and TxDOT have all approved this Agreement and the Plans.

(b) The parties hereto acknowledge and agree that TxDOT's review, comments, and/or approval of a Utility Assembly or any component thereof shall constitute TxDOT's approval of the location and manner in which a Utility Assembly will be installed, adjusted, or relocated within the State Highway right of way (the "ROW"), subject to the Developer and Owner's satisfactory performance of the Adjustment work in accordance with the approved Plans. TxDOT has no duty to review Owner facilities or components for their quality or adequacy to provide the intended Utility service.

3. **Design and Construction Standards**.

(a) All design and construction performed for the Adjustment work which is the subject of this Agreement shall comply with and conform to the following:

(1) All applicable local and State Laws, regulations, decrees, ordinances and policies, including the UAR, the Utility Manual issued by TxDOT (to the extent its requirements are mandatory for the Utility Adjustment necessitated by the Project, communicated to the Owner by the Developer or TxDOT), the requirements of the CDA, and the policies of TxDOT;

(2) All Federal Laws, regulations, decrees, ordinances and policies applicable to projects receiving Federal funding, financing and/or credit assistance, including without limitation 23 CFR 645 Subparts A and B and the Buy America provisions of 23 U.S.C § 313 and 23 CFR 635.410. The Utility Owner shall supply, upon request by the Developer or TxDOT, proof of compliance with the aforementioned Laws, rules and regulations prior to the commencement of construction;

(3) The terms of all governmental permits or other approvals, as well as any private approvals of third parties necessary for such work;

(4) The standard specifications, standards of practice, and construction methods (collectively, "standards") which the Owner customarily applies to facilities comparable to the Owner Utilities that are constructed by the Owner or for the Owner by its contractors at the Owner's expense, which standards are current at the time this Agreement is signed by the Owner, and which the Owner has submitted to the Developer in writing; and

(5) Owner agrees that all service meters must be placed outside of the State ROW.

(b) Such design and construction also shall be consistent and compatible with:

(i) The Developer's current design and construction of the Project;

(ii) The "Ultimate Configuration" for the Projec; and

(iii) Any other utilities being installed in the same vicinity.

The Owner acknowledges receipt from the Developer of Project plans and Ultimate Configuration documents as necessary to comply with the foregoing. In case of any inconsistency among any of the standards referenced in this Agreement, the most stringent standard shall apply.

(c) The plans, specifications, and cost estimates contained in Exhibit A shall identify and detail all Utility facilities that the Owner intends to abandon in place rather than remove, including material type, quantity, size, age, and condition. No facilities containing hazardous or contaminated materials may be abandoned, but shall be specifically identified and removed in accordance with the requirements of subparagraph (a). It is understood and agreed that the Developer shall not pay for the assessment and remediation or other corrective action relating to soil and ground water contamination caused by the utility facility prior to the removal.

4. **Construction by the Owner; Scheduling**.

(a) The Owner hereby agrees to perform the construction necessary to adjust the Owner Utilities. All construction work hereunder shall be performed in a good and workmanlike manner, and in accordance with the Plans (except as modified pursuant to Paragraph 17). The Owner agrees that during the Adjustment of the Owner Utilities, the Owner and its contractors will coordinate their work with the Developer so as not to interfere with the performance of work on the Project by the Developer or by any other party. "Interfere" means any action or inaction that interrupts, interferes, delays or damages Project work.

(b) The Owner may utilize its own employees or may retain such contractor or contractors as are necessary to adjust the Owner Utilities, through the procedures set forth in Form "Statement Covering Contract Work" attached hereto as Exhibit C. If the Owner utilizes its own employees for the Construction work portion of the Adjustment of Owner Utilities, this form is not required.

(c) The Owner shall obtain all permits necessary for the construction to be performed by the Owner hereunder, and the Developer shall cooperate in that process as needed. The Owner shall submit a traffic control plan to the Developer as required for Adjustment work to be performed on existing road rights of way.

(d) The Owner shall commence its construction for Adjustment of each Owner Utility hereunder promptly after (i) receiving written notice to proceed therewith from the Developer, and (ii) any Project right of way necessary for such Adjustment has been acquired either by Developer (for adjusted facilities to be located within the Project right of way) or by the Owner (for adjusted facilities to be located outside of the Project right of way), or a right-of-entry permitting Owner's construction has been obtained from the landowner by the Developer or by the Owner with the Developer's prior approval. The Owner shall notify the Developer at least 72 hours prior to commencing construction for the Adjustment of each Owner Utility hereunder.

(e) The Owner shall expeditiously stake the survey of the proposed locations of the Owner Utilities being adjusted, on the basis of the final approved Plans. The Developer shall verify that the Owner's Utilities, whether moving to a new location or remaining in place, clear the planned construction of the Project as staked in the field as well as the Ultimate Configuration.

(f) The Owner shall complete all of the Utility reconstruction and relocation work, including final testing and acceptance thereof *[check one (1) box that applies]*:

☐ On or before , 20 .

☐ A duration not to exceed calendar days upon notice to proceed by the Developer.

(g) The amount of reimbursement due to the Owner pursuant to this Agreement for the affected Adjustment(s) shall be reduced by 10% for each 30-day period (and by a pro rata amount of said 10% for any portion of a 30-day period) by which the final completion and acceptance date for the affected Adjustment(s) exceeds the applicable deadline. The provisions of this Paragraph 4(g) shall not limit any other remedy available to the Developer at Law or in equity as a result of the Owner's failure to meet any deadline hereunder.

The above reduction applies except to the extent due to:

(i) Force Majeure as described in Paragraph 24(c);

(ii) Any act or omission of the Developer, if the Owner fails to meet any deadline established pursuant to Paragraph 4(f); or

(iii) If the Developer and/or TxDOT determine, in their sole discretion, that a delay in the relocation work is the result of circumstances beyond the control of the Owner or Owner's contractor and the Developer will not reduce the reimbursement.

5. **Costs of the Work**.

(a) The Owner's costs for Adjustment of each Owner Utility shall be derived from:

(i) The accumulated total of costs incurred by the Owner for design and construction of such Adjustment, *plus*

(ii) The Owner's other related costs to the extent permitted pursuant to Paragraph 5(c) (including without limitation the eligible engineering costs incurred by the Owner for design prior to execution of this Agreement), *plus*

(iii) The Owner's right of way acquisition costs, if any, which are reimbursable pursuant to Paragraph 16.

(b) The Owner's costs associated with Adjustment of the Owner Utilities shall be developed pursuant to the method checked and described below *[check only one (1) box]*:

☐ (1) Actual costs accumulated in accordance with a work order accounting procedure prescribed by the applicable Federal or State regulatory body ("**Actual Cost**");

☐ (2) Actual costs accumulated in accordance with an established accounting procedure developed by the Owner and which the Owner uses in its regular operations ("**Actual Cost**"); or

☐ (3) The agreed sum of $_____ ("**Agreed Sum**"), as supported by the analysis of estimated costs attached hereto as part of Exhibit A.

6. **Responsibility for Costs of Adjustment Work**. The Agreed Sum or Actual Cost, as applicable, of all work to be performed pursuant to this Agreement shall be allocated between the Developer and the Owner as identified in Exhibit A and in accordance with § 203.092 of the Texas Transportation Code. An allocation percentage may be determined by application of an eligibility ratio, if appropriate, as detailed in Exhibit A; *provided, however*, that any portion of an Agreed Sum or Actual Cost attributable to Betterment shall be allocated 100% to the Owner in accordance with Paragraph 10. All costs charged to the Developer by the Owner shall be reasonable and shall be computed using rates and schedules not exceeding those applicable to similar work performed by or for the Owner at the Owner's expense. Payment of the costs allocated to the Developer pursuant to this Agreement (if any) shall be full compensation to the Owner for all costs incurred by the Owner in Adjusting the Owner Utilities (including without limitation costs of relinquishing and/or acquiring right of way).

7. **Billing, Payment, Records and Audits: Actual Cost Method**. The following provisions apply if the Owner's costs are developed under procedure (1) or (2) described in Paragraph 5(b):

(a) After (i) completion of all Adjustment work to be performed pursuant to this Agreement, (ii) the Developer's final inspection of the Adjustment work by Owner hereunder (and

resolution of any deficiencies found), and (iii) receipt of an invoice complying with the applicable requirements of Paragraph 9, the Developer shall pay to the Owner an amount equal to 90% of the Developer's share of the Owner's costs as shown in such final invoice (less amounts previously paid, and applicable credits). After completion of the Developer's audit referenced in Paragraph 7(c) and the parties' mutual determination of any necessary adjustment to the final invoice resulting therefrom, the Developer shall make any final payment due so that total payments will equal the total amount of the Developer's share reflected on such final invoice (as adjusted, if applicable).

(b) When requested by the Owner and properly invoiced in accordance with Paragraph 9, the Developer shall make intermediate payments to the Owner based upon the progress of the work completed at not more than monthly intervals, and such payments shall not exceed 80% of the Developer's share of the Owner's eligible costs as shown in each such invoice (less applicable credits). Intermediate payments shall not be construed as final payment for any items included in the intermediate payment.

(c) The Owner shall maintain complete and accurate cost records for all work performed pursuant to this Agreement. The Owner shall maintain such records for four (4) years after receipt of final payment hereunder. The Developer and their respective representatives shall be allowed to audit such records during the Owner's regular business hours. Unsupported charges will not be considered eligible for reimbursement. The parties shall mutually agree upon (and shall promptly implement by payment or refund, as applicable) any financial adjustment found necessary by the Developer's audit. TxDOT, the Federal Highway Administration (FHWA), and their respective representatives also shall be allowed to audit such records upon reasonable notice to the Owner, during the Owner's regular business hours.

8. **Billing and Payment: Agreed Sum Method**. If the Owner's costs are developed under procedure (3) described in Paragraph 5(b), then the Developer shall pay its share of the Agreed Sum to the Owner after completion of:

(a) All Adjustment work to be performed pursuant to this Agreement;

(b) The Developer's final inspection of the Adjustment work by Owner hereunder (and resolution of any deficiencies found); and

(c) The receipt of an invoice complying with the applicable requirements of Paragraph 9.

9. **Invoices**. If the Owner's costs are developed under procedure (1) or (2) described in Paragraph 5(b), then Owner shall list each of the services performed, the amount of time spent and the date on which the service was performed. The original and three (3) copies of each invoice shall be submitted to the Developer at the address for notices stated in Paragraph 22, unless otherwise directed by the Developer pursuant to Paragraph 23, together with:

(1) Such supporting information to substantiate all invoices as reasonably requested by the Developer; and

(2) Such waivers or releases of liens as the Developer may reasonably require.

The Owner shall make commercially reasonable efforts to submit final invoices not later than 120 days after completion of work. Final invoices shall include any necessary quitclaim deeds

pursuant to Paragraph 16, and all applicable record drawings accurately representing the Adjustment as installed. The Owner hereby acknowledges and agrees that any right it may have for reimbursement of any of its costs not submitted to the Developer within 12 months following completion of all Adjustment work to be performed by both parties pursuant to this Agreement shall be deemed to have been abandoned and waived. Invoices shall clearly delineate total costs and those costs that are reimbursable pursuant to the terms of this Agreement.

10. **Betterment**.

(a) For purposes of this Agreement, the term "Betterment" means any upgrading of an Owner Utility being adjusted that is not attributable to the construction of the Project and is made solely for the benefit of and at the election of the Owner, including but not limited to an increase in the capacity, capability, efficiency or function of the adjusted Utility over that provided by the existing Utility facility or an expansion of the existing Utility facility; provided, however, that the following are not considered Betterments:

(i) Any upgrading which is required for accommodation of the Project;

(ii) Replacement devices or materials that are of equivalent standards although not identical;

(iii) Replacement of devices or materials no longer regularly manufactured with the next highest grade or size;

(iv) Any upgrading required by applicable Laws, regulations or ordinances;

(v) Replacement devices or materials which are used for reasons of economy (e.g., non-stocked items may be uneconomical to purchase); or

(vi) Any upgrading required by the Owner's written "standards" meeting the requirements of Paragraph 3(a)(4).

[Include the following for fiber optic Owner Utilities only:] Extension of an Adjustment to the nearest splice boxes shall not be considered a Betterment if required by the Owner in order to maintain its written telephony standards.

Any upgrading required by the Owner's written "standards" meeting the requirements of Paragraph 3(a)(4) shall be deemed to be of direct benefit to the Project.

(b) It is understood and agreed that the Developer will not pay for any Betterments and that the Owner shall not be entitled to payment therefor. No Betterment may be performed in connection with the Adjustment of the Owner Utilities which is incompatible with the Project or the Ultimate Configuration or which cannot be performed within the other constraints of applicable Law and any applicable governmental approvals, including without limitation the scheduling requirements thereunder. Accordingly, the parties agree as follows *[check the <u>one</u> (1) box that applies and complete if appropriate]*:

☐ The Adjustment of the Owner Utilities pursuant to the Plans does not include any Betterment.

☐ The Adjustment of the Owner Utilities pursuant to the Plans includes Betterment to the Owner Utilities by reason of *[insert explanation, e.g. "replacing 12" pipe with 24" pipe]*: _____. The Owner has provided to the Developer comparative estimates for (i) all costs for work to be performed by the Owner pursuant to this Agreement, including work attributable to the Betterment, and (ii) the cost to perform such work without the Betterment, which estimates are hereby approved by the Developer. The estimated amount of the Owner's costs for work hereunder which is attributable to Betterment is $_____, calculated by *subtracting* (ii) from (i). The percentage of the total cost of the Owner's work hereunder which is attributable to Betterment is _____%, calculated by *subtracting* (ii) from (i), which remainder shall be *divided* by (i).

(c) If Paragraph 10(b) identifies Betterment, then the following shall apply:

(i) If the Owner's costs are developed under procedure (3) described in Paragraph 5(b), then the Agreed Sum stated in that Paragraph includes any credits due to the Developer on account of the identified Betterment, and no further adjustment shall be made on account of same.

(ii) If the Owner's costs are developed under procedure (1) or (2) described in Paragraph 5(b), the parties agree as follows *[If Paragraph 10(b) identifies Betterment and the Owner's costs are developed under procedure (1) or (2), check the one (1) appropriate provision]*:

☐ The estimated cost stated in Paragraph 10(b) is the agreed and final amount due for Betterment hereunder. Accordingly, each intermediate invoice submitted pursuant to Paragraph 7(b) shall include a credit for an appropriate percentage of the agreed Betterment amount, proportionate to the percentage of completion reflected in such invoice. The final invoice submitted pursuant to Paragraph 7(a) shall reflect the full amount of the agreed Betterment credit. For each invoice described in this paragraph, the credit for Betterment shall be applied before calculating the Developer's share (pursuant to Paragraph 6) of the cost of the Adjustment work. No other adjustment (either up or down) shall be made based on actual Betterment costs.

☐ The Owner is responsible for the actual cost of the identified Betterment, determined by *multiplying* (a) the Betterment percentage stated in Paragraph 10(b), by (b) the actual cost of all work performed by the Owner pursuant to this Agreement (including work attributable to the Betterment), as invoiced by the Owner to the Developer. Accordingly, each invoice submitted pursuant to either Paragraph 7(a) or Paragraph 7(b) shall credit the Developer with an amount calculated by *multiplying* (x) the Betterment percentage stated in Paragraph 10(b), by (y) the amount billed on such invoice.

(d) The determinations and calculations of Betterment described in this Paragraph 10 shall exclude right of way acquisition costs. Betterment in connection with right of way acquisition is addressed in Paragraph 16.

11. **Salvage**. For any Adjustment from which the Owner recovers any materials and/or parts and retains or sells the same, after application of any applicable Betterment credit, the Developer is entitled to a credit for the salvage value of such materials and/or parts. If the Owner's costs are developed under procedure (1) or (2) described in Paragraph 5(b), then the final invoice submitted pursuant to Paragraph 7(a) shall credit the Developer with the full salvage value. If the Owner's costs are developed under procedure (3) described in Paragraph 5(b), then the Agreed Sum includes any credit due to the Developer on account of salvage.

12. **Utility Investigations**. At the Developer's request, the Owner shall assist the Developer in locating any Utilities (including appurtenances) which are owned and/or operated by Owner and may be impacted by the Project. Without limiting the generality of the foregoing, in order to help assure that neither the adjusted Owner Utilities nor existing, unadjusted Utilities owned or operated by the Owner are damaged during construction of the Project, the Owner shall mark in the field the location of all such Utilities horizontally on the ground in advance of Project construction in the immediate area of such Utilities.

13. **Inspection and Ownership of Owner Utilities**.

    (a) The Developer shall have the right, at its own expense, to inspect the Adjustment work performed by the Owner or its contractors, during and upon completion of construction. All inspections of work shall be completed and any comment provided within **five (5) business days** after request for inspection is received.

    (b) The Owner shall accept full responsibility for all future repairs and maintenance of said Owner Utilities. In no event shall the Developer or TxDOT become responsible for making any repairs or maintenance, or for discharging the cost of same. The provisions of this Paragraph 13(b) shall not limit any rights which the Owner may have against the Developer if either party respectively damages any Owner Utility as a result of its respective Project activities.

14. **Design Changes**. The Developer will be responsible for additional Adjustment design and responsible for additional construction costs necessitated by design changes to the Project made after approval of the Plans, upon the terms specified herein.

15. **Field Modifications**. The Owner shall provide the Developer with documentation of any field modifications, including Utility Adjustment Field Modifications as well as minor changes as described in Paragraph 17(b), occurring in the Adjustment of the Owner Utilities.

16. **Real Property Interests**.

    (a) The Owner has provided, or upon execution of this Agreement shall promptly provide to the Developer, documentation acceptable to TxDOT indicating any right, title or interest in real property claimed by the Owner with respect to the Owner Utilities in their existing location(s). Such claims are subject to TxDOT's approval as part of its review of the Developer's Utility Assembly as described in Paragraph 2. Claims approved by TxDOT as to rights or interests are referred to herein as "**Existing Utility Property Interests**".

    (b) If acquisition of any new easement or other interest in real property ("**Replacement Utility Property Interest**") is necessary for the Adjustment of any Owner Utilities, then the Owner shall be responsible for undertaking such acquisition. The Owner shall implement each acquisition hereunder expeditiously so that related Adjustment

construction can proceed in accordance with the Developer's Project schedules. The Developer shall be responsible for its share (if any, as specified in Paragraph 6) of the actual and reasonable acquisition costs of any such Replacement Utility Property Interest (including without limitation the Owner's reasonable overhead charges and reasonable legal costs as well as compensation paid to the landowner), excluding any costs attributable to Betterment as described in Paragraph 16(c), and subject to the provisions of Paragraph 16(e); *provided, however*, that all acquisition costs shall be subject to the Developer's prior written approval. Eligible acquisition costs shall be segregated from other costs on the Owner's estimates and invoices. Any such Replacement Utility Property Interest shall have a written valuation and shall be acquired in accordance with applicable Law.

(c) The Developer shall pay its share only for a replacement in kind of an Existing Utility Property Interest (e.g., in width and type), unless a Replacement Utility Property Interest exceeding such standard:

(i) Is required in order to accommodate the Project or by compliance with applicable Law; or

(ii) Is called for by the Developer in the interest of overall Project economy.

Any Replacement Utility Property Interest which is not the Developer's cost responsibility pursuant to the preceding sentence shall be considered a Betterment to the extent that it upgrades the Existing Utility Property Interest which it replaces, or in its entirety if the related Owner Utility was not installed pursuant to an Existing Utility Property Interest. Betterment costs shall be solely the Owner's responsibility.

(d) For each Existing Utility Property Interest located within the Project right of way, upon completion of the related Adjustment work and its acceptance by the Owner, the Owner agrees to execute a quitclaim deed or other appropriate documentation relinquishing such Existing Utility Property Interest to TxDOT, unless the affected Owner Utility is remaining in its original location or is being reinstalled in a new location within the area subject to such Existing Utility Property Interest. All quitclaim deeds or other relinquishment documents shall be subject to TxDOT's approval as part of its review of the Utility Assembly as described in Paragraph 2. For each Existing Utility Property Interest relinquished by the Owner, the Developer shall do one (1) of the following to compensate the Owner for such Existing Utility Property Interest, as appropriate:

(i) If the Owner acquires a Replacement Utility Property Interest for the affected Owner Utility, the Developer shall reimburse the Owner for the Developer's share of the Owner's actual and reasonable acquisition costs in accordance with Paragraph 16(b) and subject to Paragraph 16(c); or

(ii) If the Owner does not acquire a Replacement Utility Property Interest for the affected Owner Utility, the Developer shall compensate the Owner for the Developer's share of the market value of such relinquished Existing Utility Property Interest, as mutually agreed between the Owner and the Developer and supported by a written valuation.

The compensation, if any, provided to the Owner pursuant to either subparagraph (i) or subparagraph (ii) above shall constitute complete compensation to the Owner for the

relinquished Existing Utility Property Interest and any Replacement Utility Property Interest, and no further compensation shall be due to the Owner from the Developer or TxDOT on account of such Existing Utility Property Interest or Replacement Utility Property Interest.

(e) All Utility Joint Use Acknowledgments (UJUA) or Utility Installation Requests (UIR), Form 1082 shall be subject to TxDOT approval as part of its review of the Utility Assembly as described in Paragraph 2. A Utility Joint Use Acknowledgment is required where an Existing Utility Property Interest exists and the existing or proposed Utility will remain or be adjusted within the boundaries of the Existing Utility Property Interest. All other accommodations not located on Existing Utility Property Interests will require a Utility Installation Request, Form 1082.

17. **Amendments and Modifications**. This Agreement may be amended or modified only by a written instrument executed by the parties hereto, in accordance with Paragraph 17(a) or Paragraph 17(b) below:

(a) Except as otherwise provided in Paragraph 17(b), any amendment or modification to this Agreement or the Plans attached hereto shall be implemented by a Utility Adjustment Agreement Amendment ("**UAAA**") in the form of Exhibit B hereto (SPD ROW-CDA-U-UAAA-OM). The UAAA form can be used for a new scope of work with concurrence of the Developer and TxDOT as long as the Design and Construction responsibilities have not changed. Each UAAA is subject to the review and approval of TxDOT, prior to its becoming effective for any purpose and prior to any work being initiated thereunder. The Owner agrees to keep and track costs for each UAAA separately from other work being performed.

(b) For purposes of this Paragraph 17(b), "**Utility Adjustment Field Modification**" shall mean any horizontal or vertical design change from the Plans included in a Utility Assembly previously approved by TxDOT, due either to design of the Project or to conditions not accurately reflected in the approved Utility Assembly (e.g., shifting the alignment of an 8 inch water line to miss a modified or new roadway drainage structure). A Utility Adjustment Field Modification agreed upon by the Developer and the Owner does not require a UAAA, provided that the modified Plans have been submitted to TxDOT for its review and comment. A minor change (e.g., an additional water valve, an added Utility marker at a ROW line, a change in vertical bend, etc.) will not be considered a Utility Adjustment Field Modification and will not require a UAAA, but shall be shown in the documentation required pursuant to Paragraph 15.

18. **Entire Agreement**. This Agreement embodies the entire agreement between the parties and there are no oral or written agreements between the parties or any representations made which are not expressly set forth herein.

19. **Assignment; Binding Effect; TxDOT as Third Party Beneficiary**. The Owner and the Developer may not assign any of its rights or delegate any of its duties under this Agreement without the prior written consent of the other parties and of TxDOT, which consent may not be unreasonably withheld or delayed; *provided, however*, that the Developer may assign any of its rights and/or delegate any of its duties to TxDOT or to any other entity with which TxDOT contracts to fulfill the Developer's obligations at any time without the prior consent of the Owner.

This Agreement shall bind the Owner, the Developer and their successors and permitted assigns, and nothing in this Agreement nor in any approval subsequently provided by any party hereto shall be construed as giving any benefits, rights, remedies, or claims to any other person, firm, corporation or other entity, including, without limitation, any contractor or other party retained for the Adjustment work or the public in general; *provided, however*, that the Owner and the Developer agree that although TxDOT is not a party to this Agreement, TxDOT is intended to be a third-party beneficiary to this Agreement.

20. **Breach by the Parties**.

(a) If the Owner claims that the Developer has breached any of its obligations under this Agreement, the Owner will notify the Developer and TxDOT in writing of such breach, and the Developer shall have **30 days** following receipt of such notice in which to cure such breach, before the Owner may invoke any remedies which may be available to it as a result of such breach; *provided, however*, that both during and after such period TxDOT shall have the right, but not the obligation, to cure any breach by the Developer. Without limiting the generality of the foregoing:

(i) TxDOT shall have no liability to the Owner for any act or omission committed by the Developer in connection with this Agreement; and

(ii) In no event shall TxDOT be responsible for any repairs or maintenance to the Owner Utilities adjusted pursuant to this Agreement.

(b) If the Developer claims that the Owner has breached any of its obligations under this Agreement, the Developer will notify the Owner and TxDOT in writing of such breach, and the Owner shall have **30 days** following receipt of such notice in which to cure such breach, before the Developer or the Developer may invoke any remedies which may be available to it as a result of such breach.

21. **Traffic Control**. The Developer shall provide traffic control or shall reimburse the Owner for the Developer's share (if any, as specified in Paragraph 6) of the costs for traffic control made necessary by the Adjustment work performed by either the Developer or the Owner pursuant to this Agreement, in compliance with the requirements of the Texas Manual on *Uniform Traffic Control Devices*. Betterment percentages calculated in Paragraph 10 shall also apply to the traffic control costs.

22. **Notices**. Except as otherwise expressly provided in this Agreement, all notices or communications pursuant to this Agreement shall be sent or delivered to the following:

Owner:
[Address Line #1]
[Address Line #2]
[City, State Zip]
Phone: ( ) -
Fax: ( ) -

Developer:
[Address Line #1]
[Address Line #2]
[City, State Zip]
Phone: ( ) -
Fax: ( ) -

A party sending a notice of default of this Agreement to another party shall also send a copy of such notice to TxDOT and to the CDA Utility Manager at the following addresses:

TxDOT: Texas Department of Transportation
Attention: Strategic Projects Division - ROW Office
125 E. 11th Street
Austin, Texas 78701-2483

TxDOT CDA Utility Manager: [Insert project address and contact]

Any notice or demand required herein shall be given (a) personally, (b) by certified or registered mail, postage prepaid, return receipt requested, or (c) by reliable messenger or overnight courier to the appropriate address set forth above. Any notice served personally shall be deemed delivered upon receipt and served by certified or registered mail or by reliable messenger or overnight courier shall be deemed delivered on the date of receipt as shown on the addressee's registry or certification of receipt or on the date receipt is refused as shown on the records or manifest of the U.S. Postal Service or such courier. Any party may designate any other address for this purpose by written notice to all other parties; TxDOT may designate another address by written notice to all parties.

23. **Approvals**. Any acceptance, approval, or any other like action (collectively "**Approval**") required or permitted to be given by either the Developer or the Owner pursuant to this Agreement:

(a) Must be in writing to be effective (except if deemed granted pursuant hereto);

(b) Shall not be unreasonably withheld or delayed; and if Approval is withheld, such withholding shall be in writing and shall state with specificity the reason for withholding such Approval, and every effort shall be made to identify with as much detail as possible what changes are required for Approval; and

(c) Except for approvals by TxDOT, and except as may be specifically provided otherwise in this Agreement, shall be deemed granted if no response is provided to the party requesting an Approval within the time period prescribed by this Agreement (or if no time period is prescribed, then **14 calendar days**), commencing upon actual receipt by the party from which an Approval is requested or required, of a request for Approval from the requesting party. All requests for Approval shall be sent out by the requesting party to the other party in accordance with Paragraph 22.

24. **Time; Force Majeure**.

(a) Time is of the essence in the performance of this Agreement.

(b) All references to “days” herein shall be construed to refer to calendar days, unless otherwise stated.

(c) No party shall be liable to another party for any delay in performance under this Agreement from any cause beyond its control and without its fault or negligence ("**Force Majeure**"), such as acts of God, acts of civil or military authority, fire, earthquake, strike, unusually severe weather, floods or power blackouts. If any such event of Force Majeure occurs, the Owner agrees, if requested by the Developer, to accelerate its efforts hereunder if reasonably feasible in order to regain lost time, so long as the Developer agrees to reimburse the Owner for the reasonable and actual costs of such efforts.

25. **Continuing Performance**. In the event of a dispute, the Owner and the Developer agree to continue their respective performance hereunder to the extent feasible in light of the dispute, including paying billings, and such continuation of efforts and payment of billings shall not be construed as a waiver of any legal right.

26. **Equitable Relief**. The Developer and the Owner acknowledge and agree that delays in Adjustment of the Owner Utilities will impact the public convenience, safety and welfare, and that (without limiting the parties' remedies hereunder) monetary damages would be inadequate to compensate for delays in the construction of the Project. Consequently, the parties hereto (and TxDOT as well, as a third party beneficiary) shall be entitled to specific performance or other equitable relief in the event of any breach of this Agreement which threatens to delay construction of the Project; *provided, however*, that the fact that specific performance or other equitable relief may be granted shall not prejudice any claims for payment or otherwise related to performance of the Adjustment work hereunder.

27. **Authority**. The Owner and the Developer each represent and warrant to the other party that the warranting party possesses the legal authority to enter into this Agreement and that it has taken all actions necessary to exercise that authority and to lawfully authorize its undersigned signatory to execute this Agreement and to bind such party to its terms. Each person executing this Agreement on behalf of a party warrants that he or she is duly authorized to enter into this Agreement on behalf of such party and to bind it to the terms hereof.

28. **Cooperation**. The parties acknowledge that the timely completion of the Project will be influenced by the ability of the Owner (and its contractors) and the Developer to coordinate their activities, communicate with each other, and respond promptly to reasonable requests. Subject to the terms and conditions of this Agreement, the Owner and the Developer agree to take all steps reasonably required to coordinate their respective duties hereunder in a manner consistent with the Developer's current and future construction schedules for the Project. The Owner further agrees to require its contractors to coordinate their respective work hereunder with the Developer.

29. **Termination**. If the Project is canceled or modified so as to eliminate the necessity of the Adjustment work described herein, then the Developer shall notify the Owner in writing and the Developer reserves the right to thereupon terminate this Agreement. Upon such termination, the parties shall negotiate in good faith an amendment that shall provide mutually acceptable terms and conditions for handling the respective rights and liabilities of the parties relating to such termination.

30. **Nondiscrimination**. Each party hereto agrees, with respect to the work performed by such party pursuant to this Agreement that such party shall not discriminate on the grounds of race, color, sex, national origin or disability in the selection and/or retention of contractors and consultants, including procurement of materials and leases of equipment.

31. **Applicable Law, Jurisdiction and Venue**. This Agreement shall be governed by the Laws of the State of Texas, without regard to the conflict of laws principles thereof. Venue for any action brought to enforce this Agreement or relating to the relationship between any of the parties shall be the District Court of County, Texas [or the United States District Court for the Western District of Texas (Austin)].

32. **Relationship of the Parties.** This Agreement does not in any way, and shall not be construed to, create a principal/agent or joint venture relationship between the parties hereto and under no circumstances shall the Owner or the Developer be considered as or represent itself to be an agent of the other.

33. **Waiver of Consequential Damages**. No party hereto shall be liable to any other party to this Agreement, whether in contract, tort, equity, or otherwise (including negligence, warranty, indemnity, strict liability, or otherwise), for any punitive, exemplary, special, indirect, incidental, or consequential damages, including, without limitation, loss of profits or revenues, loss of use, claims of customers, or loss of business opportunity.

34. **Captions**. The captions and headings of the various paragraphs of this Agreement are for convenience and identification only, and shall not be deemed to limit or define the content of their respective paragraphs.

35. **Counterparts**. This Agreement may be executed in any number of counterparts. Each such counterpart hereof shall be deemed to be an original instrument but all such counterparts together shall constitute one (1) and the same instrument.

36. **Effective Date**. This Agreement shall become effective upon the later of (a) the date of signing by the last party (either the Owner or the Developer) signing this Agreement, and (b) the date of TxDOT's approval as indicated by the signature of TxDOT's representative below.

APPROVED BY:

TEXAS DEPARTMENT OF TRANSPORTATION

By: Donald C. Toner, Jr., SR/WA
[Printed Name]

By: _____
Authorized Signature

_____ [*Title*]
Strategic Projects Division

Date: _____

OWNER

By: _____
[Print Owner Name]

By: _____
Duly Authorized Representative

_____ [*Title*]
_____ [*Company*]

Date: _____

DEVELOPER

By: _____
[Print Name]

By: _____
Duly Authorized Representative

_____ [*Title*]
_____ [*Company*]

Date: _____

County:
ROW CSJ No.:
Const. CSJ No.:
Highway:
Limits:
Fed. Proj. No.:

EXHIBIT A

PLANS, SPECIFICATIONS, COST ESTIMATES AND ALLOCATION

County:
ROW CSJ No.:
Const. CSJ No.:
Highway:
Limits:
Fed. Proj. No.:

EXHIBIT B

UTILITY ADJUSTMENT AGREEMENT AMENDMENT
(SPD-ROW-CDA-U-UAAA-OM)

County:
ROW CSJ No.:
Const. CSJ No.:
Highway:
Limits:
Fed. Proj. No.:

EXHIBIT C

STATEMENT COVERING CONTRACT WORK

STATEMENT COVERING UTILITY CONSTRUCTION CONTRACT WORK

(AS APPEARING IN ESTIMATE)

U-No.

District:

County: ROW CSJ No.:

Federal Project No.: Highway No.:

I, _____, a duly authorized and qualified representative of _____, hereinafter referred to as **Owner**, am fully cognizant of the facts and make the following statements in respect to work which will or may be done on a contract basis as appears in the estimate to which this statement is attached.

It is more economical and/or expedient for **Owner** to contract this adjustment, or **Owner** is not adequately staffed or equipped to perform the necessary work on this project with its own forces to the extent as indicate on the estimate.

Procedure to be Used in Contracting Work

☐ A. Solicitation for bids is to be accomplished through open advertising and contract is to be awarded to the lowest qualified bidder who submits a proposal in conformity with the requirements and specifications for the work to be performed.

☐ B. Solicitation for bids is to be accomplished by circulating to a list of pre-qualified contractors or known qualified contractors and such contract is to be awarded to the lowest qualified bidder who submits a proposal in conformity with the requirements and specifications for the work to be performed. Such presently known contractors are listed below:

1. _____
2. _____
3. _____
4. _____
5. _____

☐ C. The work is to be performed under an existing continuing contract under which certain work is regularly performed for **Owner** and under which the lowest available costs are developed. (If only part of the contract work is to be done under an existing contract, give detailed information by attachment hereto.)

☐ D. The utility proposes to contract outside the foregoing requirements and therefore evidence in support of its proposal is attached to the estimate in order to obtain the concurrence of the State, and the Federal Highway Administration Division Engineer where applicable, prior to

taking action thereon (approval of the agreement shall be considered as approval of such proposal).

☐ E. The utility plans and specifications, with the consent of the State, will be included in the construction contract awarded by the State.

_____ _____

[Signature of Officer/Representative] Date

_____

[Title of Officer/Representative]

County:
CSJ No.:
Highway:
Limits:
Fed. Proj. No.:
ROW Acct. No.:

AFFIDAVIT

Agreement No. _____

THE STATE OF TEXAS)
)
**COUNTY OF) **

WHEREAS, the State of Texas, acting by and through the Texas Department of Transportation, herein called TxDOT, has deemed it necessary to make certain highway improvements on Highway in County, Texas, from to ; and,

WHEREAS, it is anticipated that the hereinabove mentioned improvements will affect the facilities of _____ hereinafter called the **Owner**, at the following described locations:

[ ] and;

WHEREAS, **TxDOT** has requested that the **Owner** furnish to the information relative to interests that Owner hold in lands at each of the hereinabove referenced locations;

NOW THEREFORE, before me, the undersigned authority, this day personally appeared _____, who, after being by me duly sworn, did depose and say:

That he/she is _____ of _____ and, as such, has knowledge of the facts contained herein, and

That, to the best of his/her knowledge, said **Owner** is the owner of the following described interests in the hereinabove-indicated lands, copies of the instruments under which said **Owner** claims said interests being attached hereto and made a part hereof.

_____
Signature

_____
Title

_____
Company

Sworn to and subscribed before me this _____ day of _____, A.D. 20_____.

[Insert Seal]

_____
Notary Public, State of Texas

My Commission expires:

_____

Developer's Utility Manager

Utility No Conflict Sign-Off Form

Utility Manager: _____

Date plans received: _____

Utility Company: _____

Assembly "U" number: _____

Type of Utilities: _____

Date on Utility's plans: _____ No. of sheets in Utility's plans: _____

I, _____, the Utility Manager (UM) working on behalf of the Developer (_____) certify that a review of the above referenced Utility Plans concerning the proposed highway improvements on the _____ has been completed and have not identified any conflicts between the Utility's proposed relocation and any existing and/or proposed Utilities.

The proposed Utility Plans conform to Title 43 of the Texas Administrative Code, Section 21.31 – 21.56 of the Utility Accommodation Rules.

☐ Check box if any areas of concern and insert comments below:

Utility Manager: (UM)

_____ (Signature) _____ Date

_____ (Print Name)

Utility Design Coordinator: (UDC)

_____ (Signature) _____ Date

_____ (Print Name)

Utility Coordination Firm:

_____ (Print Name)

This form must be completed/signed and included in each Utility Assembly submitted to the Texas Department of Transportation.

Developer's Utility Design Coordinator

Utility No Conflict Sign-Off Form

Utility Design Coordinator: _____

Date plans received: _____

Utility Company: _____

Assembly "U" number: _____

Type of Utilities: _____

Date on Utility's plans: _____ No. of sheets in Utility's plans: _____

I, _____, the Utility Design Coordinator (UDC) on behalf of the Developer (_____) certify that a review of the above referenced Utility Plans concerning the proposed highway improvements on the _____ has been completed and have not identified any conflicts between the Utility's proposed relocation and any design features.

Design features include but are not limited to pavement structures, drainage facilities, bridges, retaining walls, traffic signals, illumination, signs, foundations, duct/conduit, ground boxes, erosion control facilities, water quality facilities and other Developer-Managed Utilities.

Any design changes to the _____ after the signing of this form will be coordinated through the Developer's Utility Manager and the affected Utility Owner.

☐ Check box if any areas of concern and insert comments below:

Utility Design Coordinator: (UDC)

_____ (Signature)

_____ Date

_____ (Print Name)

Utility Coordination Firm:

_____ (Print Name)

This form must be completed/signed and included in each Utility Assembly submitted to the Texas Department of Transportation.

Form SPD ROW-U-AdjCheck
REV 01/15

CDA UTILITY ADJUSTMENT CHECKLIST

(To be included with Utility Assembly Submittal)

U-No.:

District:

Utility Owner:

County(ies):

CSJ No(s).: R- C-

Project Limits:

Federal ROW Project No.:

Reimbursement (*check <u>one</u> (1) box*): Actual Cost ☐ Lump Sum ☐ Non-Reimbursable ☐

Alternate Procedure Approval Date:

Description of Work (*Approximate from/to stationing and line type*):

Estimated Start Date: , 20

Estimated Completion or Duration: , 20

Estimated Total Adjustment Costs:	$0.00	
Estimated Betterment (*in dollars and calculated %*):	$0.00	0%
Estimated Accrued Depreciation:	$0.00	
Estimated Salvage:	$0.00	
Credits and Vouchers:	$0.00	
Eligibility Ratio (*calculated and supported %*)	$0.00	0%

Noteworthy Issues/Items:

ASSEMBLY PACKAGE

1. Have the required number of Utility Adjustment Assemblies of which the TxDOT Copy is color coded, been submitted?

   Yes ☐ No ☐ N/A ☐

2. Have the following forms been submitted?

PUAA/UAAA:	Yes ☐	No ☐	N/A ☐
UJUA:	Yes ☐	No ☐	N/A ☐
Statement - Contract Work:	Yes ☐	No ☐	N/A ☐
U-1 Affidavit:	Yes ☐	No ☐	N/A ☐
Quitclaim Deed:	Yes ☐	No ☐	N/A ☐
UM/UDC Sign Off:	Yes ☐	No ☐	N/A ☐

3. Are all forms submitted complete and correct for the situation/circumstance of the Utility Adjustment?

   Yes ☐ No ☐ N/A ☐

TRANSMITTAL MEMO

4. If the Adjustment has unique characteristics, does the transmittal include explanations and clarifications?

   Yes ☐ No ☐ N/A ☐

5. Has a recommendation for approval been stated?

   Yes ☐ No ☐ N/A ☐

6. If the Utility Adjustment is in more than one (1) RCSJ (Local Jurisdictional Boundary), have the percentages in each jurisdiction been detailed?

   Yes ☐ No ☐ N/A ☐

UTILITY ADJUSTMENT AGREEMENT

7. Have language modifications to the utility agreement been approved by TxDOT?

Yes ☐ No ☐ N/A ☐

8. Has the Utility consultant-engineering contract been reviewed and approved by the Developer's Utility Manager (UM)?

Yes ☐ No ☐ N/A ☐

UTILITY ADJUSTMENT PLANS AND SPECIFICATIONS

9. Plans folded so as to fit into 8.5" x 11" file?

Yes ☐ No ☐ N/A ☐

10. Have the Utility Adjustments been designed for the Proposed Configuration?

Yes ☐ No ☐ N/A ☐

11. Project or vicinity plan provided?

Yes ☐ No ☐ N/A ☐

12. Have the plans for the Utility Adjustment been sealed by a Registered Professional Engineer (PE)?

Yes ☐ No ☐ N/A ☐

13. Has the Utility Owner signed the cover sheet of the plans verifying review and approval, if Developer is responsible for Engineering on either Owner Managed or Developer Managed Agreement?

Yes ☐ No ☐ N/A ☐

14. Backfill requirements met (item 400 referenced)?

Yes ☐ No ☐ N/A ☐

15. If excavation is required, do the plans included a note on OSHA trench excavation protection?

Yes ☐ No ☐ N/A ☐

16. Is a note provided in the plans that the adjustment will conform with the TMUTCD?

Yes ☐ No ☐ N/A ☐

17. If the adjustment involves a plastic water, sanitary sewer, or gas line, has a metal detection wire been included in the estimate or with detailed in the plans?

Yes ☐ No ☐ N/A ☐

18. Has Barlow's Formula information been submitted for un-encased high pressure pipelines? (The Barlow's calculation must be provided by the utility owner. The following information is required to complete Barlow's formula. S=Yield Strength, Wall thickness = t, Outside Diameter = D, Design Factor = F. Maximum Operating Pressure must also be given and compared to the pressure calculated with Barlow's. The Barlow calculation must be shown with the submission.)

Yes ☐ No ☐ N/A ☐

19. If the pipeline is un-encased, is there adequate coating, wrapping and cathodic protection?

Yes ☐ No ☐ N/A ☐

20. Information on plans sufficient and adequate to:

Determine necessity and justification of proposed work?

Yes ☐ No ☐ N/A ☐

Demonstrate Utility Accommodation Rules compliance?

Yes ☐ No ☐ N/A ☐

Indicate highway stationing, existing and proposed ROW, offsets from proposed ROW, existing and proposed grades, and edge of pavement lines?

Yes ☐ No ☐ N/A ☐

Provide any other necessary or essential information such as pressure, flow, offset, type, condition, wall thickness, specifications etc.?

Yes ☐ No ☐ N/A ☐

21. Is this Utility Adjustment within ROW project limits or directly related to work required within project limits?

Yes ☐ No ☐ N/A ☐

22. Are any of the proposed utility facilities installed longitudinally within a control of access?

Yes ☐ No ☐ N/A ☐

COST ESTIMATE

23. Has the Developer's Utility Design Coordinator located on the plans the major items of material listed on the estimate by scaling or stationing?

Yes ☐ No ☐ N/A ☐

24. If the agreed sum method has been marked, has a detailed, itemized estimate and matching plans been provided?

Yes ☐ No ☐ N/A ☐

25. Is the estimate properly and adequately itemized and detailed?

Yes ☐ No ☐ N/A ☐

26. Are overheads and loadings checked for reasonableness?

Yes ☐ No ☐ N/A ☐

27. Replacement utility ROW charges justified and supported?

Yes ☐ No ☐ N/A ☐

28. Eligibility ratio calculated and recommended?

Yes ☐ No ☐ N/A ☐

29. Betterment credit applicable?

Yes ☐ No ☐ N/A ☐

If yes, is credit calculated and applied properly?

Yes ☐ No ☐ N/A ☐

30. Accrued Depreciation credit applicable?

Yes ☐ No ☐ N/A ☐

If yes, is credit calculated and applied properly?

Yes ☐ No ☐ N/A ☐

31. Salvage credit applicable?

Yes ☐ No ☐ N/A ☐

If yes, is credit applied properly?

Yes ☐ No ☐ N/A ☐

32. Estimate extensions checked?

Yes ☐ No ☐ N/A ☐

AFFIDAVIT OF PROPERTY INTEREST

33. Proof of compensable property interest established by utility where applicable?

Yes ☐ No ☐ N/A ☐

If yes, according to the "**Real Property Interest**" paragraph of the PUAA:

Does the estimate detail reimbursement for "New Property" interest?

Yes ☐ No ☐ N/A ☐

Does the estimate detail compensation for relinquishing "Existing Property" interest?

Yes ☐ No ☐ N/A ☐

Did the utility owner provide a letter stating that they will quitclaim their property interest at no costs or an agreed sum if new utility property interests are not being acquired?

Yes ☐ No ☐ N/A ☐

34. Have the parcel ID numbers to be Quitclaimed been identified?

Yes ☐ No ☐ N/A ☐

35. Has the owner provided a signed letter of intent to Quitclaim, and has a copy of the correct Quitclaim Deed(s) been submitted?

Yes ☐ No ☐ N/A ☐

R.O.W. MAPS

36. Approved and current ROW Maps on file with project office?

Yes ☐ No ☐ N/A ☐

37. Have the existing and proposed utility facilities been plotted on the ROW map and attached to this assembly?

Yes ☐ No ☐ N/A ☐

COMMENTS:

Prepared by: _____ _____
Utility Design Coordinator Date

Recommended for Approval by: _____ _____
Quality Control Date

Approved by: _____ _____
Utility Manager Date

County:
Highway:
Limits:
Fed. Proj. No.:
ROW CSJ No.:
Const. CSJ No.:

UTILITY ADJUSTMENT AGREEMENT AMENDMENT
(Developer Managed)

(**Amendment No. _____ to Agreement No.: _____** -U-_____)

THIS AMENDMENT TO PROJECT UTILITY ADJUSTMENT AGREEMENT (this "Amendment"), by and between, hereinafter identified as the "**Developer**" and _____, hereinafter identified as the "**Owner**", is as follows:

WITNESSETH

WHEREAS, the STATE of TEXAS, acting by and through the Texas Department of Transportation, hereinafter identified as "**TxDOT**", proposes to construct the project identified above (the "Project", as more particularly described in the "Original Agreement", defined below); and

WHEREAS, pursuant to that certain Comprehensive Development Agreement (the "**CDA**") by and between TxDOT and the Developer with respect to the Project, the Developer has undertaken the obligation to design, construct, and potentially maintain the Project, including causing the removal, relocation, or other necessary adjustment of existing Utilities impacted by the Project (collectively, "Adjustment"); and

WHEREAS, the Owner and Developer are parties to that certain executed Project Utility Adjustment Agreement designated by the "Agreement No." indicated above, as amended by previous amendments, if any (the "Original Agreement"), which provides for the Adjustment of certain Utilities owned and/or operated by the Owner (the "Utilities"); and

WHEREAS, the parties are required to utilize this Amendment form in order to modify the Original Agreement to add the Adjustment of Owner Utilities facilities not covered by the Original Agreement; and

WHEREAS, the parties desire to amend the Original Agreement to add Additional Owner Utility facility(ies), on the terms and conditions hereinafter set forth.

NOW, THEREFORE, in consideration of the agreements contained herein, the parties hereto agree as follows:

1. **Amendment**. The Original Agreement is hereby amended as follows:

1.1 **Plans**.

(a) The description of the Owner Utilities and the proposed Adjustment of the Owner Utilities in the Original Agreement is hereby amended to add the

following Utility facility(ies) ("**Additional Owner Utilities**") and proposed Adjustment(s) to the Owner Utilities described in the Original Agreement *[insert below a description of the affected facilities (by type, size and location) as well as a brief description of the nature of the Adjustment work to be performed (e.g., "adjust 12" waterline from approximately Highway Station 100+00 to approximately Highway Station 200+00)]*: _____.

(b) The Plans, as defined in Paragraph 1 of the Original Agreement, are hereby amended to add thereto the plans, specifications and cost estimates attached hereto as Exhibit A; and

(c) The Plans attached hereto as Exhibit A, along with this Amendment, shall be submitted upon execution to TxDOT in accordance with Paragraph 2 of the Original Agreement, and Paragraph 2 shall apply to this Amendment and the Plans attached hereto in the same manner as if this Amendment were the Original Agreement. If the Owner claims an Existing Utility Property Interest for any of the Additional Owner Utilities, documentation with respect to such claim shall be submitted to TxDOT as part of this Amendment and the attached Plans, in accordance with Paragraph 15(a) of the Original Agreement.

1.2 **Reimbursement of Owner's Indirect Costs.** For purposes of Paragraph 6 of the Original Agreement, the following terms apply to the Additional Owner Utilities and proposed Adjustment:

(a) Developer agrees to reimburse the Owner its share of the Owner's indirect costs (e.g., engineering, inspection, testing, ROW) as identified in Exhibit A. When requested by the Owner, monthly progress payments will be made. The monthly payment will not exceed 80% of the estimated indirect work done to date. Once the indirect work is complete, final payment of the eligible indirect costs will be made. Intermediate payments shall not be construed as final payment for any items included in the intermediate payment.

(b) The Owner's indirect costs associated with Adjustment of the Owner Utilities shall be developed pursuant to the method checked and described below *[check only one (1) box]*:

☐ (1) Actual related indirect costs accumulated in accordance with:

(i) A work order accounting procedure prescribed by the applicable Federal or State regulatory body; or

(ii) Established accounting procedure developed by the Owner and which the Owner uses in its regular operations;

(either (i) or (ii) referred to as "**Actual Cost**"*)* or,

☐ (2) The agreed sum of $_____ ("**Agreed Sum**") as supported by the analysis of the Owner's estimated costs attached hereto as part of Exhibit A.

1.3 **Advancement of Funds by Owner for Construction Costs.**

(a) Advancement of Owner's Share, if any, of estimated costs. Exhibit A shall identify all estimated engineering and construction-related costs, including labor, material, equipment and other miscellaneous construction items. Exhibit A shall also identify the Owner's and Developer's respective shares of the estimated costs.

The Owner shall advance to the Developer its allocated share, if any, of the estimated costs for construction and engineering work to be performed by Developer, in accordance with the following terms:

☐ The Adjustment of the Owner's Utilities does not require advancement of funds.

☐ The Adjustment of the Owner's Utilities does require advancement of funds and the terms agreed to between the Developer and Owner are listed below.

[Insert terms of advance funding to be agreed between Developer and Owner.]

(b) Adjustment Based on Actual Costs or Agreed Sum.

[Check the one (1) appropriate provision, if advancement of funds is required]:

☐ The Owner is responsible for its share of the Developer actual cost for the Adjustment, including the identified Betterment. Accordingly, upon completion of all Adjustment work to be performed by both parties pursuant to this Amendment:

(i) The Owner shall pay to the Developer the amount, if any, by which the actual cost of the Betterment (as determined in Paragraph 9(b)) *plus* the actual cost of Owner's share of the Adjustment (based on the allocation set forth in Exhibit A) exceeds the estimated cost advanced by the Owner, or

(ii) The Developer shall refund to the Owner the amount, if any, by which such advance exceeds such actual cost, as applicable.

☐ The Agreed Sum is the agreed and final amount due for the Adjustment, including any Betterment, under this Amendment. Accordingly, no adjustment (either up or down) of such amount shall be made based on actual costs.

1.4 **Responsibility for Costs of Adjustment Work.** For purposes of Paragraph 4 of the Original Agreement, responsibility for the Agreed Sum or Actual Cost, as applicable, of all Adjustment work to be performed pursuant to this Amendment shall be allocated between the Developer and the Owner as identified in Exhibit A hereto and in accordance with § 203.092 of the Texas Transportation Code. An allocation percentage may be determined by application of an eligibility ratio, if appropriate, as detailed in Exhibit A; *provided however*, that any portion of an Agreed Sum or Actual Cost attributable to

Betterment shall be allocated 100% to the Owner in accordance with Paragraph 9 of the Original Agreement.

1.5 **Betterment**.

(a) Paragraph 9(b) (Betterment and Salvage) of the Original Agreement is hereby amended to add the following *[Check the one (1) box that applies, and complete if appropriate]*:

☐ The Adjustment of the Additional Owner Utilities, pursuant to the Plans as amended herein, does not include any Betterment.

☐ The Adjustment of the Additional Owner Utilities, pursuant to the Plans as amended herein, includes Betterment to the Additional Owner Utilities by reason of *[insert explanation, e.g. "replacing 12" pipe with 24" pipe]*: _____.

The Developer has provided to the Owner comparative estimates for (i) all work to be performed by the Developer pursuant to this Amendment, including work attributable to the Betterment, and (ii) the cost to perform such work without the Betterment, which estimates are hereby approved by the Owner. The estimated cost of the Developer work under this Amendment which is attributable to Betterment is $_____, calculated by *subtracting* (ii) from (i). The percentage of the total cost of the Developer work under this Amendment which is attributable to Betterment is _____%, calculated by *subtracting* (ii) from (i), which remainder is *divided* by (i).

(b) If the above Paragraph 1.6(a) identifies Betterment, the Owner shall advance to the Developer, at least **14 days** prior to the date scheduled for commencement of construction for Adjustment of the Additional Owner Utilities, the estimated cost attributable to Betterment as set forth in Paragraph 1.5(a) of this Amendment. If the Owner fails to advance payment to the Developer on or before the foregoing deadline, the Developer shall have the option of commencing and completing (without delay) the Adjustment work without installation of the applicable Betterment. *[Check the one (1) appropriate provision]*:

☐ The estimated cost stated in Paragraph 1.5(a) of this Amendment is the agreed and final amount due for Betterment under this Amendment, and accordingly no adjustment (either up or down) of such amount shall be made based on actual costs.

☐ The Owner is responsible for the Developer Actual Cost for the identified Betterment. Accordingly, upon completion of all Adjustment work to be performed by both parties pursuant to this Amendment, (i) the Owner shall pay to the Developer the amount, if any, by which the actual cost of the Betterment (determined as provided below in this paragraph) exceeds the estimated cost advanced by the Owner, or (ii) the Developer shall refund to the Owner the amount, if any, by which such advance exceeds such actual cost, as applicable. Any additional payment by the Owner shall be due within **60 days** after the Owner's receipt of the

Developers invoice therefor, together with supporting documentation; any refund shall be due within **60 days** after completion of the Adjustment work under this Amendment. The Actual Cost of Betterment incurred by the Developer shall be calculated by *multiplying* (i) the Betterment percentage stated in Paragraph 1.5(a) of this Amendment, by (ii) the Actual Cost of all work performed by the Developer pursuant to this Amendment (including work attributable to the Betterment), as invoiced by the Developer to the Owner.

(c) The determinations and calculations of Betterment described in this Amendment shall exclude right of way acquisition costs. Betterment in connection with right of way acquisition is addressed in Paragraph 15 of the Original Agreement.

1.6 **Miscellaneous**.

(a) The Owner and the Developer agree to refer to this Amendment, designated by the "Amendment No." and "Agreement Number" indicated on page 1 above, on all future correspondence regarding the Adjustment work that is the subject of this Amendment and to track separately all costs relating to this Amendment and the Adjustment work described herein.

(b) *[Include any other proposed amendments allowed by applicable Law.]*

2. **General.**

(a) All capitalized terms used in this Amendment shall have the meanings assigned to them in the Original Agreement, except as otherwise stated herein.

(b) This Amendment may be executed in any number of counterparts. Each such counterpart hereof shall be deemed to be an original instrument but all such counterparts together shall constitute one (1) and the same instrument.

(c) Except as amended hereby, the Original Agreement shall remain in full force and effect. In no event shall the responsibility, as between the Owner and the Developer, for the preparation of the Plans and the Adjustment of the Owner Utilities be deemed to be amended hereby.

(d) This Amendment shall become effective upon the later of (a) the date of signing by the last party (either the Owner or the Developer) signing this Amendment, and (b) the completion of TxDOT's review and approval as indicated by the signature of TxDOT's representative below.

APPROVED BY:

TEXAS DEPARTMENT OF TRANSPORTATION

By: Donald C. Toner, Jr., SR/WA
[Printed Name]

By: _____
Authorized Signature

_____ [*Title*]
Strategic Projects Division

Date: _____

OWNER

By: _____
[Print Name]

By: _____
Duly Authorized Representative Signature

_____ [*Title*]
[*Company*]

Date: _____

DEVELOPER

By: _____
[Print Name]

By: _____
Duly Authorized Representative

_____ [*Title*]
_____ [*Company*]

Date: _____

County:
Highway:
Limits:
Fed. Proj. No.:
ROW CSJ No.:
Const. CSJ No.:

UTILITY ADJUSTMENT AGREEMENT AMENDMENT
(Owner Managed)

(**Amendment No. _____ to Agreement No.**: _____- U -_____)

THIS AMENDMENT TO PROJECT UTILITY ADJUSTMENT AGREEMENT (this "Amendment"), by and between, hereinafter identified as the "**Developer**" and _____, hereinafter identified as the "**Owner**", is as follows:

WITNESSETH

WHEREAS, the STATE of TEXAS, acting by and through the Texas Department of Transportation, hereinafter identified as "**TxDOT**", proposes to construct the project identified above (the "Project", as more particularly described in the "Original Agreement", defined below); and

WHEREAS, pursuant to that certain Comprehensive Development Agreement (the "**CDA**") by and between TxDOT and the Developer with respect to the Project, the Developer has undertaken the obligation to design, construct, and potentially maintain the Project, including causing the removal, relocation, or other necessary adjustment of existing Utilities impacted by the Project (collectively, "Adjustment"); and

WHEREAS, the Owner and Developer are parties to that certain executed Project Utility Adjustment Agreement designated by the "Agreement No." indicated above, as amended by previous amendments, if any (the "Original Agreement"), which provides for the Adjustment of certain Utilities owned and/or operated by the Owner (the "Utilities"); and

WHEREAS, the parties are required to utilize this Amendment form in order to modify the Original Agreement to add the Adjustment of Owner Utilities facilities not covered by the Original Agreement; and

WHEREAS, the parties desire to amend the Original Agreement to add Additional Owner Utility facility(ies), on the terms and conditions hereinafter set forth.

NOW, THEREFORE, in consideration of the agreements contained herein, the parties hereto agree as follows:

1. **Amendment**. The Original Agreement is hereby amended as follows:

   (a) The description of the Owner Utilities and the proposed Adjustment of the Owner Utilities in the Original Agreement is hereby amended to add the following Utility facility(ies) ("**Additional Owner Utilities**") and proposed Adjustment(s) *[insert below a description of the affected facilities (by type, size and location) as well as a brief description of the nature of the Adjustment work to be performed (e.g., "adjust 12"*

waterline from approximately Highway Station 100+00 to approximately Highway Station 200+00")]: _____.

(b) The Plans, as defined in Paragraph 1 of the Original Agreement, are hereby amended to add thereto the Plans, specifications and cost estimates attached hereto as Exhibit A.

(c) The Plans attached hereto as Exhibit A, along with this Amendment, shall be submitted upon execution to TxDOT in accordance with Paragraph 2 of the Original Agreement, and Paragraph 2 shall apply to this Amendment and the Plans attached hereto in the same manner as if this Amendment were the Original Agreement. If the Owner claims an Existing Utility Property Interest for any of the Additional Owner Utilities, documentation with respect to such claim shall be submitted to TxDOT as part of this Amendment and the attached Plans, in accordance with Paragraph 16(a) of the Original Agreement.

(d) Paragraph 4(f) of the Original Agreement is hereby amended to add the following deadline for the Adjustment of the Additional Owner Utilities *[check one (1) box that applies]*:

☐ Owner shall complete all of the Utility reconstruction and relocation work, including final testing and acceptance thereof, on or before , 20 .

☐ Owner shall complete all of the Utility reconstruction and relocation work, including final testing and acceptance thereof, within **calendar days** after delivery to Owner of a notice to proceed by Developer;

(e) For purposes of Paragraph 5(b) of the Original Agreement, the Owner's costs associated with Adjustment of the Additional Owner Utilities shall be developed pursuant to the method checked and described below, *[check only one (1) box]*:

☐ (1) Actual costs accumulated in accordance with a work order accounting procedure prescribed by the applicable Federal or State regulatory body ("**Actual Cost**");

☐ (2) Actual costs accumulated in accordance with an established accounting procedure developed by the Owner and which the Owner uses in its regular operations ("**Actual Cost**"); or

☐ (3) The agreed sum of $_____("**Agreed Sum**"), as supported by the analysis of estimated costs attached hereto as part of Exhibit A.

(f) For purposes of Paragraph 6 of the Original Agreement, responsibility for the Agreed Sum or Actual Cost, as applicable, of all Adjustment work to be performed pursuant to this Amendment shall be allocated between the Developer and the Owner as identified in Exhibit A and in accordance with § 203.092 of the Texas Transportation Code. An allocation percentage may be determined by application of an eligibility ratio, if appropriate, as detailed in Exhibit A; *provided, however*, that any portion of an Agreed Sum or Actual Cost attributable to Betterment shall be allocated 100% to the Owner in accordance with Paragraph 10 of the Original Agreement.

(g) Paragraph 10(b) of the Original Agreement is hereby amended to add the following *[Check the <u>one</u> (1) box that applies]*:

☐ The Adjustment of the Additional Owner Utilities, pursuant to the Plans as amended herein, does not include any Betterment.

☐ The Adjustment of the Additional Owner Utilities, pursuant to the Plans as amended herein, includes Betterment to the Additional Owner Utilities by reason of *[insert explanation, e.g. "replacing 12" pipe with 24" pipe]*: _____.

The Owner has provided to the Developer comparative estimates for (i) all costs for work to be performed by the Owner pursuant to this Amendment, including work attributable to the Betterment, and (ii) the cost to perform such work without the Betterment, which estimates are hereby approved by the Developer. The estimated amount of the Owner's costs for work under this Agreement which is attributable to Betterment is $_____, calculated by *subtracting* (ii) from (i). The percentage of the total cost of the Owner's work hereunder which is attributable to Betterment is _____%, calculated by *subtracting* (ii) from (i) which remainder shall be *divided* by (i).

(h) The following shall apply to any Betterment described in Paragraph 1(g) of this Amendment:

(i) If the Owner's costs are developed under procedure (3) described in Paragraph 1(e) of this Amendment, then the agreed sum stated in that Paragraph includes any credits due to the Developer on account of the identified Betterment, and no further adjustment shall be made on account of same.

(ii) If the Owner's costs are developed under procedure (1) or (2) described in Paragraph 1(e) of this Amendment, the parties agree as follows *[check the <u>one</u> (1) appropriate provision]*:

☐ The estimated cost stated in Paragraph 1(g) of this Amendment is the agreed and final amount due for Betterment under this Amendment. Accordingly, each intermediate invoice submitted for Adjustment(s) of the Additional Owner Utilities pursuant to Paragraph 7(b) of the Original Agreement shall credit the Developer with an appropriate amount of the agreed Betterment amount, proportionate to the percentage of completion reflected in such invoice. The final invoice submitted for Adjustment(s) of the Additional Owner Utilities pursuant to Paragraph 7(a) of the Original Agreement shall reflect the full amount of the agreed Betterment credit. For each invoice described in this paragraph, the credit for Betterment shall be applied before calculating the Developer's share (pursuant to Paragraph 1(e) of this Amendment) of the cost of the Adjustment work. No other adjustment (either up or down) shall be made based on actual Betterment costs.

☐ The Owner is responsible for the actual cost of the identified Betterment, determined by *multiplying* (a) the Betterment percentage stated in Paragraph 1(g) of this Amendment, by (b) the actual cost of all work performed by the Owner pursuant to this Amendment (including work attributable to the Betterment), as invoiced by the Owner to the

Developer. Accordingly, each invoice submitted for Adjustment of the Additional Owner Utilities pursuant to either Paragraph 7(a) or Paragraph 7(b) of the Original Agreement shall credit the Developer with an amount calculated by *multiplying* (x) the Betterment percentage stated in Paragraph 1(g) of this Amendment, by (y) the amount billed on such invoice.

(i) The determinations and calculations of Betterment described in this Amendment shall exclude right of way acquisition costs. Betterment in connection with ROW acquisition is addressed in Paragraph 16 of the Original Agreement.

(j) Owner and the Developer agree to refer to this Amendment, designated by the "Amendment No." and "Agreement number" indicated on page 1 above, on all future correspondence regarding the Adjustment work that is the subject of this Amendment and to track separately all costs relating to this Amendment and the Adjustment work described herein.

(k) *[Include any other proposed amendments in compliance with the applicable Law.]*

2. **General**.

(a) All capitalized terms used in this Amendment shall have the meanings assigned to them in the Original Agreement, except as otherwise stated herein.

(b) This Amendment may be executed in any number of counterparts. Each such counterpart hereof shall be deemed to be an original instrument but all such counterparts together shall constitute one (1) and the same instrument.

(c) Except as amended hereby, the Original Agreement shall remain in full force and effect. In no event shall the responsibility, as between the Owner and the Developer, for the preparation of the Plans and the Adjustment of the Owner Utilities be deemed to be amended hereby.

(d) This Amendment shall become effective upon the later of (a) the date of signing by the last party (either the Owner or the Developer) signing this Amendment, and (b) the completion of TxDOT's review and approval as indicated by the signature of TxDOT's representative below.

APPROVED BY:

TEXAS DEPARTMENT OF TRANSPORTATION

By: Donald C. Toner, Jr., SR/WA
[Printed Name]

By: _____
Authorized Signature

_____ [*Title*]
Strategic Projects Division

Date: _____

OWNER

By: _____
[Print Owner Name]

By: _____
Duly Authorized Representative

_____ [*Title*]
_____ [*Company*]

Date: _____

DEVELOPER

By: _____
[Print Name]

By: _____
Duly Authorized Representative

_____ [*Title*]
_____ [*Company*]

Date: _____

Notice of Confidentiality Rights: If you are a natural person, you may remove or strike any of the following information from this instrument before it is filed for record in the public records: your Social Security Number or your Driver's License Number.

QUITCLAIM DEED

THE STATE OF TEXAS §
§
COUNTY OF § **KNOW ALL MEN BY THESE PRESENTS:**

That, of the County of , State of Texas, hereinafter referred to as Grantors, whether one or more, for and in consideration of the sum of Dollars ($) and other good and valuable consideration to Grantors in hand paid by the State of Texas, acting by and through the Texas Transportation Commission, the receipt of which is hereby acknowledged, and for which no lien is retained, either expressed or implied, have Quitclaimed and do by these presents Bargain, Sell, Release and forever Quitclaim unto the State of Texas all of Grantors' right, title, interest, claim and demand in and to that certain tract or parcel of land, situated in the County of , State of Texas, more particularly described in Exhibit "A," attached hereto and incorporated herein for any and all purposes.

Type in District description of acquisition here.

TO HAVE AND TO HOLD for said purposes together with all and singular the rights, privileges, and appurtenances thereto in any manner belonging unto the said State of Texas forever.

IN WITNESS WHEREOF, this instrument is executed on this the day of , .

_____ _____

_____ _____

_____ _____

Acknowledgement

State of Texas
County of

This instrument was acknowledged before me on _____

by_____.

_____
Notary Public's Signature

Corporate Acknowledgment

State of Texas
County of

This instrument was acknowledged before me on _____by

_____, _____

of _____, a _____

corporation, on behalf of said corporation.

_____
Notary Public's Signature

Utility Installation Request

Form SPD-ROW-1082
(Rev 12109)

PERMIT NUMBER		
GLOBAL POSITIONING SYSTEM COORDINATES (GPS) NORTH AMERICAN DATUM 1983, (1993 ADJUSTMENT) IN DECIMAL DEGREES(DD)		
	LATITUDE (DD)	LONGITUDE (DD)
BEGIN		
END		

To the Texas Transportation Commission

c/o District Engineer, Texas Department of Transportation Date____________

______________________________ , Texas

Formal notice is hereby given that _

proposes to place a _

line within the right of way of _________ , RM __________, Displ. __________ , to RM __________ Displ. __________ in

____________________County Texas, MNT Sec. No._ _ _ _ _ _ _ as follows: (give location, length, general design, etc.

Use additional sheet as needed)

____

____

____

We will construct and maintain the line on the highway right of way as shown on the attached drawing and in accordance with the rules, regulations and policies of the Texas Department of Transportation (TxDOT), and all governing laws, including, but not limited to, the "Texas Engineering Practice Act," "Federal Clean Water Act," the "National Endangered Species Act," "Americans with Disabilities Act," and the "Federal Historic Preservation Act." Upon request by TxDOT at any time, we will submit to TxDOT proof of compliance with all governing laws, rules and regulations before commencement of construction. Plans shall include the design, proposed location, vertical elevations, and horizontal alignments of the facility based on the department's survey datum, the relationship to existing highway facilities and the right of way line, traffic safety and access procedures, and location of existing utilities that may be affected by the proposed utility facility. The location and description of the proposed line and appurtenances is more fully shown by a complete set of drawings attached to this Utility Installation Request (Request). We will give plans to TxDOT for each future proposed modification or expansion to our facility and TxDOT will have 30 days to review and approve the plans prior to commencement of the work. A new Request may be required as a condition of approval. Our organization will use Best Management Practices to minimize erosion and sedimentation resulting from the proposed installation, and we will revegetate the project area as indicated under "Revegetation Special Provisions." We will also ensure that traffic control measures complying with applicable portions of the Texas Manual of Uniform Traffic Control Devices will be installed and maintained for the duration of this installation.

When installing, modifying or maintaining our utility on controlled access facilities, we shall conform to the Texas Transportation Code, Title 6 Roadways, Chapter 203, Subchapter C, Control of Access, §203.031 (http://www.statutes.legis.state.tx.us/). We shall limit access for servicing this installation to access via (a) frontage roads where provided, (b) nearby or adjacent public roads or streets, (c) trails along or near the highway right of way lines, connecting only to an intersecting road; from any one or all of which entry may be made to the outer portion of the highway right of way for normal service and maintenance operations. Our rights of access to the through traffic roadways and ramps shall be subject to the same rules and regulations that apply to the general public.

It is expressly understood that TxDOT does not purport hereby to grant any right, claim, title or easement in or upon highway right of way. TxDOT may require us to relocate this line, subject to the provisions of governing laws, by giving us at least 30 days written notice. We understand a new Request will be required for the relocation. We will notify TxDOT prior to commencement of any operation which requires pruning of trees so that TxDOT may provide specifications to govern performance of work, including trimming, topping, tree balance, type of cuts, painting cuts and clean up. We understand that these specifications are intended to preserve TxDOT's considerable investment in highway beautification plantings and by reducing damage due to trimming and to protect known endangered species.

Our installation shall not damage any part of the roadway structure or associated appurtenances. We will make adequate provisions to cause minimum inconveniences to the traveling public and adjacent property owners. We will not open-cut driveways or intersecting roadways without specific written permission from the owner.

Following approval, we will begin construction on or after ______________________________

Month/Day/Year

We understand TxDOT may place additional provisions and requirements as listed below, based upon, but not limited to, the type of utility being installed, local site conditions, soil types and traffic.

Additional Provisions and Requirements (for TxDOT input only)
• **General Special Provisions:**
X Are attached.
☐ Are not attached.
• **As-built Plans/Certifications of Construction:**
☐ Are required and shall be certified as accurate by an authorized representative of the company.
☐ Are required and shall be signed and sealed by a State of Texas Licensed Professional Engineer.
☐ Are not required
☐ Certification that utility was installed as approved
• **Re-vegetation Special Provisions:** In order to minimize erosion and sedimentation resulting from the proposed installation, the project area will be re-vegetated:
☐ in accordance with TxDOT's Standard Specification Item 164 which specifies the appropriate grass seed mix to be used, or:
☐ as indicated on the attachment.
TxDOT Representative to be notified 48 hours prior to beginning construction:

If approved, we understand we will assume all risks associated with this installation within the TxDOT right of way. These risks include injuries to our workers, damage to contiguous utility lines that may be in the area and injuries or damage resulting from our failure to properly install and maintain the line.

If the character, use or function of our installation is materially changed from that approved under this Request, we will notify TxDOT within 30 days after the change. In the event of a voluntary or involuntary loss of public utility status, or other legal authority for longitudinal placement of the utility facility in the highway, or there is an abandonment of the facility without the approval of TxDOT, we will at our expense remove the unauthorized portion of the facility from the right of way.

If installation of the line is not begun prior to the 91st calendar day from date of issuance, we acknowledge that, unless otherwise extended, TxDOT's approval of this Request will automatically **expire**, and we will be required to resubmit our Request. All Request submissions, whether due to expiration of approval under this paragraph or new Requests for modifications and relocations shall be in accordance with the governing laws, rules, regulations and policies existing at the time of submission. In the event we fail to comply with any or all of the requirements as set forth in this Request, the State may take such action as it deems appropriate to compel our compliance.

By signing as/for the requestor below, I certify that I am authorized to represent the requestor, that I agree to the provisions and requirements included in this Utility Installation Request, and our commencement of construction will further attest to our review and acceptance of said additional provisions and requirements.

REQUESTOR			APPROVED BY TxDOT		
Date:			**Date:**		
By:			**By:**		
Signature:			**Signature:**		
Title:			**Title:**		
Address:			**Address:**		
City	**State**	**Zip Code**	**City**	**State**	**Zip Code**
( )			( )		
Area Code	**Telephone Number**		**Area Code**	**Telephone Number**	

Privacy Statement

Contact/Help

GENERAL SPECIAL PROVISION

1. Requestor agrees to perform all project coordination, scheduling, notifications, permit requirements and submittals through TxDOT's designated design-build contractor or Developer listed below:

[Insert contractors contact information]

UTILITY JOINT USE ACKNOWLEDGEMENT

U-Number:
ROW CSJ: County:
District: Highway:
Federal Project No.: From:
Projected Highway Letting Date: To:

WHEREAS, the State of Texas, ("**State**"), acting by and through the Texas Department of Transportation ("**TxDOT**"), proposes to make certain highway improvements on that section of the above-indicated highway; and

WHEREAS, the , ("**Utility**"), proposes to remain in place, adjust or relocate certain of its facilities, if applicable, and retain title to any property rights it may have on, along or across, and within or over such limits of the highway right of way as indicated by the location map attached hereto.

NOW, THEREFORE, in consideration of the covenants and acknowledgements herein contained, the parties mutually agree as follows:

It is agreed that joint usage for both highway and utility purposes will be made of the area within the highway right of way limits as such area is defined and to the extent indicated on the aforementioned plans or sketches. Nothing in this Acknowledgement shall serve to modify or extinguish any compensable property interest vested in the **Utility** within the above described area. If the facilities shown in the aforementioned plans need to be altered or modified or new facilities constructed to either accommodate the proposed highway improvements or as part of **Utility's** future proposed changes to its own facilities, **Utility** agrees to notify **TxDOT** at least 30 days prior thereto, and to furnish necessary plans showing location and type of construction, unless an emergency situation occurs and immediate action is required. If an emergency situation occurs and immediate action is required, **Utility** agrees to notify **TxDOT** promptly. If such alteration, modification or new construction is in conflict with the current highway or planned future highway improvements, or could endanger the traveling public using said highway, **TxDOT** shall have the right, after receipt of such notice, to prescribe such regulations as necessary for the protection of the highway facility and the traveling public using said highway. Such regulations shall not extend, however, to requiring the placement of intended overhead lines underground or the routing of any lines outside of the area of joint usage above described.

If **Utility's** facilities are located along a controlled access highway, **Utility** agrees that ingress and egress for servicing its facilities will be limited to frontage roads where provided, nearby or adjacent public roads and streets, or trails along or near the highway right of way lines which only connect to an intersecting road. Entry may be made to the outer portion of the highway right of way from any one or all access points. Where supports, manholes or other appurtenances of the **Utility's** facilities are located in medians or interchange areas, access from the through-traffic roadways or ramps will be allowed by permit issued by the **State** to the **Utility** setting forth the conditions for policing and other controls to protect highway users. In an emergency situation, if the means of access or service operations as herein provided will not permit emergency repairs as required for the safety and welfare of the public, the **Utility** shall have a temporary right of access to and from the through-traffic roadways and ramps as necessary to accomplish the required repairs, provided **TxDOT** is notified immediately when such repairs are initiated and adequate provision is made by **Utility** for the convenience and safety of highway traffic. Except as expressly provided herein, the **Utility's** rights of access to the through-traffic roadways and/or ramps shall be subject to the same rules and regulations as apply to the general public.

If **Utility's** facilities are located along a non-controlled access highway, the **Utility's** rights of ingress and egress to the through-traffic roadways and/or ramps are subject to the same rules and regulations as apply to the general public.

Participation in actual costs incurred by the **Utility** for any future adjustment, removal or relocation of utility facilities required by highway construction shall be in accordance with applicable laws of the State of Texas.

It is expressly understood that **Utility** conducts the new installation, adjustment, removal, and/or relocation at its own risk, and that **TxDOT** makes no warranties or representations regarding the existence or location of utilities currently within its right of way.

The **Utility** and the **State**, by execution of this Acknowledgement , do not waive or relinquish any right that they may have under the law.

The signatories to this Acknowledgement warrant that each has the authority to enter into this Acknowledgement on behalf of the party represented.

IN WITNESS WHEREOF, the parties hereto have affixed their signatures.

Owner: _____
Name of Utility

By: _____
Authorized Signature

_____
Print or Type Name

Title: _____

Date: _____

The State of Texas

Executed and approved for the Texas Transportation Commission for the purpose and effect of activating and/or carrying out the orders, established policies or work programs heretofore approved and authorized by the Texas Transportation Commission.

By: _____
Donald C. Toner, Jr. SR/WA
Director – Strategic Projects Right of Way
Strategic Projects Division
Texas Department of Transportation

Date: _____

Texas Department of Transportation

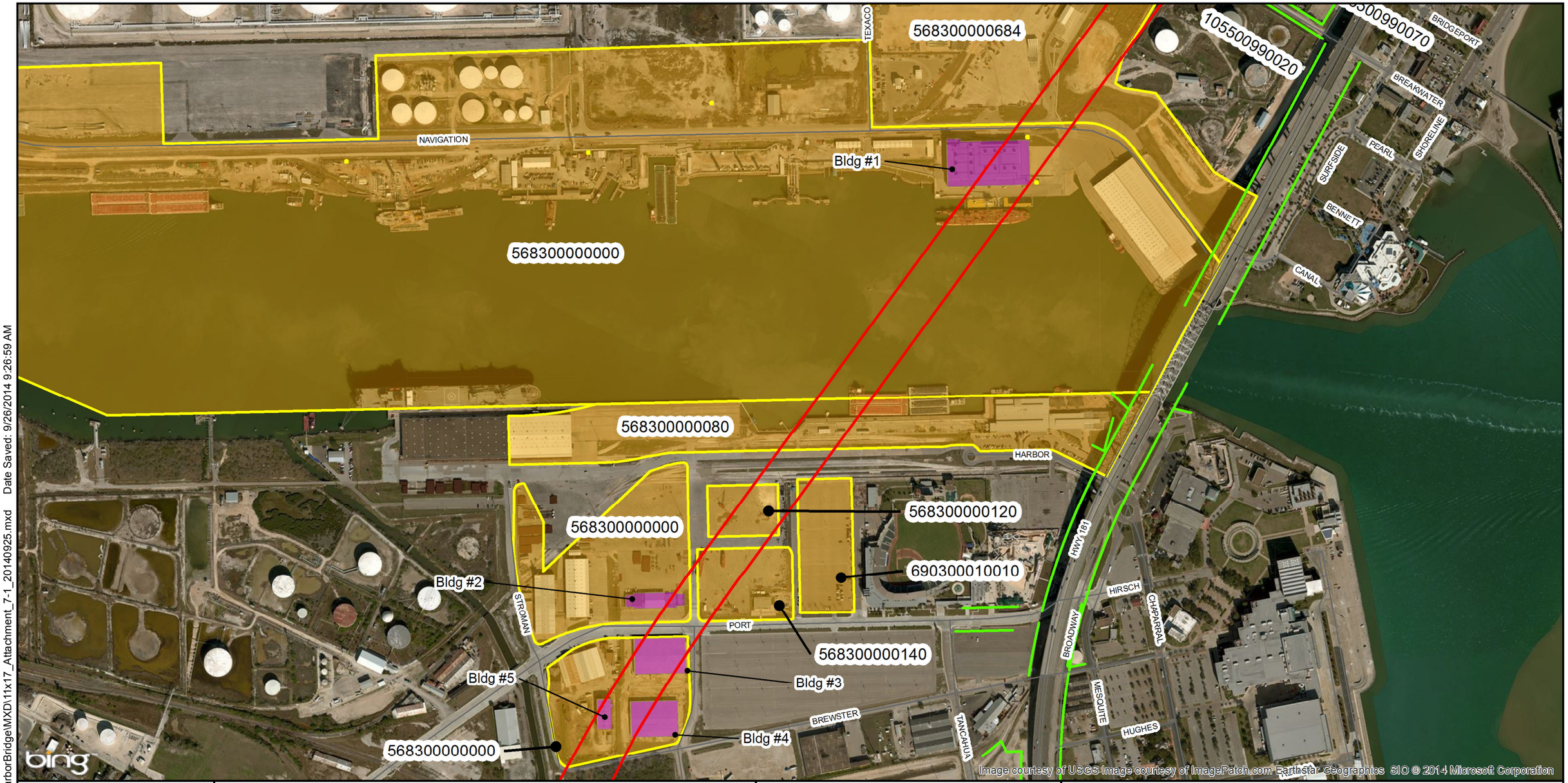
BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 7-1
PORT AUTHORITY BUILDINGS / IMPROVEMENTS TO BE DEMOLISHED



Data Source

Parcels: TxDOT
ROW: TxDOT
Structure Data: URS Corporation

Legend

- EXIST ROW
- RED ROW
- Buildings to be Demolished
- Port Property With Approved ROE Access

N
W E
S

1:6,000

1" = 500'

0 500
Feet

HNTB

Texas Department of Transportation

Attachment 7 - 1

Harbor Bridge

Port Authority Buildings/Improvements to be Demolished

09/26/2014

Path: \\SANW00\Jobs\59339\GIS\HarborBridge\MXD\11x17_Attachment_7-1_20140925.mxd Date Saved: 9/26/2014 9:26:59 AM

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

Design-Build Project

ATTACHMENT 13-1
STRUCTURE PROVISIONS

Item 400

1. Excavation and Backfill for Structures

1. DESCRIPTION

Excavate for placement and construction of structures and backfill structures. Cut and restore pavement.

2. MATERIALS

Use materials that meet the requirements of the following Items.

- Item 401, "Flowable Backfill"
- Item 421, "Hydraulic Cement Concrete"
- DMS-4600, "Hydraulic Cement"

3. CONSTRUCTION

3.1. Excavation.

3.1.1. **General**. Excavate to the lines and grades shown on the Design Documents. Provide slopes, benching, sheeting, bracing, pumping, and bailing as necessary to maintain the stability and safety of excavations up to 5 ft. deep. Excavation protection for excavations deeper than 5 ft. are governed by Item 402, "Trench Excavation Protection" and Item 403, "Temporary Special Shoring." Use satisfactory excavated material as backfill or as embankment fill. Dispose of material not incorporated into the final project off the right of way in accordance with federal, State, and local regulations.

Keep any topsoil that has been removed separate, and replace it, as nearly as feasible, in its original position when excavating for installation of structures across private property or beyond the limits of the embankment. Restore the area to an acceptable condition.

Excavate drilled shafts in accordance with Item 416, "Drilled Shaft Foundations."

3.1.1.1. **Obstructions**. Remove obstructions to the proposed construction, including trees and other vegetation, debris, and structures, over the width of the excavation to a depth of 1 ft. below the bottom of excavation. Remove as required to clear the new structure and plug in an approved manner if abandoned storm drains, sewers, or other drainage systems are encountered. Restore the bottom of the excavation to grade by backfilling after removing obstructions in accordance with this Item. Dispose of surplus materials in accordance with federal, State, and local regulations.

3.1.1.2. **Excavation in Streets**. Cut pavement and base to neat lines when structures are installed in streets, highways, or other paved areas. Restore pavement structure after completion of excavation and backfilling.

Maintain and control traffic in accordance with the approved traffic control plan and the TMUTCD.

3.1.1.3. **Utilities**. Conduct Work with minimum disturbance of existing utilities, and coordinate Work in or near utilities with the utility owners. Inform utility owners before Work begins, allowing them enough time to identify, locate, reroute, or make other adjustments to utility lines.

Avoid cutting or damaging underground utility lines that are to remain in place. Promptly notify the utility company if damage occurs. Provide temporary flumes across the excavation while open if an active sanitary sewer line is damaged during excavation, and restore the lines when backfilling has progressed to the original bedding lines of the cut sewer.

3.1.1.4. **De-Watering**. Construct or place structures in the presence of water only if approved. Place precast members, pipe, and concrete only on a dry, firm surface. Remove water by bailing, pumping, well-point installation, deep wells, underdrains, or other approved method.

Remove standing water in a manner that does not allow water movement through or alongside concrete being placed if structures are approved for placement in the presence of water. Pump or bail only from a suitable sump separated from the concrete Work while placing structural concrete or for a period of at least 36 hr. thereafter. Pump or bail during placement of seal concrete only to the extent necessary to maintain a static head of water within the cofferdam. Pump or bail to de-water inside a sealed cofferdam only after the seal has aged at least 36 hr.

Place a stabilizing material in the bottom of the excavation if the bottom of an excavation cannot be de-watered to the point the subgrade is free of mud or it is difficult to keep reinforcing steel clean. Use flexible base, cement-stabilized base or backfill, lean concrete, or other approved stabilizing material. Provide concrete with at least 275 lb. of cement per cubic yard, if lean concrete is used, and place to a minimum depth of 3 in.

3.1.2. **Bridge Foundations and Retaining Walls**. Do not disturb material below the bottom of footing grade. Do not backfill to compensate for excavation that has extended below grade. Fill the area with concrete at the time the footing is placed if excavation occurs below the proposed footing grade.

Take core samples to determine the character of the supporting materials if requested. Provide an intact sample adequate to judge the character of the founding material. Take these cores when the excavation is close to completion. Cores should be approximately 5 ft. deeper than the proposed founding grade.

Remove loose material if the founding stratum is rock or another hard material, and clean and cut it to a firm surface that is level, stepped, or serrated. Clean out soft seams, and fill with concrete at the time the footing is placed.

Place the foundation once the excavation has been inspected and authorized changes have been made to provide a uniform bearing condition if the material at the footing grade of a retaining wall, bridge bent, or pier is a mixture of compressible and incompressible material.

3.1.3. **Cofferdams**. The term “cofferdam” designates any temporary or removable structure constructed to hold surrounding earth, water, or both out of the excavation whether the structure is formed of soil, timber, steel, concrete, or a combination of these. Use pumping wells or well points for de-watering cofferdams if required.

Submit details and design calculations for sheet-pile or other types of cofferdams requiring structural members bearing the seal of a Registered Professional Engineer for review before constructing the cofferdam. TxDOT reserves the right to reject designs. Design structural systems to comply with the AASHTO *Standard Specifications for Highway Bridges* or AASHTO *LRFD Bridge Design Specifications*. Interior dimensions of cofferdams must provide enough clearance for the construction, inspection, and removal of required forms and, if necessary, enough room to allow pumping outside the forms. Extend sheet-pile cofferdams well below the bottom of the footings, and make concrete seals as well braced and watertight as practicable.

Use Class E concrete for foundation seals. Place concrete foundation seals in accordance with Item 420, "Concrete Substructures."

Make the excavation deep enough to allow for swelling of the material at the base of the excavation during pile-driving operations when it is impractical to de-water inside a cofferdam and a concrete seal is to be placed around piling driven within the cofferdam. Remove swelling material to the bottom of the seal grade after driving the piling. Remove the foundation material to exact footing grades where it is possible to de-water inside the cofferdam without placing a seal after driving piling. Do not backfill a foundation to compensate for excavation that has been extended below grade; fill such areas below grade with concrete at the time the seals or footings are placed.

Remove cofferdams after completing the substructure without disturbing or damaging the structure.

3.1.4. **Culverts and Storm Drains**. When the design requires special bedding conditions for culverts or storm drains, an excavation diagram shall be shown on the Design Documents. Do not exceed these limits of excavation.

Construct pipe structures in an open cut with vertical sides extending to a point 1 ft. above the pipe. When site conditions or the Design Documents do not prohibit sloping the cut, the excavation may be stepped or laid back to a stable slope beginning 1 ft. above the pipe. Maintain the stability of the excavation throughout the construction period.

Construct the embankment for pipe to be installed in fill above natural ground to an elevation at least 1 ft. above the top of the pipe, and then excavate for the pipe.

3.1.4.1. **Unstable Material**. Remove the material to a depth of no more than 2 ft. below the grade of the structure when unstable soil is encountered at established footing grade. Replace soil removed with stable material in uniform layers no greater than 8 in. deep (loose measurement). Each layer must have enough moisture to be compacted by rolling or tamping as required to provide a stable foundation for the structure.

Use special materials such as flexible base, cement-stabilized base, cement-stabilized backfill, or other approved material when it is not feasible to construct a stable foundation as outlined above.

3.1.4.2. **Incompressible Material**. Remove the incompressible material to 6 in. below the footing grade, backfill with an approved compressible material, and compact in accordance with Section 400.3.3., "Backfill" if rock, part rock, or other incompressible material is encountered at established footing grade while placing prefabricated Elements.

3.2. **Shaping and Bedding.** Place at least 2 in. of fine granular material for precast box sections on the base of the excavation before placing the box sections. Use bedding as shown in Figure 1 for pipe installations. Use Class C bedding. TxDOT may require the use of a template to secure reasonably accurate shaping of the foundation material. Undercut the excavation at least 4 in. where cement-stabilized backfill is indicated on the Design Documents and backfill with stabilized material to support the pipe or box at the required grade.

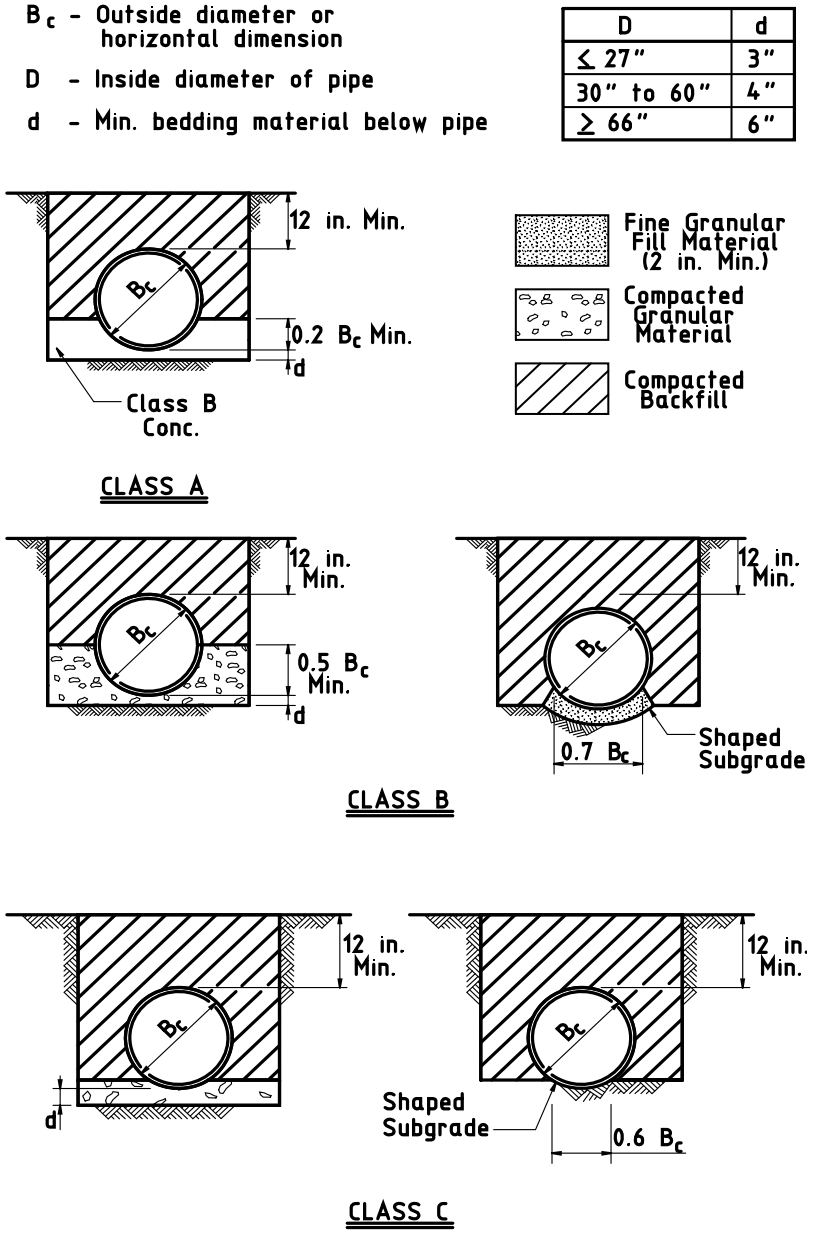


Figure 1
Bedding diagrams

3.3. **Backfill.**

3.3.1. **General**. Backfill the excavation after placement of the permanent structure as soon as practical. Use backfill free from stones large enough to interfere with compaction; large or frozen lumps that

will not break down readily under compaction; and wood or other extraneous material. Obtain backfill material from excavation or from other sources.

Place backfill in layers no greater than 10 in. deep (loose measurement) in areas not supporting a completed roadbed, retaining wall, or embankment. Place backfill in uniform layers no greater than 8 in. deep (loose measurement) in areas supporting a portion of a roadbed, retaining wall, or embankment. Compact each layer to meet the density requirements of the roadbed, retaining wall, embankment material.

Bring each layer of backfill material to the moisture content needed to obtain the required density. Use mechanical tamps or rammers to compact the backfill. Rollers may be used to compact backfill if feasible.

Cohesionless materials may be used for backfilling. Use cohesionless materials that conform to the requirements of Table 1.

Table 1

Cohesionless Material Gradation Limits

Sieve Size	Percent Retained
3 in.	0
No. 10	See Note[1]
No. 200	90-100

No. 10 sieve requirements are 0 to 30 percent retained when used as aggregate for cement-stabilized backfill.

Compact cohesionless materials using vibratory equipment, water-ponding, or a combination of both.

3.3.2. **Bridge Foundations, Retaining Walls, Manholes/Inlets and Box Culverts**. Place backfill against the structure only after the concrete has reached the design strength required in Item 421, "Hydraulic Cement Concrete."

Backfill retaining walls with material meeting the requirements of Item 423, "Retaining Walls." Backfill around bridge foundations, manholes/inlets and culverts using material with particles no more than 4 in. in greatest dimension and a gradation that permits thorough compaction. Use rock or gravel mixed with soil if the percentage of fines is enough to fill all voids and ensure a uniform and thoroughly compacted mass of proper density.

Use mechanical tamps and rammers to avoid damage to the structure where backfill material is being placed too close to the structure to permit compaction with blading and rolling equipment.

Avoid wedging action of backfill against structures. Step or serrate slopes bounding the excavation to prevent such action. Place backfill uniformly around bridge foundations. Place backfill equally and in uniform layers along both sides of manholes/inlets and culverts.

TxDOT may require backfilling of structures excavated into hard, erosion-resistant material, and subject to erosive forces, with stone or lean concrete.

Box culverts may be opened to traffic as soon as enough backfill and embankment has been placed over the top to protect culverts against damage from heavy construction equipment. Repair damage to culvert caused by construction traffic.

3.3.3. **Pipe**. Bring backfill material to the proper moisture condition after installing bedding and pipe as required and place it equally along both sides of the pipe in uniform layers no greater than 8 in. deep (loose measurement). Compact each lift mechanically. Thoroughly compact materials placed under the haunches of the pipe to prevent damage or displacement of the pipe. Place backfill in this manner to the top-of-pipe elevation. Place and compact backfill above the top of the pipe in accordance with Section 400.3.3.1., "General."

TxDOT may reject backfill material containing more than 20% by weight of material retained on a 3-in. sieve with large lumps not easily broken down or that cannot be spread in loose layers. Material excavated by a trenching machine shall generally meet the requirements of this Section as long as large stones are not present.

Place and compact additional material 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 until the minimum cover has been provided.

3.3.4. **Cement-Stabilized Backfill**. Backfill the excavation to the elevations shown with cement-stabilized backfill when shown on the Design Documents. Use cement-stabilized backfill that contains aggregate conforming to the gradation limits shown in Table 1, water, and a minimum of 7% hydraulic cement based on the dry weight of the aggregate, in accordance with Tex-120-E.

Place cement-stabilized backfill equally along the sides of structures to prevent strain on or displacement of the structure. Fill voids when placing cement-stabilized backfill. Use hand-operated tampers if necessary to fill voids.

3.3.5. **Flowable Backfill**. Backfill the excavation with flowable backfill to the elevations indicated when shown on the Design Documents. Prevent the structure from being displaced during the placement of the flowable fill, and prevent flowable fill from entering manholes/inlets and culverts, and drainage structures.

Item 401

2. Flowable Backfill

1. DESCRIPTION

Furnish and place flowable backfill for trench, hole, or other void.

2. MATERIALS

Use materials from prequalified sources listed on TxDOT's website. Use materials from non-listed sources only when tested and approved before use. Allow 30 Days for sampling, testing, and reporting results for non-listed sources. Do not combine approved material with unapproved material.

2.1. Cement. Furnish cement in accordance with DMS-4600, "Hydraulic Cement."

2.2. Fly Ash. Furnish fly ash in accordance with DMS-4610, "Fly Ash."

2.3. **Chemical Admixtures.** Furnish chemical admixtures in accordance with DMS-4640, "Chemical Admixtures for Concrete." Use specialty type admixtures to enhance the flowability, reduce shrinkage, and reduce segregation by maintaining solids in suspension when necessary. Use and proportion all admixtures in accordance with the manufacturer's recommendations.

2.4. **Fine Aggregate.** Provide fine aggregate that will stay in suspension in the mortar to the extent required for proper flow and that meets the gradation requirements of Table 1.

Table 1

Aggregate Gradation Chart

Sieve Size	Percent Passing
3/4 in.	100
No. 200	0–30

Test fine aggregate gradation in accordance with Tex-401-A.

Plasticity Index (PI) must not exceed 6 when tested in accordance with Tex-106-E.

2.5. **Mixing Water.** Use mixing water in accordance with Item 421, "Hydraulic Cement Concrete."

3. CONSTRUCTION

Submit a construction method and plan, including mix design, for approval. Provide a means of filling the entire void area, and be able to demonstrate this has been accomplished. Prevent the movement of any inserted structure from its designated location. Remove and replace or correct

the problem if voids are found in the fill or any of the requirements are not met as shown on the Design Documents.

Furnish a mix meeting the requirements of Table 2.

Table 2

Flowable Fill Mix Design Requirements

Property	Excavatable	Non-Excavatable	Test Method
28-Day Compressive Strength[1], psi	80 to 200	>200	ASTM D4832
Consistency[2], min. diameter, in.	8		ASTM D6103
Unit Weight, pcf	90 to 125	100 to 145	ASTM D6023
Air Content, %	10 to 30	5 to 15	ASTM D6023

Average of two specimens.

Mixture must not segregate.

Mix the flowable fill using a central-mixed concrete plant, ready-mix concrete truck, pug mill, or other approved method.

Furnish all labor, equipment, tools, containers, and molds required for sampling, making, transporting, curing, removal, and disposal of test specimens. Furnish test molds meeting the requirements of Tex-447-A. Transport, strip, and cure the test specimens as scheduled at the designated location. Cure test specimens in accordance with Tex-447-A. Dispose of used, broken specimens in an approved location and manner.

Item 403

3.Temporary Special Shoring

1. DESCRIPTION

Furnish and install temporary shoring to hold the surrounding earth, water, or both out of the Work area.

2. MATERIALS

Furnish new or used materials. Furnish materials that meet the requirements of Item 423, "Retaining Walls," when using temporary Mechanically Stabilized Earth (MSE) walls. Furnish materials that meet the requirements of Item 410, "Soil Nails," or Item 411, "Rock Nails," when using temporary nailed walls (rock or soil).

3. CONSTRUCTION

Developer is responsible for the temporary special shoring design. Submit details and design calculations bearing the seal of a Registered Professional Engineer before constructing the shoring. TxDOT reserves the right to reject designs. Design the shoring to comply with OSHA Standards and Interpretations, 29 CFR 1926, Subpart P, "Excavations." Design structural systems to comply with AASHTO *Standard Specifications for Highway Bridges* or AASHTO *LRFD Bridge Design Specifications*. Design shoring subject to railroad loading to comply with the AREMA *Manual for Railway Engineering* and any additional requirements of the railway being supported.

Provide vertical or sloped cuts, benches, shields, support systems, or other systems to provide the necessary protection in accordance with the approved design. Construct temporary MSE walls, when used, in accordance with Item 423, "Retaining Walls." Construct temporary nailed walls (rock or soil), when used, in accordance with Item 410, "Soil Nails," or Item 411, "Rock Nails."

Item 404

4. Driving Piling

1. DESCRIPTION

Drive piling.

2. EQUIPMENT

2.1. **Driving Equipment.** Use power hammers for driving piling with specified bearing resistance. Use power hammers that comply with Table 1. Gravity hammers may be used for driving sheet piling if no required design load is shown on the Design Documents.

For initial rating of diesel hammers to determine compliance with the requirements of Table 1, the height of fall of the ram of the single-acting (open-end) hammer must be 7 ft. For a double-acting (enclosed ram) hammer, the energy rating must be 85% of the rated output by the manufacturer.

A hammer that produces less energy than required by Table 1 may be approved if a wave equation analysis indicates the hammer can drive the specified pile against a bearing resistance of 3 times the required design load before reaching 0.l in. of penetration per blow. The bearing resistance of the piling driven with this particular equipment shall be determined in accordance with the Wave Equation Method.

Use an air compressor that supplies the volume and pressure specified by the manufacturer of the hammer. Provide an accurate pressure gauge.

Maintain the valve mechanism and other parts of power hammers so the hammer will operate at the speed and stroke length specified by the manufacturer.

Equip enclosed ram diesel hammers with a gauge and provide charts to evaluate the equivalent energy being produced. Calibrate the gauge before Work begins, whenever gauge accuracy is in question, and at least once each 6 months.

Provide an electronic stroke indicator and blow count logging device.

Table 1

Size of Driving Equipment

Piling Type	Hammer Type	Ram Weight (lb.)	Maximum Ram Stroke (ft.)	Minimum Hammer Energy (ft.-lb.)[1]
Steel	Air, Hydraulic	3,000 min.	5	Larger of 250R or 2-1/2 Wp
	Diesel	2,000 min.	10	Larger of 250R or 2-1/2 Wp
Concrete	Air, Hydraulic	3,000 min., but not less than 1/4 Wp	5	250R, but not less than 1 ft.-lb. per lb. of pile weight

Piling Type	Hammer Type	Ram Weight (lb.)	Maximum Ram Stroke (ft.)	Minimum Hammer Energy (ft.-lb.)[1]
	Diesel	2,700 min., but not less than 1/4 Wp	8[2]	250R, but not less than 1 ft.-lb. per lb. of pile weight

R = Design load in tons. Wp = Weight of pile in pounds based on plan length.

Diesel hammers with less ram weight or greater ram stroke are permitted if a wave equation analysis indicates the combination of ram weight, stroke, and cushioning will not overstress the piling.

Provide hammer cushion consisting of layers of micarta and aluminum or other material specifically produced and approved for this application..

Regulate the height of fall when using gravity hammers to avoid damage to the piling.

Drive all test piling in a structure or in any approved segment of it with the same hammer, and use the same type and size hammer to drive the remainder of the piling in the structure or segment.

Equip pile drivers with leads constructed to allow freedom of movement of the hammer and to provide adequate support to the pile during driving. The longitudinal axis of the leads, hammer, and pile should coincide.

Ensure leads are long enough, except where piling is driven through water, that a follower will not be necessary. Use 1 pile in each 10 that is long enough to permit driving without a follower when driving piling underwater and a follower is required. Drive it as a test pile for proper correlation of the follower-driven piling.

Hammers designed to operate underwater may be used for underwater driving without a follower and without the correlation required for other hammers.

2.2. **Protection of Pile Heads.** Use a steel driving head (helmet) suitable for the type and size of piling. Drive steel H-piling and sheet piling with a helmet compatible with the specific pile shape driven.

Provide a cushion block for concrete piling between the driving head and the top of the pile. Use a cushion block that is a minimum of 4 in. thick for short piling (50 ft. or less) and at least 6 in. thick for longer piling. Use multiple layers of one of the following:

3/4-in. or 1-in. structural grade southern pine or fir plywood;
green oak or gum, with the grain of the wood horizontal; or
other approved material specifically produced for this application.

Pay special attention to the condition of the cushioning material. Drive no more than 3 piles with one cushion block. Change cushioning more frequently if necessary to prevent damage. Immediately replace any cushion block that has ignited. Do not use a tight-fitting driving helmet for concrete piling. Allow room for slight movement, but ensure the driving helmet is not large enough for the pile head to rotate freely. Center concrete piling and cushion within the helmet throughout the driving operation.

3. CONSTRUCTION

This Item uses the following terms:

- **Foundation Piling**. Piling placed under interior bent footings or retaining wall abutment footings.
- **Trestle Piling**. Piling embedded directly into the abutment cap or interior bent cap.
- **Sheet Piling**. Retaining piling not considered either foundation or trestle piling.
- **Test Piling**. Specific piling driven to investigate site conditions and determine regular piling lengths.
- **Test-Loaded Piling**. Specific piling driven and test-loaded to investigate site conditions and determine regular piling lengths. Do not fabricate regular piling until test loading and analysis is completed.
- **Regular Piling**. All piling other than test piling and test-loaded piling.

Do not fabricate regular piling until test pile-driving and analysis or test loading and analysis is completed.

Complete the embankment at bridge ends before driving abutment piling. Refer to Item 423, "Retaining Walls," for provisions on piling that passes through the structural volume of retaining walls.

Do not drive foundation piling until the footing excavation is complete. Drive concrete piling once the piling concrete, including build-ups, has aged at least 14 Days. Do not drive piling in a saltwater environment until the piling concrete, including build-ups, has aged at least 21 Days after concrete placement.

Re-drive any piling that is raised when driving adjacent piling. Withdraw and replace any broken, split, or displaced piling, or correct it after a design analysis.

To control excessive stresses resulting in damage to the piling during driving, the following, alone or in combination, may be required:

increase in cushion thickness,
reduction of ram stroke,
heavier ram with a shorter stroke,
use of pilot holes or jetting when driving through hard or alternating hard and soft strata.

3.1. **Tolerance for Driving.** Drive piling to the required vertical or batter alignment, within the tolerances of this Section. Drive piling in pilot holes or with templates when necessary to comply with tolerances. Cut off piling reasonably square at the elevation shown on the Design Documents, with a tolerance of no more than 2 in. above or below established cutoff grade. Submit for approval a structural analysis and proposed corrective action, signed and sealed by a Registered Professional Engineer when tolerances are exceeded.

3.1.1. **Trestle Piling**.

- Transverse to the centerline of the bent, the top of the piling may be no more than 2 in. from the position shown on the Design Documents.
- Parallel to the centerline of the bent, the top of the piling may be no more than 4 in. from the position shown on the Design Documents.

3.1.2. **Foundation Piling**.

- The top of each pile may be no more than 4 in. in any direction from the position shown on the Design Documents.
- The center of gravity of the piling group may be no more than 3 in. from the center of gravity determined from plan location.
- The minimum edge distance for piling in a footing is 5 in.

3.2. **Penetration.** Piling lengths shown on the Design Documents are the lengths estimated to give required bearing and for estimating purposes only. Drive piling to plan tip elevations or to greater depths as necessary to obtain the required bearing resistance shown on the Design Documents.

Establish regular pile lengths on the basis of the test data when test piling or test-loaded piling is used. Drive regular piling to this approximate elevation in these cases and to greater depths as required to obtain the required bearing resistance.

Provide either pilot holes, jetting, or a combination of both for unusually hard driving conditions, typically less than 0.1 in. of penetration per blow if plan penetration is not obtained. Reduce penetration upon approval when the piling is advanced to within 5 ft. of plan length unless other penetration requirements or bearing evaluation methods govern.

3.3. **Pilot Holes.** Extend pilot holes no more than 5 ft. below the bottom of footings for foundation piling or 10 ft. below finished ground line for trestle piling. Determine the size and depth of pilot holes from the results of trial operations on the first piling driven or from available test pile data when deeper ones are required. Obtain approval for any excess depth or size of pilot holes. The maximum hole diameter permitted shall be approximately 4 in. less than the diagonal of square piling or steel H-piling and 1 in. less than the diameter of round piling.

Extend pilot holes through all embankments to natural ground when driving concrete piling.

Where a pilot hole is required in granular material that cannot be sealed off by ordinary drilling methods, a casing may be required around the boring device deep enough to prevent loose material from falling into the pilot hole.

Drive the piling below the depth of the pilot hole a minimum of 1 ft. or 100 blows, but not less than the required bearing resistance shown on the Design Documents. Do not drive piling beyond the point where the penetration per blow is less than 0.1 in. as determined by an average of 10 blows. Stop driving if damage to the pile is apparent.

3.4. **Jetting.** Jetting is permitted when the specified penetration cannot be obtained by driving and pilot holes or other methods are not feasible. Submit details of the proposed methods for approval before jetting.

Jet as required in conjunction with driving but only to the approved depth. Use enough power for jetting operations to simultaneously operate at least two 2-1/2 in. diameter pipes equipped with 3/4-in. nozzles at a pressure of 150 psi. Perform the jetting with 1 or 2 jets as determined and approved from results of trial operations.

Drive the piling below the depth of the jetting a minimum of 1 ft. or 100 blows, but not less than the required bearing resistance shown on the Design Documents. Do not drive piling beyond the point where the penetration per blow is less than 0.1 in. as determined by an average of 10 blows. Stop driving if damage to the pile is apparent.

3.5. **Hammer Formula Method of Bearing Evaluation.** Determine the dynamic bearing resistance of piling by one of the hammer formulas in this Section. If a K factor has been determined based on test piling, test-loaded piling, or other methods, the computed resistance shall be the driving resistance determined based on the appropriate formula multiplied by the K factor.

3.5.1. **Single-Acting Power Hammers**. Use the following formula:

$$P = \frac{2WH}{S + 0.1}$$

where:
P = dynamic resistance in pounds
W = weight of ram in pounds
H = height of fall of ram in feet (field measured)
S = average penetration in inches per blow for the last 20 blows

Determine *H* by an approved electronic stroke indicator and blow count logging device provided by Developer. Pending approval, H can be determined by visual observation of the ram against a calibrated rod mounted on the hammer or by the following formula:

$$H = 16.1 \times \left(\frac{30}{B}\right)^2 - 0.3$$

where *B* = blows per minute

3.5.2. **Double-Acting Power Hammers**. Use the following formula:

$$P = \frac{2E}{S + 0.1}$$

where:
P = dynamic resistance in pounds
E = manufacturer's rated energy in foot-pounds (for double-acting power hammers), or the equivalent energy in foot-pounds determined by a calibrated gauge attached to the hammer and taken when the average penetration in inches per blow is determined (for enclosed ram diesel hammer)
S = average penetration in inches per blow for the last 20 blows

3.5.3. **Other Hammer Types.** Provide a wave equation analysis for each pile, hammer, soil, and load combination for which the driving system is to be used. The analysis shall determine the bearing capacity of the piling.

3.6. **Wave Equation Method of Bearing Evaluation.** Submit the following data when Design Documents specify the bearing capacity of the piling be determined by the wave equation method:

- manufacturer's specification data for the hammer proposed for use, including all modifications and
- complete description and dimensions of all cushioning material used between the pile and helmet and in the cap block, including total thickness of each, and the direction of grain if wood is used.

These data are used to determine the required number of blows per unit of penetration the hammer must deliver to obtain the required bearing resistance.

After evaluation by the wave equation method, any change in the driving equipment may require re-evaluation. Such changes must be approved before further driving.

3.7. **Test Piling.** Drive test piling at locations shown on the Design Documents. Make test piling part of the completed Work, cut off or built up to grade as necessary. Use the required bearing evaluation method to determine bearing resistance.

Initially drive test piling to 3 ft. above plan tip elevation of the regular piling for the structure with the blow count recorded for each foot of driving (for example, drive test piling to 13 ft. above its plan tip elevation if the test piling is 10 ft. longer than regular piling). Retain the cushion if used.

Re-drive the test piling the additional length required by the Design Documents at least 7 Days after the original driving with the same hammer and cushion originally used. Record the blow count for each inch of driving for the first foot, for every 3 in. for the next 2 ft., and for each foot thereafter.

Use the data to determine regular piling lengths and K factors. The K factor shall be determined based on the following formula:

$$K = P_R / P$$

where:
K = a static correction factor applied to the evaluation method
P_R = re-drive bearing (tons) of the test pile determined by the evaluation method
P = original bearing (tons) of test pile determined by the evaluation method

3.8. **Test-Loaded Piling.** Conduct test load in accordance with Item 405, “Foundation Test Load.”

Use the data in determining regular piling lengths and K factors. The K factor shall be determined based on the following formula:

$$K = L / P$$

where:
K = a static correction factor applied to the evaluation method
L = maximum safe static load proven by test load
P = bearing resistance of the test-loaded pile determined by the evaluation method

Item 405

5. Foundation Load Test

1. DESCRIPTION

Load-test piling or drilled shafts.

2. MATERIALS

Provide piling or drilled shafts for test loading as shown on the Design Documents.

3. EQUIPMENT

Furnish all necessary tools and equipment required to perform the foundation load test.

4. CONSTRUCTION

Furnish and drive the piling in accordance with Item 404, “Driving Piling,” or construct the shaft in accordance with Item 416, “Drilled Shaft Foundations,” to be test-loaded. Use the same procedure for drilling the test shaft as for the shafts required in the structure.

Keep a complete record of pile-driving data and shaft-drilling data for all foundations used in the test load. Apply the test load no earlier than the seventh Day after driving the test piling or after placing concrete in the test shaft. Load the test shaft only after the concrete design strength has been attained.

Perform the foundation load test as stated on the Design Documents and in accordance with the following:

- ASTM D1143
- ASTM D4945
- ASTM D7383

Dismantle the test setup after completing the test if applicable.

Remove piling or shafts that are not part of the structure upon completion of the test load, or cut off at least 1 ft. below the bottom of the footing or the finished grade. Re-drive permanent piling to its original grade and bearing if it is raised during the test load.

Item 407

6.Steel Piling

1. DESCRIPTION

Furnish and place steel H-piling, pipe piling, and sheet piling.

2. MATERIALS

Furnish steel H-piling, pipe piling, and steel sheet piling in accordance with Item 441, “Steel Structures,” and details shown on the Design Documents.

Furnish steel that meets ASTM A690 or ASTM A572 Grade 50 for H-piling. Furnish steel that meets ASTM A 572 Grade 50 for pipe piling. Furnish steel that meets ASTM A328, ASTM A690, or ASTM A572 Grade 50 for hot-rolled sheet piling. Furnish steel that meets ASTM A690 or ASTM A572 Grade 50 for cold-rolled sheet piling. Steel sheet piling may be substituted with a section modulus and minimum thickness of material equal to or greater than that of the section specified. If a hot-rolled section is specified, the substitute section must also be hot-rolled.

Furnish piling in the lengths indicated on the Design Documents.

The H-piling or pipe piling may be fabricated by welding together up to 3 sections of piling with a minimum section length of 5 ft.

Shop-paint piling with 3.0 mils minimum Dry Film Thickness (DFT) inorganic zinc primer in accordance with the System III or IV paint protection system specified in Item 441, “Steel Structures.” Apply appearance or intermediate coatings only if specified on the Design Documents. Apply a marine-grade immersion coating system recommended by the manufacturer for marine, immersion service, and meeting the requirements of NORSOK Standard M-501, Coating System No. 7 for piling in marine environments. Submit a manufacturer’s certification that states the material meets the requirements of NORSOK Standard M-501, Coating System No. 7. Submit product data sheets and obtain approval of paint system before performing the Work. Paint the portion of the pile to be above finished grade or dredge line, in water, and a minimum distance of 10 ft. below finished grade or dredge line. Spot clean and paint damaged areas in the field to obtain a minimum of 3 mils DFT for inorganic zinc primer or a minimum of 15 mils DFT for the marine-grade immersion coating system. Spot clean and paint in accordance with Item 446, “Cleaning and Painting Steel.”

Reinforce steel H-pile tips when the piling is to be driven into rock, shale, or other material of similar hardness. Use the pile tip reinforcement detail shown on Common Foundation Details (FD) Standard or attach prefabricated pile points manufactured from ASTM A27 Grade 65-35 or ASTM A148 Grade 80-50 material. Furnish certification materials conforming to this requirement. Submit construction drawings for approval when alternate pile tip reinforcements are proposed.

Reinforce steel pipe piling and steel sheet piling tip when piling is to be driven into rock, shale, or other material of similar hardness. Use prefabricated pipe piling or sheet piling tip

reinforcements manufactured from ASTM A27 Grade 65-35 or ASTM A148 Grade 80-50 material. Submit construction drawings for approval when alternate pipe piling or sheet piling tip reinforcements are proposed.

Store piling above ground on adequate blocking. Keep piling clean and fully drained at all times during storage.

3. CONSTRUCTION

Drive piling in accordance with Item 404, "Driving Piling." Test load, when required, in accordance with Item 405, "Foundation Load Test."

3.1. **Splices and Cutoffs.** Make all splices for steel H-piling in accordance with detail on Common Foundation Details (FD) Standard. Submit pipe piling and sheet piling splicing locations and details of Record for approval. Drive spliced piling the additional depth required as soon as the splice is completed if the required penetration or bearing resistance has not been obtained.

Cut piling off square at plan grade or to the established grade after driving it to the approximate penetration and bearing resistance required. Cut off the damaged portion if the head of the pile is appreciably distorted or otherwise damaged below cutoff level, and splice an undamaged section in its place.

Weld in accordance with Item 448, "Structural Field Welding."

3.2. **Painting.** Apply paint in accordance with Item 446, "Cleaning and Painting Steel." Clean and paint damaged areas, field splices, or areas missing the shop coat with enough epoxy zinc primer to bring the total zinc primer to the minimum 3.0 mils DFT after driving piling. Apply at least 2.0 mils DFT each of the System III epoxy intermediate coating and appearance coating when a polyurethane appearance coating is specified on the Design Documents. Apply at least 2.0 mils DFT of the System IV appearance coating when an acrylic latex appearance coating is specified on the Design Documents. Use a concrete gray appearance coating. Extend the paint 1 ft. below finished ground line unless the piling is standing in water, in which case extend the paint to the low water line. Replace any earth removed for this painting after the paint has dried.

3.3. **Test Piling.** Test piling must meet requirements for steel piling.

Item 409

7. Prestressed Concrete Piling

1. DESCRIPTION

Furnish and place prestressed concrete piling.

2. MATERIALS

Use materials that meet the requirements of the following Items.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 425, "Precast Prestressed Concrete Structural Members"
- Item 440, "Reinforcement for Concrete"

Fabricate prestressed concrete piling in accordance with the following Items.

- Item 424, "Precast Concrete Structural Members (Fabrication)"
- Item 425, "Precast Prestressed Concrete Structural Members"

Furnish piling in the lengths indicated on the Design Documents when test or test-loaded piling is not required.

3. CONSTRUCTION

Handle and store piling in a way that minimizes the risk of damage by impact or bending stress. Store piling above ground on adequate blocking. Do not use chain slings to handle piling. Immediately review and correct conditions causing the damage to any piling. Drive piling in accordance with Item 404, "Driving Piling." Test-load, when required, in accordance with Item 405, "Foundation Load Test."

3.1. **Defects and Breakage.** Damage to piling due to faulty materials or construction methods may be cause for rejection. Piling damaged in the process of fabrication, handling, storing, hauling, or driving is subject to the acceptance criteria and repair provisions set forth in the **TxDOT** *Concrete Repair Manual*.

3.2. **Buildups and Cutoffs.** Construct buildups in accordance with plan details and Item 420, "Concrete Substructures." Make the final cut of the concrete square to the longitudinal axis for cutoffs.

3.3. **Test Piling.** Test piling must meet requirements for prestressed concrete piling.

Item 410

8. Soil Nail Anchors

1. DESCRIPTION

Construct reinforced soil nail anchors.

2. MATERIALS

Provide materials conforming to the following requirements.

2.1. **Hydraulic Cement Concrete.** Use materials that meet the requirements of Item 421, "Hydraulic Cement Concrete." Provide a neat cement or sand-cement mixture for the grout for soil nail anchors with a 7-Day compressive strength of 3,000 psi. Determine grout strength by testing the grout used for the test soil nail anchors in cubes in accordance with Tex-307-D or cylinders in accordance with Tex-418-A. Test further if the grout mixture is modified. Fly ash may be included in the grout.

Do not use grout mixed in a mobile continuous volumetric mixer.

Provide a grout mix with a minimum water-cement ratio of 0.4 and a minimum specific gravity of 1.85. Test for specific gravity in accordance with Tex-130-E.

When a sand sand-cement mixture is used for grouting soil nail anchors, provide a grout mixture with a minimum slump flow of 20 in. . Test the slump flow of the grout in accordance with ASTM C1611.

The need for stiffer grout may arise when the hollow-stem auger drilling method is used or it is desired to control leakage of grout into highly permeable granular soils or highly fractured rock. In these instances, TxDOT may waive the requirements of slump flow testing.

2.2. **Pneumatically Placed Concrete.** Use materials that meet the requirements of Class II concrete in Item 431, "Pneumatically Placed Concrete."

2.3. **Reinforcing Steel.** Use materials that meet the requirements of Item 440, "Reinforcement for Concrete." Provide epoxy coated reinforcing steel bar of the size and grade shown on the Design Documents for permanent walls. The minimum allowable epoxy coating thickness is 12 mils.

2.4. **Bar Couplers.** Provide bar couplers that develop the full nominal tensile capacity of the soil nail bars, as certified by the manufacturer.

2.5. **Nail Centralizers.** Provide expanded slit PVC centralizers with a minimum diameter of 1 in. less than the nail-hole. Wheel type centralizers are not allowed.

3. EQUIPMENT

Furnish suitable equipment to drill the holes to the specified diameter, depth, and line. Provide a drill rig with an articulating head in the vertical plane and continuous flight augers. If an auger becomes worn to the degree that the drilled hole is less than the required diameter, remove the auger from Return the auger to service once it is repaired and can provide a hole of at least the required diameter.

Furnish a hydraulic jack and reaction frame for stressing the test anchors. Furnish a pressure gauge for the jack that is graduated in 75 psi increments or less. Furnish a minimum of 2 dial gauges capable of measuring to 0.001 in. Calibrate the hydraulic jack and ram used together as a system, and furnish certified copies of load calibration curves for all jacks and ram systems to be used in the Work. Calibrate the jack and ram as a unit no more than 6 mo. before starting Work. Recalibrate stressing systems when directed or at least every 6 mo.

Furnish a grout mixer and pump of sufficient capacity to place grout properly in the required quantities.

4. CONSTRUCTION

4.1. **Soil Nail Wall Construction Plan.** Submit a soil nail wall construction plan at least 30 Days before beginning construction. Begin soil nail wall construction once the construction plan submittal is accepted. Provide detailed Project specific information in the soil nail wall construction plan that includes the following:

- Project start date, an overall description, and sequence of soil nail wall construction;
- List and sizes of excavation equipment, drill rigs (must have an articulating head in a vertical plane), cutting head (auger, rock bit, etc.), tools, tremies, and grouting equipment;
- Procedures for the sequence for the following items of Work: excavations; drilling and grouting; soil nail and wall drainage system installation; and, if appropriate, facing construction;
- Details of pneumatically placed concrete equipment and application including mix process, shooting methods, and means for determining the thickness of the concrete applied;
- A nozzleman who is certified as an American Concrete Institute (ACI) Shotcrete Nozzelman;
- Plan and methods for nail testing, both the verification tests and proof tests, with calibration certificates dated within 5 mo. of the submittal date; and
- Other information shown on the Design Documents or requested by TxDOT.

4.2. **Drilling.** Drill the hole so that its diameter is not smaller than the diameter shown on the Design Documents or established by test soil nail anchors. Control hole alignment so that it varies no more than 5 degrees from the line specified on the Design Documents. Furnish suitable drilling equipment and use methods suitable for the ground conditions. The use of drilling mud or other fluids to remove cuttings is not allowed.

4.3. **Grouting.** Place the soil nail anchor with centralizers that are spaced no more than 8 ft. apart in the hole. Set the centralizers to position the soil nail reinforcing bar within 1 in. of the center of the hole. To grout, advance the grouting pipe to the bottom of the hole, and leave it there until the hole is filled with grout and enough unsegregated grout is expelled at the top of the hole. Withdraw the pipe slowly while grouting continues, filling the void left by the grout pipe. Grout each nail within

8 hr. of the completion of drilling. Holes open longer than 8 hr. shall be rejected and backfilled with grout.

Grouting before insertion of the epoxy coated bar into the hole is only allowed with approval. Advance the grout pipe to the bottom of the hole and leave it there until the hole is filled with grout and enough unsegregated grout is expelled at the top of the hole if approved. Withdraw the pipe slowly while grouting continues, filling the void left by the grout pipe. Insert the epoxy coated bar with the centralizers attached and fill any void that is left from the insertion of the bar. Fill the hole completely to face of the cut.

If caving or sloughing of the hole occurs that prevents open-hole grouting, furnish either hollow-stem auger equipment, placing the nail reinforcing bar and grout through the auger, or casing to support the sides of the excavation Use grouting methods that result in complete filling of the hole at the ground surface. Methods may include placement of grout in multiple stages or other approved methods. Completely remove any device used to dam the front of the hole immediately after the grout takes an initial set.

Record the following information concerning the grouting:

- Type of mixer
- Water-cement ratio
- Types of additives
- Type of cement
- Volume of grout

4.4. **Soil Nail Anchor Test.**

4.4.1. **Verification Tests**. Construct and test the soil nail anchors as indicated on the Design Documents. Test the soil nail anchors before installing any production soil nail anchors. Do not use verification test nails as production soil nail anchors.

Provide an adequate reaction pad large enough to resist the required load without sinking into the soil or shifting laterally during the test. Do not use a reaction pad that sinks into the soil more than 2 in. or that allows the free end of the soil nail reinforcing bar to move laterally more than 2 in. Failure to provide an adequate reaction pad will void the soil nail anchor test. Provide additional test soil nail anchors until an adequate reaction system is achieved. Furnish additional test soil nail anchors, required due to inadequate reaction pads.

Provide a reaction pad with a center opening larger than the hole diameter to ensure that no bridging or interaction occurs between the grout column and the reaction pad. Similarly, remove all pneumatically placed concrete, excess grout, or other foreign material to expose the full face of the grout column. Ensure the reaction system does not contact or interfere with the soil nail anchor reinforcing bar during the test. Conduct the following testing method:

- Apply test loads to soil nail anchors in increments of approximately 10% of the required test load stated on the Design Documents.. Hold each load increment long enough to obtain the gauge readings and to ensure that the readings have stabilized. Hold the final maximum test load for 10 min.
- Perform initial tensioning to take the slack out of the testing apparatus at 5% of the required test load.

- Provide gauges that extend and retract freely and move smoothly throughout their range. Provide a rigid and secure system to support the gauge independently of the jack or reaction system.
- Verification Test Nail Acceptance Criteria:
  - The total creep movement is less than 0.04 in. during the final 10 min. reading increment. If movement exceeds this value, an additional hold period of 60 min. with a maximum 0.08 in. total creep movement including the movement from the original 10 min. hold is required.
  - The total measured movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length of the test nail.
  - A pullout limit state does not occur for the verification load listed on the Design Documents. Pullout limit state is definined at a load level at which the test load cannot be further increased while there is continued movement of the test nail.

Modify construction methods or procedures in the event that the test soil nail anchors fail to provide the minimum pullout capacity specified on the Design Documents. Install and test additional soil nail test anchors until adequate pullout capacity is achieved. Test soil nail anchors, in addition to the number specified on the Design Documents, are subsidiary to this Item.

Install additional soil nail test anchors following the modified construction procedures and test additional soil nail test anchors if Developer chooses to modify construction procedures after test soil nail anchors are completed and approved. This additional testing is subsidiary to this Item.

4.4.2. **Proof Tests**. Conduct Proof Testing of production nails when shown on the Design Documents. The number, length, and target load of nail(s) to be proof loaded must be satisfied and tested according to the following criteria:

- TxDOT will determine the locations of each proof test nail. Completely grout the proof test nails. Proof testing may occur before the placement of pneumatically placed concrete for the temporary face. Leave a sufficiently voided region around the nail head to allow free nail movement if proof testing is to occur after the placement of pneumatically placed concrete for the temporary facing. Provide a minimum 2 in. clear zone around the grouted nail.
- Use a reaction system as outlined in Verification Tests.
- Follow proof nail loading sequence outlined for VerificationTests, except use the required proof load stated on the Design Documents.
- Proof Test Nail Acceptance Criteria:
  - The total creep movement is less than 0.04 in. during the final 10 min. reading increment. If movement exceeds this value, an additional hold period of up to 60 min. with a maximum 0.08 in. total creep movement including the movement from the original 10 min. hold is required.
  - The total measured movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length of the test nail.
  - A pullout limit state does not occur for the proof load listed on the Design Documents. Pullout limit state is definined at a load level at which the test load cannot be further increased while there is continued movement of the test nail.

- If the proof test nails fail, Developer is responsible for redesigning the wall with supplemental soil nail anchors.

Item 411

9. Rock Nail Anchors

1. DESCRIPTION

Construct reinforced rock nail anchors.

2. MATERIALS

Provide materials conforming to the following requirements.

2.1. **Hydraulic Cement Concrete.** Use materials that meet the requirements of Item 421, "Hydraulic Cement Concrete." Provide a neat cement or sand-cement mixture for the grout for rock nail anchors with a 7-Day compressive strength of 3,000 psi. Determine grout strength by testing the grout used for the test rock nail anchors in cubes in accordance with Tex-307-D or cylinders in accordance with Tex-418-A. Test further if the grout mixture is modified. Fly ash may be included in the grout.

Do not use grout mixed in a mobile continuous volumetric mixer.

Provide a grout mix with a minimum water-cement ratio of 0.4 and a minimum specific gravity of 1.85. Test for specific gravity in accordance with Tex-130-E.

When a sand cement mixture is used for grouting rock nail anchors, provide a grout mixture with a minimum slump flow of 20 in.. Test the slump flow of the grout in accordance with ASTM C1611.

The need for stiffer grout may arise when it is desired to control leakage of grout into highly permeable or fractured rock. In these instances, TxDOT may waive the requirements of slump flow testing.

2.2. **Pneumatically Placed Concrete.** Use materials that meet the requirements of Class II concrete in Item 431, "Pneumatically Placed Concrete."

2.3. **Reinforcing Steel.** Use materials that meet the requirements of Item 440, "Reinforcement for Concrete." Provide epoxy coated reinforcing steel bar of the size and grade shown on the Design Documents for permanent walls. The minimum allowable epoxy coating thickness is 12 mils.

2.4. **Bar Couplers.** Provide bar couplers that develop the full nominal tensile capacity of the rock nail bars, as certified by the manufacturer.

2.5. **Nail Centralizers.** Provide expanded slit PVC centralizers with a minimum diameter of 1 in. less than the nail-hole. Wheel type centralizers are not allowed.

3. EQUIPMENT

Furnish suitable equipment to drill the holes to the specified diameter, depth, and line. Provide a drill rig with an articulating head in the vertical plane and continuous flight augers.

If the auger becomes worn to the degree that the drilled hole is less than the required diameter, remove the auger from service until it is repaired and can provide a hole of at least the required diameter.

Furnish a hydraulic jack and reaction frame for stressing the test anchors. Furnish a pressure gauge for the jack that is graduated in 75 psi increments or less. Furnish a minimum of 2 dial gauges capable of measuring to the 0.001 in. Calibrate the hydraulic jack and ram used together as a system, and furnish certified copies of load calibration curves for all jacks and ram systems to be used in the Work. Calibrate the jack and ram as a unit no more than 6 months before starting Work. Recalibrate stressing systems when directed or at least every 6 months.

Furnish a grout mixer and pump of sufficient capacity to place grout properly in the required quantities.

4. CONSTRUCTION

4.1. **Rock Nail Wall Construction Plan.** Submit a rock nail wall construction plan at least 30 Days before beginning construction. Begin rock nail wall construction once the construction plan submittal is accepted. Provide detailed Project specific information in the rock nail wall construction plan that includes the following:

- Project start date, an overall description, and sequence of rock nail wall construction;
- List and sizes of excavation equipment, drill rigs (must have an articulating head in a vertical plane),cutting head (auger, rock bit, etc.), tools, tremies, and grouting equipment;
- Procedures for the sequence for the following items of Work: excavations; drilling and grouting; rock nail and wall drainage system installation; and, if appropriate, facing construction;
- Details of pneumatically placed concrete equipment and application including mix process, shooting methods, and means for determining the thickness of the concrete applied;
- A nozzleman that is certified as an American Concrete Institute (ACI) Shotcrete Nozzelman;
- Plan and methods for rock nail testing, both the verification tests and proof tests, with calibration certificates dated within 5 months of the submittal date; and
- Other information shown on the Design Documents or requested by TxDOT.

4.2. **Drilling.** Drill the hole so that its diameter is not smaller than the diameter shown on the Design Documents or established by test rock nail anchors. Control hole alignment so that it varies no more than 5 degrees from the line specified on the Design Documents. Furnish suitable drilling equipment and use methods suitable for the ground conditions. The use of drilling mud or other fluids to remove cuttings is not allowed.

4.3. **Grouting.** Place the rock nail anchor with centralizers that are spaced no more than 8 ft. apart in the hole. Set the centralizers to position the rock nail reinforcing bar within 1 in. of the center of the hole. To grout, advance the grouting pipe to the bottom of the hole, and leave it there until the hole is filled with grout and enough unsegregated grout is expelled at the top of the

hole. Withdraw the pipe slowly while grouting continues, filling the void left by the grout pipe. Grout each nail within 8 hr. of the completion of drilling. Holes open longer than 8 hours shall be rejected and backfilled with grout.

Grouting before insertion of the epoxy coated bar into the hole is only allowed with approval. Advance the grout pipe to the bottom of the hole and leave it there until the hole is filled enough unsegregated grout is expelled at the top of the hole if approved. Withdraw the pipe slowly while grouting continues, filling the void left by the grout pipe. Insert the epoxy coated bar with the centralizers attached and fill any void that is left from the insertion of the bar. Fill the hole completely to face of the cut.

If caving or sloughing of the hole occurs that prevents open-hole grouting, furnish either hollow-stem auger equipment, placing the nail reinforcing bar and grout through the auger, or casing to support the sides. Use grouting methods that result in complete filling of the hole at the ground surface. Methods may include placement of grout in multiple stages or other approved methods. Completely remove any device used to dam the front of the hole immediately after the grout takes an initial set.

Record the following information concerning the grouting:

- Type of mixer
- Water-cement ratio
- Types of additives
- Type of cement
- Volume of grout

4.4. **Rock Nail Anchor Test.**

4.4.1. **Verification Tests**. Construct and test the rock nail anchors as indicated on the Design Documents. Test the rock nail anchors before installing any production rock nail anchors. Do not use verification test nails as production rock nail anchors.

Provide an adequate reaction pad large enough to resist the required load without sinking into the rock or shifting laterally during the test. Do not use a reaction pad that sinks into the rock more than 2 in. or that allows the free end of the rock nail reinforcing bar to move laterally more than 2 in. Failure to provide an adequate reaction pad shall void the rock nail anchor test. Provide additional test rock nail anchors until an adequate reaction system is achieved. Furnish additional test rock nail anchors, required due to inadequate reaction pads.

Provide a reaction pad with a center opening larger than the hole diameter to ensure that no bridging or interaction occurs between the grout column and the reaction pad. Similarly, remove all pneumatically placed concrete, excess grout, or other foreign material to expose the full face of the grout column. Ensure the reaction system does not contact or interfere with the rock nail anchor reinforcing bar during the test. Conduct the following testing method:

- Apply test loads to rock nail anchors in increments of approximately 10% of the required test load stated on the Design Documents. Hold each load increment long enough to obtain the gauge readings and ensure that the readings have stabilized. Hold the final maximum test load for 10 min.
- Perform initial tensioning to take the slack out of the testing apparatus at 5% of the required test load.

- Provide gauges that extend, retract freely, and move smoothly throughout their range. Provide a rigid and secure system to support the gauge independently of the jack or reaction system.
- Verification Test Nail Acceptance Criteria:
  - The total creep movement is less than 0.04 in. during the final 10 min. reading increment. If movement exceeds this value, an additional hold period of up to 60 min. with a maximum 0.08 in. total creep movement including the movement from the original 10 min. hold is required.
  - The total measured movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length of the test nail.
  - A pullout limit state does not occur for the verification load listed on the Design Documents. Pullout limit state is definined at a load level at which the test load cannot be further increased while there is continued movement of the test nail.

Modify construction methods or procedures in the event that the test rock nail anchors fail to provide the minimum pullout capacity specified on the Design Documents. Install and test additional rock nail test anchors until adequate pullout capacity is achieved. Test rock nail anchors, in addition to the number specified on the Design Documents, are subsidiary to this Item.

Install additional rock nail test anchors following the modified construction procedures and test additional rock nail test anchors if Developer chooses to modify construction procedures after test rock nail anchors are completed and approved. This additional testing is subsidiary to this Item.

4.4.2. **Proof Tests**. Conduct Proof Testing of production rock nails when shown on the Design Documents. The number, length, and target load of nails to be proof loaded must be satisfied and tested according to the following criteria:

- TxDOT will determine the locations of each proof test nail. Completely grout the proof test nails. Proof testing may occur before the placement of pneumatically placed concrete for the temporary face. Leave a sufficiently voided region around the nail head to allow free nail movement if proof testing is to occur after the placement of pneumatically placed concrete for the temporary facing. A minimum of 2 in. clear around the grouted nail is required.
- Use a reaction system as outlined in the Verification Tests.
- Follow proof nail loading sequence outlined in the Verification Tests, except use the required proof load stated on the Design Documents.
- Proof Test Nail Acceptance Criteria:
  - The total creep movement is less than 0.04 in. during the final 10 minute reading increment. If movement exceeds this value, an additional hold period of up to 60 minutes with a 0.08 in. total creep movement maximum including the movement from the original 10 minute hold is required.
  - The total measured movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length of the test nail.
  - A pullout limit state does not occur for the proof load listed on the Design Documents. Pullout limit state is definined at a load level at which the test load cannot be further increased while there is continued movement of the test nail.

- If the proof test nails fail, Developer is responsible for redesigning the wall with supplemental rock nail anchors.

Item 416

10. Drilled Shaft Foundations

1. DESCRIPTION

Construct foundations consisting of reinforced or non-reinforced concrete drilled shafts.

2. MATERIALS

Use materials that meet the requirements of the following Items.

- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcement for Concrete”
- Item 448, “Structural Field Welding”

Use concrete for drilled shafts that meets the requirements of Table 1.

Table 1

Concrete for Drilled Shafts

Drilled Shaft Type	Concrete
Non-reinforced	Class A
Reinforced	Class C
Slurry and underwater concrete placement	Class SS

Use coarse aggregate Grade 4, 5, or 6 for drilled shaft concrete in reinforced drilled shafts. Grade 2 or 3 may be used if the shaft is dry and reinforcing steel has a 5 in. minimum clear spacing.

Use a water-reducing, retarding admixture in accordance with DMS-4640, “Chemical Admixtures for Concrete,” in all concrete when using casing that will be pulled or when placing shafts underwater or under slurry.

Use concrete with slump that meets the requirements of Table 2 as determined by Tex-415-A.

Table 2

Slump Requirements

Placement Type	Minimum Acceptable Placement Slump, in.	Recommended Design and Placement Slump, in.	Maximum Acceptable Placement Slump, in.
Dry	5-1/2	6-1/2	7-1/2
Underwater and under slurry	7	8	9

Perform a slump loss test in accordance with Tex-430-A before beginning Work when casing is to be pulled or concrete is to be placed underwater or under slurry. Provide concrete that will maintain a slump of at least 4 in. throughout the entire anticipated time of concrete placement. Time of concrete placement is described in Items 416.3.6., "Concrete," and Item 416.3.7., "Additional Requirements for Slurry Displacement or Underwater Concrete Placement Methods." Note the temperature of the concrete mix at the beginning of the slump loss test. Place the concrete if its temperature at the time of placement into the drilled shaft is no more than 10°F higher than the slump loss test temperature. Use ice or other concrete cooling ingredients to lower concrete temperature, or run additional slump loss tests at the higher temperatures. Slump loss testing will be waived if anticipated time of concrete placement is less than 90 minutes.

Use mineral drilling slurry that meets the requirements of Table 3, as determined by Tex-130-E. Determine pH of slurry by Tex-128-E or pH paper strips.

Table 3

Mineral Slurry Requirements

Before Introduction into the Excavation			Sampled from the Bottom of the Excavation before Concreting		
Specific Gravity	**Sand Content**	**pH**	**Specific Gravity**	**Viscosity (seconds)**	**Sand Content**
≤ 1.10	≤ 1%	8-11	≤ 1.15	≤ 45	≤ 4%

Use mineral slurry consisting of processed bentonite or attapulgite clays mixed with clean fresh water. Do not use partially hydrolyzed polyacrylamide (PHPA) polymeric slurry or any other fluid composed primarily of a polymer solution.

Sample slurry from the bottom of the hole, before placing concrete, and test it in accordance with Tex-130-E. Use a pump or air lift to remove slurry that does not meet the requirements of Table 3 while adding fresh clean slurry to the top of the hole to maintain the slurry level. Continue this operation until the slurry sampled from the bottom of the hole meets the requirements.

3. CONSTRUCTION

Submit Drilled Shaft installation plan for review when required. Place the shaft to within the following tolerances:

- Vertical plumbness—1 in. per 10 feet of depth.
- Center of shaft located under column—1 in. of horizontal plan position.
- Center of shaft located under footing—3 in. of horizontal plan position.

Complete the embankment at bridge ends before installing drilled shafts that pass through the fill. Refer to Item 423, "Retaining Walls," for provisions for drilled shafts passing through the structural volume of retaining walls.

3.1. **Excavation.** The Design Documents indicate the expected depths and elevations for encountering satisfactory bearing material. Excavate as required for the shafts through all materials encountered to the dimensions and elevations shown on the Design Documents or required by the site conditions. Adjust the bottom of the shaft or alter the foundation if satisfactory founding material is not encountered at plan elevation, as approved to satisfactorily comply with design requirements. Blasting is not allowed for excavations.

Stop drilling if caving conditions are encountered, and adopt a construction method that stabilizes the shaft walls.

Do not excavate a shaft within 2 shaft diameters (clear) of an open shaft excavation, or one in which concrete has been placed in the preceding 24 hr.

Dispose of material excavated from shafts and not incorporated into the finished project in accordance with the Design Documents and with federal, State, and local Laws.

Provide suitable access, lighting, and equipment for proper inspection of the completed excavation and checking the dimensions and alignment of shafts excavation.

3.2. **Core Holes.** Take cores to determine the character of the supporting materials if directed. Use a method that shall result in recovery of an intact sample adequate for judging the character of the founding material. Such cores should be at least 5 ft. deeper than the proposed founding grade or a depth equal to the diameter of the shaft, whichever is greater. Take these cores when the excavation is complete.

3.3. **Casing.** Use casing when necessary to prevent caving of the material or to exclude ground water. Provide casing with an outside diameter not less than the specified diameter of the shaft. Use casing strong enough to withstand handling stresses and pressures of concrete and of the surrounding earth or water, and that is watertight, smooth, clean, and free of accumulations of hardened concrete.

Drill the portion of the shaft below the casing as close as possible to the specified shaft diameter. The portion of shaft below the casing may be as much as 2 in. smaller than the specified shaft diameter.

Use construction methods that result in a minimal amount of disturbed soil being trapped outside the casing. This does not apply to temporary undersized casings used to protect workers inside shafts or to drilled shafts designed for point bearing only.

Leave casing in place only if authorized or shown on the Design Documents. Extract casing only after placing the concrete to an appropriate level. Maintain sufficient concrete in the casing at all times to counteract soil and water pressure. Rotate or move the casing up or down a few inches if necessary before and during concrete placement to facilitate extraction of the casing.

3.4. **Requirements for Slurry Displacement Method.** Use the slurry displacement method to construct drilled shafts. Use this method to support the sides of the excavation with processed mineral slurry that is then displaced by concrete to form a continuous concrete shaft.

Install surface casing to a minimum of 10 ft. below existing ground before introducing slurry. Do not use casing other than surface casing. Do not use surface casing longer than 20 ft. without approval. Do not extract the surface casing until after placing the concrete.

Pre-mix slurry mixed at the Project site in a reservoir enough capacity to fill the excavation and for recovery of the slurry during concrete placement. Do not mix slurry in the shaft excavation or other hole. Allow adequate time for hydration of the slurry before introduction into the excavation.

Maintain a head of slurry in the shaft excavation at or near ground level or higher, as necessary, to counteract ground water pressure during and after drilling.

Use an air lift or proper size cleanout bucket, just before placing reinforcing steel, to remove any material that may have fallen from the sides of the excavation or accumulated on the bottom after the completion of drilling. Use a cleanout bucket if material is too large to be picked up with an air lift.

Re-process the hole with the auger if concrete placement is not started within 4 hr. of the completion of the shaft excavation. Then clean the bottom with an air lift or cleanout bucket, and check the slurry at the bottom of the hole for compliance with the slurry requirements of Item 416.2., “Materials.”

Agitate the congealed slurry to liquefaction if the slurry forms a gel before concrete placement, and whenever directed.

Recover and dispose of all slurry as approved, and in accordance with all federal, State, and local Laws. Do not discharge slurry into or in close proximity to streams or other bodies of water.

3.5. **Reinforcing Steel.** Completely assemble the cage of reinforcing steel, and place it as a unit immediately before concrete placement. The cage consists of longitudinal bars and lateral reinforcement (spiral reinforcement, lateral ties, or horizontal bands). Connect individual segments with couplers or by lapping steel as approved if overhead obstacles prevent placement of the cage as a single unit.

Extend the reinforcing steel cage as follows if the shaft is lengthened beyond plan length.

- Extend the cage to the bottom for shafts supporting structures other than bridges.
- Extend the cage to 25 ft. or to the bottom, whichever is shorter, for bridge shafts with plan lengths less than 25 ft.
- Do not extend the cage for bridge shafts with plan lengths at least 25 ft. that are lengthened less than 33% of plan length.

- Extend the cage for bridge shafts with plan lengths at least 25 ft. that are lengthened more than 33% of plan length.

If the cage does not reach the bottom of the shaft, it may be suspended, or a portion of the longitudinal steel may be extended to support the cage on the bottom of the shaft. Bars used to extend or support the cage may be lap spliced or welded by a qualified welder. Place the extension at the bottom of the shaft.

Tie spiral reinforcement to the longitudinal bars at a spacing no more than 24 in., or as required for a stable cage. Ensure lateral reinforcement is not welded to longitudinal bars.

Center the reinforcing steel cage in the excavation using "roller" type centering devices. Use enough devices to hold the cage in position along its entire length. Ensure flat or crescent-shaped centralizers ("sleds") are not used.

Support or hold down the cage to control vertical displacement during concrete placement or extraction of the casing. Use support that is concentric with the cage to prevent racking and distortion of the steel.

Check the elevation of the top of the steel cage before and after concrete placement or after casing extraction when casing is used. Downward movement of the steel up to 6 in. per 20 ft. of shaft length and upward movement of the steel up to 6 in. total are acceptable.

Maintain the minimum length of steel required for lap with column steel. Use dowel bars if the proper lap length is provided both into the shaft and into the column. Locate and tie all dowel bars into the cage before placing concrete or insert dowel bars into fresh, workable concrete.

Locate and tie anchor bolts when required before placement of concrete. Use templates or other devices to assure accurate placement of anchor bolts.

3.6. **Concrete.** Perform all Work in accordance with Item 420, "Concrete Substructures." Provide concrete with maximum placement temperatures as specified in Table 4. Provide thermal analysis to show and temperature recording devices to verify maximum core temperature requirements are met as specified in Item 420.4.7.14., "Mass Placements."

Table 4

Maximum Concrete Placing Temperature

Shaft Size	**Mix Design Options 1-5**	**Mix Design Options 6-8**
Diameter < 5'	95°F	95°F
5'≤ Diameter ≤ 7'	95°F	85°F
7' < Diameter	85°F	75°F

Form portions of drilled shaft that project above natural ground.

Remove loose material and accumulated seep water from the bottom of the excavation before placing concrete. Place concrete using underwater placement methods if water cannot be removed.

Place concrete as soon as possible after all excavation is complete and reinforcing steel is placed. Provide workable concrete that does not require vibrating or rodding. Vibrate formed portions of drilled shafts.

Place concrete continuously for the entire length of the shaft. Limit free fall of concrete to 25 ft. for dry shafts of 24 in. or smaller diameter. Use a suitable tube or tremie to prevent segregation of materials. Use a tube or tremie in sections to provide proper discharge and permit raising as the placement progresses. For dry shafts over 24 in. diameter, concrete can be allowed to free fall an unlimited distance if it does not strike the reinforcing cage or sides of the hole during placement. Provide a hopper with a minimum 3-ft.long drop-tube at the top of the shaft to direct concrete vertically down the center of the shaft when free fall is used. Do not use a shovel or other means to simply deflect the concrete discharge from the truck.

Maintain a sufficient head of concrete for cased shafts at all times above the bottom of the casing to overcome hydrostatic pressure. Extract casing at a slow, uniform rate with the pull in line with the axis of the shaft. Monitor the concrete level in the casing during extraction. Stop the extraction and add concrete to the casing as required to ensure a completely full hole upon casing removal. The elapsed time from the mixing of the first concrete placed into the cased portion of the shaft until the completion of extraction of the casing must not exceed the time for which the concrete maintains a slump of over 4 in. in accordance with Item 416.2., “Materials.” Modify the concrete mix, the construction procedures, or both for subsequent shafts if the elapsed time is exceeded.

Cure the top surface and treat any construction joint area in accordance with Item 420, “Concrete Substructures.”

3.7. **Additional Requirements for Slurry Displacement or Underwater Concrete Placement Methods.** Place concrete on the same day the shaft is excavated and as soon as possible after all excavation is complete and reinforcing steel is placed. Use an air lift or cleanout bucket of the proper size to clean the bottom of the excavation before placing the reinforcing steel cage and concrete. Place concrete through a closed tremie or pump it to the bottom of the excavation. Initially seal the tremie or pump line to positively separate the concrete from the slurry or water. Place concrete continuously from the beginning of placement until the shaft is completed. Keep the tremie full of concrete and well submerged in the previously placed concrete at all times if using a tremie. Raise the tremie as necessary to maintain the free flow of concrete and the stability of any casing used. Keep the discharge tube submerged in the previously placed concrete at all times if using a pump. Place additional concrete to ensure the removal of any contaminated concrete at the top of the shaft. Allow the top portion of concrete to flush completely from the hole at the completion of the pour until there is no evidence of slurry or water contamination. Do not attempt to remove this concrete with shovels, pumps, or other means. Level the top of shaft with hand tools as necessary.

Use a sump or other approved method to channel displaced fluid and concrete away from the shaft excavation. Recover slurry and dispose of it as approved. Do not discharge displaced fluids

into or near streams or other bodies of water. Provide a collar or other means of capturing slurry and the top portion of concrete flushed from the shaft for pours over water.

Remove the tube, reseal it at the bottom, penetrate with the tube into the concrete already placed by at least 5 ft., and recharge it before continuing if concrete placement is interrupted due to withdrawal of the submerged end of the tremie or pump discharge tube before completion.

The elapsed time from the mixing of the first concrete placed until the completion of concrete placement, including extraction of the casing, must not exceed the time for which the concrete maintains a slump of over 4 in. in accordance with Item 416.2, “Materials.” Modify the concrete mix, the construction procedures, or both for subsequent shafts if the elapsed time is exceeded.

3.8. **Test Load. Test load shafts, if required, in accordance with Item 405, “Foundation Load Test.”**

Item 420

11. Concrete Substructures

1. DESCRIPTION

Construct concrete substructures including footings, columns, caps, abutments, piers, culverts, other bridge substructure Elements, and other concrete structures as indicated.

2. MATERIALS

2.1. **Concrete.** Provide concrete in accordance with Item 421, "Hydraulic Cement Concrete." Provide the class of concrete for each type of structure or unit as shown on the Design Documents or in pertinent governing specifications**.**

2.2. **Grout or Mortar.** Provide grout for dowelling anchors or precast connections in accordance with DMS-4675, "Cementitiuous Grouts for Miscellaneous Applications."

2.3. **Latex Curing Materials.** Provide an acrylic-polymer latex admixture (acrylic resin emulsion per DMS-4640, "Chemical Admixtures for Concrete") suitable for producing polymer-modified concrete or mortar. Do not allow latex to freeze.

2.4. **Reinforcing Steel.** Provide reinforcing steel in accordance with Item 440, "Reinforcement for Concrete."

2.5. **Expansion Joint Material.** Provide materials in accordance with DMS-6310, "Joint Sealants and Fillers."

- Provide preformed fiber expansion joint material that conforms to the dimensions shown on the Design Documents.
- Provide preformed bituminous fiber material.
- Provide asphalt board that conforms to dimensions shown on the Design Documents.
- Provide re-bonded neoprene filler that conforms to the dimensions shown on the Design Documents.

2.6. **Waterstop.** Provide rubber or polyvinyl chloride (PVC) waterstops in accordance with DMS-6160, "Waterstops, Nylon Reinforced Neoprene Sheet, and Elastomeric Pads."

2.7. **Curing Materials.** Provide membrane curing compounds in accordance with DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."

Provide cotton mats that consist of a filling material of cotton "bat" or "bats" (at least 12 oz. per square yard) completely covered with unsized cloth (at least 6 oz. per square yard) stitched longitudinally with continuous parallel rows of stitching spaced at less than 4 in., or tuft both longitudinally and transversely at intervals less than 3 in. Provide cotton mats that are free from tears and in good general condition. Provide a flap at least 6 in. wide consisting of 2 thicknesses of the covering and extending along 1 side of the mat.

Provide polyethylene sheeting that is at least 4 mils thick and free from visible defects. Provide only clear or opaque white sheeting when the ambient temperature during curing exceeds 90°F or when applicable to control temperature during mass pours.

Provide burlap-polyethylene mats made from burlap impregnated on 1 side with a film of opaque white pigmented polyethylene, free from visible defects. Provide laminated mats that 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 are free of visible defects.

Provide burlap material which complies with AASHTO M 182, Class 3 (10 oz. per square yard) with the following additions:

- Manila hemp may also be used to make burlap.
- Do not use burlap fabricated from bags.
- Do not use burlap containing any water soluble ingredient which will retard the setting time of concrete.

Provide used burlap complying with the requirements stated above and that has only been used previously for curing concrete. "Like new" cleanliness is not expected, but contamination with any substance foreign to the concrete curing process, such as grease or oil, shall be cause for rejection.

2.8. **Epoxy.** Provide epoxy materials in accordance with DMS-6100, “Epoxy and Adhesives.”

3. EQUIPMENT

3.1. **Transporting and Placing Equipment.** Use appropriate transporting and placing equipment such as buckets, chutes, buggies, belt conveyors, pumps, or other equipment as necessary. Ensure concrete is not transported or conveyed through equipment made of aluminum.

Use tremies to control the fall of concrete or for underwater placement. Use tremies that are watertight and of large enough diameter to allow the placement of the concrete but less than 14 in. in diameter. Construct the tremie so the bottom can be sealed and opened once the tremie has been fully charged with concrete for underwater placements.

Use pumps with lines at least 5 in. inside diameter (I.D.) where Grade 2 or smaller coarse aggregate is used, and at least 8 in. I.D. for Grade 1 coarse aggregate.

3.2. **Vibrators.** Use immersion-type vibrators for consolidation of concrete. Provide at least 1 standby vibrator for Emergency use.

3.3. **Temperature Recording Equipment.** Use strip chart temperature recording devices, recording maturity meters in accordance with Tex-426-A, or other approved devices that are accurate to within ±2°F within the range of 32°F to 212°F for mass concrete operations, cold weather placements, and as otherwise specified.

3.4. **Artificial Heating Equipment.** Use artificial heating equipment as necessary for maintaining the concrete temperatures as specified in Item 420.4.7.11., “Placing Concrete in Cold Weather.”

3.5. **Spraying Equipment.** Use mechanically powered pressure sprayers, either air or airless, with appropriate atomizing nozzles for the application of membrane curing. Use hand-pressurized spray equipment with 2 or 3 fan-spray nozzles if approved. Ensure the spray from each nozzle overlaps the spray from adjacent nozzles by approximately 50%.

3.6. **Concrete Testing Equipment.** Provide testing equipment in accordance with Item 421.3.3., "Testing Equipment."

4. CONSTRUCTION

Obtain approval for proposed construction methods before starting Work. Approval of construction methods and equipment does not relieve Develooper's responsibility for safety or correctness of methods, adequacy of equipment, or completion of Work in full accordance with the Contract.

It is Developer's option to perform testing on structural concrete (structural classes of concrete are identified in Table 8 of Item 421.4.1., "Classification of Concrete Mix Designs,") to determine the in-situ strength to address the schedule restrictions in Item 420.4.1., "Schedule Restrictions." Developer shall perform this testing for concrete placed in cold weather. Make enough test specimens for Developer-performed testing to ensure strength requirements are met for the operations listed in Item 420.4.1., "Schedule Restrictions." Make at least 1 set of test specimens for each Element cast each day. Cure these specimens under the same conditions as the portion of the structure involved for all stages of construction. Ensure safe handling, curing, and storage of all test specimens. Provide testing personnel, and sample and test the hardened concrete in accordance with Item 421.4.8., "Sampling and Testing of Concrete." The maturity method, Tex-426-A, may be used for in-situ strength determination for schedule restrictions if approved. Coring is not allowed for in-situ strength determination for schedule restrictions. Provide TxDOT the opportunity to witness all testing operations. Report all test results to TxDOT.

4.1. **Schedule Restrictions.** Construct and open completed structures to traffic with the following limitations:

4.1.1. **Setting Forms**. Attain at least 2,500 psi compressive strength before erecting forms on concrete footings supported by piling or drilled shafts, or on individual drilled shafts. Erect forms on spread footings and culvert footings after the footing concrete has aged at least 2 curing Days as defined in Item 420.4.10., "Curing Concrete." Place concrete only after the forms and reinforcing steel have been inspected.

Support tie beam or cap forms by falsework on previously placed tie beams only if the tie beam concrete has attained a compressive strength of 2,500 psi and the member is properly supported to eliminate stresses not provided for in the design. Maintain curing as required until completion of the curing period.

Place superstructure forms or falsework on the substructure only if the substructure concrete has attained a compressive strength of 3,000 psi.

4.1.2. **Removal of Forms and Falsework**. Keep in place weight-supporting forms and falsework for bridge components and culvert slabs until the concrete has attained a compressive strength of 2,500 psi in accordance with Item 420.4.11., "Removal of Forms and Falsework." Keep all forms for mass placements in place for 4 Days following concrete placement unless otherwise approved based on the outcome of the heat control plan outlined in Item 420.4.7.14., "Mass Placements."

4.1.3. **Placement of Superstructure Members**. Erect or place superstructure members or precast substructure members only after the substructure concrete has attained a compressive strength of 3,000 psi.

4.1.4. **Opening to Traffic**. Direct traffic culverts may be opened to construction traffic when the design strength specified in Item 421.4.1., "Classification of Concrete Mix Design," has been attained if curing is maintained. Obtain approval before opening direct traffic culverts to the traveling public. Open other noncritical structural and nonstructural concrete for service upon the completion of curing.

4.1.5. **Post-Tensioned Construction**. Ensure strength requirements on the Design Documents for structural Elements designed to be post-tensioned are met for stressing and staged loading of structural Elements.

4.1.6. **Backfilling**. Backfill in accordance with Item 400, "Backfill."

4.2. **Construction Documents for Falsework and Forms.** Submit Construction Documents for falsework and forms for the following items: vertical forms for piers and single column bents; load supporting forms for caps and tie-beams; form attachments for bridges to be widened; and other items as indicated or directed. Provide design calculations when requested. Show all essential details of proposed forms, falsework, and bracing. Have a Registered Pprofessional Engineer design, seal, and sign these Construction Documents. TxDOT approval is not required, except when forms or falsework are located such that public safety can be affected, but TxDOT reserves the right to request modifications to the Construction Documents. Developer is responsible for the adequacy of these Construction Documents. Design job-fabricated formwork assuming a weight of 150 pcf for concrete, and include a liveload allowance of 50 psf of horizontal surface of the form. Do not exceed 125% of the allowable stresses used by TxDOT for the design of structures.

4.3. **Falsework.** Design and construct falsework to safely carry the maximum anticipated loads, including wind loads, and to provide the necessary rigidity. Consult AASHTO's *Guide Design Specifications for Bridge Temporary Works* and *Construction Handbook for Bridge Temporary Works* for falsework and shoring information not indicated below. Submit details in accordance with Item 420.4.2., "Construction Documents for Falsework and Forms."

Design job-fabricated falsework assuming a weight of 150 pcf for concrete, and include a liveload allowance of 50 psf of horizontal surface of the form. Do not exceed 125% of the allowable stresses used by TxDOT for the design of structures.

Do not exceed the manufacturer's maximum allowable working loads for moment and shear or end reaction for commercially produced structural units used in falsework. Include a liveload allowance of 35 psf of horizontal form surface in determining the maximum allowable working load for commercially produced structural units.

Provide timber that is sound, in good condition, and free from defects that would impair its strength. Provide timber that meets or exceeds the species, size, and grade requirements in the submitted falsework Construction Documents.

Provide wedges made of hardwood or metal in pairs to adjust falsework to desired elevations to ensure even bearing. Do not use wedges to compensate for incorrectly cut bearing surfaces.

Use sills or grillages large enough to support the superimposed load without settlement. Take precautions to prevent settling of the supporting material unless the sills or grillages are founded on solid rock, shale, or other hard materials.

Place falsework that cannot be founded on a satisfactory spread footing on piling or drilled shafts with enough bearing capacity to support the superimposed load without settlement. Drive

falsework piling to the required resistance determined by the applicable formula in Item 404, "Driving Piling." Design drilled shafts for falsework to carry the superimposed load using both skin friction and point bearing.

Weld in conformance with Item 448, "Structural Field Welding." Securely brace each falsework bent to provide the stiffness required, and securely fasten the bracing to each pile or column it crosses.

Remove falsework when it is no longer required. Pull or cut off foundations for falsework at least 2 ft. below finished ground level. Completely remove falsework, piling, or drilled shafts in a stream, lake, or bay to the approved limits to prevent obstruction to the waterway.

4.4. **Forms.** Submit formwork Construction Documents in accordance with Item 420.4.2., "Construction Documents for Falsework and Forms."

4.4.1. **General**. Provide forms of either timber or metal except where otherwise specified or permitted.

Design forms for the pressure exerted by a liquid weighing 150 pcf. Take the rate of concrete placement into consideration in determining the depth of the equivalent liquid. Include a liveload allowance of 50 psf of horizontal surface for job-fabricated forms. Do not exceed 125% of TxDOT's allowable stresses for the design of structures.

Do not exceed the manufacturer's maximum allowable working loads for moment and shear or end reaction for commercially produced structural units used for forms. Include a liveload allowance of 35 psf of horizontal form surface in determining the maximum allowable working load for commercially produced structural units.

Provide steel forms for round columns. Refer to Item 427, "Surface Finishes for Concrete," for additional requirements for off-the-form finishes.

Provide commercial form liners for imprinting a pattern or texture on the concrete surface as shown on the Design Documents and specified in Item 427.4.3.5., "Form Liner Finish."

Provide forming systems that are practically mortar-tight, rigidly braced, and strong enough to prevent bulging between supports, and maintain them to the proper line and grade during concrete placement. Maintain forms in a manner that prevents warping and shrinkage. Do not allow offsets at form joints to exceed 1/16 in.

Use only material that is inert, non-biodegradable, and nonabsorptive for forms to be left in place.

Construct all forms to permit their removal without marring or damaging the concrete. Clean all forms and footing areas of any extraneous matter before placing concrete. Provide openings in forms if needed for the removal of laitance or foreign matter.

Treat the facing of all forms with bond-breaking coating of composition that will not discolor or injuriously affect the concrete surface. Take care to prevent coating of the reinforcing steel.

Complete all preparatory Work before requesting permission to place concrete.

Cease placement if the forms show signs of bulging or sagging at any stage of the placement, and remove the portion of the concrete causing this condition immediately. Reset the forms and securely brace them against further movement before continuing the placement.

4.4.2. **Timber Forms**. Provide properly seasoned, good-quality lumber that is free from imperfections that would affect its strength or impair the finished surface of the concrete. Provide timber or lumber that meets or exceeds the requirements for species and grade in the submitted formwork Construction Documents.

Maintain forms or form lumber that will be reused so it stays clean and in good condition. Do not use any lumber that is split, warped, bulged, or marred, or that has defects in any way that will produce inferior Work. Promptly remove such lumber from the Work.

Provide form lining for all formed surfaces except:

- the inside of culvert barrels, inlets, manholes, and box girders;
- surfaces that are subsequently covered by backfill material or are completely enclosed; and
- any surface formed by a single finished board or by plywood.

Provide form lining of an approved type such as masonite or plywood. Do not provide thin membrane sheeting such as polyethylene sheets for form lining.

Use plywood at least 3/4 in. thick. Place the grain of the face plies on plywood forms parallel to the span between the supporting studs or joists unless otherwise indicated on the submitted form drawings.

Use plywood for forming surfaces that remain exposed that meets the requirements for B-B Plyform Class I or Class II Exterior of the U.S. Department of Commerce Voluntary Product Standard PS 1.

Space studs and joists so the facing form material remains in true alignment under the imposed loads.

Space wales closely enough to hold forms securely to the designated lines, scabbed at least 4 ft. on each side of joints to provide continuity. Place a row of wales near the bottom of each placement.

Place facing material with parallel and square joints, securely fastened to supporting studs.

Place forms with the form panels symmetrical (long dimensions set in the same direction) for surfaces exposed to view and receiving only an ordinary surface finish as defined in Item 420.4.13., “Ordinary Surface Finish,”. Make horizontal joints continuous.

Make molding for chamfer strips or other uses of materials of a grade that will not split when nailed and can be maintained to a true line without warping. Dress wood molding on all faces. Fill forms at all sharp corners and edges with triangular chamfer strips measuring 3/4 in. on the sides.

Use metal form ties of an approved type or a satisfactory substitute of a type that permits ease of removal of the metal to hold forms in place. Cut back wire ties at least 1/2 in. from the face of the concrete.

Use devices to hold metal ties in place that are able to develop the strength of the tie and adjust to allow for proper alignment.

Entirely remove metal and wooden spreaders that separate the forms as the concrete is being placed.

Provide adequate clean-out openings for narrow walls and other locations where access to the bottom of the forms is not readily attainable.

4.4.3. **Metal Forms.** Requirements for timber forms regarding design, mortar-tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse, and wetting also apply to metal forms except metal forms do not require lining.

Use form metal thick enough to maintain the true shape without warping or bulging. Countersink all bolt and rivet heads on the facing sides. Design clamps, pins, or other connecting devices to hold the forms rigidly together and to allow removal without damage to the concrete. Use metal forms that present a smooth surface and line up properly. Keep metal free from rust, grease, and other foreign materials.

4.5. **Drains.** Install and construct weep holes and roadway drains as shown on the Design Documents.

4.6. **Placing Reinforcement and Post-Tensioning.** Place reinforcement as provided in Item 440, "Reinforcement for Concrete." Do not weld reinforcing steel supports to other reinforcing steel except where shown on the Design Documents.

Place post-tensioning ducts, anchorages, and other hardware in accordance with the approved prestressing details and Item 426, "Post-Tensioning." Keep ducts free of obstructions until all post-tensioning operations are complete.

4.7. **Placing Concrete.** Give sufficient advance notice before placing concrete in any unit of the structure to permit the inspection of forms, reinforcing steel placement, and other preparations.

Do not place concrete when impending weather conditions would impair the quality of the finished Work. Place concrete in early morning or at night or adjust the placement schedule for more favorable weather when conditions of wind, humidity, and temperature are such that concrete cannot be placed without the potential for weather related distress.

Adequately illuminate the entire placement site as approved when mixing, placing, and finishing concrete in non-daylight hours.

Furnish adequate shelter to protect the concrete against damage from rainfall or freezing temperatures as outlined in this Item if changes in weather conditions require protective measures after Work starts. Continue operations during rainfall only if approved. Use protective coverings for the material stockpiles. Cover aggregate stockpiles only to the extent necessary to control the moisture conditions in the aggregates.

Allow at least 1 curing Day after the concrete has achieved initial set before placing strain on projecting reinforcement to prevent damage to the concrete.

4.7.1. **Placing Temperature**. Place concrete according to the following temperature limits for the classes of concrete defined in Item 421.4.1., "Classification of Concrete Mix Designs."

- Place Class C, F, H, K, or SS concrete only when its temperature at time of placement is between 50°F and 95°F. Increase the minimum placement temperature to 60°F if ground-granulated blast furnace (GGBF) slag is used in the concrete.
- Place Class S concrete, used in this Item only as indicated for culvert top slabs, only when its temperature is between 50°F and 85°F. Increase the minimum placement temperature to 60°F if ground-granulated blast furnace (GGBF) slag is used in the concrete.
- Place Class A, B, and D concrete only when its temperature at the time of placement is greater than 50°F.
- Place mass concrete in accordance with Item 420.4.7.14., "Mass Placements," only when its temperature at the time of placement is between 50°F and 75°F.

4.7.2. **Transporting Time**. Begin the discharge of concrete delivered in truck mixers within the times listed in Table 15 of Item 421, "Hydraulic Cement Concrete."

4.7.3. **Workability of Concrete**. Place concrete with a slump as specified in Item 421.4.2.4., "Slump." Concrete that exceeds the maximum slump shall be immediately rejected. Water may be added to the concrete before discharging any concrete from the truck to adjust for low slump provided that the maximum mix design water–cement ratio is not exceeded. Mix concrete in accordance with Item 421.4.6., "Mixing and Delivering Concrete," after introduction of any additional water or chemical admixtures. Do not add water or chemical admixtures after any concrete has been discharged.

4.7.4. **Transporting Concrete**. Transport concrete by buckets, chutes, buggies, belt conveyors, pumps, or other methods.

Protect concrete transported by conveyors from sun and wind to prevent loss of slump and workability. Shade or wrap with wet burlap pipes through which concrete is pumped as necessary to prevent loss of slump and workability.

Arrange and use chutes, troughs, conveyors, or pipes so the concrete ingredients will not be separated. Terminate such equipment in vertical downspouts when necessary to prevent segregation. Extend open troughs and chutes, if necessary, down inside the forms or through holes left in the forms.

Keep all transporting equipment clean and free from hardened concrete coatings. Discharge water used for cleaning clear of the concrete.

4.7.5. **Preparation of Surfaces**. Thoroughly wet all forms and hardened concrete on which concrete is to be placed before placing concrete on them. Remove any remaining puddles of excess water before placing concrete. Provide surfaces that are in a moist, saturated surface-dry condition when concrete is placed on them.

Ensure the subgrade or foundation is moist before placing concrete on grade. Lightly sprinkle the subgrade if dry.

4.7.6. **Expansion Joints**. Construct joints and devices to provide for expansion and contraction in accordance with plan details.

Use light wire or nails to anchor any preformed fiber joint material to the concrete on 1 side of the joint.

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

Remove all concrete within the joint opening soon after form removal and again where necessary after surface finishing to ensure full effectiveness of the joint.

4.7.7. **Construction Joints**. A construction joint is the joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set. Monolithic placement means the manner and sequence of concrete placing does not create a construction joint.

Make construction joints of the type and at the locations shown on the Design Documents. Additional joints in other members are not permitted without approval. Place authorized additional joints using details equivalent to those shown on the Design Documents for joints in similar locations.

Make construction joints square and normal to the forms. Use bulkheads in the forms for all vertical joints.

Thoroughly roughen the top surface of a concrete placement terminating at a horizontal construction joint as soon as practical after initial set is attained.

Thoroughly clean the hardened concrete surface of all loose material, laitance, dirt, and foreign matter, and saturate it with water. Remove all free water and moisten the surface before concrete or bonding grout is placed against it. Ensure the surface of the existing concrete is in a saturated surface-dry condition (SSD) just before placing subsequent concrete. Prewet the existing concrete by ponding water on the surface for 24 hr. before placing subsequent concrete. Use high-pressure water blasting if ponding is not possible to achieve SSD conditions 15 to 30 min. before placing the concrete. A SSD condition is achieved when the surface remains damp when exposed to sunlight for 15 min.

Draw forms tight against the existing concrete to avoid mortar loss and offsets at joints.

Bonding agents are not required. Coat the joint surface with bonding mortar, grout, epoxy, or other material if a bonding agent is required as indicated on the Design Documents. Provide Type V epoxy per DMS-6100, “Epoxies and Adhesives,” for bonding fresh concrete to hardened concrete. Place the bonding epoxy on a clean, dry surface, and place the fresh concrete while the epoxy is still tacky. Place bonding mortar or grout on a surface that is SSD, and place the concrete before the bonding mortar or grout dries. Place other bonding agents in accordance with the manufacturer’s recommendations.

4.7.8. **Handling and Placing**. Minimize segregation of the concrete and displacement of the reinforcement when handling and placing concrete. Produce a uniform, dense compact mass.

Ensure concrete free-falls no more than 5 ft. except in the case of drilled shafts, thin walls such as in culverts, or as allowed by other Items. Remove any hardened concrete splatter ahead of the plastic concrete.

Fill each part of the forms by depositing concrete as near its final position as possible. Do not deposit large quantities or concrete at 1 point and run or move the concrete along to fill the forms.

Deposit concrete in the forms in layers of suitable depth but no more than 36 in. deep.

Avoid cold joints in a monolithic placement. Sequence successive layers or adjacent portions of concrete so they can be vibrated into a homogeneous mass with the previously placed concrete before it sets. Allow no more than 1 hr. to elapse between adjacent or successive placements of concrete when re-vibration of the concrete is shown on the Design Documents except as otherwise allowed by an approved placing procedure. This time limit may be extended by 1/2 hr. if the concrete contains at least the minimum recommended dosage of a Type B or D admixture.

Use an approved Type B or D admixture to control stress cracks and cold joints in placements where differential settlement and setting time may induce cracking.

4.7.9. **Consolidation**. Carefully consolidate concrete and flush mortar to the form surfaces with immersion type vibrators. Do not use vibrators that operate by attachment to forms or reinforcement except where approved on steel forms.

Vibrate the concrete immediately after deposit. Systematically space points of vibration to ensure complete consolidation and thorough working of the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms. Insert the vibrators vertically where possible. Vibrate the entire depth of each lift, allowing the vibrator to penetrate several inches into the preceding lift. Do not use the vibrator to move the concrete to other locations in the forms. Do not drag the vibrator through the concrete. Thoroughly consolidate concrete along construction joints by operating the vibrator along and close to but not against the joint surface. Continue the vibration until the concrete surrounding reinforcements and fixtures is completely consolidated. Hand-spade or rod the concrete if necessary to ensure flushing of mortar to the surface of all forms.

4.7.10. **Installation of Dowels and Anchor Bolts**. Install dowels and anchor bolts by casting them in-place or by grouting with grout, epoxy, or epoxy mortar. Form or drill holes for grouting. Follow the manufacturer's recommended installation procedures for pre-packaged grout or epoxy anchor systems. Test anchors if required on the Design Documents or by other Items.

Drill holes for anchor bolts to accommodate the bolt embedment required by the Design Documents. Make holes for dowels at least 12 in. deep. Make the hole diameter at least twice the dowel or bolt diameter, but not exceeding the dowel or bolt diameter plus 1-1/2 in. when using cementitious grout or epoxy mortar. Make the hole diameter 1/16 to 1/4 in. greater than the dowel or bolt diameter when using neat epoxy.

Thoroughly clean holes of all loose material, oil, grease, or other bond-breaking substance, and blow them clean with filtered compressed air. Use a wire brush followed by oil-free compressed air to remove all loose material from the holes, repeating as necessary until no more material is removed. Ensure holes are in a surface-dry condition when epoxy type materials are used and in a surface-moist condition when cementitious grout is used. Develop and demonstrate for approval a procedure for cleaning and preparing the holes for installation of the dowels and anchor bolts. Completely fill the void between the hole and dowel or bolt with grouting material.

Follow exactly the requirements for cleaning outlined in the product specifications for pre-packaged systems.

Provide hydraulic cement grout for cast-in-place or grouted systems in accordance with DMS-4675, “Cementitious Grouts and Mortars for Miscellaneous Applications.”. Provide a Type III epoxy per DMS-6100, “Epoxies and Adhesives,” when neat epoxy is used for anchor bolts or dowels. Provide Type VIII epoxy per DMS-6100, “Epoxies and Adhesives,” when an epoxy grout is used. Provide grout, epoxy, or epoxy mortar as the binding agent.

Provide other anchor systems as required on the Design Documents.

4.7.11. **Placing Concrete in Cold Weather**. Protect concrete placed under weather conditions where weather may adversely affect results. Remove and replace concrete if it is determined unsatisfactory due to poor conditions.

Do not place concrete in contact with any material coated with frost or having a temperature of 32°F or lower. Do not place concrete when the ambient temperature in the shade is below 40°F and falling. Place concrete when the ambient temperature in the shade is at least 35°F and rising or above 40°F.

Provide and install recording thermometers, maturity meters, or other suitable temperature measuring devices to verify all concrete is effectively protected as follows:

- Maintain the temperature at all surfaces of concrete in bents, piers, culvert walls, retaining walls, parapets, wingwalls, top slabs of non-direct traffic culverts, and other similar formed concrete at or above 40°F for 72 hr. from the time of placement.
- Maintain the temperature of all other concrete, including the bottom slabs (footings) of culverts, placed on or in the ground above 32°F for 72 hr. from the time of placement.

Use additional covering, insulated forms, or other means and, if necessary, supplement the covering with artificial heating. Avoid applying heat directly to concrete surfaces. Cure as specified in Item 420.4.10., “Curing Concrete,” during this period until all requirements for curing have been satisfied.

Have all necessary heating and covering material ready for use before permission is granted to begin placement when impending weather conditions indicate the possible need for temperature protection.

4.7.12. **Placing Concrete in Hot Weather**. Keep the concrete at or below the maximum temperature at time of placement as specified in Item 420.4.7.1., “Placing Temperature.” Sprinkle and shade aggregate stockpiles or use ice, liquid nitrogen systems, or other approved methods as necessary to control the concrete temperature.

4.7.13. **Placing Concrete in Water**. Deposit concrete in water only when shown on the Design Documents or with approval. Make forms or cofferdams tight enough to prevent any water current passing through the space in which the concrete is being deposited. Do not pump water during the concrete placing or until the concrete has set for at least 36 hr.

Place the concrete with a tremie or pump, or use another approved method, and do not allow it to fall freely through the water or disturb it after it is placed. Keep the concrete surface level during placement.

Support the tremie or operate the pump so it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow. Submerge the lower end of the tremie or pump hose in the concrete at all times. Use continuous placing operations until the Work is complete.

Design the concrete mix in accordance with Item 421, "Hydraulic Cement Concrete," with a minimum cement content of 650 lb. per cubic yard for concrete to be placed under water. Include an anti-washout admixture in the mix design as necessary to produce a satisfactory finished product.

4.7.14. **Mass Placements**. Develop and obtain approval for a heat control plan for monolithic placements designated on the Design Documents as mass concrete to ensure the following during the heat dissipation period:

- the temperature differential between the central core of the placement and the exposed concrete surface does not exceed 35°F and
- the temperature at the central core of the placement does not exceed 160°F.

Use the ConcreteWorks© software available from TxDOT, or another approved method based on the guidelines in ACI 207, "Mass Concrete," to develop the heat control plan. TxDOT will make available technical assistance on the use of ConcreteWorks©. Develop the heat control plan using historical temperature ranges for the anticipated time of the mass placement. Re-create the plan if the Work schedule shifts by more than one month.

The heat control plan may include a combination of the following elements:

- selection of concrete ingredients including aggregates, gradation, and cement types, to minimize heat of hydration;
- use of ice or other concrete cooling ingredients;
- use of liquid nitrogen dosing systems;
- controlling rate or time of concrete placement;
- use of insulation or supplemental external heat to control heat loss;
- use of supplementary cementing materials;
- use of a cooling system to control the core temperature; or
- vary the duration formwork remains in place.

Furnish and install 2 pairs of temperature recording devices, maturity meters, or other approved equivalent devices. Install devices to measure the surface temperature no more than 3 in. from the surface. Install devices to measure the core temperature a distance of half the least dimension from the nearest surface near the point of maximum predicted heat. Use these devices to simultaneously measure the temperature of the concrete at the core and the surface. Maintain temperature control methods for 4 Days unless otherwise approved based on the submitted heat control plan. Do not use maturity meters to predict strength of mass concrete. Revise the heat control plan as necessary to maintain the temperature limitations shown above.

If the core temperature exceeds 160°F, the mass concrete Element shall be subject to review and acceptance using forensic analyses to determine its potential reduction in service life or performance. Proceed with subsequent construction on the affected Element only when notified regarding acceptance. Repair any resulting cracking if the temperature differential between the central core of the placement and the nearest concrete surface exceeds 35°F and revise the heat control plan as necessary to prevent further occurrences.

4.7.15. **Placing Concrete in Foundation and Substructure**. Do not place concrete in footings until the depth and character of the foundation has been inspected and permission has been given to proceed.

Place concrete footings upon seal concrete after the cofferdams are free from water and the seal concrete is cleaned. Perform any necessary pumping or bailing during the concreting from a suitable sump located outside the forms.

Construct or adjust all temporary wales or braces inside cofferdams as the Work proceeds to prevent unauthorized construction joints.

Omit forms when footings can be placed in a dry excavation without the use of cofferdams, if approved, and fill the entire excavation with concrete to the elevation of the top of footing.

Place concrete in columns monolithically between construction joints. Columns and caps or tie beams supported on them may be placed in the same operation or separately. Allow for settlement and shrinkage of the column concrete, if placed in the same operation, by placing it to the lower level of the cap or tie beam, and delay placement between 1 and 2 hr. before proceeding with the cap or tie beam placement.

4.7.16. **Placing Concrete in Box Culverts**. Allow between 1 and 2 hr. to elapse where the top slab and walls are placed monolithically in culverts more than 4 ft. in clear height before placing the top slab to allow for settlement and shrinkage in the wall concrete.

Accurately finish the footing slab at the proper time to provide a smooth uniform surface. Finish top slabs that carry direct traffic as specified in Item 422, “Concrete Superstructures.” Give top slabs of fill type culverts a float finish.

4.8. **Extending Existing Substructures.** Verify pertinent dimensions and elevations of the existing structure before ordering any required materials.

4.8.1. **Removal**. Remove portions of the existing structure to the lines and dimensions shown on the Design Documents. Dispose of these materials as shown on the Design Documents. Repair any portion of the remaining structure damaged as a result of the construction.

Do not use explosives to remove portions of the existing structure. Do not use a demolition ball, other swinging weight, or impact equipment. Use pneumatic or hydraulic tools for final removal of concrete at the “break” line. Use removal equipment, as approved, that will not damage the remaining concrete.

4.8.2. **Reuse of Removed Portions of Structure**. Detach and remove all portions of the old structure that are to be incorporated into the extended structure to the lines and details as specified on the Design Documents. Move the unit to be reused to the new location specified using approved methods. Place the reinforcement and extension concrete according to the plan details.

4.8.3. **Splicing Reinforcing Steel**. Splice new reinforcing bars to exposed bars in the existing structure using lap splices in accordance with Item 440, “Reinforcement for Concrete.” The new reinforcing steel does not need to be tied to the existing steel where spacing or elevation does not match that of the existing steel provided the lap length is attained. Weld in accordance with Item 448, “Structural Field Welding,” when welded splices are permitted. Install any required dowels in accordance with Item 420.4.7.10., “Installation of Dowels and Anchor Bolts.”

4.8.4. **Concrete Preparation**. Roughen and clean concrete surfaces that are in contact with new construction before placing forms. Prepare these construction joint surfaces in accordance with Item 420.4.7.7., "Construction Joints."

4.9. **Treatment and Finishing of Horizontal Surfaces.** Strike off to grade and finish all unformed upper surfaces. Do not use mortar topping for surfaces constructed under this Section.

Float the surface with a suitable float after the concrete has been struck off.

Slope the tops of caps and piers between bearing areas from the center slightly toward the edge, and slope the tops of abutment and transition bent caps from the backwall to the edge so water drains from the surface. Give the concrete a smooth trowel finish. Construct bearing areas for steel units in accordance with Item 441, "Bearing and Anchorage Devices." Give the bearing area under the expansion ends of concrete slabs and slab and girder spans a steel-trowel finish to the exact grades required. Give bearing areas under elastomeric bearing pads or nonreinforced bearing seat buildups a textured, wood float finish. Do not allow the bearing area to vary from a level plane more than 1/16 in. in all directions.

Cast bearing seat buildups or pedestals for concrete units integrally with the cap or a construction joint. Provide a latex-based mortar, an epoxy mortar, or an approved proprietary bearing mortar for bearing seat buildups cast with a construction joint. Mix mortars in accordance with the manufacturer's recommendations. Construct pedestals of Class C concrete, reinforced as shown on the Design Documents or as indicated in Figure 1 and Figure 2. The engineer of record shall design pedestals higher than 12 in.

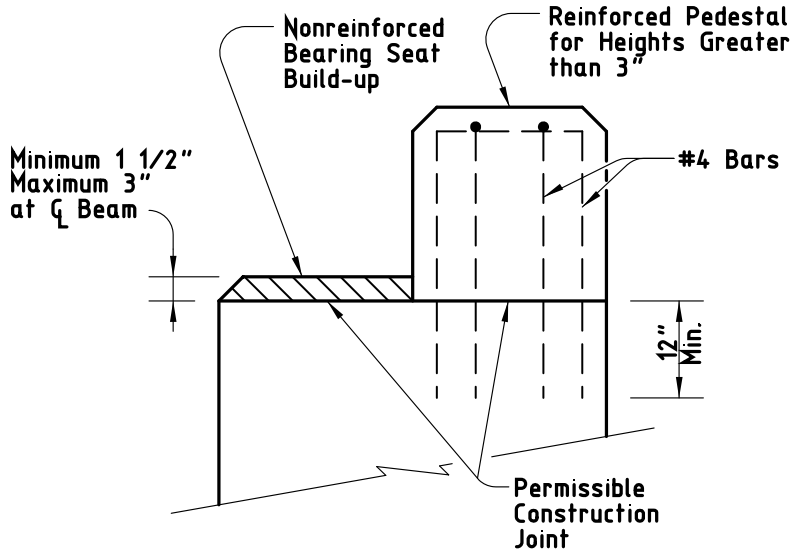


Figure 1

Section through bearing seat buildups.

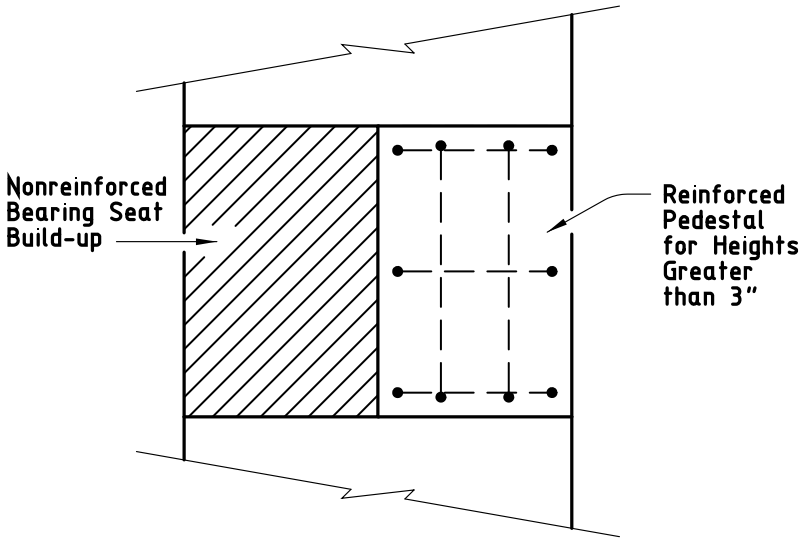


Figure 2

Plan view of bearing seat buildups.

4.10. **Curing Concrete.** Obtain approval of the proposed curing methods, equipment, and materials before placing concrete. Inadequate curing or facilities may delay all concrete placements on the job until remedial action is taken.

A curing Day is a Day when the temperature, taken in the shade away from artificial heat, is above 50°F for at least 19 hr. or, on colder Days if the temperature of all surfaces of the concrete is maintained above 40°F, for the entire 24 hr. The required curing period begins when all concrete has attained its initial set. Tex-440-A may be used to determine when the concrete has attained its initial set.

Cure all concrete for 4 consecutive Days except as allowed for the curing options listed below. Use form or membrane curing for vertical surfaces. Use only water curing for horizontal surfaces of HPC or mass concrete. Use water or membrane curing for horizontal or unformed surfaces for all other concrete.

Use one of the following curing options for vertical surfaces,.

- Form cure for 48hr. after placement.
- Form cure for 12 hr. after placement followed by membrane curing.
- For HPC Concrete, form cure for 48 hr. after placement followed by membrane curing.
- For mass concrete, form cure as required by the heat control plan followed by membrane curing if forms are removed before 4 Days.

Apply membrane curing, if used, within 2 hr. of form removal.

Use only water curing in accordance with this Section for the top surface of any concrete unit upon which concrete is to be placed and bonded at a later interval (stub walls, caps with backwalls, risers, etc.).

Cure all other concrete as specified in the pertinent Items. Use the following methods for curing concrete, subject to the requirements of this Item.

4.10.1. **Form Curing**. When forms are left in intimate contact with the concrete, other curing methods are not required except for exposed surfaces and for cold weather protection. Use another approved curing method if forms are removed before the 4-Day required curing period.

4.10.2. **Water Curing**. Keep all exposed surfaces of the concrete wet continuously for the required curing time. Use water curing in accordance with concrete mixing water in Item 421.2.4., "Water." Do not use seawater or water that stains or leaves an unsightly residue.

4.10.2.1. **Blankets**. Keep the concrete continuously wet by maintaining wet cotton or burlap mats in direct contact with the concrete for the required curing time. Weight the mats adequately to provide continuous contact with all concrete. Cover surfaces that cannot be cured by direct contact with mats, forming an enclosure well anchored to the forms or ground so outside air cannot enter the enclosure. Provide sufficient moisture inside the enclosure to keep all surfaces of the concrete wet.

4.10.2.2. **Water Spray**. Overlap sprays or sprinklers to keep all unformed surfaces continuously wet.

4.10.2.3. **Ponding**. Cover the surfaces with at least 2 in. of clean granular material, kept wet at all times, or at least 1 in. deep water. Use a dam to retain the water or saturated granular material.

4.10.3. **Membrane Curing**. Choose either Type 1-D or Type 2 membrane-curing compound. Use same type of curing compound on an individual member.

Apply membrane curing just after free moisture has disappeared at a rate of approximately 180 sq. ft. per gallon. Do not spray curing compound on projecting reinforcing steel or concrete that will later form a construction joint. Do not apply membrane curing to dry surfaces. Dampen formed surfaces and surfaces that have been given a first rub so they are moist at the time of application of the membrane.

Leave the film unbroken for the minimum curing period specified when membrane is used for complete curing. Correct damaged membrane immediately by reapplication of membrane. Polyethylene sheeting, burlap-polyethylene mats, or laminated mats in close contact with the concrete surfaces are equivalent to membrane curing.

4.11. **Removal of Forms and Falsework.** Remove forms for vertical surfaces after the concrete has aged a minimum of 12 hr. after initial set provided the removal can be done without damage to the concrete. Keep forms for mass placements in place for 4 Days following concrete placement unless otherwise approved based on the outcome of the heat control plan outlined in Item 420.4.7.14., "Mass Placements."

Leave in place weight-supporting forms and falsework spanning more than 1 ft. for all bridge components and culvert slabs until the concrete has attained a compressive strength of 2,500 psi. Remove forms for other structural components as necessary.

Remove inside forms (walls and top slabs) for box culverts and sewers after concrete has attained a compressive strength of 1,800 psi if an approved overhead support system is used to transfer the weight of the top slab to the walls of the box culvert or sewer before removal of the support provided by the forms.

Forms or parts of forms may be removed only if 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 to a depth of at least 1/2 in. from the concrete surface. Make the appliances so metal may be removed without undue chipping or spalling of the concrete, and so it leaves a smooth opening in the concrete surface when removed. Do not burn off rods, bolts, or ties.

Remove all forms and falsework.

4.12. **Defective Work.** Repair defective Work as soon as possible. Remove and replace any defect that cannot be repaired to the satisfaction of TxDOT.

4.13. **Ordinary Surface Finish.** Apply an ordinary surface finish to all concrete surfaces. Provide flat or textured surfaces as specified with uniform appearance. Address defects and surface irregularities not consistent with the intent of the expected finish by the following:

- Chip away all loose or broken material to sound concrete where porous, spalled, or honeycombed areas are visible after form removal.
- Repair spalls in accordance with the procedures outlined in the TxDOT *Concrete Repair Manual* available on TxDOT's website.
- Clean and fill holes or spalls caused by the removal of form ties, etc., with latex grout, cement grout, or epoxy grout as approved. Fill only the holes. Do not blend the patch with the surrounding concrete. On surfaces to receive a rub finish in accordance with Item 427, "Surface Finishes for Concrete," chip out exposed parts of metals chairs to a depth of 1/2 in. and repair the surface.
- Remove all fins, rust staining, runs, drips, or mortar from surfaces that will be exposed. Smooth all form marks and chamfer edges by grinding or dry-rubbing.
- Ensure all repairs are dense, well-bonded, and properly cured. Finish exposed large repairs to blend with the surrounding concrete where a higher class of finish is not specified.

Apply an ordinary surface finish as the final finish to the following exposed surfaces:

- inside and top of inlets
- inside and top of manholes
- inside of sewer appurtenances
- inside of culvert barrels

Form marks and chamfer edges do not need to be smoothed for the inside of culvert barrels.

Item 421

12. Hydraulic Cement Concrete

1. DESCRIPTION

Furnish hydraulic cement concrete for concrete pavements, concrete structures, and other concrete construction.

2. MATERIALS

Use materials from prequalified sources listed on TxDOT's website. Provide coarse and fine aggregates from sources listed in TxDOT's *Concrete Rated Source Quality Catalog* (CRSQC). Use materials from non-listed sources only when tested and approved by TxDOT before use. Allow 30 Days for sampling, testing, and reporting results for non-listed sources. Do not combine approved material with unapproved material.

2.1. **Cement. Furnish cement conforming to DMS-4600, "Hydraulic Cement."**

2.2. **Supplementary Cementing Materials (SCM).**

- **Fly Ash**. Furnish fly ash, ultra-fine fly ash (UFFA), and modified Class F fly ash (MFFA) conforming to DMS-4610, "Fly Ash."
- **Slag Cement**. Furnish Slag Cement conforming to DMS-4620, " Slag Cement."
- **Silica Fume**. Furnish silica fume conforming to DMS-4630, "Silica Fume."
- **Metakaolin**. Furnish metakaolin conforming to DMS-4635, "Metakaolin."

2.3. **Cementitious Material.** Cementitious materials are the cement and supplementary cementing materials used in concrete.

2.4. **Chemical Admixtures.** Furnish admixtures conforming to DMS-4640, "Chemical Admixtures for Concrete."

2.5. **Water.** Furnish mixing and curing water that is free from oils, acids, organic matter, or other deleterious substances. Water from municipal supplies approved by the Texas Department of Health will not require testing. Provide test reports showing compliance with Table 1 before use when using water from other sources.

Water that is a blend of concrete wash water and other acceptable water sources, certified by the concrete producer as complying with the requirements of both Table 1 and Table 2, may be used as mix water. Test the blended water weekly for 4 weeks for compliance with Table 1 and Table 2 or provide previous test results. Then test every month for compliance. Provide water test results upon request.

Table 1

Chemical Limits for Mix Water

Contaminant	Test Method	Maximum Concentration (ppm or mg\L)
Chloride (Cl)	ASTM C114	
Prestressed concrete		500
Bridge decks & superstructure		500
All other concrete		1,000
Sulfate (SO4)	ASTM C114	2,000
Alkalies (Na2O + 0.658K2O)	ASTM C114	600
Total solids	ASTM C1603	50,000

Table 2

Acceptance Criteria for Questionable Water Supplies

Property	Test Method	Limits
Compressive strength, min % control at 7 Days	ASTM C31, ASTM C39[1,2]	90
Time of set, deviation from control, h:min.	ASTM C403	From 1:00 early to 1:30 later

Base comparisons on fixed proportions and the same volume of test water compared to the control mix using 100% potable water or distilled water.

Base comparisons on sets consisting of at least two standard specimens made from a composite sample.

Do not use mix water that has an adverse effect on the air-entraining agent, on any other chemical admixture, or on strength or time of set of the concrete. Use mixing and curing water free of iron and other impurities that may cause staining or discoloration when using white hydraulic cement.

2.6. **Aggregate.**

2.6.1. **Coarse Aggregate**. Provide coarse aggregate consisting of durable particles of gravel, crushed blast furnace slag, recycled crushed hydraulic cement concrete, crushed stone, or combinations which are free from frozen material and from injurious amounts of salt, alkali, vegetable matter, or other objectionable material, either free or as an adherent coating. Provide coarse aggregate of uniform quality throughout.

Provide coarse aggregate with the requirements listed in Table 3.

Table 3

Coarse Aggregate Requirements

Description	Test Method	Limit
Weight of Clay Lumps, % max.	Tex-413-A	0.25
Weight of Shale, % max		1.0
Weight of Laminate and Friable Particle, % max		5.0
L.A. Abrasion Wear, % max	Tex-410-A	40
5-Cycle Magnesium Sulfate Soundness[1,2], non-air-entrained concrete, % max	Tex-411-A	25
5-Cycle Magnesium Sulfate Soundness[1,3], air-entrained concrete, % max		18
Loss by Decantation, % max	Tex-406-A	1.5

1. Recycled crushed hydraulic cement concrete is not subject to 5-cycle magnesium sulfate soundness requirements.
2. Allowed when air-entrained concrete is used at Developer's option.
3. Only when air-entrained concrete is required by the Design Documents.

Increase the loss by decantation limit to 3.0% for all classes of concrete and 5.0% for Class A and B if the material finer than the No. 200 sieve is determined to be at least 85% calcium carbonate in accordance with Tex-406-A, Part III, in the case of coarse aggregates made primarily from crushing stone. Provide test results upon request.

Provide coarse aggregate conforming to the gradation requirements shown in Table 4 when tested in accordance with Tex-401-A.

Table 4

Coarse Aggregate Gradation Chart

Aggregate Grade No.[1]	Maximum Nominal Size	Percent Passing on Each Sieve								
		2-1/2"	2"	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 8
1	2"	100	80–100	50–85		20–40			0–10	
2	1–1/2"		100	95–100		35–70		10–30	0–10	
3	1–1/2"		100	95–100		60–90	25–60		0–10	
4 (57)	1"			100	95–100		25–60		0–10	0–5
5 (67)	3/4"				100	90–100		20–55	0–10	0–5
6 (7)	1/2"					100	90–100	40–70	0–15	0–5
7	3/8"						100	70–95	0–25	
8	3/8"						100	95–100	20–65	0–10

1. Corresponding ASTM C33 gradation shown in parentheses.

2.6.2. **Fine Aggregate**. Provide fine aggregate consisting of clean, hard, durable particles of natural, manufactured sand, recycled crushed hydraulic cement concrete, slag, lightweight aggregate, or a combination

thereof. Provide fine aggregate free from frozen material and from injurious amounts of salt, alkali, vegetable matter, or other objectionable material.

Provide fine aggregates with the requirements in Table 5.

Table 5

Fine Aggregate Requirements

Description	Test Method	Limit
Weight of Clay Lumps, % max.	Tex-413-A	0.50
Organic Impurities[1]	Tex-408-A	Color Not Darker Than Standard
Sand Equivalent	Tex-203-F	80
Fineness Modulus	Tex-402-A	2.3 to 3.1

1. Only when air-entrained concrete is specified.

Provide fine aggregate or combinations of aggregates conforming to the gradation requirements shown in Table 6 when tested in accordance with Tex-401-A.

Table 6

Fine Aggregate Gradation Chart (Grade 1)

Sieve Size	Percent Passing
3/8 in.	100
No. 4	95–100
No. 8	80–100
No. 16	50–85
No. 30	25–65
No. 50	10–35[1]
No. 100	0–10
No. 200	0–3[2]

1. 6–35 when sand equivalent value is greater than 85.
2. 0–6 for manufactured sand.

2.6.3. **Intermediate Aggregate**. Provide intermediate aggregate consisting of clean, hard, durable particles of natural, manufactured sand, slag, recycled crushed hydraulic cement concrete, lightweight aggregate, or a combination thereof when optimized aggregate gradation (OAG) concrete is specified or when used at Developer's option. Provide intermediate aggregate free from frozen material and injurious amounts of salt, alkali, vegetable matter, or other objectionable material.

Provide intermediate aggregate with the requirements in Table 7.

Table 7

Intermediate Aggregate Requirements

Description	Test Method	Limit
Weight of Clay Lumps, % max.	Tex-413-A	0.50
L.A. Abrasion Wear[1], % max	Tex-410-A	40
5-Cycle Magnesium Sulfate Soundness[1,2,3], non-air-entrained concrete % max	Tex-411-A	25
5-Cycle Magnesium Sulfate Soundness[1,2,4], air-entrained concrete % max		18
Organic Impurities[5]	Tex-408-A	Color not Darker than Standard
Loss by Decantation[1], % max	Tex-406-A	1.5

1. Only applies to the portion retained on the No. 4 sieve, if more than 30% of the intermediate aggregate is retained on the No. 4 sieve.
2. Recycled crushed hydraulic cement concrete is not subject to 5-cycle magnesium sulfate soundness requirements.
3. Allowed when air-entrained concrete is used at Developer's option.
4. Only when air-entrained concrete is required by the Design Documents.
5. Only applies to the portion passing the 3/8" sieve, if more than 30% of the intermediate aggregate is passing the 3/8" sieve.

For the portion retained on the No. 4 sieve, if more than 30% of the intermediate aggregate is retained on the No. 4 sieve, and in the case of aggregates made primarily from crushing stone, , the loss by decantation may be increased to 3.0% for all classes of concrete and 5.0% for Class A and B if the material finer than the No. 200 sieve is determined to be at least 85% calcium carbonate in accordance with Tex-406-A, Part III. Provide test results upon request.

2.7. **Mortar and Grout.** Furnish pre-packaged grouts conforming to DMS-4675, "Cementitious Grouts and Mortars for Miscellaneous Applications," when specified for applications other than post-tension grouting.

Item 421.4.2.6 "Mix Design Options" does not apply for mortar and grout.

2.8. **Storage of Materials.**

2.8.1. **Cement and Supplementary Cementing Materials**. Store all cement and supplementary cementing materials in weatherproof enclosures that will protect them from dampness or absorption of moisture.

When permitted, small quantities of packaged cementitious material may be stored in the open, on a raised platform, and under waterproof covering for up to 48 hr.

2.8.2. **Aggregates**. Handle and store concrete aggregates in a manner that prevents contamination with foreign materials. Clear and level the sites for the stockpiles of all vegetation if the aggregates are stored on the ground and do not use the bottom 6-in. layer of aggregate without cleaning the aggregate before use.

Maintain separate stockpiles and prevent intermixing when conditions require the use of 2 or more grades of coarse aggregates. Separate the stockpiles using physical barriers where space is limited. Store aggregates from different sources in different stockpiles. Minimize segregation in stockpiles. Remix and test stockpiles when segregation is apparent.

Sprinkle stockpiles to control moisture and temperature as necessary. Maintain reasonably uniform moisture content in aggregate stockpiles.

2.8.3. **Chemical Admixtures**. Store admixtures in accordance with manufacturer's recommendations and prevent admixtures from freezing.

3. EQUIPMENT

3.1. **Concrete Plants and Mixing Equipment.** Except for volumetric stationary plant or truck (auger) mixers, each plant and truck mixer must be currently certified by the NRMCA or have an inspection report signed and sealed by a Registered Professional Engineer showing concrete measuring, mixing, and delivery equipment meets all requirements of ASTM C94. A new certification or signed and sealed report is required every time a plant is moved. Plants with a Registered Professional Engineer's inspection require re-inspection every 2 yr. Provide a copy of the certification or the signed and sealed inspection report to TxDOT. Remove equipment or facilities from service until corrected when they fail to meet specification requirements.

When allowed on the Design Documents, for concrete classes not identified as structural concrete in Table 5 or for Class C concrete not used for bridge-class structures, inspection and approval of all plants and trucks instead of the NRMCA or non-TxDOT engineer-sealed certifications may be performed. The criteria and frequency of approval of plants and trucks is the same used for NRMCA certification.

Inspect and furnish inspection reports on the condition of blades and fins and their percent wear from the original manufacturer's design for truck mixers and agitators annually. Repair mixing equipment exhibiting 10% or more wear before use. If an inspection within 12 mo. is not practical, a 2-mo. grace period (for a maximum of 14 mo. between inspections) is permitted.

3.1.1. **Scales**. Check all scales before beginning of operations, after each move, or whenever their accuracy or adequacy is questioned, and at least once every 6 mo. Immediately correct deficiencies, and recalibrate. Provide a record of calibration showing scales in compliance with ASTM C94 requirements. Check batching accuracy of volumetric water batching devices at least every 90 Days. Check batching accuracy of chemical admixture dispensing devices at least every 6 mo. Perform daily checks as necessary to ensure measuring accuracy.

3.1.2. **Volumetric Mixers**. Provide volumetric mixers with rating plates defining the capacity and the performance of the mixer in accordance with the Volumetric Mixer Manufacturers Bureau or equivalent. Provide volumetric mixers that comply with ASTM C685. Provide test data showing mixers meet the uniformity test requirements of Tex-472-A.

Volumetric truck (auger) mixers may not supply classes of concrete identified as structural concrete in Table 8.

3.1.3. **Agitators and Truck and Stationary Mixers**. Provide stationary and truck mixers capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and capable of discharging the concrete so at least 5 of the 6 requirements of Tex-472-A are met.

Perform concrete uniformity tests on mixers or agitators in accordance with Tex-472-A to resolve issues of mix uniformity and mixer performance.

Perform the mixer or agitator uniformity test at the full rated capacity of the equipment. Remove all equipment that fails the uniformity test from service.

Inspect and maintain mixers and agitators. Keep them free of concrete buildup, and repair or replace worn or damaged blades or fins.

Ensure all mixers have a plate affixed showing manufacturer's recommended operating speed and rated capacity for mixing and agitating.

3.2. **Hauling Equipment.** Provide hauling equipment capable of maintaining the mixed concrete in a thoroughly mixed and uniform mass, and discharging the concrete with a satisfactory degree of uniformity.

Provide equipment with smooth, mortar-tight metal containers equipped with gates that prevent accidental discharge of the concrete when using non-agitating equipment for transporting concrete.

Maintain hauling equipment clean and free of built-up concrete.

3.3. **Testing Equipment.** Furnish and maintain the following in accordance with the pertinent test procedure

- sieves necessary to perform aggregate gradation analysis when optimized aggregate gradation is specified,
- equipment necessary to perform Tex-415-A and Tex-422-A,
- equipment necessary to perform Tex-409-A, or Tex-425-A,
- test molds,
- curing facilities,
- maturity meters if used, and
- wheelbarrow or other container acceptable for the sampling of the concrete.

Provide strength-testing equipment when required in accordance with the Contract-controlling test.

4. CONSTRUCTION

4.1. **Classification of Concrete Mix Designs.** Provide classes of concrete meeting the requirements shown in Table 8.

A higher-strength class of concrete with equal or lower water-to-cementitious material ratio may be substituted for the specified class of concrete, when approved.

4.2. **Mix Design Proportioning.** Furnish mix designs using ACI 211, Tex-470-A, or other approved procedures for the classes of concrete listed in Table 8. Perform mix design proportioning by absolute volume method. Perform cement replacement using equivalent weight method.

Do not exceed the maximum water-to-cementitious material ratio listed in Table 8 when designing the mixture.

4.2.1. **Cementitious Materials.** Do not exceed 700 lb. of cementitious material per cubic yard of concrete.

- Use cement of the same type and from the same source for monolithic placements.
- Do not use supplementary cementing materials when white hydraulic cement is specified.

Table 8

Concrete Classes

Class of Concrete	Design Strength[1], Min. f'_c (psi)	Maximum w/cm Ratio	Coarse Aggregate Grades[2,3,4]	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Usage[5]
A	3,000	0.60	1–4, 8	I, II, I/II, IL, IP, IS, IT, V	1, 2, 4, & 7	■ When the cementitious material content does not exceed 520 lb./cu. yd., Class C fly ash may be used instead of Class F fly ash.	Inlets, manholes, curb, gutter, curb & gutter, conc. retards, sidewalks, driveways, back-up walls, anchors, non-reinforced drilled shafts
B	2,000	0.60	2–7				Riprap, traffic signal controller foundations, small roadside signs, and anchors
C[6]	3,600	0.45	1–6	I, II, I/II, IP, IS, IT[7], V	1-8		Drilled shafts, bridge substructure, bridge railing, culverts except top slab of direct traffic culverts, headwalls, wing walls, approach slabs, inlets, manholes, concrete traffic barrier (cast-in-place)
E	3,000	0.50	2–5	I, II, I/II, IL, IP, IS, IT[7], V	1-8	■ When the cementitious material content does not exceed 520 lb./cu. yd., Class C fly ash may be used instead of Class F fly ash.	Seal concrete
F[6]	Note 8	0.45	2–5	I, II, I/II, IP, IS, IT[7],V			Railroad structures; occasionally for bridge piers, columns, or bents

Class of Concrete	Design Strength[1] ,Min. f'_c (psi)	Maximum w/cm Ratio	Coarse Aggregate Grades[2,3,4]	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Usage[5]
H[6]	Note 8[7]	0.45	3–6	I, II, I/II, III, IP, IS, IT[7], V	1-5	■ Do not use Type III cement in mass placement concrete. ■ Up to 20% of blended cement may be replaced with listed SCMs when Option 4 is used for precast concrete.	Precast concrete, post-tension members
S[6]	4,000	0.45	2–5	I, II, I/II, IP, IS, IT[7],V	1-8		Bridge slabs, top slabs of direct traffic culverts
CO[6]	4,600	0.40	6	I, II, I/II, IP, IS, IT[7], V	1-8		Bridge deck concrete Overlay
LMC[6]	4,000	0.40	6–8				Latex-modified concrete overlay
SS[6]	3,600	0.45	4–6			■ Use a minimum cementitious material content of 658 lb./cu. yd. of concrete.	Slurry displacement shafts, underwater drilled shafts

Class of Concrete	Design Strength[1] ,Min. f'_c (psi)	Maximum w/cm Ratio	Coarse Aggregate Grades[2,3,4]	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Usage[5]
K[6]	Note 8	0.40	Note 8	I, II, I/II, III IP, IS, IT[7], V			Note 8

Class of Concrete	Design Strength[1] ,Min. f'_c (psi)	Maximum w/cm Ratio	Coarse Aggregate Grades[2,3,4]	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Usage[5]
HES	Note 8	0.45	Note 8	I, IL, II, I/II, III		■ Mix design options do not apply. ■ 700 lb. of cementitious material per cu. yd. limit does not apply.	Concrete pavement, concrete pavement repair
"X"(HPC)[6,9,10]	Note 11	0.45	Note 11	I, II, I/II, III IP, IS, IT[7], V	1-5, & 8	■ Maximum fly ash replacement for option 1 and 3 may be increased to 45%. ■ Up to 20% of a blended cement may be replaced with listed SCMs for Option 4. ■ Do not use Option 8 for precast concrete.	
"X"(SRC)[6,9,10]	Note 11	0.45	Note 11	I/II, II, IP, IS, IT[7], V	1-4, & 7	■ Do not use Class C Fly Ash ■ Type III-MS may be used where allowed. ■ Type I and Type III cements may be used with Options 1-3, with a maximum w/cm of 0.40. ■ Up to 20% of blended cement may be replaced with listed SCMs when Option 4 is used for precast concrete. ■ Do not use Option 7 for precast concrete.	

Class of Concrete	Design Strength[1] ,Min. f'_c (psi)	Maximum w/cm Ratio	Coarse Aggregate Grades[2,3,4]	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Usage[5]

1. Design strength must be attained within 56 Days.
2. Do not use Grade 1 coarse aggregate except in massive foundations with 4 in. minimum clear spacing between reinforcing steel bars,. Do not use Grade 1 aggregate in drilled shafts.
3. Use Grade 8 aggregate in extruded curbs.
4. Other grades of coarse aggregate maybe used in non-structural concrete classes when allowed by TxDOT.
5. For information only.
6. Structural concrete classes.
7. Do not use Type IT cements containing >5% limestone.
8. As shown on the Design Documents or specified.
9. "X" denotes class of concrete shown on the Design Documents or specified.
10. (HPC): High Performance Concrete, (SRC): Sulfate Resistant Concrete.
11. Same as class of concrete shown on the Design Documents.

4.2.2. **Aggregates**. Recycled crushed hydraulic cement concrete may be used as a coarse or fine aggregate in Class A, B, D, and E concrete. Limit recycled crushed concrete fine aggregate to a maximum of 20% of the fine aggregate.

Use light-colored aggregates when white hydraulic cement is specified.

Use fine aggregate with an acid insoluble residue of at least 60% by weight when tested in accordance with Tex-612-J in all concrete subject to direct traffic.

Use the following equation to determine if the aggregate combination meets the acid insoluble residue requirement when blending fine aggregate or using an intermediate aggregate:

$$\frac{(A_1 \times P_1)+(A_2 \times P_2)+(A_{ia} \times P_{ia})}{100} \geq 60\%$$

Where:
A_1 = acid insoluble (%) of fine aggregate 1
A_2 = acid insoluble (%) of fine aggregate 2
A_{ia} = acid insoluble (%) of intermediate aggregate passing the 3/8" sieve
P_1 = percent by weight of fine aggregate 1 of the fine aggregate blend
P_2 = percent by weight of fine aggregate 2 of the fine aggregate blend
P_{ia} = percent by weight of intermediate aggregate passing the 3/8" sieve

Alternatively to the above equation, blend fine aggregate with a micro deval loss of less than 12%, when tested in accordance with Tex-461-A, with at least 40% of a fine aggregate with an acid insoluble residue of at least 60%.

4.2.3. **Chemical Admixtures**. Do not use Type C, Type E, Type F, or Type G admixtures in Class S bridge deck concrete. Do not use chemical admixtures containing calcium chloride in any concrete.

Use a 30% calcium nitrite solution when a corrosion-inhibiting admixture is required. The corrosion-inhibiting admixture must be set neutral. Dose the admixture at the rate of gallons of admixture per cubic yard of concrete shown on the Design Documents.

4.2.4. **Air Entrainment**. Use an approved air-entraining admixture when air-entrained concrete is specified, or when an air-entraining admixture is used at Developer's option, and do not exceed the manufacturer's recommended dosage. Ensure the minimum entrained air content is at least 3.0% for all classes of concrete when air-entrained concrete is specified, during trial batch, or when providing previous field data.

4.2.5. **Slump**. Provide concrete with a slump in accordance with Table 9. When approved, the slump of a given concrete mix may be increased above the values shown in Table 9 using chemical admixtures, provided the admixture-treated concrete has the same or lower water-to-cementitious material ratio and does not exhibit segregation or excessive bleeding. Request approval to exceed the slump limits in Table 9 sufficiently in advance for proper evaluation.

Perform job control testing of slump in accordance with Item 421.4.8.3.1., "Job Control Testing."

Table 9

Placement Slump Requirements

General Usage[1]	Placement Slump Range[2], inches
Walls (over 9 in. thick), caps, columns, piers, approach slabs, concrete overlays	3 to 5
Bridge slabs, top slabs of direct traffic culverts, latex-modified concrete for bridge deck overlays	3 to 5-1/2
Inlets, manholes, walls (less than 9 in. thick), bridge railing, culverts, concrete traffic barrier, concrete pavement (formed), seal concrete	4 to 5-1/2
Precast concrete	4 to 9
Underwater concrete placements	6 to 8-1/2
Drilled shafts, slurry displaced and underwater drilled shafts	See Item 416, "Drilled Shaft Foundations."
Curb, gutter, curb and gutter, concrete retards, sidewalk, driveways, anchors, riprap, small roadside sign foundations, concrete pavement repair, concrete repair	As approved

1. For information only.
2. For fiber reinforced concrete, perform slump before addition of fibers.

4.2.6. **Mix Design Options**.

4.2.6.1. **Option 1**. Replace 20% to 35% of the cement with Class F fly ash.

4.2.6.2. **Option 2**. Replace 35% to 50% of the cement with slag cement or MFFA.

4.2.6.3. **Option 3**. Replace 35% to 50% of the cement with a combination of Class F fly ash, slag cement, MFFA, UFFA, metakaolin, or silica fume; however, no more than 35% may be fly ash, and no more than 10% may be silica fume.

4.2.6.4. **Option 4**. Use Type IP, Type IS, or Type IT cement as allowed in Table 5 for each class of concrete. Up to 10% of a Type IP, Type IS, or Type IT cement may be replaced with Class F fly ash, slag cement, or silica fume. Use no more than 10% silica fume in the final cementitious material mixture if the Type IT cement contains silica fume, and silica fume is used to replace the cement.

4.2.6.5. **Option 5**. Replace 35% to 50% of the cement with a combination of Class C fly ash and at least 6% of silica fume, UFFA, or metakaolin. However, no more than 35% may be Class C fly ash, and no more than 10% may be silica fume.

4.2.6.6. **Option 6**. Use a lithium nitrate admixture at a minimum dosage determined by testing conducted in accordance with Tex-471-A, "Lithium Dosage Determination Using Accelerated Mortar Bar Testing." Before use of the mix, provide an annual certified test report signed and sealed by a Registered Professional Engineer, from a laboratory on TxDOT's List of Approved Lithium Testing Laboratories, certified by TxDOT as being capable of testing according to Tex-471-A, "Lithium Dosage Determination Using Accelerated Mortar Bar Testing."

4.2.6.7. **Option 7**. Ensure the total alkali contribution from the cement in the concrete does not exceed 3.5 lb. per cubic yard of concrete when using hydraulic cement not containing SCMs calculated as follows:

$$\text{lb. alkali per cu. yd.} = \frac{(\text{lb. cement per cu. yd.}) \times (\%\ \text{Na}_2\text{O equivalent in cement})}{100}$$

4.2.6.8. **Option 8**. Perform annual testing as required for any deviations from Options 1–5 or use mix design options listed in Table 10. Laboratories performing ASTM C1260, ASTM C1567, and ASTM C1293 testing must be listed on TxDOT's List of Approved ASTM C1260 Laboratories. Before use of the mix, provide a certified test report signed and sealed by a Registered Professional Engineer demonstrating the proposed mixture conforms to the requirements of Table 10.

Provide a certified test report signed and sealed by a Registered Professional Engineer, when HPC is required, and less than 20% of the cement is replaced with SCMs, demonstrating ASTM C1202 test results indicate the permeability of the concrete is less than 1,500 coulombs tested immediately after either of the following curing schedules:

- Moisture cure specimens 56 Days at 73ºF.
- Moisture cure specimens 7 Days at 73ºF followed by 21 Days at 100ºF.

Table 10

Option 8 Testing and Mix Design Requirements

Scenario	ASTM C1260 Result		Testing Requirements for Mix Design Materials or Prescriptive Mix Design Options[1]
	Mix Design Fine Aggregate	Mix Design Coarse Aggregate	
A	> 0.10%	> 0.10%	■ Determine the dosage of SCMs needed to limit the 14-Day expansion of each aggregate[2] to 0.08% when tested individually in accordance with ASTM C1567, or ■ Use a minimum of 40% Class C fly ash with a maximum CaO[3] content of 25%.
B	≤ 0.10%	≤ 0.10%	■ Use a minimum of 40% Class C fly ash with a maximum CaO[3] content of 25%, or ■ Use any ternary combination which replaces 35% to 50% of cement.
	≤ 0.10%	ASTM C 1293 1 yr. Expansion ≤ 0.04%	■ Use a minimum of 20% of any Class C fly ash, or ■ Use any ternary combination which replaces 35% to 50% of cement.
C	≤ 0.10%	> 0.10%	■ Determine the dosage of SCMs needed to limit the 14-Day expansion of coarse and intermediate[2] aggregate to 0.08% when tested individually in accordance with ASTM C1567, or ■ Use a minimum of 40% Class C fly ash with a maximum CaO[3] content of 25%.
D	> 0.10%	≤ 0.10%	■ Use a minimum of 40% Class C fly ash with a maximum CaO[3] content of 25%, or ■ Use any ternary combination which replaces 35% to 50% of cement.
	> 0.10%	ASTM C1293 1 yr. Expansion ≤ 0.04%	■ Determine the dosage of SCMs needed to limit the 14-Day expansion of fine aggregate to 0.08% when tested in accordance with ASTM C1567.

1. Do not use Class C fly ash if the ASTM C1260 value of the fine, intermediate, or coarse aggregate is 0.30% or greater, unless the fly ash is used as part of a ternary system.
2. Intermediate size aggregates shall fall under the requirements of mix design coarse aggregate.
3. Average the CaO content from the previous ten values as listed on the mill certificate.

4.2.7. **Optimized Aggregate Gradation (OAG) Concrete**. The gradation requirements in Table 3 and Table 4 do not apply when OAG concrete is specified or used by Developer. Use at least 420 lb. per cubic yard of cementitious material when OAG concrete is used. Use a coarse aggregate with a maximum nominal size not larger than:

- 1/5 the narrowest dimension between sides of forms, or
- 1/3 the depth of slabs, or
- 3/4 the minimum clear spacing between individual reinforcing bars or wires, bundles of bars, individual tendons, bundled tendons, or ducts.

Use Tex-470-A to establish an initial target cumulative gradation. Use the following criteria to select the initial target cumulative gradation:

- The Coarseness and Workability factors must plot within the workability box. Machine-placed concrete generally plots in the lower region of the workability box and hand-placed concrete generally plots in the upper region of the workability box.

- The percent retained on any sieve, excluding the first and last sieves that retain material, must be at least 5.0%.
- The sum of the percent retained on any two adjacent sieves, excluding the first and last sieves that retain material, must be at least 13.0%.
- The cumulative percent passing should generally follow the maximum density line on the 0.45 power chart and should not deviate beyond the maximum and minimum tolerance lines except as noted in Tex-470-A.

Make necessary adjustments to individual aggregate stockpile proportions during OAG concrete production when the cumulative combined percent passing deviates from the target cumulative gradation by more than the allowable tolerances listed in Table 11.

Table 11

Tolerances for Optimized Aggregate Gradation Concrete

Description	Allowable Tolerance
Cumulative % passing each sieve, 1/2" sieve and larger	± 5.0
Cumulative % passing each sieve, smaller than 1/2" and larger than No. 30 sieve	± 3.0
Cumulative % passing each sieve, No. 30 sieve and smaller	± 2.0

4.2.8. **Self-Consolidating Concrete (SCC)**. Provide SCC meeting the following requirements shown in Table 12 when approved for use in precast or drilled shaft concrete. Use concrete with a slump flow that can be placed without vibration and will not segregate or excessively bleed.

Increase the slump flow of a given concrete mix above the values shown in Table 12 when approved, provided the concrete has the same or lower water-to-cementitious material ratio and meets all other requirements listed in Table 12. Request approval to exceed the slump flow limits sufficiently in advance for proper evaluation.

Table 12

Mix Design Requirements for SCC

Tests	Test Method	Acceptable Limits
Slump Flow for Precast Concrete	ASTM C1611	22 to 27
Slump Flow for Drilled Shafts	ASTM C1611	19 to 24
T_{50}, sec	ASTM C1611	2 to 7
VSI Rating	ASTM C1611	0 or 1
Passing Ability, in.	ASTM C1621	≤ 2
Segregation Column, %	ASTM C1610	≤ 10
Bleeding, %	ASTM C232	≤ 2.5

4.3. **Concrete Trial Batches.** Perform preliminary and final trial batches when required by the Design Documents, or when previous satisfactory field data is not available. Submit previous satisfactory field data showing the proposed mix design conforms to specification requirements when trial batches are not required and before concrete is placed.

Perform preliminary and final trial batches for all self-consolidating concrete mix designs.

4.3.1. **Preliminary Trial Batches**. Perform all necessary preliminary trial batch testing when required, and provide documentation including mix design, material proportions, and test results substantiating the mix design conforms to specification requirements.

4.3.2. **Final Trial batches**. Make all final trial batches using the proposed ingredients in a mixer that is representative of the mixers to be used on the job when required. Make the batch size at least 50% of the mixer's rated capacity. Perform fresh concrete tests for air content and slump, and make, cure, and test strength specimens for compliance with specification requirements. Test at least one set of design strength specimens, consisting of two specimens per set, at 7-Day, 28-Day, and at least one additional age. Before placing, provide TxDOT the option of witnessing final trial batches, including the testing of the concrete.

Conduct all testing listed in Table 12 when performing trial batches for self-consolidating concrete. Make an additional mixture with 3% more water than the preliminary trial batch. Make necessary adjustments to the mix design if this additional mixture does not meet requirements of Table 12. Cast and evaluate mock-ups for precast concrete that are representative of the actual product. Provide TxDOT the option of witnessing final trial batches, including the testing of the concrete and the casting of the mock-ups before placement.

Establish 7-Day compressive strength target values using the following formula for each Class A, B, and E concrete mix designs to be used:

$$\text{Target value} = \text{Minimum design strength} \times \frac{\text{7-day avg. trial batch strength}}{\text{28-day avg. trial batch strength}}$$

Submit previous satisfactory field data, data from a new trial batch, or other evidence showing the change will not adversely affect the relevant properties of the concrete when changes are

made to the type, brand, or source of aggregates, cement, SCM, water, or chemical admixtures. Submit the data for approval before making changes to the mix design. A change in vendor does not necessarily constitute a change in materials or source. During concrete production, dosage changes of chemical admixtures used in the trial batches will not require a re-evaluation of the mix design.

Developer has the option of performing trial batches in conjunction with concrete placements except for SCC mixtures, when new trial batches are required during the course of the Project.

Establish the strength–maturity relationship in accordance with Tex-426-A when the maturity method is specified or permitted. When using the maturity method, any changes in any of the ingredients, including changes in proportions, shall require the development of a new strength–maturity relationship for the mix.

4.3.3. **Mix Design of Record**. Once a trial batch or previously satisfactory field data substantiates the mix design, the proportions and mixing methods used become the mix design of record. Do not exceed mix design water-to-cement ratio.

4.4. **Production Testing.**

4.4.1. **Aggregate Moisture Testing**. Determine moisture content per Tex-409-A or Tex-425-A for coarse, intermediate, and fine aggregates at least twice a week, when there is an apparent change, or for new shipments of aggregate. When aggregate hoppers or storage bins are equipped with properly maintained electronic moisture probes for continuous moisture determination, moisture tests per Tex-409-A or Tex-425-A are not required. Electronic moisture probes, however, must be verified at least every 90 Days against Tex-409-A and be accurate to within 1.0% of the actual moisture content.

When producing SCC, and when aggregate hoppers or storage bins are not equipped with electric moisture probes, determine the moisture content of the aggregates before producing the first concrete batch each Day. Thereafter, determine the moisture content every four hours or when there is an apparent change while SCC is being produced.

4.4.2. **Aggregate Gradation Testing**. Perform a sieve analysis in accordance with Tex-401-A on each stockpile used in the blend at least one Day before producing OAG concrete when producing optimized aggregate gradation concrete. Perform sieve analysis on each stockpile after every 10,000 cubic yards of OAG concrete produced. Provide sieve analysis data to TxDOT.

4.5. **Measurement of Materials.**

4.5.1. **Non-Volumetric Mixers**. Measure aggregates by weight. Correct batch weight measurements for aggregate moisture content. Measure mixing water, consisting of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates, and water introduced in the form of admixtures, by volume or weight. Measure ice by weight. Measure cement and supplementary cementing materials in a hopper and on a separate scale from those used for other materials. Measure the cement first when measuring the cumulative weight. Measure concrete chemical admixtures by weight or volume. Measure batch materials within the tolerances of Table 13.

Table 13

Mix Design Batching Tolerances—Non-Volumetric Mixers

Material	Tolerance (%)
Cement, wt.	-1 to +3
SCM, wt.	-1 to +3
Cement + SCM (cumulative weighing), wt.	-1 to +3
Water, wt. or volume	±3
Fine aggregate, wt.	±2
Coarse aggregate, wt.	±2
Fine + coarse aggregate (cumulative weighing), wt.	±1
Chemical admixtures, wt. or volume	±3

Ensure the quantity measured, when measuring cementitious materials at less than 30% of scale capacity, is accurate to not less than the required amount and not more than 4% in excess. Ensure the cumulative quantity, when measuring aggregates in a cumulative weigh batcher at less than 30% of the scale capacity, is measured accurate to ±0.3% of scale capacity or ±3% of the required cumulative weight, whichever is less.

Measure cement in number of bags under special circumstances when approved. Use the weights listed on the packaging. Weighing bags of cement is not required. Ensure fractional bags are not used except for small hand-mixed batches of approximately 5 cu. ft. or less and when an approved method of volumetric or weight measurement is used.

4.5.2. **Volumetric Mixers**. Provide an accurate method of measuring all ingredients by volume, and calibrate equipment to assure correct measurement of materials within the specified tolerances. Base tolerances on volume–weight relationship established by calibration, and measure the various ingredients within the tolerances of Table 14. Correct batch measurements for aggregate moisture content.

Table 14

Mix Design Batching Tolerances—Volumetric Mixers

Material	Tolerance
Cement, wt. %	0 to +4
SCM, wt. %	0 to +4
Fine aggregate, wt. %	±2
Coarse aggregate, wt. %	±2
Admixtures, wt. or volume %	±3
Water, wt. or volume %	±1

4.6. **Mixing and Delivering Concrete.**

4.6.1. **Mixing Concrete**. Operate mixers and agitators within the limits of the rated capacity and speed of rotation for mixing and agitation as designated by the manufacturer of the equipment. Provide concrete in a thoroughly mixed and uniform mass with a satisfactory degree of uniformity when tested in accordance with Tex-472-A.

Do not top-load new concrete onto returned concrete.

Adjust mixing times and batching operations as necessary when the concrete contains silica fume to ensure the material is completely and uniformly dispersed in the mix. The dispersion of the silica fume within the mix will be verified by TxDOT, using cylinders made from trial batches. Make necessary changes to the batching operations, if uniform dispersion is not achieved, until uniform and complete dispersion of the silica fume is achieved.

Mix concrete by hand methods or in a small motor-driven mixer when permitted, for small placements of less than 2 cu. yd. For such placements, proportion the mix by volume or weight.

4.6.2. **Delivering Concrete**. Deliver concrete to the Project in a thoroughly mixed and uniform mass, and discharge the concrete with a satisfactory degree of uniformity. Conduct testing in accordance with Tex-472-A when there is a reason to suspect the uniformity of concrete.

Maintain concrete delivery and placement rates sufficient to prevent cold joints.

Adding chemical admixtures or the portion of water withheld is only permitted at the jobsite to adjust the slump or slump flow of the concrete. Do not add water or chemical admixtures to the batch after more than an amount needed to conduct slump testing has been discharged. Turn the drum or blades at least 30 additional revolutions at mixing speed to ensure thorough and uniform mixing of the concrete. When this water is added, do not exceed the approved mix design water-to-cementitious material ratio.

Before unloading, furnish the delivery ticket for the batch of concrete containing the information required on TxDOT Form 596, “Concrete Batch Ticket.” Verify all required information is provided on the delivery tickets. Suspend concrete operations until the corrective actions are

implemented if delivery tickets do not provide the required information. Verify the design water-to-cementitious material ratio is not exceeded.

Begin the discharge of concrete delivered in truck mixers within the times listed in Table 15. Concrete may be discharged after these times provided the concrete temperature and slump meet the requirements listed in this Item and other pertinent Items. Perform these tests with certified testing personnel per Item 421.4.8.1., "Certification of Testing Personnel." Provide TxDOT the option of witnessing testing of the concrete.

Table 15

Concrete Discharge Times

Fresh Concrete Temperature, °F	Max. time after batching for concrete not containing Type B or D admixtures, min.	Max. time after batching for concrete containing Type B or D admixtures[1], min.
90 and above	45	75
75 ≤ T < 90	60	90
T < 75	90	120

13. Concrete must contain at least the minimum manufacturer's recommended dosage of Type B or D admixture.

4.7. **Placing, Finishing, and Curing Concrete.** Place, finish, and cure concrete in accordance with the pertinent Items.

4.8. **Sampling and Testing of Concrete.** All fresh and hardened concrete is subject to testing as follows:

4.8.1. **Certification of Testing Personnel**. Developer personnel performing testing must be either ACI-certified or qualified by a TxDOT-recognized equivalent written and performance testing program for the tests being performed. Personnel performing these tests are subject to TxDOT approval. Use of a commercial laboratory is permitted at Developer's option. All personnel performing testing using the maturity method must be qualified by a training program recognized by TxDOT before using this method on the job.

4.8.2. **Fresh Concrete**. Provide safe access and assistance during sampling. Fresh concrete shall be sampled for testing at the discharge end if using belt conveyors or pumps. When it is impractical to sample at the discharge end, a sample shall be taken at the time of discharge from the delivery equipment and correlation testing shall be performed and documented to ensure specification requirements are met at the discharge end.

4.8.3. **Testing of Fresh Concrete**. Test for the fresh properties listed in Table 16.

Table 16

Fresh Concrete Tests

Tests	Test Methods
Slump[1]	Tex-415-A
Temperature[1]	Tex-422-A
Air Content[2]	Tex-414-A, Tex-416-A or ASTM C457

1. Job-control testing performed by Developer.
2. Only required during concrete trial batch when air-entrained concrete is specified on the Design Documents.

Concrete with a slump lower than the minimum placement slump in Table 9 after the addition of all water withheld, or concrete exhibiting segregation and excessive bleeding may be rejected.

When SCC exceeds the maximum placement slump flow or VSI rating, immediately resample and retest the concrete slump flow and VSI rating. If the concrete exceeds the maximum placement slump flow or VSI rating after the retest, the concrete shall be rejected.

4.8.3.1. **Job-Control Testing**. Perform job-control concrete temperature and slump testing as specified in Table 17. Provide TxDOT the opportunity to witness the testing. Immediately notify TxDOT of any concrete temperature or slump nonconformity issues. Furnish a copy of all test results to TxDOT daily.

Table 17

Job-Control Testing Frequencies

Concrete Placements	Frequency
Bridge Deck Placements	Test the first few loads, then every third load delivered.
All Other Structural Class Concrete Placements	One test every 60 cu. yd. or fraction thereof.
Non-Structural Class Concrete Placements	One test every 180 cu. yd. or fraction thereof.

Immediately resample and retest the concrete slump when the concrete exceeds the slump range at time of placement. If the concrete exceeds the slump range after the retest, and is used at Developer's option, Developer shall make strength specimens as specified in Item 421.5., "Acceptance of Concrete" and report results to TxDOT.

4.8.3.2. **Strength Specimen Handling**. Remove specimens from their molds and deliver TxDOT test specimens to curing facilities within 24 to 48 hr. after molding, in accordance with pertinent test procedures. Clean and prepare molds for reuse if necessary.

5. ACCEPTANCE OF CONCRETE

Sample and test the fresh and hardened concrete for acceptance. The test results shall be reported to Developer and the concrete Supplier. Investigate the quality of the materials, the

concrete production operations, and other possible problem areas to determine the cause for any concrete that fails to meet the required strengths as outlined below. Take necessary actions to correct the problem including redesign of the concrete mix. Resume concrete operations only after obtaining approval for any proposed corrective actions.

5.1. **Structural Concrete.** For concrete classes identified as structural concrete in Table 8, make and test 7-Day and 28-Day specimens. Acceptance shall be based on attaining the design strength given in Table 8.

5.2. **Not Used.**

5.3. **All Other Concrete.** For concrete classes not identified as structural concrete in Table 8, make and test 7-Day specimens. Acceptance on the 7-Day target value shall be established in accordance with Item 421.4.3., “Concrete Trial Batches.”

Item 422

14. Concrete Superstructures

1. DESCRIPTION

Construct reinforced concrete bridge slabs, decks, flat slabs, slab and girder units (pan formed), approach slabs, or other bridge superstructure Elements as indicated.

2. MATERIALS

2.1. **Concrete.** Provide concrete conforming to Item 421, "Hydraulic Cement Concrete." Provide Class S or S (HPC) concrete for all cast-in-place concrete. Provide the class of concrete for precast components indicated on the Design Documents or in pertinent governing Items.

2.2. **Reinforcing Steel.** Provide reinforcing steel in accordance with Item 440, "Reinforcement for Concrete."

2.3. **Structural Grout.** Provide grout in accordance with DMS-4675, "Cementitious Grouts and Mortars for Miscellaneous Applications."

2.4. **Expansion Joint Material.** Provide materials in accordance with DMS-6310, "Joint Sealants and Fillers."

- Provide preformed bituminous fiber expansion joint material.
- Provide a Class 4, 5, or 7 low-modulus silicone sealant.
- Provide asphalt board that conforms to dimensions shown on the Design Documents.
- Provide re-bonded neoprene filler that conforms to the dimensions shown on the Design Documents.

2.5. **Foam Bedding Strips for Prestressed Concrete Panels.** Use extruded polystyrene conforming to ASTM C578, Type VI (40 psi compressive strength).

Provide a manufacturer's certification or data sheet stating the foam meets these requirements. Use an adhesive or bonding agent compatible with polystyrene as recommended by the polystyrene manufacturer.

2.6. **Evaporation Retardants.** Provide evaporation retardants in accordance with DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."

2.7. **Curing Materials.** Provide membrane curing compounds in accordance with DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."

Provide cotton mats that consist of a filling material of cotton "bat" or "bats" (at least 12 oz. per square yard) completely covered with unsized cloth (at least 6 oz. per square yard) stitched longitudinally with continuous parallel rows of stitching spaced at less than 4 in., or tuft both longitudinally and transversely at intervals less than 3 in. Provide cotton mats that are free from tears and in good general condition. Provide a flap at least 6 in. wide consisting of 2 thicknesses of the covering and extending along one side of the mat.

Provide polyethylene sheeting that is at least 4 mils thick and free from visible defects. Provide opaque white sheeting when the ambient temperature during curing exceeds 90°F.

Provide burlap-polyethylene mats made from burlap impregnated on one side with a film of opaque white pigmented polyethylene, free from visible defects. Provide laminated mats that have at least one layer of an impervious material such as polyethylene, vinyl plastic, or other acceptable material (either as a solid sheet or impregnated into another fabric) and are free of visible defects.

Provide burlap material which complies with AASHTO M 182, Class 3 (10 oz. per square yard) with the following additions:

Manila hemp may also be used to make burlap.

Do not use burlap fabricated from bags.

Do not use burlap containing any water soluble ingredient which will retard the setting time of concrete.

Provide used burlap complying with the requirements stated above, and that only has been used previously for curing concrete. "Like new" cleanliness is not expected, but contamination with any substance foreign to the concrete curing process, such as grease or oil, shall be cause for rejection.

2.8. **Epoxy.** Provide epoxy materials that conform to DMS-6100, “Epoxy and Adhesives”.

3. EQUIPMENT

3.1. **Fogging Equipment.** Use fogging equipment that can apply water in a fine mist, not a spray. Produce the fog using equipment that pumps water or water and air under high pressure through a suitable atomizing nozzle. Use hand-held mechanical equipment portable enough to use in the direction of any prevailing wind and adaptable for intermittent use to prevent excessive wetting of the concrete.

3.2. **Transporting and Placing Equipment.** Use appropriate transporting and placing equipment such as buckets, chutes, buggies, belt conveyors, pumps, or other equipment as necessary. Do not transport or convey concrete through equipment made of aluminum. Use carts with pneumatic tires for carting or wheeling concrete over newly placed slabs.

Use tremies that are watertight to control the fall of concrete and of large enough diameter to allow the placement of the concrete but less than 14 in. in diameter.

Use pumps with lines at least 5 in. inside diameter (I.D.) where Grade 2 or smaller coarse aggregate is used and at least 8 in. I.D. for Grade 1 coarse aggregate.

3.3. **Vibrators.** Use immersion-type vibrators for consolidation of concrete. Provide at least 1 standby vibrator for Emergency use.

3.4. **Screeds and Work Bridges for Bridge Slabs.** Use a self-propelled transverse screed or a mechanical longitudinal screed for bridge slabs. Use transverse screeds that are able to follow the skew of the bridge for skews greater than 15°. Equip transverse screeds with a pan float. Manually operated screeding equipment may be used if approved for top slabs of culverts, small placements, or unusual conditions. Use screeds that are rigid and heavy enough to hold true to shape and have sufficient adjustments to provide for the required camber or section. Equip the screeds, except those of the roller drum type, with metal cutting edges.

Use sufficient work bridges for finishing operations for bridge slabs. Mount a carpet drag to a work bridge or a moveable support system that can vary the area of carpet in contact with the concrete. Use carpet pieces long enough to cover the entire width of the placement. Splice or overlap the carpet as necessary. Ensure enough carpet is in contact longitudinally with the concrete being placed to provide the desired surface finish. Use artificial grass-type carpeting with a molded polyethylene pile face with a blade length between 5/8 and 1 in. and minimum weight of 70 oz. per square yard. Ensure the carpet has a strong, durable backing not subject to rot and the facing is adequately bonded to the backing to withstand the intended use. A burlap drag, attached to the pan float on a transverse screed, may be used instead of the carpet drag.

3.5. **Temperature Recording Equipment.** Use strip chart temperature recording devices, recording maturity meters in accordance with Tex-426-A, or other approved devices that are accurate within ±2°F within the range of 32°F to 212°F.

3.6. **Artificial Heating Equipment.** Use artificial heating equipment as necessary for maintaining the concrete temperatures as specified in Item 422.4.6.11., "Placing Concrete in Cold Weather."

3.7. **Sawing Equipment.** Use sawing equipment capable of cutting grooves in completed bridge slabs and top slabs of direct traffic culverts. Provide grooves that are 1/8 to 3/16 in. deep, nominally 1/8 in. wide, and spaced at 1 in. Use sawing equipment capable of cutting grooves in hardened concrete within 18 in. of the barrier rail or curb.

3.8. **Spraying Equipment.** Use mechanically powered pressure sprayers, either air or airless, with appropriate atomizing nozzles for the application of membrane curing. Mechanically driven spraying equipment, adaptable to the rail system used by the screeds, may be used for applying membrane curing to bridge slabs. Use hand-pressurized spray equipment equipped with 2 or 3 fan-spray nozzles if approved. Ensure the spray from each nozzle overlaps the spray from adjacent nozzles by approximately 50%.

3.9. **Concrete Testing Equipment.** Provide testing equipment in accordance with Item 421.3.3., "Testing Equipment."

4. CONSTRUCTION

Obtain approval for proposed construction methods before starting Work. Approval of construction methods and equipment does not relieve Developer's responsibility for safety or correctness of methods, adequacy of equipment, or completion of Work in full accordance with the Contract. Attend the pre-construction (pre-pour) meetings for bridge slabs conducted by Deveoper. Provide and obtain approval for proposed finishing methods, interim curing methods, and final curing methods.

It is Developer's option to perform testing on structural concrete (structural classes of concrete are identified in Table 8 of Item 421.4.1., "Classification of Concrete Mix Designs,") to determine the in-situ strength to address the schedule restrictions listed below. TxDOT may require Developer to perform this testing for concrete placed in cold weather. Make enough test specimens for Developer-performed testing to ensure strength requirements are met for the operations listed below. Make at least 1 set of test specimens for each Element cast each Day. Cure these specimens under the same conditions as the portion of the structure involved for all stages of construction. Ensure safe handling, curing, and storage of all test specimens. Provide testing personnel, and sample and test the hardened concrete in accordance with Item 421.4.8., "Sampling and Testing of Concrete." The maturity method, Tex-426-A, may be used for in-situ

strength determination for schedule restrictions if approved. Coring not allowed for in-situ strength determination for schedule restrictions. Provide TxDOT the opportunity to witness all testing operations. Report all test results to TxDOT.

4.1. Schedule Restrictions and Inspection Hold-Points.

4.1.1. **Placement of Superstructure Members**. Place or cast superstructure members after the substructure concrete has attained a compressive strength of 3,000 psi.

4.1.2. **Longitudinal Screeding of Bridge Slabs**. Place a longitudinal screed directly on previously placed concrete slabs to check and grade an adjacent slab only after the previously placed slab has aged at least 24 hr. Place and screed the concrete after the previously placed slabs have aged at least 48 hr. Maintain curing of the previously placed slabs during placement.

4.1.3. **Staged Placement of Bridge Slabs on Continuous Steel Units**. Ensure the previously placed concrete attains a compressive strength of 3,000 psi when staged placement of a slab is required or used before placing the next stage placement. Multiple stages may be placed in a single Day if approved by the engineer of record.

4.1.4. **Storage of Materials on the Structure**. Obtain approval to store materials on completed portions of a structure once a compressive strength of 3,000 psi has been attained. Maintain proper curing if materials will be stored on structures before completion of curing.

4.1.5. **Placement of Equipment and Machinery**. Do not place erection equipment or machinery on the structure until the concrete has attained the design strength specified in Item 421.4.1., "Classification of Concrete Mix Designs."

4.1.6. **Carting of Concrete** Cart, wheel, or pump concrete over completed slabs after the completed concrete has attained a compressive strength of 3,000 psi. Maintain curing during these operations.

4.1.7. **Placing Bridge Rails**. Reinforcing steel and concrete for bridge rails may be placed on bridge slabs once the slab concrete has attained a compressive strength of 3,000 psi. Ensure the slab concrete has attained its design strength specified in Item 421.4.1., "Classification of Concrete Mix Designs," before placing railing concrete if slipforming methods are used for railing concrete.

4.1.8. **Opening to Construction Traffic**. Bridges may be opened to all construction traffic when the design strength specified in Item 421.4.1., "Classification of Concrete Mix Designs," has been attained if curing is maintained. Avoid crossing bridges at high speeds until railing concrete, if present, has attained a compressive strength of 3,000 psi.

4.1.9. **Opening to Full Traffic**. Bridges may be opened to the traveling public when the design strength specified in Item 421.4.1., "Classification of Concrete Mix Designs," has been attained for all structural Elements including railing subject to impact from traffic and when curing has been completed for all slabs. Obtain approval before opening bridges to the traveling public.

4.1.10. **Inspection Hold-Points**.

- Beam erection and bracing
- Formwork, including setting of precast panels
- Placing reinforcing steel
- Screed dry run and pre-pour clear cover checks
- Attend pre-pour meeting conducted by Developer

- Post-curing crack inspection

4.2. **Forms.** Submit Construction Documents for forms for decks or slabs on beams or girders, overhangs, cast-in-place spans, and bracing systems for girders when the overhang exceeds 3 ft. 6 in. Submit similar Construction Documents for other units of the superstructure. Show all essential details of proposed forms and bracing. Have a Registered Professional Engineer design, seal, and sign these Construction Documents. TxDOT approval is not required, but TxDOT reserves the right to request modifications to the Construction Documents. Developer is responsible for the adequacy of these Construction Documents.

Design job-fabricated formwork assuming a weight of 150 pcf for concrete, and include a liveload allowance of 50 psf of horizontal surface of the form. Do not exceed 125% of the allowable stresses used by TxDOT for the design of structures.

Use conventional forms, permanent metal deck forms, or prestressed concrete panels for slabs on beams or girders. Use permanent metal deck forms or conventional forms for thickened slabs, diaphragms, or other regions as shown on the Design Documents where prestressed concrete panels are not used. Provide prestressed concrete panels as shown on the Design Documents and in accordance with Item 424, “Precast Concrete Structural Members (Fabrication).” Provide copies of the precast panel layout drawings from the panel fabricator.

Use only material that is inert, non-biodegradable, and nonabsorptive for forms to be left in place.

Overhang form supports that transmit a horizontal force to a steel girder or beam or to a prestressed concrete beam are permitted provided a satisfactory structural analysis has been made of the effect on the girder or beam as indicated in the submitted formwork Construction Documents.

Use beam bracing as indicated on the Construction Documents when overhang brackets are used on prestressed concrete beam spans with slab overhangs not exceeding 3 ft. 6 in. Provide and design additional support or bracing for the outside beams regardless of the type of beam used for spans with overhangs exceeding this amount.

Punch or drill holes full size in the webs of steel members for support of overhang brackets or torch-cut them to 1/4 in. under size and ream them full size. Do not burn the holes full size. Leave the holes open. Never fill the holes by welding.

Attachment of forms or screed supports for bridge slabs to steel I-beams or girders may be by welding subject to the following requirements:

- Do not weld to tension flanges or to areas indicated on the Design Documents.
- Weld in accordance with Item 448, “Structural Field Welding.”

When setting forms of any type take into account:

- deflections due to cast-in-place slab concrete and railing shown in the dead load deflection diagram,
- differential beam or girder deflections due to skew angles and the use of certain stay-in-place slab forming systems, and
- deflection of the forming system due to the wet concrete.

Securely stake forms to line and grade and maintain in position for bridge approach slabs. Rigidly attach inside forms for curbs to the outside forms.

Construct all forms to permit their removal without marring or damaging the concrete. Clean all forms and footing areas of any extraneous matter before placing concrete. Provide openings in forms if needed for the removal of laitance or foreign matter.

Treat the facing of all forms with bond-breaking coating of composition that will not discolor or injuriously affect the concrete surface. Take care to prevent coating of the reinforcing steel.

Complete all preparatory Work before placing concrete.

4.2.1. **Precast Panels**. Profile each beam to determine the actual camber or sag of the beams before placing panels. Adjust the profile grade line, panel elevation, and bearing seat elevations as needed to obtain the required cover over the slab reinforcement and slab thickness. Make adjustments over suitable increments when a profile grade line adjustment is necessary, depending on span lengths, so the revised grade line will produce a uniform profile and good riding qualities. Obtain approval for the grade adjustments before placement. Consider actual beam camber in adjacent spans or slab placements when adjusting the grade line. Inspect each panel as they are set for any cracking during transit, storage, or handling. Refer to Item 424.4.3.1., "Defects and Breakage," for rejection criteria due to cracking.

4.2.2. **Permanent Metal Decking**. Submit signed and sealed design calculations in addition to the required formwork drawings. Design and install formwork in accordance with the Design Documents and formwork drawings. The Design Documents shall govern in cases where the Design Documents and the formwork drawings conflict.

4.2.3. **Conventional Forms**. Provide properly seasoned good-quality lumber free from imperfections that would affect its strength or impair the finished surface of the concrete. Provide timber or lumber that meets or exceeds the requirements for species and grade in the submitted formwork Construction Documents.

Maintain forms or form lumber that will be reused so that it stays clean and in good condition. Do not use any lumber that is split, warped, bulged, or marred or that has any defect that will produce inferior Work; remove such lumber from the Work.

Use plywood at least 3/4 in. thick. Place the grain of the face plies on plywood forms parallel to the span between the supporting studs or joists. Use plywood for forming surfaces that remain exposed that meets the requirements for B-B Plyform Class I or Class II Exterior of the U.S. Department of Commerce Voluntary Product Standard PS 1.

Space studs and joists so that the facing form material remains in true alignment under the imposed loads.

Place forms with the form panels symmetrically (long dimensions set in the same direction) for surfaces exposed to view and receiving only an ordinary surface finish as defined in Item 420.4.13., "Ordinary Surface Finish." Make horizontal joints continuous.

Make molding for chamfer strips or other uses of materials of a grade that will not split when nailed and can be maintained to a true line without warping. Dress wood molding on all faces. Fill

forms at all sharp corners and edges with triangular chamfer strips measuring 3/4 in. on the sides.

4.3. **Placing Reinforcement.** Place reinforcement as provided in Item 440, "Reinforcement for Concrete." Do not weld reinforcing steel supports to I-beams or girders or to reinforcing steel except where shown on the Design Documents.

4.4. **Drains.** Install and construct weep holes and roadway drains as shown on the Design Documents.

4.5. **Extending Existing Slabs.** Verify pertinent dimensions and elevations of the existing structure before ordering any required materials.

4.5.1. **Removal**. Remove portions of the existing structure to the lines and dimensions shown on the Design Documents. Dispose of these materials as shown on the Design Documents. Remove any metal railing without damaging it, and stack it neatly on the right of way at locations that do not interfere with traffic or construction or at locations shown on the Design Documents. All removed metal railing remains the property of TxDOT. Repair any portion of the remaining structure damaged as a result of the construction. Do not use explosives to remove portions of the existing structure. Do not use a demolition ball, other swinging weight, or impact equipment. Use pneumatic or hydraulic tools for final removal of concrete at the "break" line. Use removal equipment, as approved, that will not damage the remaining concrete.

4.5.2. **Reuse of Removed Portions of Structure**. Detach and remove all portions of the old structure that are to be incorporated into the extended structure to the lines and details as specified on the Design Documents. Move the unit to be reused to the new location specified using approved methods. Place the reinforcement and extension concrete according to the plan details.

4.5.3. **Breaking Back Bridge Slabs**. Saw the top surface of the slab for bridge slabs and direct traffic slabs of box culverts along the "break" line to a depth of 1/2 in. before breaking back. Do not cut the reinforcement at the "break" line. Sever the concrete at the "break" line. Do not damage the remaining reinforcement within 1 lap length of the "break" line during removal of the designated portion of the existing structure.

4.5.4. **Splicing Reinforcing Steel**. Splice new reinforcing bars to exposed bars in the existing structure using lap splices in accordance with Item 440, "Reinforcement for Concrete." The new reinforcing steel does not need to be tied to the existing steel where spacing or elevation does not match that of the existing steel provided the lap length is attained. Weld in accordance with Item 448, "Structural Field Welding," when welded splices are permitted. Install any required dowels in accordance with Item 422.4.6.10., "Installation of Dowels and Anchor Bolts."

4.5.5. **Concrete Preparation**. Roughen and clean concrete surfaces that are in contact with new construction before the placing of forms. Prepare these construction joint surfaces in accordance with Item 422.4.6.7., "Construction Joints."

4.6. **Placing Concrete.** Give sufficient advance notice before placing concrete in any unit of the structure to permit the final inspection of forms, reinforcing steel placement, and other preparations. Obtain approval for proposed curing methods based on forecast weather conditions for the expected duration of the pour and use the evaporation rate nomograph as mentioned below to determine the required curing options.

Follow the sequence of placing concrete shown on the Design Documents or specified.

Do not place concrete when impending weather conditions would impair the quality of the finished Work. Place concrete in early morning or at night or adjust the placement schedule for more favorable weather if conditions of wind, humidity, and temperature are such that concrete cannot be placed without the potential for plastic shrinkage cracking. Consult the evaporation rate nomograph in the Portland Cement Association's *Design and Control of Concrete Mixtures* or the evaporation rate spreadsheet available on TxDOT's website for shrinkage cracking potential. Adequately illuminate the entire placement site when mixing, placing, and finishing concrete in non-daylight hours as approved.

Furnish adequate shelter to protect the concrete against damage from rainfall or from freezing temperatures as outlined in this Item if changes in weather conditions require protective measures after Work starts. Continue operations during rainfall only if approved. Use protective coverings for the material stockpiles. Cover aggregate stockpiles only to the extent necessary to control the moisture conditions in the aggregates.

Allow at least 1 curing Day after the concrete has achieved initial set before placing strain on projecting reinforcement to prevent damage to the concrete.

4.6.1. **Placing Temperature**. Place superstructure concrete only when its temperature at the time of placement is between 50°F and 85°F. Increase the minimum placement temperature to 60°F if Ground Granulated Blast Furnace (GGBF) slag is used in the concrete.

4.6.2. **Transporting Time**. Begin the discharge of concrete delivered in truck mixers within the times listed in Table 15 of Item 421, "Hydraulic Cement Concrete."

4.6.3. **Workability of Concrete**. Place concrete with a slump as specified in Item 421.4.2.5., "Slump." Concrete that exceeds the maximum slump shall be immediately rejected. Water may be added to the concrete before discharging any concrete from the truck to adjust for low slump provided the maximum mix design water-cement ratio is not exceeded. Mix concrete after introduction of any additional water or chemical admixtures in accordance with Item 421.4.6., "Mixing and Delivering Concrete." Do not add water or chemical admixtures after any concrete has been discharged.

4.6.4. **Transporting Concrete**. Use a method and equipment capable of maintaining the rate of placement shown on the Design Documents or required by this Item to transport concrete to the forms. Transport concrete by buckets, chutes, buggies, belt conveyors, pumps, or other methods.

Protect concrete transported by conveyors from sun and wind to prevent loss of slump and workability. Shade or wrap with wet burlap pipes through which concrete is pumped as necessary to prevent loss of slump and workability.

Arrange and use chutes, troughs, conveyors, or pipes so the concrete ingredients will not be separated. Terminate such equipment in vertical downspouts, when necessary, to prevent segregation. Extend open troughs and chutes, if necessary, down inside the forms or through holes left in the forms.

Keep all transporting equipment clean and free from hardened concrete coatings. Discharge water used for cleaning clear of the concrete.

4.6.5. **Preparation of Surfaces**. Thoroughly wet all forms, prestressed concrete panels, T-beams, slab beams, and concrete box beams on which concrete is to be placed before placing concrete on them. Remove

any remaining puddles of excess water before placing concrete. Provide surfaces that are in a moist, saturated surface-dry condition when concrete is placed on them.

Ensure the subgrade or foundation is moist before placing concrete for bridge approach slabs.

4.6.6. **Expansion Joints**. Construct joints and devices to provide for expansion and contraction in accordance with plan details and the requirements of this Section and Item 454, "Bridge Expansion Joints."

Prevent bridging of concrete or mortar around expansion joint material in bearings and expansion joints.

Use forms adaptable to loosening or early removal in construction of all open joints and joints to be filled with expansion joint material. Loosen these forms as soon as possible after final concrete set to permit free movement of the span without requiring full form removal and avoid expansion or contraction damage to the adjacent concrete.

Provide preformed fiber joint material or a high density foam in the vertical joints of the roadway slab, curb, median, or sidewalk when the Design Documents show a Type A joint, and fill the top 1 in. with the specified joint sealing material. Install the sealer in accordance with Item 438, "Cleaning and Sealing Joints and Cracks (Rigid Pavement and Bridge Decks)," and the manufacturer's recommendations.

Use light wire or nails to anchor any preformed fiber joint material to the concrete on 1 side of the joint.

Ensure that finished joints conform to the plan details with the concrete sections completely separated by the specified opening or joint material.

Remove all concrete within the joint opening soon after form removal and again where necessary after surface finishing to ensure full effectiveness of the expansion joint.

4.6.7. **Construction Joints**. A construction joint is formed by placing plastic concrete in direct contact with concrete that has attained its initial set. Monolithic placement means the manner and sequence of concrete placing does not create a construction joint.

Make construction joints of the type and at the locations shown on the Design Documents. Do not make joints in bridge slabs not shown on the Design Documents. Additional joints in other members are not permitted without approval. Place authorized additional joints using details equivalent to those shown on the Design Documents for joints in similar locations.

Make construction joints square and normal to the forms. Use bulkheads in the forms for all vertical joints.

Thoroughly clean the hardened concrete surface of all loose material, laitance, dirt, and foreign matter, and saturate it with water. Remove all free water and moisten the surface before concrete or bonding grout is placed against it. Ensure the surface of the existing concrete is in a saturated surface-dry (SSD) condition just before placing subsequent concrete. Prewet the existing concrete by ponding water on the surface for 24 hr. before placing subsequent concrete. Use high-pressure water blasting to achieve SSD conditions 15 to 30 min. before placing the

concrete if ponding is not possible. An SSD condition is achieved when the surface remains damp when exposed to sunlight for 15 min.

Draw forms tight against the existing concrete to avoid mortar loss and offsets at joints.

Bonding agents are not required. Coat the joint surface with bonding mortar, grout, epoxy, or other material as indicated on the Design Documents or other Items if a bonding agent is required. Provide Type V epoxy per DMS-6100, "Epoxies and Adhesives," for bonding fresh concrete to hardened concrete. Place the bonding epoxy on a clean, dry surface, and place the fresh concrete while the epoxy is still tacky. Place bonding mortar or grout on a surface that is SSD, and place the concrete before the bonding mortar or grout dries. Place other bonding agents in accordance with the manufacturer's recommendations.

4.6.8. **Handling and Placing**. Minimize segregation of the concrete and displacement of the reinforcement when handling and placing concrete. Produce a uniform, dense, compact mass.

Do not allow concrete to free-fall more than 5 ft. Remove any hardened concrete splatter ahead of the plastic concrete.

Fill each part of the forms by depositing concrete as near its final position as possible. Do not deposit large quantities at one point and run or work the concrete along the forms.

Avoid cold joints in a monolithic placement. Sequence successive layers or adjacent portions of concrete so they can be vibrated into a homogeneous mass with the previously placed concrete before it sets.

Use an approved Type B or D set retarding agent to control stress cracks and cold joints in placements where differential settlement and setting time may induce cracking.

4.6.9. **Consolidation**. Carefully consolidate concrete and flush mortar to the form surfaces with immersion type vibrators. Do not use vibrators that operate by attachment to forms or reinforcement except where approved on steel forms.

Vibrate the concrete immediately after deposit. Systematically space points of vibration to ensure complete consolidation and thorough working of the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms. Insert the vibrator vertically where possible except for slabs where it may be inserted in a sloping or horizontal position. Vibrate the entire depth of each lift, allowing the vibrator to penetrate several inches into the preceding lift. Do not use the vibrator to move the concrete to other locations in the forms. Do not drag the vibrator through the concrete. Thoroughly consolidate concrete along construction joints by operating the vibrator along and close to but not against the joint surface. Continue the vibration until the concrete surrounding reinforcements and fixtures is completely consolidated. Hand-spade or rod the concrete if necessary to ensure flushing of mortar to the surface of all forms. Concentrate vibration efforts along the beams lines when precast concrete panels are used for deck construction.

4.6.10. **Installation of Dowels and Anchor Bolts**. Install dowels and anchor bolts by casting them in-place or by grouting with grout, epoxy, or epoxy mortar. Form or drill holes for grouting. Use only epoxy when installing horizontal dowels into the edges of slabs. Follow the manufacturer's

recommended installation procedures for pre-packaged grout or epoxy anchor systems. Test anchors if required on the Design Documents or by other Items.

Drill holes for anchor bolts to accommodate the bolt embedment required by the Design Documents. Make holes for dowels at least 12 in. deep. Make the hole diameter at least twice the dowel or bolt diameter, but the hole need not exceed the dowel or bolt diameter plus 1-1/2 in. when using cementitious grout or epoxy mortar. Make the hole diameter 1/16 to 1/4 in. greater than the dowel or bolt diameter when using neat epoxy unless indicated otherwise by the epoxy manufacturer.

Thoroughly clean holes of all loose material, oil, grease, or other bond-breaking substance, and blow them clean with filtered compressed air. Use a wire brush followed by oil-free compressed air to remove all loose material from the holes, repeating as necessary until no more material is removed. Ensure holes are in a surface-dry condition when epoxy type materials are used and in a surface-moist condition when cementitious grout is used. Develop and demonstrate for approval a procedure for cleaning and preparing the holes for installation of the dowels and anchor bolts. Completely fill the void between the hole and dowel or bolt with grouting material. Follow exactly the requirements for cleaning outlined in the product specifications for pre-packaged systems.

Provide a Type III epoxy per DMS-6100, “Epoxies and Adhesives,” when neat epoxy is used for anchor bolts or dowels. Provide Type VIII epoxy per DMS-6100, “Epoxies and Adhesives,” when an epoxy grout is used. Provide grout, epoxy, or epoxy mortar as the binding agent.

Provide other anchor systems as required on the Design Documents.

4.6.11. **Placing Concrete in Cold Weather**. Protect concrete placed under weather conditions where weather may adversely affect results. If concrete placed under poor conditions is unsatisfactory, remove and replace it.

Do not place concrete in contact with any material coated with frost or with a temperature of 32°F or lower. Do not place concrete when the ambient temperature in the shade is below 40°F and falling. Place concrete when the ambient temperature in the shade is at least 35°F and rising or above 40°F.

Provide and install recording thermometers, maturity meters, or other suitable temperature measuring devices to verify all concrete is effectively protected. Maintain the temperature of the top surface of bridge slabs and top slabs of direct traffic culverts at 50°F or above for 72 hr. from the time of placement and above 40°F for an additional 72 hr.

Use additional covering, insulated forms, or other means and, if necessary, supplement the covering with artificial heating. Avoid applying heat directly to concrete surfaces. Cure as specified in Item 422.4.8., “Final Curing,” during this period until all requirements for curing have been satisfied.

Have on hand all necessary heating and covering material, ready for use, before permission is granted to begin placement when impending weather conditions indicate the possible need for temperature protection. Distress caused by concrete drying out as a result of delayed set and strength gain associated with cold weather are a result of Developer’s actions and are subject to repair in accordance with Item 422.4.10., “Defective Work."

4.6.12. **Placing Concrete in Hot Weather**. Use an approved Type B or D set retarding agent in all concrete for superstructures and top slabs of direct traffic culverts, except concrete containing GGBF slag, when the temperature of the air is above 85°F.

Keep the concrete at or below the maximum temperature at time of placement as specified above. Sprinkle and shade aggregate stockpiles or use ice, liquid nitrogen systems, or other approved methods as necessary to control the concrete temperature.

4.6.13. **Placing Concrete in Superstructure**. Place simple span bridge slabs without transverse construction joints by using either a self-propelled transverse finishing machine or a mechanical longitudinal screed. Use of manually operated screeding equipment may be permitted for small placements or for unusual conditions such as narrow widening, variable cross slopes, or transitions. Support the screed adequately on a header or rail system stable enough to withstand the longitudinal or lateral thrust of the equipment. Adjust the profile grade line as necessary to account for variations in beam camber and other factors to obtain the required slab thickness and concrete cover over the slab reinforcement. Set beams and verify their surface elevations in a sufficient number of spans so that when adjustment is necessary, the profile grade line can be adjusted over suitable increments to produce a smooth riding surface. Take dead load deflection into account in setting the grades of headers and rail systems. Use construction joints, when required or permitted for slab placements on steel or prestressed concrete beams, as shown on the Design Documents. Release falsework under the spans before placing concrete on steel girder or truss spans, and swing the spans free on their permanent supports.

Provide additional camber to offset the initial and final deflections of the span as indicated on the Design Documents for concrete flat slab, concrete slab, and girder spans cast-in-place on falsework. Provide camber of approximately 3/8 in. for 30-ft. spans and 1/2 in. for 40-ft. spans to offset initial and final deflections for concrete slab and girder spans using pan forms. Provide a camber of 1/8 in. for 10-ft. spans but no more than 1/2 in. for concrete flat slab, concrete slab, and girder spans not using pan forms when dead load deflection is not shown on the Design Documents.

Provide a camber of 1/4 in. in addition to deflection for slabs without vertical curvature on steel or prestressed concrete beams. Provide camber for specified vertical curvature and transverse slopes.

Make 1 or more passes with the screed over the bridge slab segment before placing concrete on it to ensure proper operation and maintenance of grades and clearances. Use an approved system of checking to detect any vertical movement of the forms or falsework. Maintain forms for the bottom surface of concrete slabs, girders, and overhangs to the required vertical alignment during concrete placing.

Level, strike off, and screed the surface while carrying a slight excess of concrete ahead of the screed to fill all low spots as soon as the concrete has been placed and vibrated in a section wide enough to permit working. Move longitudinal screeds 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. Move transverse screeds longitudinally approximately 1/5 of the drum length for each complete out-and-back pass of the carriage. Screed the surface of the concrete enough times and at intervals to produce a uniform surface true to grade and free of voids.

Fog unformed surfaces of slab concrete in bridge slabs and in top slabs of direct traffic culverts from the time of initial strikeoff of the concrete until finishing is completed and required interim

curing is in place. Do not use fogging as a means to add finishing water and do not work moisture from the fog spray into the fresh concrete.

Retard the concrete for simple spans only if necessary to complete finishing operations or as required by this Section. Bring the top of curb and sidewalk section to the correct camber and alignment when filling curb forms, and finish them as described in this Item.

4.6.13.1. **Transverse Screeding**. Install rails for transverse finishing machines that are supported from the beams or girders so the supports may be removed without damage to the slab. Prevent bonding between removable supports and the concrete in an acceptable manner. Do not allow rail support parts that remain embedded in the slab to project above the upper mat of reinforcing steel. Rail or screed supports attached to I-beams or girders are subject to the requirements of this Item. Place concrete at a minimum rate of 30 ft. of bridge slab per hour for transverse screeding. Deposit concrete parallel to the skew of the bridge so all girders are loaded uniformly along their length. Deposit slab concrete between the exterior beam and adjacent beam before placing concrete in the overhang portion of the slab. Furnish personnel and equipment capable of placing, finishing, and curing the slab at an acceptable rate to ensure compliance with the specifications. Place concrete in transverse strips. Start placement at the lowest end on profile grades greater than 1-1/2%.

At Developer's option, attach a pan drag and either a carpet or burlap drag to the screed assembly to float and provide surface micro-texture in one operation. Adjust the contact pressure of the pan drag to smooth high spots and fill any depressions left by the screed. Adjust the weight or position of the carpet or burlap drag to produce a smooth sandy micro-texture without blemishes, marks, or scratches deeper than 1/16 in. Fill screed rail support holes and holes from depth checks for slab thickness and reinforcing cover with concrete, and finish them to match the rest of the slab.

4.6.13.2. **Longitudinal Screeding**. Use of temporary intermediate headers will be permitted for placements over 50 ft. long if the rate of placement is rapid enough to prevent a cold joint and if these headers are designed for easy removal to permit satisfactory consolidation and finish of the concrete at their locations. Deposit slab concrete between the exterior beam and the adjacent beam before placing concrete in the overhang portion of the slab. Place concrete in longitudinal strips starting at a point in the center of the segment adjacent to 1 side except as this Section indicates, and complete the strip by placing uniformly in both directions toward the ends. Start placing at the lowest end for spans on a profile grade of 1-1/2% or more. Use strips wide enough that the concrete within each strip remains plastic until placement of the adjacent strip. Place the concrete in proper sequence to be monolithic with the adjacent longitudinal strips of the slabs where monolithic curb construction is specified.

4.6.13.3. **Placements on Continuous Steel Units**. Place slabs on continuous steel units in a single, continuous operation without transverse construction joints using a self-propelled transverse finishing machine or a mechanical longitudinal screed. Retard the initial set of the concrete sufficiently to ensure concrete remains plastic in at least 3 spans immediately preceding the slab being placed. Use construction joints, when required for slab placements on steel beams or girders, as shown on the Design Documents. Ensure the previously placed concrete attains a compressive strength of 3,000 psi when staged placement of a slab is required on the Design Documents before placing the next stage concrete. Multiple stages may be placed in a single day if approved. Use an approved placing sequence that will not overstress any of the supporting members where Design Documents permit staged placing without specifying a particular order of placement.

4.6.13.4. **Slab and Girder Units**. Place girders, slab, curbs of slab, and girder spans monolithically. Fill concrete girder stems first, and place the slab concrete within the time limits specified in this Item. Place concrete in the stems for a short distance if using a transverse screed, and then place the concrete in transverse strips. Fill the outside girder stem first, beginning at the low end or side, if using a longitudinal screed, and continue placement in longitudinal strips.

4.7. **Finish and Interim Curing of Bridge Slabs.** Obtain approval of the proposed interim curing methods, equipment, and materials at the pre-pour meeting before placing concrete. Take into account forecast weather conditions to determine the interim curing methods to use.

Use work bridges or other suitable facilities to perform all finishing operations and to provide access, if necessary, to check measurements for slab thickness and reinforcement cover.

Work the screeded surface to a smooth finish with a long-handled wood or metal float or hand-float it from work bridges over the slab. Floating may not be necessary if the pan float attached to a transverse screed produces an acceptable finish. Avoid overworking the surface of the concrete. Avoid use of finish water.

Perform sufficient checks, witnessed by TxDOT, with a long-handled 10-ft. straightedge on the plastic concrete to ensure the final surface will be within specified tolerances. Make the check with the straightedge parallel to the centerline. Lap each pass half over the preceding pass. Remove all high spots, and fill and float all depressions over 1/16 in. deep with fresh concrete. Continue checking and floating until the surface is true to grade and free of depressions, high spots, voids, or rough spots. Fill screed-rail support holes with concrete, and finish them to match the top of the slab.

Provide a uniform micro-texture using a carpet drag, burlap drag, or broom finish. Finish the surface to a smooth sandy texture without blemishes, marks, or scratches deeper than 1/16 in. Apply the surface texturing using a work bridge or platform immediately after completing the straightedge checks. Draw the carpet or burlap drag 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. For bridge approach slabs the carpet drag, burlap drag, or broom finish may be applied either longitudinally or transversely.

Evaporation protection is required if the evaporation rate exceeds 0.15 lbs/sf/hr based on the *Evaporation Calculation for Concrete Worksheet* as shown on TxDOT's website, the evaporation rate nomograph in the Portland Cement Association's *Design and Control of Concrete Mixtures* or if indicated on the Design Documents.

4.7.1. **Evaporation Protection.** Use one of the following methods for evaporation protection:

4.7.1.1. **Evaporation Retardant.** Coat the concrete surface immediately after the carpet or burlap drag, or broom finish with a single application of evaporation retardant at a rate recommended by the manufacturer. Do not allow more than 10 min. to elapse between the texturing at any location and application of evaporation retardant. The evaporation retardant may be applied using the same work bridge used for surface texturing. Do not work the concrete surface once the evaporation retardant has been applied.

4.7.1.2. **Wet Burlap.** Place pre-wet burlap no more than 10 ft. behind the finishing operation. A work bridge may be required to avoid marring the surface. Ensure the wet burlap covers the entire surface. Use sprayers, hoses, sprinklers, or other similar methods to keep the burlap continuously wetted until application of the final curing.

4.7.2. **Interim Curing.** Apply interim curing using one of the following options, after applying the evaporation protection (if needed):

4.7.2.1. **Membrane Cure.** Apply membrane interim curing at a rate of approximately 180 sq. ft. per gallon. Apply before the water sheen disappears but do not place over standing water. Fog as necessary to maintain the wet sheen. Do not spray membrane curing on a dry surface.

4.7.2.2. **Wet Burlap.** Place pre-wet burlap no more than 10 ft. behind the finishing operation. Burlap used for evaporation protection will also be considered as the interim curing.

4.8. **Final Curing.** Obtain approval of the proposed curing methods, equipment, and materials at the pre-pour meeting before placing concrete. Inadequate curing or facilities may delay all concrete placements on the job until remedial action is taken. Apply final curing as soon as possible after interim curing without damaging the surface finish. Check the adequacy of the curing each Day of the curing period. Take corrective action or modify the curing methods as needed to maintain a moist concrete surface.

A curing Day is a Day when the temperature, taken in the shade away from artificial heat, is above 50°F for at least 19 hr. or, on colder Days if the temperature of all surfaces of the concrete is maintained above 40°F, for the entire 24 hr. The required curing period begins when all concrete has attained its initial set. Tex-440-A may be used to determine when the concrete has attained its initial set.

Cure all superstructure concrete according to the following:

- Concrete using Type I or III cement: 8 Days
- Concrete using Type I/II or II cement: 10 Days
- Concrete with any type of SCM: 10 Days

Place polyethylene sheeting, burlap-polyethylene blankets, laminated mats, or insulating curing mats in direct contact with the slab when the air temperature is expected to drop below 40°F during the first 72 hr. of the curing period. Weigh down these curing materials with dry mats to maintain direct contact with the concrete and 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 the concrete drops below the specified curing temperature. Avoid applying heat directly to concrete surfaces.

Use one of the following water curing methods for final curing. Keep all exposed surfaces of the concrete wet continuously for the required curing time. Use water for curing that meets the requirements for concrete mixing water in Item 421.2.4., “Water.” Do not use seawater or water that stains or leaves an unsightly residue.

4.8.1. **Cotton Mats**. Keep the concrete continuously wet by maintaining wet cotton mats in direct contact with the concrete for the required curing time. Weight the mats adequately to provide continuous contact with all concrete. Cover surfaces that cannot be cured by direct contact with mats, forming an enclosure well anchored to the forms or ground so outside air cannot enter the enclosure.

Provide sufficient moisture inside the enclosure to keep all surfaces of the concrete wet. Use of soaker hoses and plastic covering is acceptable provided the concrete surface remains continuously wet for the required curing duration.

4.8.2. **Burlap Mats**. The burlap used for interim curing may also be used for final curing if kept continuously wetted and completely covered with plastic sheeting. Overlap plastic sheeting and weigh down sufficiently so air cannot get under the plastic.

4.8.3. **Burlap-polyethylene Mats**. Place these mats over soaker hoses or other similar methods to keep the concrete surface wetted for the duration of the curing period. Overlap the mats and weight down sufficiently so air cannot get under the mats.

4.9. **Removal of Forms and Falsework.** Forms for vertical surfaces may be removed after the concrete has aged 12 hr. after initial set provided the removal can be done without damage to the concrete.

Remove forms for inside curb faces and for bridge rails whenever removal can be done without damage to the curb or railing.

Leave in place weight-supporting forms and falsework spanning more than 1 ft. until the concrete has attained a compressive strength of 2,500 psi. Remove forms for other structural components as necessary.

Forms or parts of forms may be removed only if 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 to a depth of at least 1/2 in. from the concrete surface. Make the appliances so that metal may be removed without undue chipping or spalling of the concrete, and so that it leaves a smooth opening in the concrete surface when removed. Do not burn off rods, bolts, or ties.

Remove all forms and falsework.

Apply an ordinary surface finish as the final finish to the bottom of bridge slabs between girders or beams, and vertical and bottom surfaces of interior concrete beams or girders.

Form marks and chamfer edges do not need to be smoothed for the bottom of bridge slabs between girders or beams. Remove all fins, runs, drips, or mortar from surfaces that will be exposed.

4.10. **Defective Work.** Developer is responsible for the ride quality of the finished bridge slab. Developer shall use a 10 ft. straightedge (1/8 in. in 10 ft.) to verify ride quality and determine locations where corrections are needed. Submit a plan for approval to produce a ride of acceptable quality if TxDOT determines the ride quality is unacceptable. Make all corrections for ride before saw-cutting grooves.

Repair defective Work as soon as possible. Remove and replace any defect that cannot be repaired to the satisfaction of TxDOT.

Inspect the deck or slab for plastic shrinkage and settlement cracking after completion of final curingand within five Days after curing mats removed. Seal any noted shrinkage cracks attributable to Developer placing, curing and finishing practices using gravity feed crack repair.

Transverse cracks over interior bents in continuous slab units do not need to be sealed in this manner.

4.11. **Final Surface Texture.** Saw-cut grooves in the hardened concrete of bridge slabs, bridge approach slabs, and direct traffic culverts to produce the final texturing after completion of the required curing period. Cut grooves perpendicular to the structure centerline. Cut grooves across the slab within 18 in. of the barrier rail, curb, or median divider. Adjust groove cutting at skewed metal expansion joints in bridge slabs by using narrow-width cutting heads so all grooves end within 6 in. of the joint, measured perpendicular to the centerline of the metal joint. Leave no ungrooved surface wider than 6 in. adjacent to either side of the joint. Ensure 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, is 1 in. Cut grooves continuously across construction joints or other joints in the concrete less than 1/2 in. wide. Apply the same procedure described above where barrier rails, curbs, or median dividers are not parallel to the structure centerline to maintain the 18 in. maximum dimension from the end of the grooves to the gutter line. Cut grooves continuously across formed concrete joints. Provide either a carpet drag or broom finish for micro-texture when saw-cut grooves are not required on the Design Documents. In this case ensure an adequate and consistent micro-texture is achieved by applying enough weight to the carpet and keeping the carpet or broom from getting plugged with grout. For surfaces that do not have adequate texture, TxDOT may require corrective action including diamond grinding or shot blasting.

Give a carpet drag, burlap drag, or broom finish to all concrete surfaces to be overlaid when the Design Documents call for a concrete overlay (CO) to be placed on the slab (new construction). Saw-grooving is not required in this case. Provide an average texture depth for the finish of approximately 0.035 in. with no individual test falling below 0.020 in. when tested in accordance with Tex-436-A. Revise finishing procedures to produce the desired texture if the texture depth falls below what is intended.

Give all concrete surfaces to be covered a lightly textured broom or carpet drag finish when the Design Documents require an asphalt seal, with or without overlay, on the slab (new construction). Provide an average texture depth of approximately 0.025 in. when tested in accordance with Tex-436-A.

Item 423

15. Retaining Walls

1. DESCRIPTION

Furnish, construct, and install retaining walls.

2. MATERIALS

2.1. **General. Furnish materials in accordance with the following:**

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"
- Item 445, "Galvanizing"
- Item 458, "Waterproofing Membranes for Structures"

Use concrete for retaining walls that conforms to the requirements of Table 1.

Table 1

Concrete for Retaining Walls

Application	Concrete
Cast-in-place, non-reinforced	Class A
Cast-in-place, reinforced	Class C
Precast	Class H, f'_c = 4,000 psi

Furnish concrete for machine-made concrete block units in accordance with ASTM C90, Class 1, Type II, except the minimum 28-Day compressive strength must be 4,000 psi with maximum moisture absorption of 7%.

Provide Type 1 filter fabric in accordance with DMS-6200, "Filter Fabric." Provide filter fabric rated as UV-resistant when used as part of the exposed facing for a temporary wall.

Joint fillers, pads, waterstops, and other incidental materials must be as shown on the Design Documents.

Epoxy coat all steel used in concrete panels and coping including connectors, dowels, stirrups, and reinforcing steel when the Design Documents call for epoxy coating of steel earth reinforcements.

2.2. **Definitions.** This Item uses the following terms:

- **Permanent Wall**. A retaining wall with a design service life of 75 years. All walls are presumed to be permanent walls.

- **Temporary Wall**. A retaining wall so designated by description, with a design service life of 3 years.
- **Mechanically Stabilized Earth (MSE) Wall**. A wall consisting of a volume of select backfill with tensile earth reinforcement Elements distributed throughout. Permanent MSE walls use a precast concrete panel as a facing Element. Temporary MSE walls use welded wire fabric with filter fabric backing as a facing Element.
- **Concrete Block Wall**. A retaining wall that uses machine-made, precast concrete block units as facing Elements. The walls may use a volume of select fill with tensile earth reinforcements distributed throughout, or may use only the facing unit and unit fill weight for support.

2.3. **Fabrication.**

2.3.1. **Cast-in-Place**. Meet Item 420, "Concrete Substructures."

2.3.2. **Formed Precast**. Meet Item 424, "Precast Concrete Structural Members (Fabrication)."

2.3.3. **Machine-Made Precast**. Furnish machine-made concrete block units in accordance with ASTM C90, sampled and tested in accordance with ASTM C140. Furnish units with molded dimensions within 1/8 in. of specified dimensions, except height must be within 1/16 in.

2.4. **Backfill.**

2.4.1. **Non-Select**. Furnish non-select backfill for walls other than temporary and permanent MSE and concrete block walls as indicated on the Design Documents. Non-select fill shall be of the type specified on the Design Documents. Provide material with a maximum plasticity index of 30 if no type is specified as determined by Tex-106-E.

2.4.2. **Select**. Select backfill is required in specific areas of permanent and temporary MSE and concrete block-type retaining walls. Provide select backfill that is free from organic or otherwise deleterious materials and that conforms to the gradation limits shown in Table 2 as determined by Tex-401-A.

Provide backfill that does not contain shale, caliche, or other soft, poor-durability coarse aggregate particles. Reclaimed Asphalt Pavement (RAP) is not allowed. Crushed Concrete or manufactured sand is allowed for temporary walls with a service life of 3 years or less. Test each source of backfill for durability/soundness using Tex-411-A, 5-cycle magnesium sulfate soundness. Backfill material with a maximum 5-cycle soundness loss exceeding 25% shall be rejected. Alternately, Tex-461-A, Micro-Deval abrasion may be used if the corresponding results show loss is not greater than 20%, otherwise Tex-411-A governs aggregate verification.

Type AS, BS, and DS particles larger than 1/4 in. must be angular or completely crushed. Provide mechanically crushed gravel or stone backfill. Gravel from each aggregate source shall have a minimum of 95% two or more mechanically induced crushed faces, as Tex-460-A, Part I determines. Rounded rock or rounded gravel is not allowed. Natural sand meeting the requirements of this Section is permitted for use.

Table 2

Select Backfill Gradation Limits

Type	Sieve Size	Percent Retained
AS	3 in.	0
	1/2 in.	50–100
	No. 4	See Note
	No. 40	85–100
	No. 200	95–100
BS	3 in.	0
	No. 4	See Note
	No. 40	40–100
	No. 200	85–100
CS	3 in.	0
	No. 4	See Note
	No. 200	75–100
DS	3 in.	0
	3/8 in.	85–100
	No. 200	95–100

Note—Use No. 4 sieve for determination of rock backfill as described in this main paragraph, "Backfill."

When the backfill gradation results in 85% or more material retained on the No. 4 sieve, the backfill shall be considered rock backfill. All Type DS backfill is considered rock backfill.

In addition to the requirements for Type CS select fill, the fraction finer than the No. 200 sieve must have a Plasticity Index (PI) in accordance with Tex-106-E not greater than 6.

Furnish Type BS backfill for permanent walls; Type CS backfill for temporary walls; and Type DS backfill for areas of walls subject to inundation, or below the 100-year flood elevation as noted on the Design Documents.

Furnish backfill meeting the requirements of this Section but with a maximum particle size of 3/4 in. when nonmetallic or epoxy coated earth reinforcements are used.

2.4.3. **Drainage Aggregate**. Use drainage aggregate to fill the void within concrete block units and in the zone 1 ft. behind the units. Provide drainage aggregate that is free from organic or otherwise deleterious materials and that conforms to the gradation limits in Table 3 as Tex-110-E determines.

Table 3

Drainage Aggregate Gradation Limits

Sieve Size	Percent Retained
1 in.	0
3/4 in.	25–50
1/2 in.	50–100
No. 4	75–100

2.4.4. **Cement-Stabilized Backfill**. Use cement-stabilized backfill when required. Stabilize Type CS backfill with 5% hydraulic cement by dry weight of the backfill material. Use a stationary plant to thoroughly mix the backfill material, cement, and water. Place and compact the backfill within 2 hours of mixing. Provide special drainage provisions when cement-stabilized backfill is used, as shown on the Design Documents.

2.4.5. **Electrochemical**. Provide backfill meeting the following additional requirements for permanent retaining wall systems using galvanized metallic earth reinforcements:

- The pH is between 5.5 and 10.0 as Tex-128-E determines.
- Resistivity is more than 3,000 ohm-cm as Tex-129-E determines.
- Material with resistivity between 1,500 and 3,000 ohm-cm may be used if the chloride content is less than 100 ppm and the sulfate content is less than 200 ppm as Tex-620-J determines.

Perform electrochemical testing on the raw, unstabilized backfill material when cement-stabilized backfill is used.

2.5. **Earth Reinforcements.** Furnish earth reinforcements that meet the design requirements. Galvanize or epoxy coat all steel Elements for permanent walls in contact with soil. Epoxy coat in accordance with Item 440, “Reinforcement for Concrete,” except provide a minimum 18-mil coating thickness. Epoxy coat the reinforcing only when shown on the Design Documents. Use connection hardware that is likewise nonmetallic or epoxy coated when using nonmetallic or epoxy coated earth reinforcements.

3. CONSTRUCTION

3.1. **General.** Construct retaining walls in accordance with details shown on the Design Documents, on the approved working drawings, and to the pertinent requirements of the following Items:

- Item 400, “Excavation and Backfill for Structures”
- Item 420, “Concrete Substructures”
- Item 458, “Waterproofing Membranes for Structures”

Construct required piling or drilled shafts in accordance with the pertinent specification.

3.2. **Options.** When optional design details are shown on the Design Documents, Developer is required to use the same facing design within an area of continuous retaining walls.

Provide drawings for review indicating the proposed design arrangement when proposing the use of 2 or more systems.

3.3. **Working Drawings.** When proprietary wall systems are used for permanent or temporary walls, submit casting drawings, construction drawings, and design calculations bearing the seal of a Registered Professional Engineer for review and approval following the TxDOT Guide to Electronic Shop Drawing Submittal process. Upon completion of construction, submit a set of reproducible Record Drawings.

3.3.1. **Casting Drawings**. Include all information necessary for casting wall Elements, including railing and coping when prefabricated. Show shape and dimensions of panels; size, quantity, and details of the reinforcing steel; quantity, type, size, and details of connection and lifting hardware; and additional necessary details.

3.3.2. **Construction Drawings**. Include a numbered panel layout showing horizontal and vertical alignment of the walls as well as the existing and proposed groundlines. Include all information needed to erect the walls, including the proposed leveling pad elevations; the type and details of the soil reinforcing system (if applicable); the details and manufacturer of all pads, fillers, and filter fabric; the limits and dimensions of structural backfill; details necessary to incorporate coping, railing, inlets, drainage, and electrical conduit; and additional necessary details.

Leveling pad elevations may vary from the elevations shown on the Design Documents. Provide at least 1 ft. of cover from the top of the leveling pad to finish grade.

3.3.3. **Design Calculations**. Include calculations covering the range of heights and loading conditions on the Project. Calculations for both internal and external stability as described on the Design Documents are required. Include a summary of all design parameters used; material types, strength values, and assumed allowables; loads and loading combinations; and factor-of-safety parameters.

3.4. **Permanent MSE Walls.** Grade the foundation for the structure level to a width equal or exceeding the length of the reinforcing system. Perform proof rolling on retaining wall foundation area to identify any loose, soft, or unsuitable materials. Material not meeting a maximum rut depth of 1 in. per pass of pneumatic tire roller should continue to be rolled or removed and replaced with suitable material. Pneumatic tire rolling will be waived for portions of wall with a reinforcement length of 8’; for these conditions proof rolling shall be required with a smooth-wheeled vibratory roller or other approved roller.

Place drilled shafts and piling located within the MSE volume before construction of the wall. Place any required pipe underdrain before construction of the wall. Complete MSE wall construction before construction of abutment caps and abutment wing walls. Completion of walls and abutment should be in conjunction with Project phasing or to allow for completion of walls that meets the proper placement and compaction at abutments.

Place the concrete leveling pad as shown on the construction drawings. Provide a wood float finish, and wait a minimum of 24 hr. before beginning panel erection. No curing or strength testing of the leveling pad concrete is required.

Shim the first row of panels as necessary to achieve correct alignment. Use plastic shims or other material that will not deteriorate. Remove and replace the leveling pad or provide a grout level-up if the required shim height exceeds 1 in.

Place filter fabric behind the wall along the joint between the leveling pad and the panels. Grout areas where filter fabric spans more than 6 in. at leveling pad steps.

Place and compact fill material over the leveling pad to an elevation even with or above the surrounding ground after backfilling the first row of panels. Do not allow water to accumulate and stand at the base of the wall.

Place filter fabric behind all wall joints and at the intersection of retaining walls with other structures, including riprap. Cover joints at least 6 in. on each side and use adhesive to hold the filter fabric in place.

Exercise care while lifting, setting, and aligning panels to prevent damage to the panels. Discontinue any operation that results in chipping, spalling, or cracking of panels. Remove and replace damaged panels.

Provide external bracing for the initial row of panels. Use wooden wedges, clamps, or other means necessary to maintain position and stability of panels during placement and compaction of backfill. Remove wooden wedges as soon as the panel or coping above the wedged Element is erected and backfilled. Remove all wedges after completing the wall.

Review plumbness and position of each row of panels before placing the subsequent row. Remove and rebuild any portion of the wall that is out of tolerance. Modify panel batter and bracing, and backfill material, placement, and compaction methods as required to maintain wall tolerances.

Construct walls to a local vertical and horizontal alignment tolerance of 3/4 in. when measured along a 10-ft. straightedge relative to vertical and horizontal wall control line. Construct walls to an overall vertical tolerance (plumbness from top to bottom) of 1/2 in. per 10 ft. of wall height. Construct walls so the maximum offset at any panel joint is between 3/8 in. and 3/4 in. and no joint is open to the extent the filter fabric is visible from the front of the wall.

Place backfill to closely follow the erection of each row of panels. Place the select and embankment backfill to the same elevation where possible, and operate the compaction equipment over the interface. Do not create a continuous, distinct, vertical joint between the select and embankment backfill. Complete the embankment after construction of the retaining wall.

Maintain the stability of the interface area between the existing ground and the select fill when building a wall against existing ground. Remove and recompact any material that loosens, caves, or fails.

Compact backfill to provide at least 95% of density determined in accordance with Tex-114-E. Field density determination shall be made in accordance with Tex-115-E.

Sprinkle backfill as required to ensure adequate uniformly distributed moisture in each lift before and during compaction. Place fill in lifts of 8 in. or less (loose measurement). Place fill in a manner that avoids segregation of the fill. Decrease the lift thickness if necessary to obtain the required compaction. Use hand-operated or walk-behind compaction equipment in the 3 ft. wide strip adjacent to the wall panels. Do not displace panels or distort or damage the reinforcement

system during compaction. Modify backfill material, placement, and compaction methods as necessary to meet density requirements while maintaining wall tolerances.

Place and compact the backfill to the reinforcement level, at each earth reinforcement level, before placing the reinforcement. Place earth reinforcements perpendicular to the face of the wall. Remove slack in connections before placing backfill. Pre-tension each layer of reinforcement to remove slack before placing backfill for systems using nonmetallic earth reinforcements. Use devices capable of mechanically applying and holding the required force. Do not operate tracked equipment directly on any reinforcement.

Cover the rock backfill with filter fabric before placing the 2 ft. of backfill immediately below the pavement structure or top of wall when rock backfill is used. Overlap the fabric at least 18 in. at splices, and extend it past the edge of the rock backfill at least 18 in. Use backfill that contains sufficient fines to fill the voids in a compacted state above the filter fabric. Place a horizontal layer of filter fabric as noted above when transitioning from rock backfill to finer grained backfill anywhere within the wall volume.

Prevent surface water or rainwater from damaging the retaining walls during construction. Shape the backfill to prevent water from ponding or flowing on the backfill or against the wall face. Remove and replace any portion of the retaining wall damaged or moved out of tolerance by erosion, sloughing, or saturation of the retaining wall or embankment backfill.

3.5. **Temporary MSE Walls.** Provide a facing system rigid enough to maintain a smooth and straight wall face both during and after construction.

Grade and compact the foundation for the structure as described in Item 423.3.4., “Permanent MSE Walls.”

Place earth reinforcement and facing system in accordance with the approved working drawings. Backfill the 2-ft. zone immediately behind the facing with clean, coarse rock meeting the requirements of Coarse Aggregate Grade 1, 2, or 3 of Item 421, “Hydraulic Cement Concrete,” or of Type DS backfill as described in Item 423.2.4.2., “Select.” Cement-stabilized backfill as described in Item 423.2.4.4., “Cement-Stabilized Backfill,” may be used in place of the coarse rock.

Place and compact backfill in accordance with Item 423.3.4., “Permanent MSE Walls.”

Construct walls to a vertical and horizontal alignment tolerance of 3 in. when measured along a 10-ft. straightedge. Construct walls to an overall vertical tolerance (plumbness from top to bottom) of 2 in. per 10 ft. of wall height. Place adjacent facing Elements so the maximum out-of-plane offset at any facing Element joint is less than 1 in. Place facing Elements and filter fabric with no gaps in the facing or fabric.

Prevent surface water or rainwater from damaging the retaining walls during and after construction. Place temporary berms or curbs, shape the backfill, or use other approved methods to prevent water from flowing against or over the wall face. Remove and replace any portion of the wall damaged or moved out of tolerance by erosion, sloughing, or saturation of the retaining wall or embankment backfill.

3.6. **Concrete Block Retaining Walls.** The concrete block units may be sampled and tested before shipment or upon delivery to the construction site. Display for approval, samples of block units indicating the color, texture, and finish. Store, transport, and handle all block units carefully to prevent cracking or damage.

Grade and compact the foundation for the structure, and place the leveling pad as described in Item 423.3.4., "Permanent MSE Walls."

Place the concrete block facing units in accordance with the approved working drawings. Fill the voids within the units and fill the 1-ft. zone immediately behind the facing with drainage aggregate as described in Item 423.2.4.3., "Drainage Aggregate." Systems tested without unit fill may omit the fill as indicated on the approved drawings. Systems with approved filter fabric details may omit the drainage aggregate in the 1-ft. zone immediately behind the facing.

Place reinforcements and backfill for walls using earth reinforcements in accordance with the requirements of Item 423.3.4., "Permanent MSE Walls." Pay particular attention to the connection details of the earth reinforcements to the concrete block units.

Construct walls to a vertical and horizontal alignment tolerance of 1-1/2 in. when measured along a 10-ft. straightedge. Construct walls to an overall vertical tolerance (deviation from the vertical or battered control line, top to bottom) of 1 in. per 10 ft. of wall height. Place adjacent facing Elements so the maximum out-of-plane offset at any facing Element joint is less than 1 in. Place facing Elements with maximum 1/4-in. gaps between block units.

Prevent surface water or rainwater from damaging the retaining walls during construction. Shape the backfill to prevent water from ponding or flowing on the backfill or against the wall face. Remove and replace all portions of the retaining wall damaged or moved out of tolerance by erosion, sloughing, or saturation of the retaining wall or embankment backfill.

Item 424

16. Precast Concrete Structural Members (Fabrication)

1. DESCRIPTION

Fabricate precast prestressed and precast nonstressed concrete members. This Item, in conjunction with DMS-7300, "Precast Concrete Fabrication Plants," applies to both multi-project and project-specific fabrication plants. For this Item, the following definitions apply:

- **Prestressing**. The introduction of internal stresses (pre-tensioning or post-tensioning) into a structural member by tensioning and anchoring strands, bars, or wires to counteract the stresses resulting from the applied load.
- **Pre-Tensioning**. The application of prestressing force to the tensioning devices before casting concrete.
- **Post-Tensioning**. The application of prestressing force to the tensioning devices after concrete has hardened.
- **Tendon**. Any single unit used to apply prestressing force to the member. For post-tensioned units, a tendon is a bar, group of wires, or group of strands with common end anchorage.
- **Multi-Project Fabrication Plant**. A facility at an offsite location that fabricates precast prestressed or precast nonstressed members. This definition also applies to single Contract offsite facilities.
- **Project-Specific Fabrication Plant**. A temporary facility at or near the Project location that fabricates precast prestressed or precast nonstressed members for only one Contract. This definition may be applied to temporary facilities that fabricate for multiple Contracts, if approved.
- **Nonstressed Members**. Precast concrete members that have not been pre-tensioned or post-tensioned.
- **Prestressed Members**. Precast concrete members fabricated by the process of pre-tensioning, post-tensioning, or a combination of both methods.
- **Minor Prestressed Members**. Includes piling, bridge deck panels, and sound wall panels.
- **Major Prestressed Members**. Includes all other prestressed members not listed as minor prestressed members.
- **I-beams**. For this specification all I-girders and bulb-tee beams are referred to as I-beams.
- **Self-Consolidating Concrete (SCC)**. A highly workable concrete that can flow through densely reinforced or complex structural Elements under its own weight and adequately fill voids without segregation or excessive bleeding without the need for vibration.
- **Temperature Probe**. Thermocouple for measuring concrete temperature or air temperature.
- **Temperature Recording Device**. Data logger for recording temperatures from the temperature probes.

2. EQUIPMENT

2.1. **Field Office and Inspection Laboratory.** Provide a field office and inspection laboratory for multi-project and project-specific fabrication plants in accordance with DMS-7300, "Precast Concrete Fabrication Plants."

2.2. **Furnishings and Laboratory Equipment.** Provide furnishings and laboratory equipment for multi-project and project-specific fabrication plants in accordance with DMS-7300, "Precast Concrete Fabrication Plants."

2.3. **Plant Facilities.** Provide plant facilities for multi-project and project-specific fabrication plants that produce prestressed members in accordance with DMS-7300, "Precast Concrete Fabrication Plants."

2.4. **Batch Plant.** Provide batch plant onsite for SCC construction. Do not use volumetric mixers for SCC.

3. MATERIALS

Furnish materials in accordance with Item 425, "Precast Prestressed Concrete Structural Members" and other pertinent Items.

4. CONSTRUCTION

4.1. **General Requirements.**

4.1.1. **Shop Drawings**. Prepare and electronically submit shop drawings before fabrication as documented in the *Guide to Electronic Shop Drawing Submittal* available on the TxDOT website. Provide one complete approved 11 × 17 in. set in hardcopy to the TxDOT inspector at the fabrication plant. Stamp it "For TxDOT Inspector."

Provide a title block on each sheet in the lower right corner with the following information:

- sheet index data shown on lower right corner of the Design Documents,
- sheet numbering for shop drawings,
- name of structure or stream,
- name of owner or developer,
- name of fabricator or Supplier, and
- name of Developer.

4.1.1.1. **Prestressed Members**. Furnish shop drawings for prestressed members. Submit the proposed designs on forms furnished by TxDOT when optional designs are permitted by the Design Documents. Obtain approval of these designs before casting. Approval of optional designs does not relieve Developer from the responsibility of furnishing a satisfactory completed structure. Provide submittals for precast post-tensioned members in accordance with this specification and Item 426, "Post-Tensioning."

4.1.1.2. **Nonstressed Members**. Furnish shop drawings for nonstressed members when required by the Design Documents or pertinent Items.

4.1.2. **Plant Approval**.

4.1.2.1. **Plant Submittals**. Provide submittals in accordance with DMS-7300, "Precast Concrete Fabrication Plants," for each particular plant operation. This requirement does not apply to Project-specific nonstressed member fabrication plants.

4.1.2.2. **Plant Audits**. Multi-project and project-specific fabrication plants must pass initial and periodic TxDOT-directed plant audits in accordance with DMS-7300, "Precast Concrete Fabrication Plants."

4.1.3. **Notice of Beginning Work**. Give adequate notice before beginning Work as specified in Table 1. Include a schedule for all fabrication processes and dates when inspections are to occur.

Table 1

Notice of Beginning Work

Plant Location	Notice Required
In Texas	7 Days
In the contiguous United States	21 Days
Outside the contiguous United States	60 Days

Perform no Work in the plant before fabrication is authorized. Developer must bear all TxDOT travel costs when changes to their fabrication or inspection schedules are not adequately conveyed to TxDOT.

4.1.4. **Personnel Qualifications**. Provide qualified personnel in accordance with DMS-7300, "Precast Concrete Fabrication Plants," for each particular plant operation.

4.1.5. **Quality Responsibilities**. The quality responsibilities for Developer for each particular plant operation shall be in accordance with DMS-7300, "Precast Concrete Fabrication Plants."

4.2. **Fabrication.** Prepare a casting schedule on TxDOT-approved forms per DMS-7300, "Precast Concrete Fabrication Plants," and submit it daily to TxDOT before fabrication. This requirement does not apply to Project-specific minor prestressed member or Project-specific nonstressed member fabrication plants. Perform fabrication during daylight hours. Submit lighting details electronically for review before installing lighting system. Allow for plant and TxDOT inspection.

4.2.1. **Forms**. Design forms to prevent damage to the concrete from restraint as the concrete shrinks, from form expansion and contraction from thermal changes, from stripping operations, and from dimensional changes due to pre-tensioning. Forms, regardless of material, must conform to the profiles, dimensions, and tolerances of the finished product as specified on the Design Documents and in this Item. Maintain forms free from dents, grease, or other foreign materials that may affect the appearance of the member, and clean forms thoroughly before each casting operation and immediately before applying a form-release agent.

4.2.1.1. **External Forms**. Construct side and bottom forms of steel. Timber forms, when permitted, must meet the requirements of Item 420.4.4., "Forms." End headers may be of other material as approved.

Construct forms with sufficient thickness, external bracing and stiffeners, and anchorage to withstand the forces generated during concrete placement and consolidation. Do not stabilize forms with bracing and holding devices that will remain in the finished member.

Provide corners with a chamfer or radius where shown on the Design Documents.

Maintain forms sufficiently mortar-tight to prevent damage that requires repair to the finished product. Where sections of forms will be joined, an offset of 1/16 in. for flat surfaces and 1/8 in. for corners and bends is permitted. Longitudinal form joints in prestressed concrete beams are not permitted except for in the side forms of slab beams, decked slab beams, box beams, and X-beams. Do not allow vertical or horizontal gaps or offsets to exceed 1/4 in. between adjacent sections of built-up end headers.

Check the grade and alignment of forms each time they are set, and maintain them during placement of concrete.

Apply a form-release agent, in accordance with the manufacturer's recommendations, to the facing of forms before placing concrete. Use a form-release agent that facilitates form removal and does not affect any required coating, painting, or color-staining operations. Do not use materials that appreciably stain or react with the concrete. Remove excess form-release agent from the form surface before casting, and ensure it does not contaminate strands, reinforcing steel, and embedments. Use a clear form-release agent of the same brand throughout the casting of retaining wall panels per structure.

Construct the forms to facilitate removal of members without damage to the concrete.

Construct and maintain the soffit (liner) to provide a maximum 1/4 in. variation from the theoretical plane, and do not allow the soffit to vary more than 1/4 in. between any 2 points in any 50 ft. length.

At Developer's option, construct side forms for bridge deck panels and prestressed piling with a draft for ease of product removal. Maintain product dimensional tolerances per Table 3. A maximum 1/4 in. draft is allowed for bridge deck panels.

4.2.1.2. **Internal Forms**. Use solid expanded polystyrene conforming to ASTM C578 Type I for forming internal voids. The form material must be inert, non-biodegradable, non-absorptive, and strong enough to maintain sufficient rigidity to withstand the forces generated during concrete placement and consolidation without damage. Other materials for forming internal voids may be used when approved. Provide certification of conformance for void forms.

Anchor internal void forms to prevent movement or misalignment while placing concrete. Provide hold-down devices for all types of void forms at 30-in. maximum spacing. Do not use internal hold-down or lateral bracing devices that will remain in the finished member. Provide enough bearing area on the void form to prevent penetration of hold-down devices into the void form. Splice void form sections to prevent separation or misalignment during concrete placement and consolidation operations.

During casting, verify and document void form placement at 10-ft. maximum spacing using an approved method.

Vent void forms without solid cores to eliminate high air pressure caused by heat of hydration. Insert a 3/4-in. diameter plastic tube into the top of the void before placing concrete, and leave it in place until there is no possibility of damage from pressure. Remove the plastic tube afterwards and seal the hole with an approved repair material and procedure.

Drain prestressed concrete box beams and U-beams through the bottom flange by forming holes in each voided area as shown on the Design Documents.

4.2.2. **Prestressing**. Perform pre-tensioning in accordance with this Item and post-tensioning in accordance with Item 426, "Post-Tensioning."

4.2.2.1. **Prestressing Equipment**. Furnish hydraulic jacks with sufficient capacity for prestressing the steel. Equip the jacks with instruments for monitoring the hydraulic pressure. Provide gauges at least 6 in. in diameter and with means to prevent the gauge pointer from fluctuating. Electronic pressure transducers with digital indicators may be used. Pressure gauges or electronic pressure indicators must indicate the load directly to 1% of the maximum gauge or sensor/indicator capacity or 2% of the maximum load applied, whichever is smaller.

Calibrate each jack and its gauge with the cylinder extension in the approximate position at final jacking force. Jacks and gauges for post-tensioning and single-strand pre-tensioning must be calibrated as a unit. Have certified calibration charts furnished by an independent laboratory and with each jack and gauge used on the Project. Provide certified calibration of each ram before starting stressing operations on the Project and:

- every 6 mo. thereafter for post-tensioning operations,
- every 12 mo. thereafter for pre-tensioning operations.

The calibration frequency for multiple-strand pre-tensioning equipment may be extended to every 24 mo. thereafter if an approved master gauge system monitors it. The master gauge must check this equipment when suspect results occur and at least every 6 mo. Calibrate the master gauge per the manufacturer's recommendations and at least every 12 mo.

Recalibrate jacks and gauges when a malfunction occurs, when repairs such as replacing the seals, changing the length of the hydraulic lines, or changing the pump occur, or when using gauges that have not been calibrated with the jack.

Post-tensioning jacks must have provisions for measuring tendon elongation directly on the strand, bar, or wire. The jacks must be capable of slow release of force to properly seat the tendon anchors.

Single-strand stressing jacks for pre-tensioning must have provisions for measuring the elongation directly on the strand.

Multi-strand de-tensioning jacks must have sufficient capacity and throw to permit simultaneous release of the entire load in the strands. Use an approved single-strand flame-release procedure to release the remaining load if there is not enough throw in the multi-strand jacks to release all load in the strands.

4.2.2.2. **Pre-Tensioning**. Pre-tension all strands to a uniform initial load between 5% and 25% of the final load. Apply the load within a tolerance of:

- $\pm$100 lb. per strand if the designated initial load is less than or equal to 10% of the final load, or
- $\pm$200 lb. per strand if the designated initial load is greater than 10% of the final load.

Measure the initial load with a calibrated dynamometer or other suitable equipment.

Do not allow the modulus of elasticity of individual strands to vary more than 1% from each other when multiple-strand tensioned. Use a weighted average modulus of elasticity of strands to calculate elongation for multiple-strand tensioning operations.

Establish reference marks on the strand for measuring elongation after initial tensioning. Provide means for measuring the elongation of the strand to an accuracy of 1% of the theoretical elongation or 1/8 in., whichever is smaller. Establish independent references on the strand adjacent to each anchorage, to indicate slippage that may occur between the time of initial stressing and final release of the strands.

Do not allow the stress in the strand to exceed 80% of the specified ultimate tensile strength of the strand at any time.

Do not use any portion of the strand that has been previously gripped with chucks in the length of strand to be tensioned, except where gripped with chucks during initial tensioning. Do not drive over prestressing strand.

Strand chucks designed with spring caps must be used with the spring caps. Visually inspect strand chucks that are not equipped with spring caps to ensure all wedges are evenly seated after applying initial load. Correct unevenly seated wedges by releasing the stress, repositioning wedges, and reapplying the initial load.

Failure of individual wires in a 7-wire strand is acceptable if the total area of wire failure is not more than 2% of the total cross-sectional area of all strands in the member, and if no more than 1 wire fails in any single strand. Any setup with one or more broken wires must be examined by a Registered Professional Engineer or Quality Control Supervisor (as defined in DMS-7300, “Precast Concrete Fabrication Plants,”) to determine the cause before continuing stressing operations on the particular casting line.

4.2.2.2.1. **Strand Splicing**. Do not splice draped strands. One splice per straight strand will be permitted subject to the following:

- Locate splices outside the members.
- Splice strands with the lay or twist in the same direction to avoid unraveling.
- Splice all straight strands in a multiple-strand tensioning operation so an adjustment can be made for the average seating loss.
- Cut strand ends to be spliced with shears, abrasive saws, or grinders to remove regions where chucks were previously seated. Cut in the same manner at least 12 in. from strand ends to be spliced that were previously flame cut.

4.2.2.2.2. **Single and Multiple Straight Strand Tensioning**. After initial tensioning, apply the required load to the strands as shown on the Design Documents by means of single-strand or multiple-strand hydraulic jacks equipped with calibrated gauges. Verify the final load in the strands by observing either the gauge pressure or elongation and independently checking the other. The final load and elongation must agree within 5% of the computed theoretical values. Additionally, the final load and elongation must agree algebraically with each other within 5%. Suspend tensioning operations until the problem has been identified and corrected in the event of discrepancies greater than these tolerances.

Verify uniform application of load to strands for multiple-strand-tensioning systems by measuring the movement on opposite sides of the anchorage.

4.2.2.2.3. **Draped Strand Tensioning**. Verify the intermediate load by observing either the gauge pressure or elongation and independently checking the other when draped strands are tensioned in a straight or partially- draped position before application of final load. The intermediate or final load, if strands are tensioned in the final position, and elongation must agree within 5% of the computed theoretical values. Additionally, the intermediate or final load and elongation must agree algebraically with each other within 5%. Suspend tensioning operations until the problem has been identified and corrected in the event of discrepancies greater than these tolerances.

After application of final load, measurements on individual draped strands to establish differential stresses at selected points on the member shall be averaged at a cross-section of the member, and the averages must be within 5% of the theoretical elongation. The measured elongation of any individual draped strand must not vary from the theoretical elongation by more than 10% at any measured cross-section. Suspend tensioning operations until the problem has been identified and corrected in the event of discrepancies greater than these tolerances.

Other methods to measure the intermediate load and final load in the draped strands may be submitted for approval.

4.2.2.2.4. **Strand Debonding**. Encase strands in plastic sheathing along the entire debonded length, and seal the ends with waterproof tape when shown on the Design Documents. Use split plastic sheathing only if the seam is sufficiently sealed with waterproof tape to prohibit grout infiltration. Do not use sheathing that will permanently alter the physical or chemical properties of the surrounding concrete.

Full-length debonding of straight strands will be approved on an individual basis. Full-length debonding, when permitted, must be symmetrical about the vertical centerline of the beam and limited to 10% of the total number of straight strands or 6 straight strands, whichever is less. Do not debond draped strands full length. When using a concrete anchor block to combined strand patterns the same criteria applies.

4.2.2.3. **Combined Pre-Tensioning and Post-Tensioning**. When the Design Documents call for a combination of pre-tensioning and post-tensioning, all of the requirements for pre-tensioning in this specification and for post-tensioning in Item 426, “Post-Tensioning” apply.

4.2.3. **Placing Reinforcing Steel**. Place reinforcing steel in accordance with Item 440, “Reinforcement for Concrete.” Reinforcing steel projection outside of the member must not be more than 1/2 in. or less than 3/4 in. from plan dimension Do not damage sheathing for strand debonding. Do not tie reinforcing steel to debonded strand regions.

Weld steel components in accordance with Item 448, “Structural Field Welding.” Provide welding procedure specifications (WPSs) for approval, and welding personnel certifications per the applicable AWS code. **Quality of Concrete**. Provide concrete in accordance with Item 421, “Hydraulic Cement Concrete.” Use the class of concrete shown on the Design Documents or in the pertinent Item for each type of structure or unit. Provide concrete meeting the approved mix design water-cement ratio. SCC is not allowed for Project-specific fabrication plants. Mix concrete for a period of 1 min. for 1 cu. yd. and 15 sec. for each additional cu. yd. of rated capacity of the mixer. Count the mixing time from the time all materials are in the drum. Increase mixing time if necessary to achieve a uniform mix. Control concrete by compressive strength

tests of cylinders or other pertinent performance tests detailed on the Design Documents or pertinent Items. Concrete compressive-strength test cylinders shall be made, cured, and tested in accordance with Tex-704-I. Cure release-of-tension strength cylinders in accordance with Tex-715-I when match-cure technology is used.

High-strength concrete (f'_c > 9000 psi) is accepted based on 56-Day compressive strength testing. Concrete design-strength test cylinders for high-strength concrete shall be made, cured, and tested in accordance with Tex-704-I.

Product with concrete that fails to meet minimum design compressive strength requirements shall be reviewed. Cores taken to determine the strength of the in-situ concrete shall be in accordance with Tex-424-A. All cores from precast members must meet 100% of the minimum design compressive strength requirements. TxDOT may require reimbursement for testing of cores. Test results from a commercial laboratory must be sealed by a Registered Professional Engineer.

SCC used for prestressed beams must have a Modulus of Elasticy of 5000 ksi at 28 Days. Test the concrete mix design before use in accordance with ASTM C469.

4.2.4. **Placing Concrete**. Place concrete only when its temperature at time of placement is between 50°F and 95°F.

Take responsibility for producing quality concrete under any weather condition and ensure adequate weather protection provisions are on-site and available for immediate use.

Provide immediate protective measures without compromising the quality of the product if rainfall occurs after concrete placing operations have started. Failure to immediately provide adequate weather protection may be cause for rejection of the affected product.

Maintain concrete transporting equipment clean and free from hardened concrete coatings.

At the time of concrete placement, reinforcing steel, strands, and embedments must be free of dirt, oil, or other bond-breaking substances.

Place and adequately consolidate concrete while all lifts are in a plastic state. Concrete must not exhibit segregation or excessive bleeding. Minimize concrete flow lines and displacement of the reinforcing steel, strands, embedments, and ducts during concrete placement. Concrete must not exhibit segregation or excessive bleeding. Minimize concrete flow lines and displacement of the reinforcing steel, strands, embedments, and ducts during concrete placement.

Place concrete as near as possible to its final position in the forms except when using SCC. Do not deposit large quantities of concrete at one location and run or work it along the forms to other locations except for SCC. Place SCC in a manner to avoid segregation.

Do not allow fresh concrete to free-fall more than 8 ft..

Work the coarse aggregate back from the face of the concrete, and force the concrete under and around the reinforcing steel, strands, embedments, and ducts. If prestressed concrete I-beams are cast in multiple lifts, the thickness of the first lift must be slightly above the juncture of the bottom flange and web.

Cast prestressed concrete box beams monolithically in 2 stages, maintaining the concrete in the previously placed bottom slab in a plastic state until the web (side wall) concrete is placed and vibrated into the bottom slab.

The maximum time between the addition of mixing water or cement to the concrete batch and the placing of concrete in the forms is 30 min. for concrete delivered in non-agitated delivery equipment and 60 min. for concrete delivered in agitated delivery equipment. If conditions of wind, humidity, and temperature cause quick stiffening of the concrete, the required placement times may be reduced and an approved retarder may be required, or increased if currently in use. Submit a plan for approval, if necessary, to demonstrate the concrete can be properly placed, consolidated, and finished without reducing placement time limits.

The maximum acceptable placement slump shall be in accordance with Item 421, "Hydraulic Cement Concrete." When the maximum acceptable placement slump or slumpflow is exceeded, the affected concrete shall be rejected and retesting for slump or slumpflow will not be allowed regardless of the concrete placement times.

Additional requirements for precast mass placements shall be in accordance with Item 420, "Concrete Substructures." In the case of a conflict between the two Items the more stringent requirements apply.

4.2.4.1. **Placing Concrete in Cold Weather**. Maintain concrete temperature between 50°F and 95°F at time of placement as specified in Item 424.4.2.4., "Placing Concrete," and maintain the concrete temperature of precast members at or above 50°F during the specified curing period as specified in Item 424.4.2.6., "Curing of Concrete." Do not place concrete when the atmospheric temperature in the shade is below 40°F and falling. Concrete may be placed when the atmospheric temperature in the shade is at least 35°F and rising or above 40°F, provided adequate cold-weather protection provisions are on-site and available for immediate use before placing concrete when weather conditions indicate a possible need for temperature protection. When required, provide necessary covering material or an approved accelerated curing system in accordance with Item 424.4.2.6.3., "Accelerated Curing," and do not allow any concrete to remain unprotected for longer than 1 hr. after placement. Do not place concrete in contact with any material coated with frost or with material at a temperature of 32°F or lower. Do not apply heat directly to concrete surfaces if accelerated curing is used. Take protective measures to ensure the difference between air temperature and concrete surface temperature does not cause thermal cracking.

Maintain aggregates free from ice, frost, and frozen lumps. Heat the aggregate and the water when needed to produce the minimum concrete placement temperature of 50°F, but:

- do not allow the water temperature to exceed 180°F or the aggregate temperature to exceed 150°F,
- heat the aggregate uniformly to eliminate overheated areas in the stockpile that might cause flash set of the cement, and
- provide an aggregate and water mixture temperature between 50°F and 85°F before introduction of the cement.

4.2.4.2. **Placing Concrete in Hot Weather**. Keep concrete at or below 95°F at time of placement in accordance with Item 424.4.2.4., "Placing Concrete." Use any of the following methods, as needed, to control the concrete placement temperature:

- Cool the aggregate by sprinkling or fogging (fine mist) with water, shading, or using an approved liquid nitrogen system and procedure.
- Cool the fresh concrete by using chilled mixing water, partially replacing mixing water with shaved or crushed ice, or using an approved system and procedure to discharge liquid nitrogen into concrete during batching.

Apply a fog spray (fine mist) of water to this steel just before placing concrete when the temperature of steel forms, strand, or reinforcing steel is greater than 120°F. Water droplets left on the form surfaces must not adversely affect surface finishes.

When field conditions are such that evaporation of water from the concrete makes the surface finishing operation difficult, a fog spray (fine mist) of water may be applied above the concrete surface. Do not fog directly toward the concrete or in any manner that will wash cement paste from the fresh concrete surface or cause water to puddle. Do not fog as a means to add finishing water and do not work moisture from the fog spray into the fresh concrete. An approved evaporation retardant conforming to DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants," is also acceptable if used in accordance with the manufacturer's recommendations. Do not apply the evaporation retardant when floating and troweling concrete. Do not allow it to puddle or be worked into the concrete surface immediately after application. Misuse of fog spray or evaporation retardant will be cause for disallowing its use. Shade the concrete during casting if necessary.

Use an approved retarder, in accordance with the manufacturer's recommendations, when the air temperature is above 85°F if necessary to control concrete slump loss and lengthen the time for placing, consolidating, and finishing operations.

4.2.4.3. **Consolidation of Concrete**. Consolidate concrete thoroughly with high-frequency vibration immediately after placement. For prestressed concrete beams and piling, internal vibration is required and may be supplemented with external vibration.

Provide at least 1 on-site standby vibrator of the type being used for Emergency use.

Perform concrete vibration using trained personnel and proper timing and spacing to ensure adequate consolidation. Revise the concrete placement and consolidation procedures, and review the concrete mix design and batching procedures, if necessary, when unacceptable defects such as excessive honeycombing, aggregate or mortar pockets or surface air voids (bugholes) are present. Provide supplemental vibrators or modify the vibration system when required to accomplish thorough consolidation of the concrete and complete embedment of the strands, reinforcing steel, embedments, or ducts. Avoid segregation or excessive bleeding of the concrete during vibration.

4.2.4.3.1. **Internal Vibration**. Insert vibrators into the concrete immediately after concrete placement at points spaced to ensure uniform vibration of the entire concrete mass. Limit the insertion spacing to within the radius where the vibrators are visibly effective. Allow the vibrators to sink into the concrete by their own weight and penetrate into previously placed lifts that are still in a plastic state to thoroughly consolidate the layers together and prevent cold joints. Withdraw the vibrators slowly to avoid forming holes after the concrete is thoroughly consolidated.

Do not allow prolonged contact of vibrators with forms so vibrator marks on concrete surfaces are minimal. Do not use vibrators to move concrete to other locations in the forms.

Use vibrators with nonmetallic vibrating heads to prevent damage to the epoxy coating when epoxy coated reinforcing steel is used. Increase the consolidation time and decrease the insertion spacing, if necessary, when using these vibrators.

4.2.4.3.2. **External Vibration**.

4.2.4.3.2.1. **Form Vibrators**. Form vibrators may be used to consolidate thin members, supplement internal vibration, or consolidate members with highly congested reinforcing steel.

Determine the size, number, and location of external vibrators to provide enough intensity of vibration to the desired area of the form. Adjust the spacing, frequency, amplitude, and duration of vibration according to the concrete mix and size of member to produce uniform consolidation of the concrete.

4.2.4.3.2.2. **Surface Vibrators**. Use vibratory screeds to consolidate thin sections. Move vibratory screeds at a rate that will bring enough mortar to the surface to embed and cover the coarse aggregate. Do not over vibrate by causing an excessive amount of mortar to be brought to the surface.

4.2.4.3.2.3. **Vibrating Tables**. Determine the size, number, and location of external vibrators to provide enough intensity of vibration to the desired area of the form. Adjust the spacing, frequency, amplitude, and duration of vibration according to the concrete mix and size of member to produce uniform consolidation of the concrete.

4.2.4.3.3. **Vibration of Self-Consolidating Concrete (SCC)**. Provide an adequate amount of viscosity modifying admixture (VMA) in SCC mix when internal vibration is used.

4.2.5. **Finishing of Concrete**. Finished, unformed surfaces must not have distortions greater than 1/4 in. Screed or rough-float unformed surfaces of members, bringing enough mortar to the surface to embed and cover the coarse aggregate. Provide a uniform rough wood float finish to the surface of the member. Do not loosen aggregate when roughening the surface with a broom or when providing a tine finish.

Provide a smooth metal trowel finish for surfaces at anchor bolt locations.

4.2.6. **Curing of Concrete**. Cure concrete to promote early cement hydration by providing adequate moisture on exposed surfaces and by maintaining the concrete temperature or curing enclosure air temperature at the concrete surface within the limits specified in this Section. Provide uniform temperature and moisture on the surfaces to prevent differential shrinkage that may cause warping or cracking. Prevent temperature differentials within the concrete that cause thermal cracking.

Begin curing after the finishing operation, before the formation of plastic shrinkage cracks, and as soon as damage to the surface finish will not occur. Provide fog spray or an evaporation retardant after finishing and before curing if needed to prevent plastic shrinkage cracks. Apply fog spray or evaporation retardant in accordance with Item 424.4.2.4.2., “Placing Concrete in Hot Weather.” Keep exposed concrete surfaces continuously wet for the duration of the specified curing period. Membrane curing compound is only permitted as noted in this Section or in the pertinent Item.

Approved equipment and materials for curing must be on-site and available for immediate use before placing concrete. Provide temperature probes to monitor the concrete temperature or curing enclosure air temperature as specified in Table 2.

Table 2

Temperature Probe Requirements

Condition	Major Prestressed Members	Minor Prestressed Members	Nonstressed Members
Forecasted atmospheric temperature ≥ 50°F during specified curing period	2 concrete temperature probes per casting line to monitor high concrete temperature regions[5]	2 concrete temperature probes per casting line to monitor high concrete temperature regions[1,5]	N/A
Forecasted atmospheric temperature < 50°F during specified curing period	2 concrete temperature probes per casting line to monitor high concrete temperature regions[5], and 2 concrete temperature probes per casting line to monitor low concrete temperature regions[2,5]	2 concrete temperature probes per casting line to monitor high concrete temperature regions[1,5,] and 2 concrete temperature probes per casting line to monitor low concrete temperature regions[2,5]	1 concrete temperature probe per 100 cu. yd. of concrete or fraction thereof to monitor low concrete temperature regions[2]
Forecasted atmospheric temperature < 40°F during additional 3-Day curing period[3]	N/A	1 concrete temperature probe per similar curing condition for prestressed piling only	N/A
When accelerated curing is used	2 temperature probes per casting line to monitor curing enclosure air temperature at concrete surfaces[4,5]	2 temperature probes per casting line to monitor curing enclosure air temperature at concrete surfaces[4,5]	1 temperature probe per 100 cu. yd. of concrete or fraction thereof to monitor curing enclosure air temperature at concrete surfaces

Excluding prestressed bridge deck panels and prestressed retaining wall panels.

When accelerated curing is used, concrete temperature probes to monitor low concrete temperature regions are not required.

After attaining specified release-of-tension strength.

These probes are in addition to the concrete temperature probes required for monitoring high concrete temperature regions.

Place probes at the beginning and end of casting line.

Attach each temperature probe to a separate temperature recording device. When accelerated curing is used, 1 curing enclosure air temperature probe may also be attached to this multi-channel temperature recording device.

Inadequate curing facilities or lack of attention to the proper curing of concrete will be cause for TxDOT to stop concrete placement until approved curing is provided. Inadequate curing may be cause for rejection of the affected product.

Forms may be removed at the discretion of Developer at any time after the concrete has reached sufficient strength to prevent physical damage to the member. Do not interrupt curing for more than 60 min. during form removal.

The following curing requirements apply for prestressed members:

- Cure concrete continuously, except as allowed during form removal, until the compressive strength of the concrete has reached the specified release-of-tension strength and until de-tensioning has been performed.
- Maintain concrete temperatures between 50°F and 150°F during the curing period. The maximum allowable concrete temperature may be increased to 170°F if Developer uses one of the concrete mix design options listed in Item 421.4.2.6., "Mix Design Options," other than options 6, 7, and 8. TxDOT may require lowering of the total cementitious content in the concrete mix design to the limits specified in Item 421, "Hydraulic Cement Concrete," for repeated violations of the maximum curing temperature.
- Membrane curing is permitted only for unformed surfaces of prestressed wall panels and interim curing on unformed surfaces of prestressed piling. Use Type 1-D or Type 2 curing compound conforming to DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants," for this application.
- Water cure prestressed piling an additional 3 Days after attaining the specified release-of-tension strength. Do not interrupt curing for more than 4 hr. when moving piling to the storage area. Maintain the concrete temperature of piling at 50°F or above during this additional curing period.

The following curing requirements apply for nonstressed members:

- Cure concrete continuously, except as allowed during form removal, for 4 Days or until the compressive strength of the concrete has reached the design strength.
- Maintain concrete temperatures between 50°F and 150°F during the curing period. The maximum allowable concrete temperature may be increased to 170°F if Developer uses one of the concrete mix design options listed in Item 421.4.2.6., "Mix Design Options," other than options 6, 7, and 8.
- Membrane curing is permitted on nonstressed members, except for surfaces to be painted or color-stained.

Cure members for an additional 24 hr. beginning immediately after the normal curing period if they are out of cure at any time other than during the allowable 60 min. for form removal or during the allowable 4 hr. for moving piling to storage.

Members failing to meet the concrete temperature requirements or curing enclosure air temperature requirements during curing shall be reviewed. Repeated failure to maintain proper concrete temperatures may be cause for rejection of the affected product.

4.2.6.1. **Water Curing**. Water curing provides additional moisture to concrete and prevents moisture loss. Water used for curing must meet the requirements for concrete mixing and curing water specified in

Item 421.2.4., "Water." Do not use seawater or water that stains or leaves an unsightly residue that cannot be removed. Monitor and maintain a temperature differential between curing water and concrete surface temperature that prevents thermal cracking.

4.2.6.1.1. **Wet Mat Method**. Use water-saturated cotton mats, burlap, burlap-polyethylene sheeting, or other approved moisture-retaining materials. Anchor the wet mats adequately to provide continuous contact with exposed concrete surfaces.

4.2.6.1.2. **Water Spray Method**. Use overlapping sprays, sprinklers, or soil-soaker hoses so concrete surfaces are kept continuously wet.

4.2.6.1.3. **Ponding Method**. Use an approved retarder when the air temperature is above 85°F in accordance with the manufacturer's recommendations if necessary to control concrete slump loss and lengthen the time for placing, consolidating, and finishing operations.

4.2.6.1.4. **Moisture Retention Curing**. Moisture retention curing prevents moisture loss from the concrete.

4.2.6.1.4.1. **Form Curing Method**. Concrete surfaces in direct contact with forms that are left in place will not require additional curing methods unless cold-weather protection is necessary.

4.2.6.1.4.2. **Impermeable Cover Method**. Cover exposed concrete surfaces with polyethylene sheeting, burlap-polyethylene sheeting, impervious paper, or other approved impermeable materials placed in close contact with concrete surfaces to keep them continuously wet. Provide additional moisture inside the enclosure in accordance with Item 424.4.2.6.1., "Water Curing," if this is not enough to keep exposed concrete surfaces continuously wet.

4.2.6.2. **Membrane Curing**. Liquid membrane-forming curing compound is a moisture retention covering that is applied as a liquid. It is only permitted as noted in Item 424.4.2.6., "Curing of Concrete."

Use Type 1-D or Type 2 membrane curing compound in accordance with DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants." Apply membrane curing compound with equipment and in a manner specified in Item 420.3.5., "Spraying Equipment" and Item 420.4.10.3., "Membrane Curing," respectively.

Do not contaminate reinforcing steel, embedments, or concrete surfaces that will later be in direct contact with cast-in-place concrete unless the curing compound can be completely removed to the satisfaction of TxDOT when applying membrane curing compound.

Use membrane curing compounds that do not appreciably stain the concrete.

4.2.6.3. **Accelerated Curing**. Accelerated curing is defined as curing with artificial heat provided to the curing enclosure or forms.

Test accelerated-curing facilities for a minimum of 48 hr. to demonstrate temperature variations do not exceed 20°F between any points in the curing enclosure. Submit accelerated curing facility drawings and test results, and obtain approval before using these facilities for TxDOT Work. The test may be performed on the entire casting line with either freshly cast concrete inside the forms or with empty forms. Provide 1 curing enclosure air temperature probe per 100 ft. of casting line when accelerated curing facilities are being tested.

Maintain the air temperature in the curing enclosure between 50°F and 85°F until initial set of the concrete (as determined in accordance with Tex-440-A when establishing mix designs under representative temperature conditions) and for at least 3 hr. after concrete placement. The concrete temperature may then be raised uniformly at a maximum rate of 36°F per hour. Provide an unobstructed air space of at least 6 in. between surfaces of the concrete and the curing jacket.

Monitor and maintain the curing enclosure air temperature between 50°F and 160°F during accelerated curing for prestressed and nonstressed concrete members. Do not allow the air temperature to exceed 160°F for more than 1 cumulative hour during the entire curing period. Do not allow the air temperature to exceed 170°F at any time during the specified curing period. Arrange the location of the heat discharge into the curing enclosure so temperature variations do not exceed 20°F between any points in the curing enclosure.

Provide curing enclosure air temperature probes to monitor the temperature at the concrete surface as specified in Table 2.

Provide enough moisture inside the curing enclosure to keep exposed concrete surfaces continuously wet for the specified curing period.

Provide other acceptable curing methods for the remaining curing period if accelerated curing is terminated before the specified curing period has elapsed.

4.2.6.3.1. **Steam Curing**. Steam cure in accordance with the requirements of accelerated curing. Position steam outlets so live steam is not applied directly on the concrete, forms, or test cylinders.

4.2.6.3.2. **Alternate Methods**. Other methods of accelerated curing, such as the use of radiant heaters or portable heater, may be permitted if they meet the requirements of accelerated curing. The use of any alternate method requires written approval.

4.2.7. **Detensioning**. Release the tension in the strands after concrete strength requirements are met using a sequence to minimize premature wire breakage or shock and damage to the concrete members. Release strands by multiple-strand de-tensioning or single-strand flame de-tensioning. Ensure strands are not released individually with single-strand jacks.

Flame-release each strand simultaneously at both ends of the casting bed, using a symmetrical sequence prepared by a Registered Professional Engineer if strands are released individually. Heat the strands over an approved strand length and duration when flame de-tensioning so that the metal slowly elongates and gradually loses strength. Do not abruptly flame-cut strand by holding the heat source in a concentrated location on the strand. Submit the flame-release procedures and sequences for approval. Approval of flame-release sequences does not relieve Developer from responsibility for meeting the product workmanship requirements of Item 424.4.3., “Workmanship.”

Release the tension in the strand hold-down anchor slowly to minimize shock and damage to the concrete member when draped strands are used. Heat the anchor until the metal slowly elongates and gradually loses strength if heat is used to release the hold-down anchor. Provide positive external hold-downs to offset the vertical forces in the members when the sum of the hold-down forces is greater than half the weight of the member or for any amount of vertical

force that has previously caused cracking. External hold-downs are to remain on each member until de-tensioning has been complete.

4.3. **Workmanship.** Formed surfaces must not have excessive surface honeycombing, aggregate or mortar pockets, air voids, lift lines, stains, or vibrator marks. Remove form-joint-offset marks in excess of the tolerances specified in Item 424.4.2.1.1., "External Forms," and fins and rough edges along chamfer lines, in a manner that will not damage the member. Repair fabrication holes, except box beam and U-beam drain holes, with an approved repair material and procedure.

Recess strands in accordance with the TxDOT *Concrete Repair Manual*. Submit for approval any other moisture-barrier systems for protecting strands.

Before shipment of members, remove:

- concrete, paste, dirt, oil, or other bond-breaking substances from exposed reinforcing steel, and
- laitance, dirt, oil, or other bond-breaking substances from concrete surfaces to be in contact with cast-in-place concrete.

4.3.1. **Defects and Breakage**.

Members that sustain damage or surface defects during fabrication, handling, storage, hauling, or erection are subject to review. Evaluate and repair members in accordance with the TxDOT *Concrete Repair Manual*. Submit proposed deficiencies in accordance with TxDOT's NCR guidelines and obtain approval before performing repairs. Repair Work must reestablish the member's structural integrity, durability, and aesthetics to the satisfaction of TxDOT.

When deficiencies occur, determine the cause and take immediate corrective action. Failure to take corrective action, leading to similar repetitive deficiencies, could be cause for rejection of members.

Cracks that extend to the nearest reinforcement plane and fine surface cracks that do not extend to the nearest reinforcement plane, but are numerous or extensive, are subject to review.

Cracks in prestressed members that tend to close upon transfer of stress to the concrete are acceptable. Cracks that do not tend to close are subject to review.

Seal cracks in I-beam ends exceeding 0.005 in. in width. The fabricator must decrease the spacing of Bars R and S in I-beam by providing additional bars to help limit crack width. No less than 1 in. clearance between bars will be permitted. The fabricator must take approved corrective actions if cracks greater than 0.005 in. form.

Prestressed bridge deck panels shall be rejected for any of the following conditions:

- any crack extending to the reinforcing plane and running parallel and within 1 in. of a strand for at least 1/3 of the embedded strand length; or
- any transverse or diagonal crack, including corner cracks and breaks, intersecting at least 2 adjacent strands and extending to the reinforcing plane.

Prestressed bridge deck panels that sustain damage, cracks not listed above, or surface defects during fabrication, handling, storage, hauling, or erection are subject to review.

4.3.2. **Tolerances**.

4.3.2.1. **Prestressed Members**. Allowable tolerances for the dimensions and configurations shown on the Design Documents or approved shop drawings are shown in Table 3.

Variations greater than those specified in Table 3 are subject to review. However, these tolerances do not relieve Developer from the responsibility of furnishing a completed structure that is in reasonably close conformity with the lines, grades, cross-sections, dimensions, and details specified. Correct members not meeting these tolerances, to achieve a satisfactory completed structure. This also includes correction due to variations in vertical beam camber. Correction may require replacement of the member.

Horizontal misalignment (sweep) in beams, which may increase at a later time and exceed the tolerance shown in Table 3, may be acceptable if the members can be hauled, erected, and aligned to within the allowable tolerance without being damaged. Store these members in a manner that will minimize the sweep.

Embedments must be firmly held in proper position to avoid movement during concrete placement. Place embedments in accordance with the manufacturer's recommendations. Place weld clip inserts for permanent metal deck forming no more than 1/16 in. from the beam edge.

Table 3

Allowable Tolerances for Prestressed Members

Dimension	I-beams	U-beams	Box and Slab Beams	Double-T Beams	Bridge Deck Panels	Piling	Wall Panels[1]
Length (perpendicular to strands for bridge deck panels)	±1"	±1"	±1"	±3/4"	±1/2"	−1"[2]	±3/16"
Width (parallel to strands for bridge deck panels)	+3/4" −1/4"	±1/4"	±1/4"	±1/2"	±1/2"	±1/4"	±3/16"
Nominal depth (thickness in case of panels)	+1/2" −1/4"	±1/4"	±1/4"	±1/4"	+1/4" −1/8"	±1/4"	±3/16"
Thickness: top slab or flange	+1/2" −1/4"	±1/2"	±1/2"	±1/4"	NA	NA	NA
Thickness: bottom slab or flange	+1/2" −1/4"	±1/2"	±1/2"	NA	NA	NA	NA
Thickness: web or wall	+3/4" −1/4"	±1/2"	±1/2"	±1/4"	NA	NA	NA
Horizontal alignment (deviation from straightness of all panel edges)	±1/8" per 10' of length	±1/8" per 10' of length, 3/4" max.	±1/4"	±1/4"	±1/8"	±1/8" per 10' of length	±1/8" per 10' of length, 1/2" max.
Deviation of ends (horizontal skew)	±1/2"	±1/2"	±1/2"	±1/2"	±1/2"	±1/8"	±1/4" per 5' of width, 1/2" max.
Deviation of ends (vertical batter)	±1/2" [8]	±1/2" [8]	±1/2"	±1/2"	NA	±1/8"	±1/4"
Notched end areas (for diaphragms): depth	±1/4"	NA	±1/4"	±1/4"	NA	NA	NA
Notched end areas (for diaphragms): length	+2" −1"	NA	+2" −1"	+2" −1"	NA	NA	NA
Bearing surfaces: perpendicular to vertical axis	±1/8"	NA	NA	±1/16"	NA	NA	NA
Bearing surfaces: deviation from plane	±1/16"	±1/8"	±1/8"	±1/16"	NA	NA	±1/16[3]
Anchor hole location: from end of member	+3/4" −1/4"	±1/4"	±1/4"	+3/4" −1/4"	NA	NA	NA
Anchor hole location: longitudinal spacing	±3/4"	±1/2"	±1/2"	±3/4"	NA	NA	NA
Anchor hole location: transverse location	±1/4"	±1/4"	±1/4"	±1/4"	NA	NA	NA

Dimension	I-beams	U-beams	Box and Slab Beams	Double-T Beams	Bridge Deck Panels	Piling	Wall Panels[1]
Diaphragm or lateral tie location	±1/2"	NA	±1/2"	±1/2"	NA	NA	NA
Position of internal void form (longitudinal for box beams and U-beams)	NA	±1"	±1"[4,5]	NA	NA	±1/2"	NA
Projection of reinforcing steel outside of member	+1/2" −3/4"	+1/2" −3/4"	+1/2" −3/4"	+1/2" −3/4"	+1/2" −3/4"	NA	+1/2" −3/4"
Position of strands: vertical	±1/4"[6]	±1/4"	±1/4"	±1/4"	±1/8"[7]	±1/4"	±1/8"
Position of strands: horizontal	±1/4"	±1/4"	±1/4"	±1/4"	±1/2"	±1/4"	±1/2"
Debonded length of strands	±3"	±3"	±3"	±3"	NA	NA	NA
Position of strand hold-down points	±6"	±6"	±6"	±6"	NA	NA	NA
Position of handling devices: parallel to length	±6"	±6"	±6"	±6"	As shown on Design Documents	±6"	±6"
Position of handling devices: transverse to length	±1"	±1"	±1"	±1"	As shown on Design Documents	±1"	±1"
Local flatness of formed surfaces (excluding bearing surface)	±1/4" in 10'	±1/4" in 10'	±1/4" in 10'	±1/4" in 10'	±1/4"	±1/4" in 10'	±1/4" in 10'
Bow (length and width)	NA	NA	NA	NA	NA	NA	±1/4" per 10'

1. Prestressed and nonstressed wall panels (tie back, C-wall, sound wall, etc.) except MSE wall panels.
2. Maximum length as approved.
3. Measured along the panel depth at the top and bottom panel sides.
4. Voided box beams only.
5. Length of box beam internal void form +1", −6".
6. For draped strands, the tolerance for vertical position of strands at the end of the beam may be increased to ±1/2" provided the tested concrete compressive strength, before release of tension into the member, is at least 5% greater than the release-of-tension strength shown on the Design Documents.
7. Measured from bottom of panel.
8. 3/4 in. max for beams exceeding a height of 54 in.

4.3.2.2. **Nonstressed Members**. The allowable tolerances for nonstressed members are as specified in Table 4. The allowable tolerances for nonstressed wall panels, except MSE wall panels, are as specified in Table 3.

Table 4

Allowable Tolerances for Nonstressed Members

Member	Dimension	Tolerance
MSE wall panels and wall components[1] (coping, posts, etc.)	All dimensions (including deviation from edge straightness)	±3/16 in.
	Deviation of ends (horizontal skew)	±1/4 in. in 5 ft., ±1/2 in. max.
	Local flatness of formed surfaces	±1/8 in. in 5 ft.
	Connection hardware	±1/2 in.

1. Includes wall components for tie-back walls, C-walls, sound walls, etc.

4.4. **Storage and Handling.** Mark members for identification immediately after form removal as shown on approved shop drawings in accordance with the requirements of the pertinent Items. Do not change any identification markings or transfer material to other projects. Inspect members immediately before shipping to the jobsite for damage that may have occurred in storage. Store and handle prestressed and nonstressed members in accordance with Item 425, "Precast Prestressed Concrete Structural Members."

Item 425

17. Precast Prestressed Concrete Structural Members

1. DESCRIPTION

Furnish and erect precast prestressed concrete members fabricated by pre-tensioning, post-tensioning, or a combination of the two.

2. MATERIALS

Use materials that meet requirements of the following Items.

- Item 420, “Concrete Substructures”
- Item 421, “Hydraulic Cement Concrete”
- Item 426, “Post-Tensioning”
- Item 427, “Surface Finishes for Concrete”
- Item 434, “Bridge Bearings”
- Item 440, “Reinforcement for Concrete”
- Item 442, “Metal For Structures”
- Item 445, “Galvanizing”
- Item 448, “Structural Field Welding”
- DMS-4650, “Hydraulic Cement Concrete Curing Materials and Evaporation Retardants”
- DMS-7300, “Precast Concrete Fabrication Plants”

3. CONSTRUCTION

Fabricate precast prestressed concrete members in accordance with Item 424, “Precast Concrete Structural Members (Fabrication).” Fabricate railroad structures in accordance with the latest AREMA *Manual for Railway Engineering* and Item 424, “Precast Concrete Structural Members (Fabrication).” In the case of a conflict between the AREMA manual and Item 424, “Precast Concrete Structural Members (Fabrication),” the more stringent requirements apply.

3.149. **Handling, Storing, Hauling, and Erection.** Properly handle, store, haul, and erect all members so that they are placed in the structure in a manner to avoid excessive bending stresses and without damage. Lift members with approved lifting devices as shown on the shop drawings.

Maintain beams in an upright position at all times, and raise and support them near the ends to prevent torsion unless approved on shop or erection drawings.

Do not move members from the casting yard until all requirements of the pertinent Items have been met. Haul beams to the Project site after at least 7 Days have elapsed since casting.

The storage area must be clean and well drained. Prevent excessive or differential settlement of members by storing them on:

- stable ground and
- dunnage of sufficient size, shape, and strength to prevent crushing.

Place dunnage a distance no more than 3% of the beam length from the beam ends. When approved, cantilever beams may be supported at locations other than near the ends. Support concrete box beams and U-beams under the solid end block area during handling, storage, hauling, and erection.

Separate members with blocking arranged in vertical planes that will not crush under load when members are stacked. Stack members so lifting devices are accessible and undamaged. Use dunnage or blocking material that will not damage or stain the required finish.

Rearrange improperly stored members and inspect them for damage. Members that are improperly stored and become cracked, warped, or otherwise damaged in storage may be rejected.

Securely tie or brace all beams during erection in accordance with minimum erection and bracing standards. Protect traffic 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 when railroad or roadway traffic must be maintained beneath beams already placed. Protect traffic with nets or flooring with openings not larger than 1 in.

Fit mating surfaces to prevent excessive grout leakage when erecting precast prestressed concrete bridge deck panels. Fill the joint with grout or seal it with an acceptable caulking compound before placing the cast-in-place portion of the slab if such fit is not provided.

Finish surfaces of beams or other members after slab placement in accordance with Item 420.4.13., “Ordinary Surface Finish,” and Item 427, “Surface Finishes for Concrete.”

Correct beam discrepancies including, but not limited to horizontal misalignment or variations in vertical camber, to achieve a satisfactory completed structure. Correction may require replacement of the member.

Item 426

18. Post-Tensioning

1. DESCRIPTION

Furnish, store, and handle post-tensioning materials and perform post-tensioning of cast-in-place and precast structural units.

2. MATERIALS

Furnish materials that meet requirements of the most current versions of the following documents: Post-Tensioning Institute's *Guide Specification for Grouted Post-Tensioning* (PTI/ASBI M50) and Post-Tensioning Institute's *Specification for Grouting of Post-Tensioned Structures* (PTI M55).

2.1. **Prestressing Steel.** Furnish prestressing steel strand conforming to one of the following types:

- Seven-wire steel strand meeting DMS-4500, "Steel Strand, Uncoated Seven-Wire Stress Relieved and Low Relaxation for Prestressed Concrete," or
- Grade 150, high strength, coarse thread bars meeting ASTM A722.

2.2. **Post-Tensioning System.** Furnish a post-tensioning system following the minimum requirements for Protection Level 2 (PL-2) in accordance with PTI/ASBI M50. Prequalify post-tensioning systems using tests on complete tendons for compliance with the requirements of PTI/ASBI M50.

The following exceptions apply:

- The embedded parts of the anchorage are not required to be galvanized or epoxy coated,.
- Provide pre-packaged grouts in accordance with DMS-4670, "Grouts for Post-Tensioning" and Class C grout per PTI M55. Do not use grouts that exceed the manufacturers' recommend shelf life or 6 months, whichever is less.
- Provide unbonded single strand tendons in accordance with PTI M10.2-00: "Specification for Unbonded Single Strand Tendons."

3. EQUIPMENT

3.1. **Stressing Equipment.** Provide hydraulic jacks, pressure gauges, and other stressing equipment that meets PTI/ASBI M50.

3.2. **Grouting Equipment.** Provide grout mixing, testing, and pumping equipment that meets PTI M55.

4. CONSTRUCTION

The requirements of Item 420, "Concrete Substructures" and Item 422, "Concrete Superstructure" shall govern for cast-in-place construction. Item 424, "Precast Concrete Structural Members (Fabrication)," shall govern for precast concrete units or members.

4.1. **Qualifications of Personnel.** Perform all Work for post-tensioning, including duct and hardware installation, strand insertion, and tendon or bar stressing, under the direct supervision of an individual certified as a PTI Level 2 Bonded PT Field Specialist. Perform all grouting operations under the direct supervision of an individual who has received a Grouting Technician Certification from the American Segmental Bridge Institute (ASBI).

4.2. **Required Submittals.** Submit information required in this Section for post-tensioned Elements, in addition to forming and falsework Construction Documents required by Item 420, "Concrete Substructures" and Item 424, "Precast Concrete Structural Members (Fabrication)." Include all necessary construction information in these submittals for cast-in-place and precast construction including, but not limited to the information required in this Section.

4.3. **Design Calculations.** Provide design procedures, coefficients, allowable stresses, tendon spacing, and clearances in accordance with the AASHTO *LRFD Bridge Design Specifications* and PTI/ASBI M50. Submit sufficient calculations to support the proposed system and method of post-tensioning including friction loss diagrams. When the required jacking force for a particular type of tendon, duct, and configuration is furnished on the Design Documents, design calculations are not required except to adjust for conditions different from those shown on the Design Documents.

4.3.1. **Post-Tensioning Details**. Provide drawings with details that meet the requirements of PTI/ASBI M50 and this specification.

4.3.2. **Grouting Plan**. Submit for approval written grouting procedures at least 4 weeks before the start of the Element's construction. Include items required by PTI M55.

Include the names of people responsible for PT installation and grouting operations, with the foreman of each grouting crew certified as a PTI Level 2 Bonded PT Field Specialist and ASBI Certified Grouting Technician.

4.4. **Packaging, Storing, and Handling of Post-Tensioning Components.** Package, store, and handle post-tensioning steel, grout, duct, and other accessories in accordance with PTI/ASBI M50 and PTI M55. Acceptance and rejection criteria for strand shall follow PTI/ASBI M50 and PTI M55.

The following exceptions apply:

- Grout storage onsite shall be limited to 30 Days.
- Install grout caps and ensure vents are closed at all times so that water and other contaminants cannot enter the duct before strand installation.
- Do not flush ducts at any time.

4.5. **Duct and Prestressing Steel Installation for Post-Tensioning.** Follow PTI/ASBI M50 for duct and prestressing steel installation procedures and requirements. Verify that concrete strength requirements on the Design Documents are met for stressing and staged loading of post-tensioned structural Elements.

Stress the tendons within 7 Days of installing the strand in the ducts. Follow the tensioning procedure noted in the approved post-tensioning details.

4.6. **Grouting.** Grout in accordance with PTI M55.

Grout within 14 Days of tendon stressing. Obtain approval to extend the grouting time before stressing tendons.

Do not allow the grout temperature to exceed 85°F during mixing and pumping. Do not grout when the ambient temperature is below 35°F. Field-test the grout in accordance with Table 1 during grout installation. Perform field-testing by trained personnel while witnessed by TxDOT. Pump at the lowest pressure possible that will maintain a continuous flow of grout.

Table 1

Requirements for Field-Testing of Grout

Test	Frequency	Requirement
Schupak Pressure Bleed Test (ASTM C1741)	1 per Day	per DMS-4670
Fluidity test (Tex-437-A, Method 2)	2 every 2 hr. 2 min. per Day	per DMS-4670
Compressive Strength test (3" × 6" cylinders)	1 per Day	per DMS-4670
Mud Balance test (Tex-130-E Part II)[1]	2 per Day	per DMS-4670

Take one sample from the mixer and one sample from the farthest duct outlet.

Item 427

19. Surface Finishes for Concrete

1. DESCRIPTION

Finish concrete surface as specified.

2. MATERIALS

Furnish materials in accordance with this Article for the type of surface finish specified.

2.1. **Coatings.**

2.1.1. **Adhesive Grout and Concrete Paint**. Provide coatings in accordance with DMS-8110, "Coatings for Concrete." Match color of coating with Federal Standard 595B color 35630, concrete gray.

2.1.2. **Opaque Sealer**. Provide penetrating-type sealer in accordance with DMS-8110, "Coatings for Concrete." Match color of coating with Federal Standard 595B color 35630, concrete gray.

2.1.3. **Silicone-Based Paint**. Provide silicone resin emulsion paint (SREP) meeting the requirements of DMS-8141, "Paint, Silicon Resin for Concrete." Match color of coating with Federal Standard 595C color 35630, concrete gray.

2.2. **Exposed Aggregate Finish.** Provide approved aggregates meeting the grading requirements shown on the Design Documents. Provide gravel consisting of predominantly rounded particles. Use crushed stone when a bush-hammered finish is desired. Provide a concrete surface retardant. Provide clear Type II permanent anti-graffiti coating in accordance with DMS-8111, "Anti-Graffiti Coatings."

3. EQUIPMENT

TxDOT may require demonstration of the equipment's capabilities.

3.1. **Low-Pressure Water Blasting.** Use equipment capable of supplying a minimum pressure at the nozzle end of 3,000 psi at a minimum flow rate of 3 gpm. Use a 0° rotary, vibratory, or wobble-type nozzle. Use equipment capable of including abrasives in the water stream when specified on the Design Documents.

3.2. **Abrasive Blasting.** Use equipment with filters to produce oil-free air and also water-free air when dry air is required.

3.3. **Slurry Blasting.** Use equipment capable of combining air and abrasives with water to form a wet blast media capable of cleaning and preparing surface without creating dust.

3.4. **Spraying.** Use equipment with fluid and air pressure regulators and gauges to allow for adjustment to produce a uniform spray pattern for spray applications.

3.5. **Off-the-Form Finish Forms.** Use nonstaining, nonporous, high-quality forming materials (e.g., steel or medium-density and high-density overlaid plywood forms). Use steel or high-density overlaid plywood forms when the same form will be used more than twice.

3.6. **Form Liners.** Provide form liners capable of producing a patterned finish as shown on the Design Documents. Use form liners that provide a clean release from the concrete surface without pulling or breaking the textured concrete.

4. CONSTRUCTION

Provide the finish specified on the Design Documents for the specific surface areas.

4.1. **Surface Areas of Finish.** "Surface area of finish" designates the areas where the specified surface is to be applied.

4.1.1. **Surface Area I**:

- surfaces of railing;
- exterior vertical faces of fascia beams, slabs, slab spans, arches, and box girders;
- the outside bottom surface of fascia beams and girders;
- the underside of overhanging slabs to the point of juncture of the supporting beam;
- the entire underside of slab spans when shown on the Design Documents;
- vertical and underside surfaces of bents and piers;
- all surfaces of tie beams, abutments, bridge wingwalls, culvert headwalls, wingwalls, and retaining walls exposed to view after all backfill and embankment is placed; and
- all other exposed surfaces shown on the Design Documents to require surface treatment.

4.1.2. **Surface Area II**: Surfaces of railing, all wingwalls, and the exterior vertical faces of slabs.

4.1.3. **Surface Area III**: Only the top and roadway faces of all concrete railing and bridge wingwalls.

4.1.4. **Surface Area IV**: Areas designated on the Design Documents.

4.2. **Coatings. Apply the coating specified on the Design Documents.**

4.2.1. **Preparation**. Clean the surface thoroughly before applying a coating by chemical cleaning, if required, and by blast cleaning.

Submit a containment plan that details the procedures proposed to keep public property, private property, and the environment from being adversely affected by the cleaning and painting operations. Do not discharge washwater into body of water or conveyance without TCEQ approval. Collect and properly dispose of any paint or debris dislodged as a result of cleaning operations.

4.2.1.1. **Chemical Cleaning**. Clean surfaces contaminated with oil, grease, or other contaminants by scrubbing the area with an approved detergent or other concrete cleaning material before blast cleaning. Do not use a solvent that will stain the surface or inhibit coating adhesion. Perform the following test to check for surface contamination of oil type materials:

- Spray the surface with a fine mist of potable water.
- Examine the area to see if water beads up.
- Clean the surface if beading is found.

4.2.1.2. **Blast Cleaning**. Blast clean the designated surface to remove weak surface material, curing compound, and other contaminants before applying a specified coating, leaving a lightly etched uniformly textured surface. Use an approved abrasive propelled by oil-free air with or without the addition of potable water, or blast with potable water with or without the addition of an approved abrasive at sufficient pressure to effectively clean and prepare the surface. Maintain the stand-off-distance of the nozzle to a maximum of 12 in. from the surface being cleaned when water blasting.

Do not damage concrete surface by gouging, spalling, or exposing coarse aggregate by the blasting operation.

Blow clean oil- and moisture-free air on all surfaces with sufficient pressure to remove loose particles immediately before application of any coating. Perform the following test to check for surface cleanliness:

- Press a 10 in. long strip of 2 in. wide clear packing tape on the surface by rubbing with moderate pressure.
- Grasp the free end of the tape, and remove the tape from the surface with a sharp jerk.
- Examine the surface of the tape for clinging particles.

Continue cleaning the concrete surface until there are no particles clinging to the tape surface for subsequent tests. An additional test that can be used to check the surface for dust is to wipe the surface with a dark cloth and then examine the cloth for discoloration.

4.2.2. **Application**. Mix coating materials thoroughly with a mechanical mixer at a speed that causes the mixture to rotate entirely in the container. Ensure complete mixing by probing the container with a stirring device searching for non-dispersed or settled material.

Apply coatings once the new concrete has aged a minimum of 28 Days except for the adhesive grout coating. Do not apply coatings when weather conditions will be detrimental to the final surface finish as determined by TxDOT. Do not apply coatings when surface temperature of the concrete exceeds 95°F.

Apply coatings to obtain a consistent color and texture.

4.2.2.1. **Adhesive Grout**. Apply coating on a moistened surface to a uniform minimum thickness of 1/16 in. Apply when ambient temperature is at least 50°F.

4.2.2.2. **Concrete Paint**. Apply the coating on a dry surface in 2 coats for a total maximum application rate of 150 sq. ft. per gallon. Match the color of the applied coating with the color standard shown on the Design Documents. Do not thin material. Apply when ambient temperature is between 50°F and 100°F.

4.2.2.3. **Opaque Sealer**. Apply the coating to a dry surface in 2 coats for a total maximum application rate of 200 sq. ft. per gallon. Match the color of the applied coating with the approved color standard shown on the Design Documents. Do not thin the material. Apply when ambient temperature is between 40°F and 100°F.

4.2.2.4. **Silicone Resin Paint**. Apply the coating on a dry surface in 2 coats at a rate not exceeding 299 sq. ft. per gallon per coat. Do not thin the material. Wait a minimum of 12 hr. between coats. Apply when ambient temperature is between 50°F and 95°F.

Repair surface finish where coating has been applied that exhibits peeling, flaking, or discoloration or has been damaged during construction. Remove defective or damaged coating. Clean and recoat repair area in accordance with the requirements of this Item.

4.3. **Special Surface Finishes.** Submit a Work plan for any special finish shown on the Design Documents. Include in the Work plan the type of aggregates, materials, variation of panel or pattern arrangement, dimensions, construction methods, and other features affecting the Work as is necessary for the "Special Surface Finish" specified.

4.3.1. **Blast Finish**. Provide surface profile as shown on the Design Documents, or meet the minimum requirements of Item 427.4.2.1., "Preparation." Construct a 4 × 4 ft. sample panel using the same concrete used in construction of the member to receive the blast finish. Prepare the surface of the sample panel to meet the specified finish, and obtain approval of the sample finish. Use the approved sample panel finish as the standard for surfaces requiring a blast finish.

4.3.2. **Slurry Coat Finish**. Provide cementitious slurry coat finish to concrete surfaces within 14 Days of placing concrete or later as approved. Water blast surface to moisten surface before application when application of slurry coat occurs more than 14 Days after placing concrete. Do not apply slurry coat finish to surfaces receiving another type coating finish.

Submit for approval proposed slurry recipe including cement, latex concrete additive, with or without sand, and other additives before application. Tint mixture of slurry as specified on the Design Documents. Maintain consistent slurry throughout Project only modifying recipe to account for color variations being noticed as Work progresses.

Rub in slurry with carborundum stone, stiff bristle brush, or other approved device. Limit thickness of applied slurry to a maximum of 1/16 in. thick. Demonstrate application methods for slurry coat and obtain approval of proposed surface. Apply slurry coat to obtain a tightly adhering cementitious finish to concrete surface. Remove material and reapply if slurry coat is not tightly adhering or is cracked.

4.3.3. **Rub Finish**. Provide a finish to the surface by rubbing the surface with a carborundum stone or other approved material. Begin rubbing the surface immediately after forms have been removed. Provide blast finish or other finish if rubbing surface is delayed to the point where the surface is dry and unable to be rubbed to produce an acceptable finish. Perform the requirements to obtain the ordinary surface finish specified in Item 420.4.13., "Ordinary Surface Finish," concurrently with rubbing the surface. Rub concrete-patching areas after the patch material has thoroughly set and blend the patch in with the surrounding area to produce a surface with uniform color and texture where concrete patching is performed.

Keep the surface continuously wet after form removal until the rubbing is complete. Rub the surface sufficiently to bring the wetted concrete surface to a paste producing a smooth dense surface without pits, form marks, or other irregularities. Do not use cement grout to form the paste on the surface. Stripe the surface with a brush to conceal the rubbing pattern and allow the paste to reset. Wash the concrete with potable water after the paste has sufficiently set to leave it with a neat and uniform appearance and texture. Apply membrane curing, if required, in accordance with Item 420, "Concrete Substructures," after rubbing is complete.

4.3.4. **Off-the-Form Finish**. Provide a finish with minimal surface defects and uniform color and texture by using non-staining, non-porous, high-quality forming materials. Use the same type of forming materials for like Elements for the entire structure.

Use mortar-tight forms to prevent leakage and discoloration. Seal joints with compressible gasket material, caulk, tape, or by other suitable means that are not detrimental to the concrete finish if necessary. Use one brand and type of form-release agents for all surfaces. Do not use barrier-type (wax, fuel oil, carrier oil, etc.) release agents. Use form-release agents containing a rust inhibitor on steel forms. Clean rust off steel forms before use. Use plywood that will not cause discoloration of the concrete surface.

Direct special attention to consolidation and vibration of the concrete around the form surfaces to minimize bug holes. Modify concrete placement and vibration techniques if surface contains an excessive amount of bug holes. Remove all forms without interruption once form removal begins to prevent discoloration due to differing form curing times.

Do not use membrane curing on surfaces with off-the-form finish.

Repair honeycombed and spall areas with least dimension larger than 2 in. in accordance with the concrete surface repair procedures outlined in Item 420, “Concrete Substructures,” to obtain an ordinary surface finish as defined in Item 420.4.13., “Ordinary Surface Finish.” Patch honeycombed and spall areas with least dimension greater than 3/4 in. but smaller than 2 in. by filling defect with repair material omitting the chipping operation. Do not patch honeycombed and spall areas with least dimension smaller than 3/4 in. Perform required repairs as soon as forms are removed. Match repair material color and texture with surrounding concrete surfaces. Minimize the area of repair by not smearing the repair material over acceptable concrete surfaces in an attempt to blend the repair with the surrounding concrete. Cut out form ties at least 1/2 in. below the surface, and patch accordingly. Perform repair Work as soon as possible after removing forms so that concrete and repair material have similar ages. Replace or refurbish the forms when TxDOT determines defective formwork is causing an excessive amount of repair Work.

4.3.5. **Form Liner Finish**. Provide patterned finish as shown on the Design Documents. Do not splice form liner panels in a way that causes a noticeable transition or line between pieces. Wash and clean form liners after each use when the forms can be reused. Replace form liners that have become damaged or worn.

Construct a sample panel for each form liner finish. Approval is required to verify the sample panel meets the requirements of the Design Documents and specifications before beginning Work. Upon approval, the sample panel becomes the model panel that all other Work shall be compared against. Deviation in color, grade, or depth from the model panel is grounds for rejection of the form liner finish. Removal of defective Work may be necessary as determined by TxDOT and in accordance with the surface finish requirements outlined in Item 420, “Concrete Substructures,” to obtain an ordinary surface finish as defined in Item 420.4.13., “Ordinary Surface Finish.”

Seal all form liner joints to prevent leakage at the surface.

4.3.6. **Exposed Aggregate Finish**. Provide exposed aggregate finish as indicated on the Design Documents. Provide a depth of finish between 3/8 in. and 1/2 in..

Apply a concrete surface retarder that penetrates approximately 1/4 in. into the forms or concrete surface to help achieve the desired finish. Apply 2 or 3 coats to wood forms to account for absorption if necessary. Tape or caulk form joints to prevent escape of the retarder during

the placing operations. Protect the form surfaces from sun and rain while exposed to the atmosphere. Re-treat form surfaces with retarder if disturbed. Protect adjacent areas of concrete not requiring exposed aggregate finish from the retarder.

Remove forms 12 to 15 hr. after concrete placement but not before concrete has gained sufficient strength to support the self-weight of the member. Expose the aggregate for the finish immediately after form removal. Remove the grout paste covering the aggregate to be exposed by an approved method. Do not loosen the aggregate by the grout removal operation. Maintain required curing on all surfaces except for the time while the aggregate is being exposed. Cure using wet mats or membrane after the aggregate is exposed.

Repair defective areas as determined by TxDOT.

Re-clean exposed aggregate surfaces by an approved method. Apply a coat of clear Type II permanent anti-graffiti coating to cleaned exposed aggregate surface. Apply anti-graffiti coatings by spray, roller, or brush at the application rates recommended by the manufacturer.

Item 428

20. Penetrating Concrete Surface Treatment

1. DESCRIPTION

Prepare surface and apply a penetrating sealant treatment to concrete surfaces.

2. MATERIALS

Provide penetrating surface treatment in accordance with DMS-8140, "Concrete Surface Treatment (Penetrating)."

3. CONSTRUCTION METHODS

Apply surface treatment to locations shown on the Design Documents. Treat the upper surfaces of the roadway slab (including direct traffic culverts), bridge sidewalks and medians, the inside faces of curbs, and concrete rails for bridge decks. Do not treat surfaces given a higher finish as defined in Item 427, "Surface Finishes for Concrete.".

Refer to the manufacturer's specifications for instruction on the use of the treatment material in addition to the requirements of this Item.

Clean the concrete surfaces using shot or abrasive blasting followed by vacuuming and air blasting as needed, to remove all visible curing compound, oils, and any other contaminants that retard or prevent penetration of the mixture before treatment application. Additionally, roughen vertical and overhead steel formed surfaces that are smooth in appearance by abrasive blasting or other approved method. Completely remove all spent abrasive media. Demonstrate the method of cleaning before proceeding.

Do not damage the concrete surface to the point the coarse aggregate is exposed. Apply the treatment material after the entire cleaned surface has been accepted.

Apply the treatment material no sooner than 28 Days after casting the concrete.

Delay the treatment to concrete riding surfaces requiring mechanical grinding or grooving until approved to proceed.

Apply treatment material to a dry surface no sooner than 24 hours after any water has reached the concrete surface. Apply treatment material when surface temperature is between 40°F and 100°F.

Do not dilute or alter the treatment material.

Apply the treatment material at a rate of 100 sq. ft. of surface area per gallon. Treat the upper side of horizontal and near-horizontal surfaces in 1 pass or coat. Treat the vertical and overhead surfaces in 2 passes or coats. Apply the first coat to fully saturate the surface and until refusal.

Allow the first coat to be absorbed, but do not allow the surface to completely dry before applying the second coat. Wait no longer than 1 hr. for application of the second coat.

Use a spray applicator equipped with a spray bar to apply the treatment material to deck surfaces.

Apply the treatment material at a uniform rate, covering the entire surface being treated.

Follow the treatment material manufacturer's specifications regarding required lapse time before traffic is permitted on the treated surface.

Item 429

21. Concrete Structure Repair

1. DESCRIPTION

Remove and repair unsound, delaminated, or spalled concrete.

2. MATERIALS

Submit all proposed repair materials for approval. Provide materials as outlined in the TxDOT *Concrete Repair Manual* and in accordance with the requirements of the following Items.

- Item 421, "Hydraulic Cement Concrete"
- Item 431, "Pneumatically Placed Concrete"
- Item 440, "Reinforcement for Concrete"
- DMS-4655, "Concrete Repair Materials"
- DMS-6100, "Epoxies and Adhesives"

2.1. **Concrete Repair Materials.** Provide repair materials suitable for the appropriate horizontal, vertical, or overhead application meeting the requirements in DMS-4655, "Concrete Repair Materials." Use Type A materials when rapid strength gain is necessary and Type C (non-rapid) materials for standard concrete repairs. Use Type B ultra-rapid hardening materials only if indicated on the Design Documents. Prepackaged repair materials not meeting the requirements of DMS-4655, "Concrete Repair Materials," or not on TxDOT's list of pre-approved materials may be used only with approval. Repair corrosion-induced spalls using materials that do not contain corrosion inhibitors. TxDOT may disallow any product based on its structural compatibility or appearance.

2.2. **Pneumatically Applied Materials.** Pneumatically applied concrete or mortar may be used, if approved, for any repair thickness. Provide and place pneumatically applied concrete in accordance with Item 431, "Pneumatically Placed Concrete." Prepare trial batches of any proposed repair material and application method.

2.3. **Epoxy Mortars.** Use Type VIII neat epoxy or epoxy mortar per DMS-6100, "Epoxies and Adhesives," for repairs less than 1 in. thick.

2.4. **Concrete.** Provide Class C concrete for substructures, Class S concrete for decks, or concrete of the specified design strength as follows:

- as an option for vertical/overhead repairs greater than 6 in. thick;
- for full or partial depth slab repairs;
- for replacement of entire members or Elements;
- as an option for horizontal repairs greater than 4 in. thick.

Submit a mix design for approval in accordance with Item 421, "Hydraulic Cement Concrete." Include all pertinent information on admixtures. Do not use corrosion-inhibiting admixtures.

2.5. **Steel.** Provide steel pins, studs, or expansion bolts with a minimum diameter of 1/8 in. and a minimum length of 2 in. to attach reinforcement at the locations shown on the Design Documents. Provide reinforcing steel, either welded wire fabric or reinforcing bars, as required by this Item.

3. CONSTRUCTION METHODS

Follow the procedures outlined in the TxDOT *Concrete Repair Manual*. Developer may propose alternate repair methods for review and approval before commencing Work.

Submit for approval all materials and methods of application at least 3 weeks before beginning any repair Work.

Repair locations shall be indicated on the Design Documents.

3.1. **Crack Repair.** Repair cracks.

3.2. **Repair of Defective Work.** Repair or replace defective areas and patched areas that have debonded after completion of curing.

Item 431

22. Pneumatically Placed Concrete

1. DESCRIPTION

Furnish and place pneumatically applied concrete for the construction of portions of structures, repairing concrete structures, encasement of structural steel members, lining ditches and tunnels, soil-nail walls, retaining walls, and other Work as shown on the Design Documents.

2. MATERIALS

Provide pre-bagged concrete materials for concrete structure repair and class of concrete shown on the Design Documents for other Work.

Submit pre-bagged materials information for approval. Material testing may be required before approval and installation test panels shall be required in accordance with Item 431.2.4., "Proportioning and Mixing."

Provide materials in accordance with the pertinent requirements of the following Items with the exceptions noted in Items 431.2.1., "Exceptions to Item 421, 'Hydraulic Cement Concrete,'" Item 431.2.2., "Exceptions to Item 440, 'Reinforcement for Concrete,'" and Item 431.2.3., "Exception to DMS-6310, 'Joint Sealants and Fillers.'"

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"
- DMS-4655, "Concrete Repair Materials"
- DMS-6310, "Joint Sealants and Fillers"

2.1. **Exceptions to Item 421, "Hydraulic Cement Concrete."** Provide a fine aggregate that meets the requirements of Item 421, "Hydraulic Cement Concrete," Table 4, Grade 1, and a coarse aggregate that meets the requirements of Item 421, "Hydraulic Cement Concrete," Table 3, Grade 7.

2.2. **Exceptions to Item 440, "Reinforcement for Concrete."** Provide mushroom headed steel anchors or expansion anchor hook bolts with a minimum diameter of 1/8 in. and a minimum length of 2 in. to attach reinforcement for the repair of concrete structures as shown on the Design Documents. Reinforcing steel may be either welded wire fabric or reinforcing bars.

2.3. **Exception to DMS-6310, "Joint Sealants and Fillers."** Provide a preformed bituminous fiber material.

2.4. **Proportioning and Mixing.** Submit for approval a proposed mix design conforming to the basic mix design requirements provided in Table 1.

Table 1

Classes of Concrete

Class	Ratio of Cement to Total Aggregate[1]	Minimum 7-Day Compressive Strength (psi)[2]
I	1:4	3,000
II	1:5	2,500

More cement may be used when approved.

Higher minimum strengths may be specified.

Measure the cement and aggregates by volume and mix with enough water to achieve the desired consistency. Use as little water as possible to achieve sufficient adhesion. Mix concrete sufficiently dry so it will not sag or fall from vertical or inclined surfaces or separate in horizontal Work.

Prepare test panels using the same air pressure, nozzle tip, and position to be used for the production Work to verify the mix design before approval. Apply a 3 in. layer of concrete to a plywood sheet with minimum dimensions of 18 in. × 18 in. for each test panel. Cure the test panels in the same manner as the proposed Work.

Take three cores, each 2 in. in diameter, out of each test panel and test in compression at seven Days in accordance with Tex-424-A. The mix design will be approved when the average strength of the three cores conforms to the strengths shown in Table 1. Provide additional test panels if there are any changes in materials, equipment, or nozzle operator during the Work.

3. CONSTRUCTION

3.1. **Qualification.** Provide experienced personnel able to produce concrete satisfying plan requirements and of uniform quality as required. Provide documentation of nozzle operator's qualification for the process proposed and orientation of the application meeting the minimum requirements when shown on the Design Documents.

Demonstrate nozzle operator's abilities by constructing test panels before commencement of Work. Orient test panels to match application direction of placement. Include reinforcing steel in the test panel with similar spacing as in member. Qualification test panels may be used for mix verification in accordance with Item 431.2.4., "Proportioning and Mixing."

3.2. **Surface Preparation.** Grade the area of proposed Work accurately to the elevation and dimensions shown on the Design Documents when concrete is to be placed against soil. Compact with sufficient moisture to provide a firm foundation and to prevent absorption of water from the concrete but without free surface moisture.

Remove paint, rust, loose mill scale, grease or oil, and all other foreign materials that may reduce the bond of the concrete to the steel when concrete is used to encase structural steel members.

Remove all deteriorated or loose material by chipping with pneumatic, electric, or hand tools when concrete is placed against concrete or rock. Cut square or slightly undercut shoulders

approximately 1 in. deep along the perimeter of repair areas. Sandblast the surface to clean all rust from exposed reinforcing steel and to produce a clean rough-textured surface on the concrete or rock. Wet the surface against which the concrete will be placed for at least 1 hour with potable water. Place the concrete when the surface has dried to a saturated surface-dry (SSD) condition. Achieve SSD conditions by high-pressure water blasting 15 to 30 min. before placing the repair material, soaking a minimum of 12 hr., or by other approved methods. An SSD condition is achieved when the surface remains damp when exposed to sunlight for 15 min.

Provide joints, side forms, headers, and shooting strips for backing or paneling. Use ground or gauging wires where necessary to establish thickness, surface planes, and finish lines.

3.3. **Reinforcement.** Place and secure reinforcement to ensure there is no displacement from impact of applying pneumatically placed concrete. Place reinforcing bars at a spacing not less than 2-1/2 in. Support reinforcing wire fabric or bars using mushroom headed anchors, expansion hook bolts, or grouted rebar capable of resisting a pullout force of 2,500 lb. Space anchors no more than 12 in. center-to-center on overhead surfaces, 18 in. center-to-center on vertical surfaces, and 36 in. center-to-center on top horizontal surfaces. Use at least 3 anchors in each individual patch area. Do not use explosive force to shoot anchors into concrete. Check the resistance to pullout of the reinforcing anchors when directed. Notify TxDOT before installation of the anchors. Locate anchors so there is no damage to prestressing tendons or conduits embedded in the concrete.

Use reinforcement when performing repair Work in all areas where the thickness of the concrete will exceed 1-1/2 in. Use a single layer of either 2 × 2 – W1.2 × W1.2 or 3 × 3 –W1.5 × W1.5 of welded wire fabric, or approved equivalent. Use a single layer of wire fabric to reinforce each 4 in. thickness of patch or fractional part in areas where the concrete thickness exceeds 4 in. Encase completely each layer of wire fabric in concrete that has taken its initial set before installing the succeeding layer of wire fabric. Place the reinforcing fabric parallel to the finished surface, and support it so it will be at least 3/4 in. out from the surface to be covered. Provide at least 1 in. clearance between the finished concrete surface and all steel items including anchors, reinforcing bars, and wire fabric. Lap adjacent fabric sheets at least 6 in. and tie together securely at a spacing of no more than 18 in. Pre-bend fabric before installing to fit around corners and into re-entrant angles.

Pre-bend the welded wire fabric for encasement of steel members using a template to conform as nearly as possible to the outlines of the members to be encased. Drill holes between 1/2 and 1 in. in diameter in the webs of the members as close as possible to the flanges to allow for attachment of the reinforcing fabric. Space these holes at approximately 3 ft. on center. Use 3/8-in. diameter rods placed through these holes to secure the reinforcing fabric. Hold the reinforcing fabric at least 3/4 in. out from the surface of the steel member. Lap adjacent fabric sheets at least 6 in. and tie together at a spacing of no more than 12 in.

3.4. **Pneumatic Placement of Concrete.** Pneumatically applied concrete can be either dry-mix or wet-mix. The dry-mix process consists of dry-mixed fine aggregate and hydraulic cement to which water is added immediately before its pneumatic expulsion from a nozzle. The wet-mix process consists of mechanically premixed concrete pneumatically applied through a nozzle.

3.4.1. **General**. Place the concrete when the ambient temperature is above 35°F and rising and material temperature is between 50°F and 90°F for wet-mix and below 100°F for dry-mix. Do not place concrete against a surface containing frost, ice, or standing water. Protect concrete from freezing or quick drying after placement. Apply the concrete using pneumatic equipment that sprays the

mix onto the prepared surface at a velocity less than 100 ft. per second for construction of portions of structures, repairing concrete structures, or encasement of structural steel members. Minimize rebound and produce a compacted dense homogenous mass. Do not apply concrete if high winds will prevent proper application or if rain could wash out the concrete.

Hold the nozzle approximately 2 to 4 ft. from the surface and position it so the concrete impinges nearly at right angles to the surface being covered. Use shooting strips to ensure straight lines, square corners, and a plane surface of concrete. Place to keep the trapping of rebound to a minimum. Slope the concrete off to a thin edge at the end of each day's Work or at similar stopping periods requiring construction joint. Thoroughly clean and wet previously placed concrete before placing an adjacent or additional section. Apply a sufficient number of coats to obtain the required thickness. Place coats on vertical and overhead surfaces in layers of such thickness to prevent sloughing, sagging, tearing, or debonding. Provide a sufficient interval between successive layers in sloping, vertical, or overhead Work to allow initial but not final set. Clean the surface to remove the thin film of laitance to provide for a bond with succeeding applications. Remove rebound and accumulated loose sand from the surface to be covered before placing of the original or succeeding layers of concrete. Correct any sags or other defects to the proper section.

Place concrete to completely encase reinforcing steel. Encase reinforcing steel by shooting with sufficient velocity and plasticity that material flows around and behind reinforcement.

Apply the concrete using either the wet-mix or dry-mix process. Mix the materials thoroughly and uniformly using a paddle or drum type mixer designed for pneumatic application. Wet-mix process applications can use transit-mix concrete. Do not use the wet-mix process for repair of damaged concrete.

Clean mixing and placing equipment at regular intervals. Inspect the nozzle liner and water and air injection system daily; replace worn parts as necessary.

Do not reuse rebound or overspray concrete.

3.4.2. **Dry-Mix Process**. Use a compressor or blower capable of delivering a sufficient volume of oil-free air at the pressure shown in Table 2. Maintain steady pressure throughout the placing process.

Use a water pump with the size and capacity to deliver water to the nozzle with a pressure at least 15 psi more than the required air pressure.

The values shown in Table 2 are based on a hose length of 150 ft. with the nozzle less than 25 ft. above the delivery equipment. Increase operating pressure approximately 5 psi for each additional 50 ft. of hose and approximately 5 psi for each 25 ft. the nozzle is raised.

Table 2

Compressor Capacities

Compressor Capacity, CFM	Hose Diameter, in.	Maximum Size of Nozzle Tip, in.	Operating Air Pressure Available, psi
250	1	3/4	40

Compressor Capacity, CFM	Hose Diameter, in.	Maximum Size of Nozzle Tip, in.	Operating Air Pressure Available, psi
315	1-1/4	1	45
365	1-1/2	1-1/4	55
500	1-5/8	1-1/2	65
600	1-3/4	1-5/8	75
750	2	1-3/4	85

3.4.3. **Wet-Mix Process**. Operate the pump at a line pressure between 100 psi and 299 psi. Use delivery hoses between 1-1/2 in. and 3 in. in diameter. Use mixing equipment capable of thoroughly mixing the materials in sufficient quantity to maintain continuous placement.

3.5. **Construction Joints.** Use a square butt joint where the joint is subject to compressive stress or is over existing construction joints. Use tapered or square butt joints at other locations. Square the outside 1 in. of tapered joints perpendicular to the surface.

3.6. **Finish.** Use a sharp trowel to cut off all high spots after the concrete has been placed to the desired thickness or screed to a true plane as determined by shooting strips or by the original concrete surface. Lightly apply cutting screeds, where used, to all surfaces so as not to disturb the concrete for an appreciable depth. Work in an upward direction when concrete is applied on vertical surfaces. Give the finished concrete a final flash coat of about 1/8 in. Obtain a uniform appearance on all exposed surfaces.

3.7. **Curing.** Cure encasements with water for 4 Days. Cure repairs and structural construction using either a piece of wet burlap taped over the repaired area with a covering of 4-mil minimum plastic sheet also taped in place or membrane curing as approved. Overlap the burlap with the plastic sheet and continuously tape the edges with a tape at least 3 in. wide (air duct tape or better) to completely enclose the mat and hold in moisture. Cure in this manner for 4 Days. Curing is not required for soil-nail walls unless walls are the final exposed surfaces, which in this case, cure at least 4 Days in accordance with Item 420, “Concrete Substructures.” Apply membrane curing in accordance with Item 420.2.7., “Curing Materials” for tunnel and ditch linings and vertical or overhead patches as approved.

3.8. **Repair of Defects.** Repair or replace debonded areas.

Item 432

23. Riprap

1. DESCRIPTION

Furnish and place concrete, stone, cement-stabilized, or special riprap.

2. MATERIALS

Furnish materials in accordance with the following Items.

- Item 420, “Concrete Substructures”
- Item 421, “Hydraulic Cement Concrete”
- Item 431, “Pneumatically Placed Concrete”
- Item 440, “Reinforcement for Concrete”
- DMS-6200, “Filter Fabric”

2.1. **Concrete Riprap.** Use Class B Concrete.

2.2. **Pneumatically Placed Concrete Riprap.** Use Class II concrete that meets Item 431, “Pneumatically Placed Concrete.”

2.3. **Stone Riprap.** Use durable natural stone with a bulk specific gravity of at least 2.50 as determined by Tex-403-A. Provide stone that, when tested in accordance with Tex-411-A, has weight loss of no more than 18% after 5 cycles of magnesium sulfate solution and 14% after 5 cycles of sodium sulfate solution.

Perform a size verification test on the first 5,000 sq. yd. of finished riprap stone for all types of stone riprap. Test the riprap stone in accordance with ASTM D5519. Additional tests may be required. Place additional riprap once the initial 5,000 sq. yd. of riprap has been approved.

Provide grout or mortar in accordance with Item 421, “Hydraulic Cement Concrete,” when specified. Provide grout with a consistency that will flow into and fill all voids.

Provide filter fabric in accordance with DMS-6200, “Filter Fabric.” Provide Type 2 filter fabric for protection stone riprap. Provide Type 2 filter fabric for Type R, F, or Common stone riprap when shown on the Design Documents.

2.3.1. **Type R**. Use stones between 50 and 250 lb. with at least 50% of the stones heavier than 100 lb.

2.3.2. **Type F**. Use stones between 50 and 250 lb. with at least 40% of the stones heavier than 100 lb. Use stones with at least 1 broad flat surface.

2.3.3. **Common**. Use stones between 50 and 250 lb. Use stones that are at least 3 in. in their least dimension. Use stones that are at least twice as wide as they are thick. When shown on the Design Documents or approved, material may consist of broken concrete removed under the Contract or from other approved sources. Cut exposed reinforcement flush with all surfaces before placement of each piece of broken concrete.

2.3.4. **Protection**. Use boulders or quarried rock that meets the gradation requirements of Table 1. Both the width and the thickness of each piece of riprap must be at least 1/3 of the length. When shown on the Design Documents, material may consist of broken concrete removed under the Contract or from other approved sources. Cut exposed reinforcement flush with all surfaces before placement of each piece of broken concrete. Determine gradation of the finished, in-place, riprap stone in accordance with ASTM D5519.

Table 1

In-Place Protection Riprap Gradation Requirements

Size	Maximum Size (lb.)	90% Size[1] (lb.)	50% Size[2] (lb.)	8% Size[3] Minimum (lb.)
12 in.	200	80–180	30–75	3
15 in.	320	170–299	60–165	20
18 in.	530	290–475	105–220	22
21 in.	800	460–720	175–299	25
24 in.	1,000	550–850	200–325	30
30 in.	2,600	1,150–2,250	400–900	40

1. Defined as that size such that 10 percent of the total riprap stone, by weight, is larger and 90 percent is smaller.

2. Defined as that size such that 50 percent of the total riprap stone, by weight, is larger and 50 percent is smaller.

3. Defined as that size such that 92 percent of the total riprap stone, by weight, is larger and 8 percent is smaller.

TxDOT may require in-place verification of the stone size. Determine the in-place size of the riprap stone by taking linear transects along the riprap and measuring the intermediate axis of the stone at select intervals. Place a tape measure along the riprap and determine the intermediate axis size of the stone at 2 ft. intervals. Measure a minimum of 100 stones, either in a single transect or in multiple transects, then follow ASTM D5519 Test Procedure Part B to determine the gradation. Table 2 is a guide for comparing the stone size in inches to the stone weight shown in Table 1.

Table 2

Protection Riprap Stone Size[1]

Size	Dmax (in.)	D90 (in.)	D50 (in.)	D8 (in.)
12 in.	13.76	10.14–13.29	7.31–9.92	3.39
15 in.	16.10	13.04–15.75	9.21–12.91	6.39
18 in.	19.04	15.58–18.36	11.10–14.21	6.59
21 in.	21.85	18.17–21.09	13.16–15.75	6.88

24 in.	23.53	19.28–22.29	13.76–16.18	7.31
30 in.	32.36	24.65–30.84	17.34–22.72	8.05

1. Based on a Specific Gravity of 2.5 and using the following equation for the intermediate axis diameter $D = \{(12*W)/(Gs*62.4*0.85)\}^{1/3}$
where:
D = intermediate axis diameter in in.;
W = weight of stone in lbs.;
Gs = Specific Gravity of stone.
Note—If the Specific Gravity of the stone is different than 2.5, then the above equation can be used to determine the appropriate size using the actual Specific Gravity.

If required , provide bedding stone that, in-place, meets the gradation requirements shown in Table 3. Determine the size distribution in Table 3 in accordance with ASTM D6913.

Table 3

Protection Riprap Bedding Material Gradation Requirements

Sieve Size (Sq. Mesh)	% by Weight Passing
3 in.	100
1-1/2 in.	50–80
3/4 in.	20–60
No. 4	0–15
No. 10	0–5

2.4. **Cement-Stabilized Riprap.** Provide aggregate that meets Item 247, "Flexible Base," for the type and grade shown on Design Documents. Use cement-stabilized riprap with 7% hydraulic cement by dry weight of the aggregate.

2.5. **Special Riprap.** Furnish materials for special riprap according to the Design Documents.

3. CONSTRUCTION

Dress slopes and protected areas to the line and grade shown on the Design Documents before the placement of riprap. Place riprap and toe walls according to details and dimensions shown on the Design Documents.

3.1. **Concrete Riprap.** Reinforce concrete riprap with 6 × 6 – W2.9 × W2.9 welded wire fabric or with No. 3 or No. 4 reinforcing bars spaced at a maximum of 18 in. in each direction. Alternative styles of welded wire fabric that provide at least 0.058 sq. in. of steel per foot in both directions may be used if approved. A combination of welded wire fabric and reinforcing bars may be provided when both are permitted. Provide a minimum 6-in. lap at all splices. Provide horizontal cover of at least 1 in. and no more than 3 in. at the edge of the riprap. Place the first parallel bar no more than 6 in. from the edge of concrete. Use approved supports to hold the reinforcement approximately equidistant from the top and bottom surface of the slab. Adjust reinforcement during concrete placement to maintain correct position.

Sprinkle or sprinkle and consolidate the subgrade before the concrete is placed. All surfaces must be moist when concrete is placed.

Compact and shape the concrete once it has been placed to conform to the dimensions shown on Design Documents. Finish the surface with a wood float after it has set sufficiently to avoid slumping to secure a smooth surface or broom finish as approved.

Cure the riprap immediately after the finishing operation according to Item 420, "Concrete Substructures."

4.7. **Stone Riprap.** Provide the following types of stone riprap when shown on the Design Documents:

- **Dry Riprap**. Stone riprap with voids filled with only spalls or small stones.
- **Grouted Riprap**. Type R, F, or Common stone riprap with voids grouted after all the stones are in place.
- **Mortared Riprap**. Type F stone riprap laid and mortared as each stone is placed.

Use spalls and small stones lighter than 25 lb. to fill open joints and voids in stone riprap, and place to a tight fit.

Place mortar or grout only when the air temperature is above 35°F. Protect Work from rapid drying for at least 3 Days after placement.

Place filter fabric with the length running up and down the slope. Ensure fabric has a minimum overlap of 2 ft. Secure fabric with nails or pins. Use nails at least 2 in. long with washers or U-shaped pins with legs at least 9 in. long. Space nails or pins at a maximum of 10 ft. in each direction and 5 ft. along the seams. Alternative anchorage and spacing may be used when approved.

3.1.1. **Type R**. Construct riprap as shown in Figure 1 on the *Stone Riprap Standard* and as shown on the Design Documents. Place stones in a single layer with close joints so most of their weight is carried by the earth and not the adjacent stones. Place the upright axis of the stones at an angle of approximately 90° to the embankment slope. Place each course from the bottom of the embankment upward with the larger stones in the lower courses.

Fill open joints between stones with spalls. Place stones to create a uniform finished top surface. Do not exceed a 6-in. variation between the tops of adjacent stones. Replace, embed deeper, or chip away stones that project more than the allowable amount above the finished surface.

Prevent earth, sand, or foreign material from filling the spaces between the stones when the Design Documents require Type R stone riprap to be grouted. Wet the stones thoroughly after they are in place, fill the spaces between the stones with grout, and pack. Sweep the surface of the riprap with a stiff broom after grouting.

3.1.2. **Type F**.

3.1.2.1. **Dry Placement**. Construct riprap as shown in Figure 2 on the *Stone Riprap Standard*. Set the flat surface on a prepared horizontal earth bed, and overlap the underlying course to secure a lapped surface. Place the large stones first, roughly arranged in close contact. Fill the spaces between the large stones with suitably sized stones placed to leave the surface evenly stepped and conforming to the contour required. Place stone to drain water down the face of the slope.

3.1.2.2. **Grouting**. Construct riprap as shown in Figure 3 on the *Stone Riprap Standard*. Size, shape, and lay large flat-surfaced stones to produce an even surface with minimal voids. Place stones with the flat surface facing upward parallel to the slope. Place the largest stones near the base of the slope. Fill spaces between the larger stones with stones of suitable size, leaving the surface smooth, tight, and conforming to the contour required. Place the stones to create a plane surface with a variation no more than 6 in. in 10 ft. from true plane. Provide the same degree of accuracy for warped and curved surfaces. Prevent earth, sand, or foreign material from filling the spaces between the stones. Wet the stones thoroughly after they are in place, fill the spaces between them with grout, and pack. Sweep the surface with a stiff broom after grouting.

3.1.2.3. **Mortaring**. Construct riprap as shown in Figure 2 on the *Stone Riprap Standard*. Lap courses as described for dry placement. Wet the stones thoroughly before placing mortar. Bed the larger stones in fresh mortar as they are being place and shove adjacent stones into contact with one another. Spread excess mortar forced out during placement of the stones uniformly over them to fill all voids completely. Point up all joints roughly either with flush joints or shallow, smooth-raked joints.

3.1.3. **Common**. Construct riprap as shown in Figure 4 on the *Stone Riprap Standard*. Place stones on a bed excavated for the base course. Bed the base course of stone well into the ground with the edges in contact. Bed and place each succeeding course in even contact with the preceding course. Use spalls and small stones to fill any open joints and voids in the riprap. Ensure the finished surface presents an even, tight surface, true to the line and grades of the typical sections.

Prevent earth, sand, or foreign material from filling the spaces between the stones when the Design Documents require grouting common stone riprap. Wet the stones thoroughly after they are in place; fill the spaces between them with grout; and pack. Sweep the surface with a stiff broom after grouting.

3.1.3.1. **Protection**. Construct riprap as shown in Figure 5 on the *Stone Riprap Standard*. Place riprap stone on the slopes within the limits shown on the Design Documents. Place stone for riprap on the filter fabric to produce a reasonably well-graded mass of riprap with the minimum practicable percentage of voids. Construct the riprap to the lines and grades shown on the Design Documents or staked in the field. A tolerance of +6 in. and −0 in. from the slope line and grades shown on the Design Documents is allowed in the finished surface of the riprap. Place riprap to its full thickness in a single operation. Avoid displacing the filter fabric. Ensure the entire mass of stones in their final position is free from objectionable pockets of small stones and clusters of larger stones. Do not place riprap in layers, and do not place it by dumping it into chutes, dumping it from the top of the slope, pushing it from the top of the slope, or any method likely to cause segregation of the various sizes. Obtain the desired distribution of the various sizes of stones throughout the mass by selective loading of material at the quarry or other source or by other methods of placement that will produce the specified results. Rearrange individual stones by mechanical equipment or by hand if necessary to obtain a reasonably well-graded distribution of stone sizes. Use the bedding thickness shown and place stone for riprap on the bedding material to produce a reasonably well-graded mass of riprap with the minimum practicable percentage of voids if required on the Design Documents.

3.2. **Pneumatically Placed Concrete Riprap, Class II.** Meet Item 431, “Pneumatically Placed Concrete.” Provide reinforcement following the details on the Design Documents and Item 440, “Reinforcement for Concrete.” Support reinforcement with approved supports throughout placement of concrete.

Give the surface a wood-float finish or a gun finish. Cure the riprap with membrane-curing compound immediately after the finishing operation in accordance with Item 420, “Concrete Substructures.”

3.3. **Cement-Stabilized Riprap.** Follow the requirements of the Design Documents and the provisions for concrete riprap except when reinforcement is not required.

3.4. **Special Riprap.** Construct special riprap according to the Design Documents.

Item 434

24. Bridge Bearings

1. DESCRIPTION

Furnish and install bearings for the support of bridge superstructure and substructure members. Bridge bearings under this specification consist of the two following categories and subcategories:

1.1. Elastomeric Bridge Bearings:

- **Plain Elastomeric Bearings**. Consisting of elastomer only.
- **Laminated Elastomeric Bearings**. Consisting of alternating individual layers of elastomer and steel laminates, with or without a steel top plate and special components (steel guide bars and bottom plate).
- **Sliding Elastomeric Bearings**. Consisting of a steel top (sole) plate with a stainless steel facing (upper component) bearing on a lower component. The lower component consists of a layer of polytetrafluoroethylene (PTFE) recessed and bonded to a steel plate that is vulcanized to the top of a laminated elastomeric bearing pad with or without special components (steel guide bars and bottom plate).

Plain and laminated elastomeric bridge bearings are designated by hardness (durometer), size, and configuration and, in the case of laminated bearings, by the thickness of the individual layers of elastomer and the size and position of any steel top plates.

1.2. **High Load Multi-Rotational (HLMR) Bearings:**

- **Disc Bearings**. Consisting of a polyether urethane disc contained between upper and lower steel bearing plates. The bearing has a shear resisting mechanism to prevent relative horizontal movement of the bearing plates and transmit horizontal loads.
- **Pot Bearings**. Consisting of a plain elastomeric disc confined by a shallow steel cylinder (pot) and a steel piston which engages the cylinder sufficiently to prevent their relative horizontal movement.

Provision for sliding movements (if required) uses a separate steel top plate with stainless steel facing (upper component) bearing on a lower component, and a lower component with a layer of PTFE bonded to the top of the upper steel bearing plate of the HLMR assembly. If required on the Design Documents, restriction of lateral movement is provided by guide bars integrated with the steel top plate and interface components of the same stainless steel facing and PTFE layer.

HLMR bridge bearings are designated by configuration (fixed, multi-direction expansion, or guided expansion) and the vertical service reaction requirements. Fixed configurations allow rotation about the horizontal axis and prevent horizontal movement in all directions. Multi-direction expansion configurations allow rotation about the horizontal axis and horizontal movement in all directions. Guided expansion configurations allow rotation about the horizontal axis and horizontal movement in one direction as indicated on the Design Documents, while guide bars and keyways restrict horizontal movement in the orthogonal direction. Provide either

disc bearings or pot bearings. Provide a fabricator-designed HLMR bearing meeting the performance and dimensional criteria described on the Design Documents and in the Materials Article of this Item.

Bearings consisting of hinged steel bolster and rocker shoes, steel flat, cylindrical, or spherical bearings, and single/multiple steel roller bearings are not covered by this Item and must conform to Item 442, "Metal for Structures."

2. MATERIALS

2.1. **Plain and Laminated Elastomeric Bearings.** Furnish bearings produced by a manufacturer from elastomer formulations approved by TxDOT. TxDOT maintains a list of approved bridge bearing elastomer formulations.

2.1.1. **Elastomer**. Provide elastomer for bearings formulated from previously unvulcanized 100% virgin polychloroprene rubber polymers meeting the physical properties, heat resistance, and compression set requirements of AASHTO M 251, Table X1.1. Do not provide bearings containing previously vulcanized synthetic rubber or other synthetic rubber-like polymers. Perform material tests on the finished product in accordance with the applicable test methods. Do not use standard laboratory test slabs for this purpose. Prepare test specimens from the finished product in accordance with ASTM D3183.

Obtain approval for each elastomer formulation before use on TxDOT projects. Submit certified test results to TxDOT to prequalify and obtain approval of a particular formulation. Show actual test values obtained and the required values for the physical properties, heat resistance, and compression set of the elastomer when tested for compliance with the minimum requirements of AASHTO M 251, Table X1.1.

Forward samples (freight prepaid) to TxDOT or their contracted testing laboratory when directed.

Submit only elastomer of the type or types to be supplied. Submit prequalification samples consisting of 2 finished bearings typical of the formulation and workmanship for TxDOT projects. Submit 2 samples of each type when laminated and plain bearings are required. Laminated sample bearings may represent both plain bearings and laminated bearings for an elastomer formulation.

Plain sample bearings must measure 9 in. × 19 in. × 1 in. Laminated sample bearings must measure 9 in. × 14 in. × 1-1/2 in. with the following number of steel laminates:

- 50 durometer—3 steel laminates,
- 60 durometer—2 steel laminates, and
- 70 durometer—2 steel laminates.

Adhesion testing of laminated prequalification samples will be performed by TxDOT in accordance with Tex-601-J, Part I—Adhesion Test Method 1. Bond failure between the elastomer and steel laminates must occur as stated in this test method to constitute a passing test result. Presence of chlorinated compounds (neoprene) in the elastomer will be verified by TxDOT in accordance with Tex-601-J, Part IV—Chlorinated Compound Test Method.

Certify that the submitted samples are of the same basic elastomer formulation and of equivalent cure as the finished products to be furnished on TxDOT projects.

Complete prequalification testing shall be performed for each formulation at least once every 2 yr. and when necessary.

2.1.2. **Steel Laminates**. Provide steel laminates, for laminated bearings, of commercial grade steel strip or sheet with a thickness of 0.105 ±0.015 in.

2.1.3. **Steel Top Plates**. Provide steel top plates, when required for laminated bearings, in accordance with the Design Documents.

2.1.4. **Special Components**. Provide steel guide bars and bottom plates, when required for laminated bearings, in accordance with the Design Documents.

2.1.5. **Coatings.** Provide protective coatings for steel components materials in accordance with Item 445, "Galvanizing," or DMS-8104, "Paint, Shop Application for Structural Steel."

2.2. **Sliding Elastomeric Bearings**.

2.2.1. **Lower Component**.

2.2.1.1. **PTFE**. Furnish PTFE materials that are pure virgin polytetrafluoroethylene fluorocarbon resin, unfilled. The finished materials must exhibit the physical properties shown in Table 1.

2.2.1.2. **Laminated Elastomeric Bearing Pad and Steel Plate**. Furnish laminated elastomeric bearing pads in accordance with Section 434.2.1., "Plain and Laminated Elastomeric Bearings." Provide steel plates attached to laminated elastomeric bearing pads in accordance with the Design Documents.

Table 1

Required PTFE Physical Properties

Physical Property	Test Method	Value (Unfilled)
Tensile strength, psi	ASTM D4894	2,800 min.
Elongation, %	ASTM D4894	200 min.
Melting point	ASTM D4894	622 ±4°F
Specific gravity	ASTM D792	2.16 ±0.03

2.2.2. **Upper Component**.

2.2.2.1. **Steel Top (Sole) Plates**. Provide steel top (sole) plates in accordance with the Design Documents, and finished to ANSI #500 or better on the surface interfacing with the stainless steel sheet.

2.2.2.2. **Stainless Steel**. Provide Type 304 stainless steel sheet in accordance with ASTM A240. The thickness must be at least 1/16 in.

2.2.3. **Special Components**. Provide steel guide bars and bottom plates, when required for laminated bearings, in accordance with the Design Documents.

2.2.4. **Coatings**. Provide coating materials as required in accordance with Item 445, "Galvanizing" and DMS-8104, "Paint, Shop Application for Structural Steel."

2.3. **HLMR Bearings**.

2.3.1. **Structural Design**. Provide a fabricator-developed design for the HLMR (disc or pot) bearings, meeting the service and factored vertical load capacity, service and factored horizontal load capacity, rotational capacity, and translation capacity requirements indicated in the Design Documents and augmented by the requirements of this Item. Provide a bearing capable of transmitting 15% of the service vertical force as a factored horizontal load if no horizontal load capacity is provided in the Design Documents. Provide a design that uses sole plate geometry or a grout interface to accommodate the longitudinal and transverse aspects of the bridge grade, and does not require the bearing to accommodate this in rotation. If the bridge Element supported by the bearing is cambered for dead load to be applied after the bearing is positioned, the dead load design rotation of the elastomer may be neglected provided the fabricator-developed design has checked the bearing for this temporary condition to ensure no damage occurs and there is no metal-to-metal contact. Provide a design that meets the current versions of the AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications. Assume the plan rotations do not include requirements for uncertainties and construction tolerance stipulated in the AASHTO Specifications.

2.3.2. **Maintenance Functionality**. Provide a fabricator-developed design that allows future removal with a maximum vertical jacking height of 1/4 in. after the load is removed. Provide a design with minimum 4-in. distance between the bottom of masonry plate and top of sole plate.

2.3.3. **Elements of HLMR Bearings**.

2.3.3.1. **Lower Component**.

2.3.3.1.1. **Polyether Urethane for Disc Bearings**. Furnish polyether urethane discs conforming to the material requirements of the AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications, and the load and rotation demand indicated in 434.2.3.1

2.3.3.1.2. **Elastomeric Rotational Element for Pot Bearings**. Provide elastomer conforming to the material requirements of the AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications, and the load and rotation demand indicated in 434.2.3.1 with the exception that usage of virgin natural polyisoprene (natural rubber) is not allowed.

2.3.3.1.3. **PTFE**. For expansion HLMR bearings, furnish PTFE materials that are pure virgin polytetrafluoroethylene fluorocarbon resin, unfilled. The finished materials must exhibit the physical properties shown in Table 1. Provide PTFE that is bonded to the top steel bearing plate of the HLMR assembly in accordance with AASHTO LRFD Bridge Construction Specifications.

2.3.3.2. **Upper Component**.

2.3.3.2.1. **Steel Top Plates**. Provide steel top plates in accordance with the AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications. Provide an ANSI #500 or better finish on the surface interfacing with the stainless steel sheet for expansion bearings. At the fabricator's option, the steel top plate may serve the function of the sole plate between the supported structure and the HLMR bearing assembly provided it matches geometric bevel requirements, plan dimensions, and minimum thickness for the sole plate depicted on the Design Documents, while maintaining the performance requirements and avoiding damage due to

installation. Otherwise, provide connectivity between the top plate and the sole plate or grouted interface as indicated on the Design Documents. Coordinate any necessary adjustments to the sole plate geometry, connection method, or grouted interface to ensure compatibility with the structural design, prior to ordering any materials. Provide bolted connections for connection to steel trapezoidal box girder superstructures.

2.3.3.2.2. **Stainless Steel**. Provide Type 304 stainless steel sheet in accordance with ASTM A240. The thickness must be at least 1/16 in.

2.3.3.3. **Miscellaneous Components**.

2.3.3.3.1. **Lateral Guides**. Provide guide bars integrated with the steel top plate and interface components of stainless steel facing and PTFE for guided HLMR expansion bearings. Submit alternate interface components to stainless steel and PTFE for review and approval. Provide details indicating guide bar, stainless steel, and PTFE attachment and design to sustain the lateral loads specified on the Design Documents while maintaining unimpeded expansion capability.

2.3.3.3.2. **Piston**. Provide in accordance with the AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications.

2.3.3.3.3. **Pot**. Provide in accordance with the AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications.

2.3.3.3.4. **Sealing Rings**. Provide in accordance with the AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications.

2.3.3.3.5. **Sealants**. Provide in accordance with the AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications.

2.3.3.4. **Supporting Masonry Plate and Anchor Rods**. Coordinate any necessary adjustments to masonry plate geometry, connection method, or grout interface to ensure compatibility with the structure design before ordering any materials. Provide medium strength, mild steel or better type anchor rods in accordance with Item 449, “Anchor Bolts,” including nuts and washers.

2.3.3.5. **Coatings**. Provide coating materials as required in accordance with Item 445, “Galvanizing,” or DMS-8104, “Paint, Shop Application for Structural Steel.” Submit fabricator-preferred alternative coatings for review and approval.

3. CONSTRUCTION

3.1. **Plain and Laminated Elastomeric Bearings.** Electronically submit shop drawings for the complete assembly before fabrication of laminated elastomeric bearings with or without steel top plates or special components in accordance with the Design Documents and Item 441, “Steel Structures.” Provide a bearing layout with the shop drawings.

Mold together components of a laminated bearing to form an integral unit free of voids or separations in the elastomer or between the elastomer and the steel laminates or plates. Provide wellvulcanized elastomer between the laminates or plates and on the outer surfaces of the bearing that is uniform and integral and resists separation by mechanical means into separate, definite, welldefined elastomeric layers. Evidence of this layered construction, either at the outer surfaces or within the bearing, shall be cause for rejection. Repair of damaged elastomer on sides

of laminated bearings is not allowed for product acceptance. Repair of damaged elastomer on top or bottom surfaces of laminated bearings is allowed when approved.

Cover edges of steel laminates with 1/8 in. to 1/4 in. of elastomer except exposure of the laminates will be permitted at approved laminate restraining devices and around holes entirely enclosed in the finished structure. Position laminates within 1/8 in. of plan location.

Plain bearings may be molded individually, cut from previously molded strips or slabs molded to the full thickness of the finished bearings, or extruded and cut to length. The finish of cut surfaces must be ANSI 250, or smoother. The finished bearings must have no voids or separations detectable either at the bearing surfaces or within the bearing. Plain elastomeric bearings must be well vulcanized, uniform and integral units of such construction that the bearing is incapable of being separated by any mechanical means into separate, definite, welldefined elastomeric layers. Evidence of layered construction either at the outer surfaces or within the bearing shall be cause for rejection.

The permissible variation from the dimensions and configuration shown on the Design Documents for both plain and laminated bearings shall be as listed in AASHTO M 251, Table 2. Flash tolerance, finish, and appearance must meet the requirements of the latest edition of the *Rubber Handbook* published by the Rubber Manufacturers Association, Inc., RMA F3 and T.063 for molded bearings and RMA F2 for extruded bearings.

Perform required welding in accordance with Item 441, “Steel Structures.” Manufacture guide bars, when required, so adjacent top and bottom bar surfaces are parallel to within 1/16 in. in the assembled position. The tolerance for diameter of anchor bolt holes is +1/8 in., −0. The maximum deviation for flatness of steel plates is 1/16 in. in any 24 in.

3.1.1. **Markings**. Mark the bearing type on the surface of each bearing as shown on the Design Documents. The marking must remain legible until placement in the structure. Permanently mark, in addition, laminated bearings with:

- manufacturer’s name or trademark,
- lot number,
- date of manufacture (month-year), and
- direction of slope.

Place this permanent marking on a face which is visible after erection of the bridge.

3.1.2. **Testing and Acceptance**. The sampling and testing of laminated bearing production, after prequalification approval, shall be as follows:

3.1.2.1. **Laminated Bearings**. Subject each laminated bearing to a compression of 2,250 psi. Provide calibrated equipment per ASTM E4 for this compression testing. Each bearing will be acceptable if there is no visible evidence of bond failure or other damage and if the finished bearing meets other pertinent portions of this Item. Samples may be taken if the quality of production becomes questionable.

3.1.3. **Documentation**. Furnish certified laboratory test results on the elastomer properties of each batch or lot of compound for both plain and laminated bearings. Provide copies of certified mill test reports for laminated bearing steel top plates and any required steel special components.

3.1.4. **Storage**. Protect plain and laminated bearingsfrom sunlight until placement in the structure.

3.1.5. **Field Methods**. Provide concrete surfaces for bearing areas under plain and laminated elastomeric bearings in accordance with Item 420.4.9., "Treatment and Finishing of Horizontal Surfaces."

Do not damage the elastomer when welding near bearings.

Damaged bearings shall be subject to rejection and require replacement.

3.2. **Sliding Elastomeric Bearings.** Electronically submit shop drawings for the complete assembly before fabrication of sliding elastomeric bearings in accordance with the Design Documents and Item 441, "Steel Structures." Provide a bearing layout with the shop drawings.

Finish the steel top (sole) plate surface, interfacing with the stainless steel sheet, per Section 434.2.2.2.1., "Steel Top (Sole) Plates." Provide this finished surface flat to a tolerance of 1/32 in. Provide the remaining surface, outside the stainless steel sheet interface, flat to a tolerance of 1/16 in. in any 24 in.

Attach the stainless steel sheet to the steel top (sole) plate by continuous fillet-welding around the edges with an approved welding electrode. Do not extend the weld above the sliding surface. Protect the sliding surface from weld spatter. Polish the stainless steel sheet to a bright mirror finish less than 20 micro-in. rms, and solvent-clean to remove traces of polishing compound after attachment to the steel plate.

Fabricate the laminated elastomeric bearing pads according to Section 434.3.1., "Plain and Laminated Elastomeric Bearings." Vulcanize the laminated elastomeric bearing pad to the PTFE-faced steel plate. Machine the steel plate recessed surface flat to a tolerance of 1/32 in. and within 1/32 in. of required depth. Bond the PTFE material to the steel plate recessed surface with an approved adhesive. Fit the PTFE material into the recessed surface with not more than 1/32-in. gaps around the perimeter.

Perform required welding in accordance with Item 441, "Steel Structures." Manufacture guide bars when required so that adjacent top and bottom bar surfaces are parallel to within 1/16 in. in the assembled position. The tolerance for diameter of anchor bolt holes is +1/8 in., -0 in.

3.2.1. **Markings.** Mark the bearing type on the surface of each sliding elastomeric bearing. The marking must remain legible until placement in the structure. Permanently mark the laminated elastomeric bearing pad with the information specified in 434.3.1.1, "Markings."

3.2.2. **Testing and Acceptance.** Test a minimum of 10% of the sliding elastomeric bearing assemblies to a compressive strength of 2,250 psi. Provide calibrated equipment per ASTM E4 for this compression testing. No tested sliding elastomeric bearing may show visible damage to the PTFE or stainless steel surfaces nor evidence of bond failure between the:

- PTFE-faced steel plate and laminated elastomeric bearing pad,
- steel laminates and elastomer within the laminated elastomeric bearing pad, and
- steel plate and PTFE.

Perform check tests if necessary on the steel, laminated elastomeric bearing pads, or PTFE material to verify the properties required under Section 434.2.2., "Sliding Elastomeric Bearings."

Bearings represented by test specimens passing the requirements of this Item will be approved for use in the structure subject to on-site inspection for visible defects.

3.2.2.1. **Lower Component.** Manufacture 1 additional bearing lower component per project for testing purposes. Notify TxDOT which will sample a bearing lower component at random from the lot, after bearings have been manufactured for a project. Forward selected samples (freight prepaid) to TxDOT or to their contracted testing laboratory when directed. Lower component samples shall be tested to the following:

- Tex-601-J, Part II—Adhesion Test Method 2. Adhesion between the PTFE material and steel plate must meet a minimum 20 lb. per inch.
- Tex-601-J, Part III—Adhesion Test Method 3. Bond failure between the PTFE-faced steel plate and the laminated elastomeric bearing pad must occur as stated in this test method to constitute a passing test result.

3.2.2.2. **Documentation.** Furnish copies of certified mill test reports for the steel top (sole) plate, stainless steel, PTFE-faced steel plate, and any required steel special components. Provide a manufacturer's certification that the PTFE material meets the requirements of this Item. Furnish certified laboratory test results on the elastomer properties of each batch or lot of compound for laminated elastomeric bearing pads.

3.2.3. **Storage.** Store sliding elastomeric bearings horizontally in a dry, sheltered area. Provide moisture and dust-resistant wrapping maintained in good condition until installation. Lift bearings only from the undersides. Protect bearings from damage, dirt, oil, grease, and other foreign substances.

3.2.4. **Field Methods.** Provide concrete surfaces for bearing areas under sliding elastomeric bearings in accordance with Item 420, “Treatment and Finishing of Horizontal Surfaces.”

Refer to the Design Documents for temperature setting corrections for all bridges and bearing alignment relative to a chord for curved bridges. Perform such adjustments if the Design Documents do not address these requirements.

Exercise care in any field-welding required for the installation of a sliding elastomeric bearing to prevent damage to the elastomer, PTFE, or stainless steel surface. Repair damage to protective coating on the bearings and apply the final appearance coat in accordance with Item 446, “Field Cleaning and Painting Steel.”

Damaged bearings shall be subject to rejection and require replacement.

3.3. **HLMR Bearings.** Electronically submit shop drawings for the complete assembly, before fabrication of HLMR bearings, in accordance with the Design Documents. Provide a bearing layout with the shop drawings including geometric placement on substructure. Provide design calculations sealed by a Registered Professional Engineer.

3.3.1. **Markings.** Provide a permanent identification mark indicating each bearing’s position in the structure and a direction arrow oriented in the forward station direction. Ensure the primary identification mark or a second such mark is provided at a visible location on the bearing after superstructure construction.

3.3.2. **Testing and Acceptance.** Coordinate arrangements for sampling and testing with TxDOT. Notify TxDOT before manufacturing all or a significant number of bearings for the Project. Coordinate with TxDOT the number and type of tests that must be observed by a designated TxDOT

representative. Perform testing in accordance with Section 18, “Bearing Devices,” of the current AASHTO LRFD Bridge Construction Specifications. Use prequalification for certain tests only if approved by TxDOT.

Disassemble bearings for visual inspection after testing. Replace or repair any bearings that reveal malfunction such as lift-off, galling between components, excessive deflection, yielding of steel, wrinkling of stainless steel, and flow or bond failure of PTFE. Perform testing to validate performance of replaced or repaired bearings.

3.3.3. **Storage.** Store HLMR bearings horizontally in a dry, sheltered area. Provide moisture and dust-resistant wrapping maintained in good condition until installation. Lift bearings only from the undersides. Protect bearings from damage, dirt, oil, grease, and other foreign substances.

3.3.4. **Field Methods.** Provide concrete surfaces for bearing areas under HLMR bearings in accordance with Section 420.4.9., “Treatment and Finishing of Horizontal Surfaces.”

Do not disassemble bearings. Clean any contaminated sliding surfaces by the fabricator.

Place HLMR bearings on preformed fabric pads as indicated in Section 441.3.11.6., “Bearing and Anchorage Devices.” Refer to the Design Documents for temperature setting corrections for all bridges and bearing alignment relative to a chord for curved bridges. Perform such adjustments if the Design Documents do not address these requirements.

Exercise care in any field-welding required for the installation of an HLMR bearing to prevent damage to the elastomer, disc Element, PTFE, or stainless steel surface. Perform repair of damage to the prime coat on the bearings and apply the final appearance coat in accordance with Item 446, “Cleaning and Painting Steel.”

Damaged bearings shall be subject to rejection and require replacement.

Item 438

25. Cleaning and Sealing Joints

1. DESCRIPTION

Clean and seal joints in new or existing rigid concrete pavements and bridge decks. Resize joints in rigid concrete pavements and approach slabs as shown on the Design Documents.

2. MATERIALS

Use sealants of the class specified on the Design Documents that meet the requirements of DMS-6310, "Joint Sealants and Fillers." Use primers recommended by the manufacturer of the sealant if required.

Provide backer rods that are circular and are 25 percent larger than the joint opening. Use backer rods compatible with the sealant that do not react or bond together.

3. EQUIPMENT

Use equipment that meets sealant manufacturer's recommendations. Use air compressors equipped with appropriate filters for removing oil and water from the air. Provide concrete saws with sufficient capacity to cut full depth of concrete pavement, approach slabs, and pan girder joints.

4. CONSTRUCTION

Submit information from the sealant manufacturer showing recommended equipment and installation procedures before starting Work. All equipment and procedures shall be subject to approval. If the equipment causes damage to dowels, reinforcing steel, concrete, base, sub-base, or subgrade, repair the damage and change the procedure and equipment to prevent further damage.

4.1. **Preparation.** Remove all debris, dirt, dust, saw-cuttings, and other foreign material from joint by an approved method. Collect and dispose of all the removed material.

Remove existing preformed bituminous fiber board material or other spacer material the full depth of the joint along with all other debris in the joint opening. Resize the joint sealant space by sawing to the width and depth shown on the Design Documents to accommodate the type of sealant specified.

Clean debris from the diaphragm windows below the joints on concrete slab and girder bridges.

Abrasive blast clean the vertical faces of joints armored with steel to remove all visible rust, paint, mill scale, and other forms of contamination, leaving a white metal appearance. Clean concrete and other surfaces by method approved and in accordance with the manufacturer's specifications before placing sealant. Air blast the joint after cleaning to remove all dust.

Saw-cut concrete pavement and concrete approach slab full depth to resize joint opening as shown on the Design Documents. Clean all debris out of the joint full depth of concrete pavement.

4.2. **Sealing.** Place the sealant in accordance with the manufacturer's recommended procedures. Apply the primer, when required, at the specified rate and time interval before applying the sealant. Apply the sealant to dry joint surfaces unless otherwise recommended by the sealant manufacturer. Tool any sealant material that is not self-leveling to force the sealant against the joint surfaces.

Place approved support spacers into joints as shown on the Design Documents for concrete pavement. Place a backer rod in the joint opening to prevent the sealant from flowing through the joint and to hold the sealant at its required elevation. Set the top of the sealant and thickness of sealant as shown on the Design Documents. Do not place sealant in an expansion-type joint if surface temperature is below 55°F or above 90°F.

Item 439

26. Bridge Deck Overlays

1. DESCRIPTION

Overlay concrete bridge deck surface with concrete overlay (CO), latex-modified concrete overlay (LMC), or multi-layer polymer overlay (MLPO). Remove and replace deteriorated or delaminated concrete as indicated or directed.

2. MATERIALS

Provide materials conforming to the pertinent requirements of the following Items except as noted below.

- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"

2.1. **Latex for LMC.** Provide latex admixture meeting the requirements of DMS-4640, "Chemical Admixtures for Concrete."

Store latex at temperatures between 40°F and 85°F. Do not allow latex to freeze.

2.2. **Grout for CO or LMC.** Provide grout for bonding new concrete to existing concrete consisting of equal parts by weight of hydraulic cement and sand when shown on the Design Documents. Mix with sufficient water to form a stiff slurry, which can be applied with a stiff brush or broom to the existing concrete in a thin, even coating that will not run or puddle in low spots.

2.3. Materials for MLPO:

2.3.1. **Crack Sealant**. Furnish epoxy crack sealant conforming to DMS-6100, "Epoxies and Adhesives," Type IV, and compatible with the multiple layer polymer overlay determined by the manufacturer of the overlay system. Epoxy, methacrylate, or polymer crack sealant not meeting the requirements of DMS-6100, "Epoxies and Adhesives," for Type IV epoxy may be used if part of the manufacturer's overlay system.

2.3.2. **Sand**. Furnish finely graded, oven-dry mason's sand (for broadcast over crack sealant) that is compatible with the multiple layer polymer overlay determined by the manufacturer of the overlay system.

2.3.3. **Aggregate**. Furnish aggregate (for polymer overlay) that conforms to the gradation specified in Table 1. Use an angular-shaped aggregate with a Mohs scale hardness of 6 or greater. Use aggregates that are non-friable, non-polishing, clean, kiln-dried to a maximum moisture content of 0.2% by weight, and free of dirt, clay, asphalt, and other organic materials. All aggregate materials retained in the #8 sieve must have at least 1 mechanically fractured face. Aggregate not meeting the gradation requirements in Table 1 may be accepted if part of an overlay system.

Table 1

Aggregate Gradation Requirements[1]

	Sieve No. 4	Sieve No. 8	Sieve No. 16	Sieve No. 30
% by weight passing sieve	100%	30-75%	0-5%	0-1%

Based on the washed sieve analysis given in Tex-200-F, Part II.

2.3.4. **Resin for Polymer Overlay**. Furnish a polymer resin composed of epoxy, modified epoxy or methyl methacrylate (MMA). The resin (neat) and resulting polymer overlay system (composite consisting of resin and aggregate) must comply with the property requirements specified in Table 2. Furnish a 2-component, 100% solid, 100% reactive resin free of volatile solvents for epoxy-based resin. Formulate the resin to volumetric mixing proportions such as 1 part "A" to 1 part "B" according to the overlay system manufacturer's recommendations. Furnish a flexibilized methyl methacrylate (Component A) and a powdered hardener (Component B) for MMA resin.

Table 2

Requirements for Resin and Polymer Overlay System

Property	Requirement[1]	Test Method
Viscosity (neat)	7–70 poises	Tex-614-J
Gel time (neat)	15 min. minimum	Tex-614-J
Compressive strength at 5 hr. (composite)	1,000 psi minimum	Tex-618-J
Compressive strength at 48 hr. (composite)	3,000 psi minimum	Tex-618-J
Tensile strength at 7 Days (neat)	1,800–5,000 psi	Tex-618-J
Resilience at 48 hr. (neat)	70% minimum	Tex-618-J
Elongation at 7 Days (neat)	30% minimum	Tex-618-J
Bond Strength (neat)	250 psi minimum	Tex-614-J
Shore D hardness (neat)	60-70	ASTM D2240
Absorption at 24 hr. (neat)	1% maximum	ASTM D570
Thermal compatibility (composite)	No delamination of overlay	ASTM C884 with modifications; one cycle is 8 hr. at 60°C followed by16 hr. at -21°C. Determine results after 9 cycles.

1. Values are based on composite specimens or neat samples cured or aged and tested at 24°C (75°F).

3. EQUIPMENT

3.1. Surface Preparation Equipment.

3.1.1. **Concrete Removal and Surface Preparation**. Provide equipment meeting the requirements of Item 483, "Concrete Bridge Deck Surfacing."

3.1.2. **Abrasive Blasting**. Provide equipment capable of removing oil, dirt, slurry, curing compound, laitance, etc., from the surface of the concrete.

3.1.3. **Sawing**. Provide equipment capable of sawing concrete to the specified depth of overlay when required.

3.1.4. **Power-Driven Chipping Tools**. Provide tools not heavier than a nominal 30 lb. class for bulk removal of concrete.

3.1.5. **Chipping Hammers**. Provide chipping hammers not heavier than a nominal 15 lb. class to remove concrete beneath any reinforcing bars.

3.1.6. **Cleaning**. Provide magnetic equipment followed by vacuum equipment to remove spent steel shot. Provide vacuum equipment for final cleaning of prepared surfaces.

3.1.7. **Test Apparatus for MLPO**. Provide all equipment to perform tensile adhesion test prescribed in ASTM C1583.

3.2. **Proportioning and Mixing Equipment**.

3.2.1. **Grout Mixer**. Provide a volumetric continuous or mortar mixer.

3.2.2. **Concrete Overlay**. Follow applicable provisions of Item 421, "Hydraulic Cement Concrete."

3.2.3. **Latex-Modified Concrete Overlay**. Follow the applicable provisions of Item 421, "Hydraulic Cement Concrete." Proportion and mix the latex-modified concrete at the Project site using a suitable approved mixer capable of thoroughly mixing the ingredients to a uniform consistency.

3.2.4. **Multi-Layer Polymer Overlay**. Furnish equipment suitable for mixing and placing the overlay system components recommended by the manufacturer of the overlay system. Furnish paint rollers or notched squeegees to apply crack sealant and resin.

Provide aggregate spreading equipment or methods capable of uniformly applying the aggregate so 100% of the polymer material is covered to excess.

3.3. **Placing and Finishing Equipment**.

3.3.1. **Hand Tools**. Provide sufficient hand tools for placing, consolidating, striking off, and finishing stiff plastic concrete.

3.3.2. **Finishing Equipment for Concrete Overlay**. **Provide an approved surface vibrator moving ahead of the finishing** machine or an approved vibrating screed for overlay consolidation. Provide work bridges or other suitable facilities to perform all finishing operations.

3.3.3. **Finishing Equipment for Latex-Modified Concrete Overlay**. Provide a mechanical strike-off to ensure a uniform thickness of concrete in front of the screed. Design the bottom face of the screed to minimize tearing of the surface of the plastic concrete.

Provide a finishing machine capable of forward and reverse motion under positive control. Make appropriate provisions for raising the screeds to clear the screeded surface for traveling in

reverse. Equip the finishing machine to travel on and screed off of any adjacent completed lane without damaging it. Use approved manual screeds and vibrators to consolidate and finish small or irregular areas inaccessible to the finishing machine. Provide work bridges or other suitable facilities to perform finishing operations and density checks.

4. CONSTRUCTION OF CONCRETE OR LATEX MODIFIED CONCRETE OVERLAYS

4.1. **General**. Provide for approval a detailed Work plan including equipment and manpower before beginning any Work.

Provide sufficient lighting to make quality workmanship and adequate inspection possible during night placements. Lighting must be approved before operations begin.

Provide sufficient labor and equipment for proportioning, mixing, placing, and finishing concrete overlay at a rate of at least 40 ft. of finished overlay per hour. Do not allow traffic other than construction equipment for the overlay on any portion of the prepared bridge deck before the overlay has been placed. Provide side and end forms for supporting the screed and containing the overlay concrete. Provide reinforcement, when required, in accordance with Item 440, “Reinforcement for Concrete,” and the details shown on the Design Documents.

Place concrete only when the air or deck temperature is 40°F or above and the concrete temperature is between 50°F and 85°F. Do not cart concrete batches over the completed overlay until the overlay concrete has attained a 3,000-psi compressive or 425-psi flexural strength. If carts are used, provide timber planking of at least 3/4 in. thickness for the remainder of the curing period. Provide carts equipped with pneumatic tires. Do not interrupt curing operations for the purpose of carting concrete over finished slabs.

Open the structure with the completed overlay to normal construction traffic or to the traveling public in accordance with Section 420.4.1., “Schedule Restrictions.”

4.2. **Surface Preparation**. Do not scarify concrete surfaces with a grooved or tined finish. Prepare these surfaces by abrasive blasting or water-injected abrasive blasting as required to remove dirt, oil, curing compound, laitance, surface mortar, and other material that would inhibit bonding of the overlay, but leave the striations intact.

Scarify the surfaces of slabs to be rehabilitated to the depths shown on the Design Documents in accordance with Item 483, “Concrete Bridge Deck Surfacing.”

Remove and dispose of deteriorated or delaminated areas of concrete as shown on the Design Documents or as determined by the use of a sounding hammer, chain drag, or other acceptable device, and by visual inspection after scarifying as approved.

Remove and repair deteriorated concrete below the indicated depth of scarification in accordance with Item 429, “Concrete Structure Repair”. Use only hydraulic-cement concrete for these repairs. Ensure the repaired surface is flush with the surrounding scarified surfaces. Allow the repair concrete to cure before placing the overlay concrete.

Use a jackhammer not heavier than a nominal 30 lb. class to remove deteriorated concrete in small areas not accessible to the mechanical scarifier, and to spot-remove small areas of

deteriorated concrete to a depth down to the existing top reinforcing steel. This class of jackhammer may also be used for concrete removal between existing reinforcing bars to a greater depth. Use chipping hammers not heavier than a nominal 15 lb. class to remove concrete from beneath any reinforcing bars. Avoid cutting, stretching, or damaging exposed reinforcing steel by direct impact of these power tools. Repair or replace reinforcing steel damaged during the concrete removal process. Operate all jackhammers and chipping hammers at an angle of 45° or less measured from the surface of the slab.

Remove the concrete surrounding the reinforcing bars to a minimum depth of 1/2 in. below the bar to permit the new concrete to bond to the entire periphery of the exposed bar if reinforcing steel is exposed during bridge deck surfacing.

Clean all exposed reinforcing steel, scarified surfaces, and newly exposed concrete surfaces including construction joints against curbs or parapet walls by wet or dry grit blasting before placing the concrete. Blast corroded reinforcing steel to gray metal. Remove and place all blast debris in an approved disposal site. Repair or replace damaged reinforcing steel as required.

Water blast surfaces prepared by abrasive blasting or water-injected abrasive blasting. Continually saturate the prepared surface by soaking or ponding for 24 hr. before placing the overlay. Remove windblown dust, dirt, debris, or standing water from the surface with a high-pressure filtered air blasting just before placing the overlay.

4.3. **Classification and Mix Design**. Provide a mix design in accordance with Item 421, "Hydraulic Cement Concrete." Use a water reducing chemical admixture as necessary to achieve the desired consistency without exceeding the specified water to cementitious material ratio. Provide a mix design with an entrained air content of the fresh concrete of 6% with a tolerance of ±1% when tested in accordance with Tex-414-A or Tex-416-A together with the following requirements:

4.3.1. **Concrete Overlay**. Provide Class CO concrete with a coarse aggregate factor of at least 0.55.

4.3.2. **Latex-Modified Concrete**. Provide Class LMC concrete with a cement content of at least 658 lb. per cubic yard, a latex admixture content of at least 24.5 gal. per cubic yard, and a water content of no more than 18.9 gal. per cubic yard. Provide a mix design using a coarse aggregate volume of 30% to 45% by weight of the total aggregate and a weight ratio of cement-to-sand to coarse aggregate of 1.0:2.8:1.7 based on aggregate in a saturated surface-dry condition. Use a commercially available antifoaming agent with the polymer modifier as necessary to control the air content in the mix.

4.4. **Placing and Finishing Concrete**. Grade the screed rails or headers to ensure the concrete is finished to the required profile. Place the rails or headers outside the area to be overlaid. Provide anchorage of headers or supporting rails for horizontal and vertical stability as necessary. A hold-down device anchored into the concrete will not be permitted unless the concrete is to be subsequently overlaid. Obtain approval for Construction Documents for anchor support of headers or rails before beginning Work.

Provide the overlay thickness specified on the Design Documents. Adjust the screed and screed rail as necessary to provide the approved grade and required thickness. Check the clearance between the screed and existing surface for nonreinforced overlays by attaching a filler block with a thickness of 1/8 in. less than the overlay thickness to the bottom of the screed. Pass the screed over the area to be overlaid with the filler block in place. Correct any areas having

insufficient clearance by adjusting the screed and rail system or by chipping or scarifying. Check screed clearance and reinforcement cover for reinforced overlays.

Construct longitudinal joints at locations shown on the Design Documents. Construct a straight and vertical edge at transverse and longitudinal construction joints. Saw joints before placing the adjacent overlay course.

Install expansion joints in the overlay at the same locations as the expansion joints in the deck.

Moisten the prepared surface to a saturated surface-dry condition just before placing the overlay concrete. Remove standing water from the surface before placing the overlay concrete.

Do not use bonding grout or by this Item. Moisten the prepared surface to a saturated surface-dry condition before placing bonding grout when required. Scrub a thin coating of grout into the prepared surface immediately before placing the concrete. Ensure all surfaces including vertical joints receive a thorough, even coating and that no excess grout collects in pockets. Apply the grout so it does not become dry before it is covered with concrete. Coat areas of the bridge deck where concrete has been removed below the top mat of reinforcing steel with bonding grout if required, and fill them with overlay concrete or Class S concrete as applicable to cover the reinforcing steel. Adequately consolidate and rough float these areas just ahead of the overlay placement. Stop all operations if grout dries out, and remove the grout using high-pressure water blasting.

Place and mechanically strike off the overlay concrete slightly above the final grade. Follow this strike-off by mechanically consolidating and screeding the surface to the final grade. Vibrate all concrete into the corners and angles of the edges. Hand-finish the surface with a float as necessary to produce a tight, uniform surface.

Assure dense, watertight construction joints by properly consolidating the concrete and float-finishing the top surface of the joint flush with the adjacent concrete.

Meet the straightedge and finishing requirements specified in Item 420, “Finish of Bridge Slabs,” for the finishing of the concrete overlay.

4.5. **Curing**. Wet-burlap cure the overlay as soon as possible after the concrete has been textured. Overlay that dries out or cracks before the wet burlap is applied shall be rejected. Keep the burlap continuously wet for 48 hr. for LMC and for 4 Days for CO overlays. Water-cure the overlay in accordance with Section 420.4.10., “Curing Concrete,” for an additional 7 Days. Maintain the surface temperature of the concrete above 40°F for the required curing period. Remove and replace rejected overlay concrete.

5. CONSTRUCTION OF MULTI-LAYER POLYMER OVERLAY

5.1. **Developer Submittals**. Submit the following documentation, and obtain approval before Work commences:

5.1.1. **Product Data**. Submit a list of materials to be used. Provide manufacturer’s product data sheets that include: material specifications for the proposed polymer overlay system; mechanical, physical, and chemical properties; environmental durability; limitations; maintenance instructions; and general recommendations on storage, mixing, application, cleanup, and disposal of materials. Submit a resin mix design which includes the name and type of all ingredients, the mix ratios to be used, and the application rate for each material. Include in the submittal a chart showing the

expected cure times (in minutes) at the corresponding temperatures between 40°F and 100°F (in 10°F increments) for the proposed mix designs.

5.1.2. **Certification of Compliance**. Provide a certificate of compliance from an independent, nationally recognized laboratory stating the materials to be used meet the requirements of this specification. Furnish samples of the materials to be used as required by TxDOT.

5.1.3. **Material Safety Data Sheets**. Provide manufacturer's Material Safety Data Sheets (MSDS) for all materials to be used on site and certification the materials conform to local, State, and federal environmental and worker's safety Laws and regulations.

5.1.4. **Work Plan**. Submit a Work plan for constructing the overlay including at least the following: proposed equipment, materials, and procedures for preparing the surface and placing the overlay; proposed removal and replacement of existing non-compatible deck repair materials; repair procedures for patching deteriorated areas and repairing cracks exposed by surface preparation; and an anticipated schedule for traffic control. The Work plan must meet the approval of the manufacturer of the polymer overlay system. Any Deviations from the application prescribed by this specification must be approved.

5.1.5. **Technical Support Representative**. Submit name and qualifications of overlay system manufacturer's representative who shall be on the jobsite at initiation of Work.

5.2. **Handling of Materials**. Transport and store polymer materials in their original containers in accordance with the manufacturer's recommendations and requirements. Clearly mark containers as "Part A—Contains Resin" or "Part B—Contains Curing Agent," and include the following information on each container: name of product, name and address of manufacturer, mixing proportions and instructions, lot and batch numbers, date manufactured, and quantity contained. Store aggregates in a clean and moisture-free atmosphere that is protected from all potential sources of contamination.

5.3. **Deck Repair**. Repair the deck in accordance with applicable Items before surface preparation and if indicated on the Design Documents. Use only repair materials that are compatible with the crack sealant and overlay systems the system manufacturers' determined. Do not use phosphate-based repair materials unless the overlay system manufacturer determines them to be compatible.

5.4. **Surface Preparation**. Prepare the entire concrete deck surface after all repairs have cured in accordance with the repair material manufacturer's recommendations by removing weak concrete, asphaltic materials, oils, dirt, rubber, curing compound, paint, carbonation, laitance, weak surface mortar, and other potentially detrimental materials that, in the opinion of the overlay system manufacturer's representative, would prevent proper bonding to or curing of the overlay material. Use power-driven hand tools only in areas where mechanical surface preparation equipment cannot reach. Conduct all hand tool operations before using mechanical surface preparation equipment. Select a surface preparation technique such as size and flow of abrasive or water pressure, travel speed, and number of passes that will provide a surface profile equivalent to ICRI Guide No. 03732, Profile 5 or higher.

Use compressed air equipment to clean all dust, debris, and concrete fines from the deck surface and vertical faces of curbs and barrier walls up to a height of 1 in. above the overlay after hand tool and mechanical surface preparation is complete.

Do not allow public traffic onto any portion of the deck that has been prepared and cleaned, or onto any area where all courses have not been placed and allowed to fully cure. Overlay application equipment only is allowed to drive on the prepared deck surface or on any

intermediate course during the overlay application as long as these surfaces are not contaminated or otherwise damaged.

Protect all prepared surfaces from subsequent contamination, and remove any contamination found on the deck or intermediate courses after initial preparation. The deck surfaces shall be inspected for presence of contaminants immediately before placing sealant or any course of the overlay system. Apply the sealant or first course of the overlay within 24 hr. of surface preparation, and place all intermediate courses of the overlay within 7 Days of initial surface preparation.

5.5. **Tensile Adhesion Testing**. Conduct direct pull-off tests in accordance with ASTM C1583 to determine the adequacy of the selected surface preparation (size of shot, flow of shot, forward speed of blast machinery, number of passes, blast pressure, etc.) and cleaning methods. Conduct these tests when the surface temperature is below 80°F. Core through the test overlay to a depth of 0.5 inches into the underlying concrete.

Conduct one tensile adhesion test for each span or 500 sq. yd. whichever is smaller. In addition to representative portion tests, TxDOT may require additional tensile adhesion tests be performed on areas inaccessible to mechanical surface preparation equipment. Developer must remove residual test materials adhering to the deck, make necessary adjustments to the surface preparation methods, and retest all representative portions with failing test results until one passing tensile adhesion test result (from 3 pull-off tests) is obtained for each area tested.

One tensile adhesion test result is the average of 3 pull-off tests conducted over a 1 ft. × 3 ft. test site prepared with at least 1 layer of polymer. Surfaces with tension adhesion test results demonstrating average tensile bond strengths of at least 250 lbs. per square inch are considered acceptable.

5.6. Application of Crack Sealant. Apply the crack sealant in conjunction with the first layer of polymer overlay if the crack sealant and overlay system manufacturers determine it is compatible. Do not place crack sealant on new hydraulic cement concrete that is less than 28 Days old unless the overlay system manufacturer allows it in writing. Allow the deck and all cracks to dry fully before applying crack sealant. Place the crack sealant on repairs only after completion of curing of the repair material and with the concurrence, in writing, of the polymer overlay system manufacturer. Identify moisture in the deck using a plastic sheet left taped in place for a minimum of 2 hr. (per ASTM D4263) or other approved methods.

Mix, place, and cure the crack sealant in accordance with the sealant manufacturer's written recommendations. Do not apply crack sealant if the ambient air temperature is expected to drop below the sealant manufacturer's recommended application temperature range within 8 hr. after application or if the gel time is expected to drop below 10 min.

Broadcast sand at the rate recommended by the sealant manufacturer in such a manner that complete coverage of the treated area is attained while the crack sealant is still tacky. Cure treated area until vacuuming or sweeping can be conducted without tearing or otherwise damaging the treated surface.

Repair any areas in which the treated surface is damaged, contaminated, or does not receive adequate sand embedment before gelling to create a surface compatible with the overlay system as the overlay system manufacturer determines.

5.7. **Application of Polymer Overlay**. Do not place polymer overlay on new hydraulic cement concrete that is less than 28 Days old. Place polymer overlay on repairs only after completion of curing of the repair material and with the concurrence, in writing, of the polymer overlay system manufacturer. Allow the deck to dry fully before applying polymer overlay. Identify moisture in the deck using a plastic sheet left taped in place for at least 2 hr. (per ASTM D4263) or other approved methods. Remove all loose sand or aggregate, and attain approval before placement of each polymer overlay course.

Mix, place, and cure the polymer overlay materials in accordance with the overlay system manufacturer's written recommendations. Do not apply polymer overlay if the ambient air temperature is expected to drop below the overlay system manufacturer's recommended application temperature range within 8 hr. after application or if the gel time is expected to drop below 10 min. MMA overlays may be placed as a slurry, with resin and aggregate pre-mixed, in accordance with the manufacturer's recommendations.

Broadcast aggregate onto the still fluid resin binder until a dry layer of aggregate is present over the entire surface. Immediately broadcast additional aggregate until a dry surface is established if wet spots develop. Accomplish all aggregate broadcasting while binder is still fluid. Cure each course of overlay until vacuuming or sweeping can be conducted without tearing or otherwise damaging the overlay surface. Repair any intermediate courses in which the treated surface is damaged, contaminated, or does not receive adequate aggregate before gelling to create an intermediate surface compatible with the next overlay course as the overlay system manufacturer determines. Repair damaged areas in accordance with the overlay system manufacturer's recommendations if the final polymer overlay surface is damaged or marred.

The nominal finished overlay thickness is at least 3/8 in. measured from the highest point on the deck surface to the peaks of the aggregate. Apply the polymer with aggregates in multiple courses (minimum of two for epoxy systems, and at least one course for slurry applied MMA) as prescribed by the overlay system manufacturer but at rates no less than specified in Table 3. Stagger and overlap longitudinal joints between successive courses so no ridges form.

Table 3

Polymer and Aggregate Application Rates

Course	Polymer (gal./100 sq. ft.)	Aggregate (lb./sq. yd.)
Epoxy 1	Not less than 2.5	> 10
Epoxy 2	Not less than 5.0	> 14
MMA 1	Not less than 4.0	>13

Protect all bridge deck expansion joints from intrusion of polymer overlay materials. Remove overlay over all expansion joints within 12 hr. of application and before opening the overlay surface to traffic. Removal may be accomplished by scoring the overlay before gelling, by saw-cutting after curing, or by other method approved by the overlay system manufacturer.

Obtain approval to open any course to traffic. Obtain approval of cleaning and surface preparation methods for initial courses that were opened to traffic before the final course was applied. Do not allow construction traffic on the final course until it has cured sufficiently to

prevent damage by wheel loads. Minimum curing periods shall be in accordance with the submitted curing time chart.

5.8. **Repair of Defects**. TxDOT will examine the completed Work for defects. Immediately repair or take corrective action for delaminations, raveling, weathering, incomplete aggregate coverage, or other defects found during TxDOT's examination.

Item 440

27. Reinforcement for Concrete

1. DESCRIPTION

Furnish and place reinforcement of the type, size, and details shown on the Design Documents.

2. MATERIALS

2.1. **Approved Mills**. Before furnishing steel, producing mills of reinforcing steel for TxDOT must be pre-approved in accordance with DMS-7320, "Qualification Procedure for Reinforcing Steel Mills," by TxDOT, which maintains a list of approved producing mills. Reinforcing steel obtained from unapproved sources will not be accepted.

Contact TxDOT with the name and location of the producing mill for stainless reinforcing steel, low carbon/chromium reinforcing steel, or dual-coated reinforcing steel at least 4 weeks before ordering any material.

2.2. **Deformed Steel Bar Reinforcement**. Provide deformed reinforcing steel conforming to one of the following:

- ASTM A615, Grades 60, 75, or 80;
- ASTM A996, Type A, Grade 60;
- ASTM A996, Type R, Grade 60, permitted in concrete pavement only (Furnish ASTM A996, Type R bars as straight bars only and do not bend them. Bend tests are not required.); or
- ASTM A706, Grades 60 or 80.

Provide the grade of reinforcing steel shown on the Design Documents. Provide Grade 60 if no grade is shown.

The nominal size, area, and weight of reinforcing steel bars this Item covers are shown in Table 1.

Table 1

Size, Area, and Weight of Reinforcing Steel Bars

Bar Size Number (in.)		Diameter (in.)	Area (sq. in.)	Weight per ft.
3		0.375	0.11	0.376
4		0.500	0.20	0.668
5		0.625	0.31	1.043
6		0.750	0.44	1.502
7		0.875	0.60	2.044
8		1.000	0.79	2.670

Bar Size Number (in.)		Diameter (in.)	Area (sq. in.)	Weight per ft.
9		1.128	1.00	3.400
10		1.270	1.27	4.303
11		1.410	1.56	5.313
14		1.693	2.25	7.650
18		2.257	4.00	13.60

Note—Bar size numbers (in.) are based on the number of eighths of an inch included in the nominal diameter of the bar.

2.3. **Smooth Steel Bar Reinforcement**. Provide smooth bars for concrete pavement with a yield strength of at least 60 ksi and meeting ASTM A615. Provide steel conforming to ASTM A615 or meet the physical requirements of ASTM A36 for smooth bars that are larger than No. 3. Designate smooth bars by size number up to No. 4 and by diameter in inches above No. 4.

2.4. **Spiral Reinforcement**. Provide bars or wire for spiral reinforcement of the grade and minimum size or gauge shown on the Design Documents.

Provide smooth or deformed wire conforming to ASTM A1064. Provide bars conforming to ASTM A615; ASTM A996, Type A; or ASTM A675, Grade 80, meeting dimensional requirements of ASTM A615.

2.5. **Weldable Reinforcing Steel**. Provide reinforcing steel conforming to ASTM A706 or with a maximum carbon equivalent (C.E.) of 0.55% if welding of reinforcing steel is required or desired. Provide a report showing the percentages of Elements necessary to establish C.E. for reinforcing steel that does not meet ASTM A706, in order to be structurally welded. These requirements do not pertain to miscellaneous welds on reinforcing steel as defined in Section 448.4.2.1.1., "Miscellaneous Welding Applications."

Calculate C.E. using the following formula:

$$C.E. = \%C + \frac{\%Mn}{6} + \frac{\%Cu}{40} + \frac{\%Ni}{20} + \frac{\%Cr}{10} - \frac{\%Mo}{50} - \frac{\%V}{10}$$

Do not weld stainless reinforcing steel. Provide stainless reinforcing steel suitable for welding, if required, and submit welding procedures and electrodes for approval.

2.6. **Welded Wire Reinforcement**. Provide welded wire reinforcement (WWR) conforming to ASTM A1064. Observe the relations shown in Table 2 among size number, diameter in inches, and area when ordering wire by size numbers. Precede the size number for deformed wire with "D" and for smooth wire with "W."

Designate WWR as shown in the following example: 6 × 12 – W16 × W8 (indicating 6-in. longitudinal wire spacing and 12-in. transverse wire spacing with smooth No. 16 wire longitudinally and smooth No. 8 wire transversely).

Table 2

Wire Size Number, Diameter, and Area

Size Number (in.)	Diameter (in.)	Area (sq. in.)
31	0.628	0.310
30	0.618	0.300
28	0.597	0.280
26	0.575	0.260
24	0.553	0.240
22	0.529	0.220
20	0.505	0.200
18	0.479	0.180
16	0.451	0.160
14	0.422	0.140
12	0.391	0.120
10	0.357	0.100
8	0.319	0.080
7	0.299	0.070
6	0.276	0.060
5.5	0.265	0.055
5	0.252	0.050
4.5	0.239	0.045
4	0.226	0.040
3.5	0.211	0.035
2.9	0.192	0.035
2.5	0.178	0.025
2	0.160	0.020
1.4	0.134	0.014
1.2	0.124	0.012
0.5	0.080	0.005

Note—Size numbers (in.) are the nominal cross-sectional area of the wire in hundredths of a square inch. Fractional sizes between the sizes listed above are also available and acceptable for use.

2.7. **Epoxy Coating**. Provide epoxy coated reinforcing steel as shown on the Design Documents. Before furnishing epoxy coated reinforcing steel, an epoxy applicator must be pre-approved in accordance with DMS-7330, "Qualification Procedure for Reinforcing Steel Epoxy Coating Applicators." TxDOT maintains a list of approved applicators.

Furnish coated reinforcing steel meeting the requirements in Table 3.

Table 3

Epoxy Coating Requirements for Reinforcing Steel

Material	Specification
Bar	ASTM A775 or A934
Wire or WWR	ASTM A884 Class A or B
Mechanical couplers	As shown on the Design Documents
Hardware	As shown on the Design Documents

Use epoxy coating material and coating repair material that complies with DMS-8130, "Epoxy Powder Coating for Reinforcing Steel." Patch no more than 1/4-in. total length in any foot at the applicator's plant.

Maintain identification of all reinforcing steel throughout the coating and fabrication process and until delivery to the Project site.

Furnish 1 copy of a written certification the coated reinforcing steel meets the requirements of this Item and 1 copy of the manufacturer's control tests.

2.8. **Mechanical Couplers**. Use couplers of the type specified in DMS-4510, "Mechanical Couplers for Reinforcing Steel," Article 4510.5.A, "General Requirements" when mechanical splices in reinforcing steel bars are shown on the Design Documents.

Furnish only couplers produced by a manufacturer pre-qualified in accordance with DMS-4510, "Mechanical Couplers for Reinforcing Steel." Ensure sleeve-wedge type couplers are not used on coated reinforcing. Sample and test couplers for use on individual projects in accordance with DMS-4510, "Mechanical Couplers for Reinforcing Steel." Furnish couplers only at locations shown on the Design Documents.

Furnish couplers for stainless reinforcing steel with the same alloy designation as the reinforcing steel.

2.9. **Fibers.** Supply fibers conforming to DMS-4550 "Fibers for Concrete" at the minimum dosage listed on the Material Producer List maintained by TxDOT when allowed by the Design Documents. Use non-metallic fibers when shown on the Design Documents.

2.10. **Stainless Reinforcing Steel**. Provide deformed steel bars of the types listed in Table 4a and conforming to ASTM A955, Grade 60 or higher when stainless reinforcing steel is required on the Design Documents.

Table 4a

Acceptable Types of Deformed Stainless Steel Bar

• **UNS Designation**	S31653	S31803	S24100	S32304
• **AISI Type**	316LN	2205	XM-28	2304

2.11. **Low Carbon/Chromium Reinforcing Steel**. Provide deformed steel bars conforming to ASTM A1035, Grade 100 when low carbon/chromium reinforcing steel is required on the Design Documents.

2.12. **Dual-Coated Reinforcing Steel**. Provide deformed bars conforming to ASTM A1055, Grade 60 or higher when dual-coated reinforcing steel is required on the Design Documents.

2.13. **Glass Fiber Reinforced Polymer Bars (GFRP).** Provide bars conforming to the AASHTO LRFD *Bridge Design Guide Specifications for GFRP-Reinforced Concrete Bridge Decks and Traffic Railings*, Section 4, "Material Specifications" when GFRP bars are required on the Design Documents. Provide sample certification demonstrating the GFRP bar Supplier has produced bar that meets the Material Specifications two months before fabrication. Furnish certification upon shipment that the GFRP bar supplied meets the Material Specifications.

3. CONSTRUCTION

3.2. **Bending**. Fabricate reinforcing steel bars as prescribed in the CRSI *Manual of Standard Practice* to the shapes and dimensions shown on the Design Documents. Fabricate in the shop if possible. Replace improperly fabricated, damaged, or broken bars. Repair damaged or broken bars embedded in a previous concrete placement.

The inside diameter of bar bends, in terms of the nominal bar diameter (d), must be as shown in Table 5.

Table 5

Minimum Inside Diameter of Bar Bends

Bend	Bar Size Number (in.)		Pin Diameter
Bends of 90° and greater in stirrups, ties, and other secondary bars that enclose another bar in the bend	3, 4, 5		4d
	6, 7, 8		6d
Bends in main bars and in secondary bars not covered above	3 through 8		6d
	9, 10, 11		8d
	14, 18		10d

Note—Bar size numbers (in.) are based on the number of eighths of an inch included in the nominal diameter of the bar.

Bend-test representative specimens as described for smaller bars in the applicable ASTM specification where bending No. 14 or No. 18 Grade 60 bars is required. Make the required 90° bend around a pin with a diameter of 10 times the nominal diameter of the bar.

Bend stainless reinforcing steel in accordance with ASTM A955.

3.3. Tolerances. Fabrication tolerances for bars are shown in Figure 1.

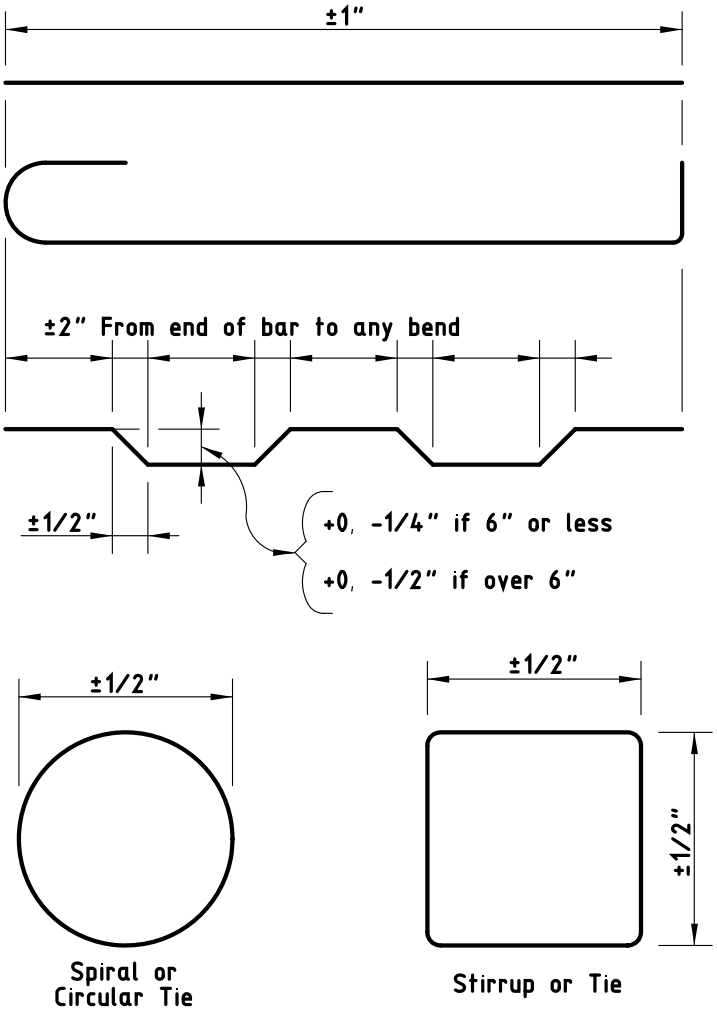


Figure 1

Fabrication tolerances for bars.

3.4. **Storage.** Store reinforcement above the ground on platforms, skids, or other supports, and protect it from damage and deterioration. Ensure reinforcement is free from dirt, paint, grease, oil, and other foreign materials when it is placed in the Work. Use reinforcement free from defects such as cracks and delaminations. Rust, surface seams, surface irregularities, or mill scale will not be cause for rejection if the minimum cross-sectional area of a hand wire-brushed specimen meets the requirements for the size of steel specified.

Do not allow stainless reinforcing steel to be in direct contact with uncoated reinforcing steel, nor with galvanized reinforcing steel. This does not apply to stainless steel wires and ties. Store stainless reinforcing steel separately, off the ground on wooden supports.

3.5. **Splices**. Lap-splice, weld-splice, or mechanically splice bars as shown on the Design Documents. Additional splices not shown on the Design Documents will require approval. Splices not shown on the Design Documents will be permitted in slabs no more than 15 in. in thickness, columns, walls, and parapets.

- Do not splice bars less than 30 ft. in plan length. For bars exceeding 30 ft. in plan length, the distance center-to-center of splices must be at least 30 ft. minus 1 splice length, with no more than 1 individual bar length less than 10 ft.. Make lap splices not shown on the Design Documents, but otherwise permitted, in accordance with Table 6. Maintain the specified concrete cover and spacing at splices, and place the lap-spliced bars in contact, securely tied together.

Table 6

Minimum Lap Requirements for Steel Bar Sizes through No. 11

Bar Size Number (in.)		Uncoated Lap Length	Coated Lap Length
3		1 ft. 4 in.	2 ft. 0 in.
4		1 ft. 9 in.	2 ft. 8 in.
5		2 ft. 2 in.	3 ft. 3 in.
6		2 ft. 7 in.	3 ft. 11 in.
7		3 ft. 5 in.	5 ft. 2 in.
8		4 ft. 6 in.	6 ft. 9 in.
9		5 ft. 8 in.	8 ft. 6 in.
10		7 ft. 3 in.	10 ft. 11 in.
11		8 ft. 11 in.	13 ft. 5 in.

Note—Bar size numbers (in.) are based on the number of eighths of an inch included in the nominal diameter of the bar.

- Do not lap No. 14 or No. 18 bars.
- Lap spiral steel at least 1 turn.
- Splice WWR using a lap length that includes the overlap of at least 2 cross wires plus 2 in. on each sheet or roll. Splices using bars that develop equivalent strength and are lapped in accordance with Table 5 are permitted.
- Lap the existing longitudinal bars with the new bars as shown in Table 6 for box culvert extensions with less than 1 ft. of fill. Lap at least 1 ft. 0 in. for extensions with more than 1 ft. of fill.
- Ensure welded splices conform to the requirements of the Design Documents and of Item 448, “Structural Field Welding.” Field-prepare ends of reinforcing bars if they will be butt-welded. Delivered bars must be long enough to permit weld preparation.
- Install mechanical coupling devices in accordance with the manufacturer’s recommendations at locations shown on the Design Documents. Protect threaded male or female connections, and ensure the threaded connections are clean when making the connection. Do not repair damaged threads.
- Mechanical coupler alternate equivalent strength arrangements, to be accomplished by substituting larger bar sizes or more bars, will be considered if approved in writing before fabrication of the systems.

3.6. **Placing**. Place reinforcement as near as possible to the position shown on the Design Documents. Do not vary bars from plan placement by more than 1/12 of the spacing between bars in the plane of the bar parallel to the nearest surface of concrete. Do not vary bars from plan placement by more than 1/4 in in the plane of the bar perpendicular to the nearest surface of concrete. Provide a minimum 1-in. clear cover of concrete to the nearest surface of bar.

For bridge slabs, the clear cover tolerance for the top mat of reinforcement is −0, +1/2 in.

Locate the reinforcement accurately in the forms, and hold it firmly in place before and during concrete placement by means of bar supports that are adequate in strength and number to prevent displacement and keep the reinforcement at the proper distance from the forms. Provide bar supports in accordance with the CRSI *Manual of Standard Practice*. Use Class 1 supports, approved plastic bar supports, precast mortar, or concrete blocks when supports are in contact with removable or stay-in-place forms. Use Class 3 supports in slab overlays on concrete panels or on existing concrete slabs. Bar supports in contact with soil or subgrade must be approved.

Use Class 1A supports with epoxy coated reinforcing steel. Provide epoxy or plastic coated tie wires and clips for use with epoxy coated reinforcing steel.

Use mortar or concrete with a minimum compressive strength of 5,000 psi for precast bar supports. Provide a suitable tie wire in each block for anchoring to the bar.

Place individual bar supports in rows at 4-ft. maximum spacing in each direction. Place continuous type bar supports at 4-ft. maximum spacing. Use continuous bar supports with permanent metal deck forms.

The exposure of the ends of longitudinals, stirrups, and spacers used to position the reinforcement in concrete pipe and storm drains is not cause for rejection.

Tie reinforcement for bridge slabs and top slabs of direct traffic culverts at all intersections, except tie only alternate intersections where spacing is less than 1 ft. in each direction. Tie the bars at enough intersections to provide a rigid cage of reinforcement for reinforcement cages for other structural members. Fasten mats of WWR securely at the ends and edges.

Clean mortar, mud, dirt, debris, oil, and other foreign material from the reinforcement before concrete placement. Do not place concrete until authorized.

Stop placement until corrective measures are taken if reinforcement is not adequately supported or tied to resist settlement, reinforcement is floating upward, truss bars are overturning, or movement is detected in any direction during concrete placement.

3.7. **Handling, Placing, and Repairing Epoxy Coated Reinforcing Steel**.

3.7.1. **Handling**. Provide systems for handling coated reinforcing steel with padded contact areas. Pad bundling bands or use suitable banding to prevent damage to the coating. Lift bundles of coated reinforcement with a strongback, spreader bar, multiple supports, or a platform bridge. Transport the bundled reinforcement carefully, and store it on protective cribbing. Do not drop or drag the coated reinforcement.

3.7.2. **Placing**. Do not flame-cut coated reinforcement. Saw or shear-cut only when approved. Coat cut ends as specified in Section 440.3.6.3., "Repairing Coating."

Do not weld or mechanically couple coated reinforcing steel except where specifically shown on the Design Documents. Remove the epoxy coating at least 6 in. beyond the weld limits before welding and 2 in. beyond the limits of the coupler before assembly. Clean the steel of oil, grease, moisture, dirt, welding contamination (slag or acid residue), and rust to a near-white finish after welding or coupling. Check the existing epoxy for damage. Remove any damaged or loose epoxy back to sound epoxy coating.

Coat the splice area after cleaning with epoxy repair material to a thickness of 7 to 17 mils after curing. Apply a second application of repair material to the bar and coupler interface to ensure complete sealing of the joint.

3.7.3. **Repairing Coating**. Use material that complies with the requirements of this Item and ASTM D3963 for repairing of the coating. Make repairs in accordance with procedures recommended by the manufacturer of the epoxy coating powder. Apply at least the same coating thickness as required for the original coating for areas to be patched. Repair all visible damage to the coating.

Repair sawed and sheared ends, cuts, breaks, and other damage promptly before additional oxidation occurs. Clean areas to be repaired to ensure they are free from surface contaminants. Make repairs in the shop or field as required.

3.8. **Handling and Placing Stainless Reinforcing Steel**. Handle, cut, and place stainless reinforcing steel bar using tools that are not used on carbon steel. Do not use carbon steel tools, chains, slings, etc. when handling stainless steel. Use only nylon or polypropylene slings. Cut stainless steel reinforcing using shears, saws, abrasive cutoff wheels, or torches. Remove any thermal oxidation using pickling paste. Do not field bend stainless steel reinforcing without approval.

Use 16 gauge fully annealed stainless steel tie wire conforming to the material properties listed in Section 440.2.9., "Stainless Reinforcing Steel." Support all stainless reinforcing steel on solid plastic, stainless steel, or epoxy coated steel chairs. Do not use uncoated carbon steel chairs in contact with stainless reinforcing steel.

3.9. **Bending, Handling, Repairing, and Placing GFRP Bars**. Fabricate, handle, repair, and place GFRP bars in accordance with the AASHTO LRFD Bridge Design Guide Specifications for GFRP-Reinforced Concrete Bridge Decks and Traffic Railings, Section 5, Construction Specifications.

Item 441

28. Steel Structures

1. DESCRIPTION

Fabricate and erect structural steel and other metals used for steel structures or for steel portions of structures.

2. MATERIALS

2.1. **Base Metal**. Use metal that meets Item 442, "Metal for Structures."

2.2. **Approved Electrodes and Flux-Electrode Combinations**. Use only electrodes and flux-electrode combinations found on the list of approved electrodes and flux-electrode combinations TxDOT maintains. To request a product be added to this list or to renew an expired approval, electronically submit a current Certificate of Conformance containing all tests required by the applicable AWS A5 specification according to the applicable welding code (for most construction, AASHTO/AWS D1.5, *Bridge Welding Code*, or AWS D1.1*, Structural Welding Code—Steel*) to TxDOT.

2.3. **High-Strength Bolts**. Use fasteners that meet Item 447, "Structural Bolting." Use galvanized fasteners on field connections of bridge members when ASTM A325 bolts are specified and steel is painted.

2.4. **Paint Systems.** Provide the paint system (surface preparation, primer, intermediate, and appearance coats as required) shown on the Design Documents. Provide System IV if no system is specified.

Standard paint systems for painting new steel include the following:

2.4.1.1. **System III-B**. Provide paint in accordance with DMS-8101, "Structural Steel Paints-Performance." Provide inorganic zinc (IOZ) prime coat, epoxy intermediate coat, and urethane appearance coat for all outer surfaces except those to be in contact with concrete. Provide epoxy zinc prime coat for touchup of IOZ.

2.4.1.2. **System IV**. Provide paint in accordance with DMS-8101, "Structural Steel Paints-Performance." Provide IOZ prime coat and acrylic latex appearance coat for all outer surfaces except those to be in contact with concrete. Provide epoxy zinc prime coat for touchup of IOZ.

2.4.2. **Paint Inside Tub Girders and Closed Boxes**. Provide a white polyamide cured epoxy. Provide IOZ primer meeting the requirements of DMS-8101, "Structural Steel Paints—Performance," to all interior faying surfaces and splice plates.

2.4.3. **Special Protection System**. Provide the type of paint system shown on the Design Documents. Special Protection Systems must have completed NTPEP Structural Steel Coatings (SSC) testing regimen as a complete system, with full data available through NTPEP.

2.4.4. **Galvanizing**. Provide galvanizing, as required, in accordance with Item 445, "Galvanizing."

2.4.5. **Paint over Galvanizing**. Paint over galvanized surfaces, when required, in accordance with Item 445, "Galvanizing."

2.4.6. **Field Painting**. Provide field paint, as required, in accordance with Item 446, "Field Cleaning and Painting Steel."

3. CONSTRUCTION

3.1. **General Requirements**.

3.1.1. **Applicable Codes**. Perform all fabrication of bridge members in accordance with AASHTO/NSBA Steel Bridge Collaboration S2.1. Follow all applicable provisions of the appropriate AWS code (D1.5 or D1.1) except as otherwise noted on the Design Documents or in this Item. Weld sheet steel (thinner than 1/8 in.) in accordance with ANSI/AWS D1.3, Structural Welding Code—Sheet Steel. Requirements of this Item are in addition to the requirements of S2.1 for bridge members. Follow the more stringent requirement in case of a conflict between this Item and S2.1. Perform all bolting in accordance with Item 447, "Structural Bolting."

Fabricate railroad underpass structures in accordance with the latest AREMA *Manual for Railway Engineering* and this Item. In the case of a conflict between this Item and the AREMA manual, the more stringent requirements apply.

3.1.2. **Notice of Fabrication**. Give adequate notice before commencing fabrication Work as specified in Table 1. Include a schedule for all major fabrication processes and dates when inspections are to occur.

Table 1

Notice of Beginning Work

Plant Location	Notice Required
In Texas	7 Days
In the contiguous United States	21 Days
Outside the contiguous United States	60 Days

Perform no Work in the plant before fabrication is authorized. Developer must bear all TxDOT travel costs when changes to their fabrication or inspection schedules are not adequately conveyed to TxDOT.

3.1.3. **Bridge Members**. Primary bridge members include:

- web and flanges of plate, tub, and box girders;
- rolled beams and cover plates;
- floor beam webs and flanges;
- arch ribs and arch tie beams or girders;
- truss members;
- diaphragm members for curved plate girders or beams;
- pier diaphragm members for tub girders;
- splice plates for primary members; and
- any other member designated as "primary" or "main" on the Design Documents.

Secondary bridge members include:

- bracing (diaphragms, cross frames, and lateral bracing); and

- all other miscellaneous bridge items not considered primary bridge members.

3.1.4. **Responsibility**. Developer is responsible for the correctness and completeness of shop drawings and for the fit of shop and field connections.

3.1.5. **Qualification of Plants and Personnel**.

3.1.5.1. **Plants**. Fabrication plants that produce bridge members must be approved in accordance with DMS-7370, "Steel Bridge Member Fabrication Plant Qualification." TxDOT maintains a list of approved bridge member fabrication plants.

Fabrication plants that produce non-bridge steel material listed below must be approved in accordance with DMS-7380, "Steel Non-Bridge Member Fabrication Plant Qualification." TxDOT maintains a list of approved non-bridge fabrication plants for the following items:

- Roadway Illumination Poles
- High Mast Illumination Poles
- High Mast Rings and Support Assemblies
- Overhead Sign Support Structures
- Traffic Signal Poles
- Intelligent Transportation System (ITS) Poles

TxDOT will evaluate non-bridge member fabrication plants for competence of the plant, equipment, organization, experience, knowledge, and personnel to produce acceptable Work.

3.1.5.2. **Personnel**. Provide a QC staff qualified in accordance with the applicable AWS code. Provide an adequate number of qualified QC personnel for each specific production operation. QC must be on-site and independent of production personnel. QC personnel must be proficient in utilizing the applicable Design Documents, specifications, and test methods, and in verifying compliance with the plant QC and production procedures. Welding inspectors must be current AWS Certified Welding Inspectors for bridge member plants, and for non-bridge member plants requiring TxDOT approval per DMS-7380, "Steel Non-Bridge Member Fabrication Plant Qualification." The QC staff must provide inspection of all materials and workmanship before TxDOT's inspection. Provide the TxDOT inspector with adequate personnel and equipment needed to move material for inspection access. QC is solely Developer's responsibility.

3.1.5.3. **Nondestructive Testing (NDT)**. Personnel performing NDT must be qualified in accordance with the applicable AWS code and the employer's Written Practice. Level III personnel who qualify AS Level I and Level II inspectors must be certified by ASNT for which the NDT Level III is qualified. Testing agencies and individual third-party contractors must also successfully complete periodic audits for compliance, performed by TxDOT. In addition, ultrasound technicians must pass a hands-on test TxDOT administers. This will remain current provided they continue to perform testing on TxDOT materials as evidenced by test reports requiring their signature. A technician who fails the hands-on test must wait 6 months before taking the test again. Qualification to perform ultrasonic testing will be revoked when the technician's employment is terminated or when the technician goes 6 months without performing a test on a TxDOT project. The technician must pass a new hands-on test to be re-certified.

3.1.5.4. **Welding Procedure Specifications Qualification Testing**. For bridge member fabrication, laboratories performing welding procedure specifications (WPSs) qualified by testing must be approved in accordance with DMS-7360, "Qualification Procedure for Laboratories Performing Welding

Procedure Qualification Testing." TxDOT maintains a list of laboratories approved to perform WPS qualification testing.

3.1.6. **Drawings**.

3.1.6.1. **Erection Drawings**. Submit erection drawings prepared by a Registered Professional Engineer, including calculations, for approval at least four weeks before erecting any portion of field-spliced (welded or bolted) girders, railroad underpasses, trusses, arches, or other members for which erection drawings are required on the Design Documents. Include drawings and calculations for any temporary structures used to support partially erected members. Erection drawings are not required for rolled I-beam units.

Prepare erection drawings following the procedures outlined in Section 2.2 of the AASHTO/NSBA Steel Bridge Collaboration S10.1. As a minimum, include:

- plan of work area showing structure location relative to supports and all obstructions;
- equipment to be used including allowable load information;
- erection sequence for all pieces;
- member weights and center of gravity location of pieces to be lifted;
- locations of cranes, holding cranes, and temporary supports (falsework), including when to release load from temporary supports and holding cranes;
- details of falsework including specific bracing requirements with maximum allowable design wind speed clearly indicated;
- girder lifting points;
- diaphragm and bracing requirements; and
- minimum connection requirements when more than the standard requirements.

Perform girder erection analyses using UT-Lift and UT-Bridge software available on TxDOT's website or other suitable commercial software. Ensure temporary stresses in members being erected will not cause permanent damage and that stability is maintained throughout the erection operations. Provide actual input files and output results from UT-Lift and UT-Bridge, or graphical and hard copy results from commercial software programs.

Do not proceed if site conditions differing from those depicted on the approved erection drawings could affect temporary support stresses, erected girders, or public safety in any manner. Revise erection drawings and resubmit for approval before proceeding if site conditions could affect these things.

3.1.6.2. **Shop Drawings**. Prepare and electronically submit shop drawings before fabrication for each detail of the general plans requiring the use of structural steel, forgings, wrought iron, or castings as documented in the *Guide to Electronic Shop Drawing Submittal* available on the TxDOT website for other items the standard specifications require.

Indicate joint details on shop drawings for all welds. Provide a title block on each sheet in the lower right corner that includes:

- Project identification data including federal and State Project numbers,
- sheet numbering for the shop drawings,
- name of the structure or stream for bridge structures,
- name of owner or developer,
- name of the fabricator or Supplier, and

- name of Developer.

Provide one set of 11 x 17-in. approved shop drawings in hardcopy to TxDOT for the inspector at the fabrication plant.

3.1.6.2.1. **Bridge Members**. Prepare drawings in accordance with AASHTO/NSBA Steel Bridge Collaboration G1.3, "Shop Detail Drawing Presentation." Print a bill of material on each sheet, including the Charpy V-Notch (CVN) and fracture-critical requirements, if any, for each piece. Indicate fracture-critical areas of members.

3.1.6.2.2. **Non-Bridge Members**. Furnish shop drawings for non-bridge members when required by the Design Documents or pertinent Items.

3.1.7. **Welding Procedure Specifications (WPSs)**. Submit WPSs and test reports in accordance with the applicable AWS code to TxDOT before fabrication begins, and identify which procedures will be used for each joint or joint type. Do not begin fabrication until WPSs are approved.

Post the approved WPSs for the welding being performed on each welding machine, or use another approved method of ensuring the welder has access to the procedure information at all times.

3.1.8. **Documentation**. Before beginning fabrication, provide a completed Material Statement Form 1818 (a.k.a. D-9-USA-1) with supporting documentation (such as mill test reports (MTRs)) that the producing mill issues and qualified personnel verifies. Ensure the documentation legibly reflects all information the applicable ASTM specifications require. Supply documents electronically to TxDOT.

Provide a copy of the shipping or storage invoice, as material is shipped or placed in approved storage, that reflects:

member piece mark identification and calculated weight per piece from the contract drawings,
number of pieces shipped or in storage,
total calculated weight for each invoice per bid item, and
the unique identification number of the shipping or storage invoice.

The inspector's acceptance of material or finished members will not prohibit subsequent rejection if the material or members are found to be damaged or defective. Replace rejected material promptly.

3.1.9. **Material Identification**. Assembly-mark individual pieces and issue cutting instructions to the shop using a system that will maintain identity of the original piece.

Identify structural steel by standard and grade of steel. Also differentiate between material toughness requirements (CVN, fracture-critical) as well as any other special physical requirements. In addition, identify structural steel for primary members by mill identification numbers (heat numbers). Use an approved identification system. Use either paint or low-stress stencils to make identification markings on the metal. Mark the material as soon as it enters the shop and carry the markings on all pieces through final fabrication. Transfer the markings before cutting steel for primary members of bridge structures into smaller pieces. Loss of identification marking on any piece, with no other positive identification, or loss of heat number identification on any primary member piece will render the piece unacceptable for use. Unidentifiable material

may be approved for use after testing to establish acceptability to the satisfaction of TxDOT. Have an approved testing facility perform testing and a Registered Professional Engineer sign and seal the results.

3.2. **Welding**.

3.2.1. **Details**.

3.2.1.1. **Rolled Edges**. Trim plates with rolled edges used for webs by thermal cutting.

3.2.1.2. **Weld Tabs**. Use weld tabs at least 2 in. long for manual and semi-automatic processes, at least 3 in. long for automatic processes, and in all cases at least as long as the thickness of the material being welded. Use longer weld tabs as required for satisfactory Work.

3.2.1.3. **Weld Termination**. Terminate fillet welds approximately 1/4 in. from the end of the attachment except for galvanized structures and flange-to-web welds, for which the fillet weld must run the full length of the attachment.

3.2.1.4. **No-Paint Areas at Field-Welded Connections**. Keep surfaces within 4 in. of groove welds or within 2 in. of fillet welds free from shop paint.

3.2.1.5. **Galvanized Assemblies**. Completely seal all edges of tightly contacting surfaces by welding before galvanizing.

3.2.1.6. **Submerged-Arc Welding (SAW)**. Do not use hand-held semiautomatic SAW for welding bridge members unless altered to provide automatic guidance.

3.2.1.7. **Tubular Stiffeners for Bridge Members**. Weld in accordance with AWS D1.5, using WPSs qualified based on tests on ASTM A709 Gr. 50 steel.

3.2.2. **Shop Splices**.

3.2.2.1. **Shop Splice Locations**. Keep at least 6 in. between shop splices and stiffeners or cross-frames. Obtain approval for shop splices added after shop drawings are approved.

3.2.2.2. **Grinding Splice Welds**. Grind shop groove welds in flange plates smooth and flush with the base metal on all surfaces whether the joined parts are of equal or unequal thickness. Grind so the finished grinding marks run in the direction of stress, and keep the metal below the blue brittle range (below 350°F). Groove welds in web plates, except at locations of intersecting welds, need not be ground except as required to meet AWS welding code requirements.

3.2.3. **Joint Restraint**. Never restrain a joint on both sides when welding.

3.2.4. **Stiffener Installation**.

3.2.4.1. **Flange Tilt**. Members must meet combined tilt and warpage tolerances before the installation of stiffeners. Cut stiffeners to fit acceptable flange tilt and cupping. Minor jacking or hammering that does not permanently deform the material will be permitted.

3.2.4.2. **Stiffeners Near Field Splices**. Tack weld intermediate stiffeners within 12 in. of a welded field splice point in the shop. Weld the stiffeners in the field in accordance with Item 448, “Structural Field Welding,” after the splice is made.

3.2.5. **Nondestructive Testing (NDT)**. Perform magnetic particle testing (MT), radiographic testing (RT), or ultrasonic testing (UT) as specified in D1.5 for bridge structures. Additional welds may be designated for NDT on the Design Documents. Retest repaired groove welds per the applicable AWS code after repairs are made and have cooled to ambient temperature. Complete NDT and repairs before assembly of parts into a member, but after any heat-correction of weld distortion.

3.2.5.1. **Radiographic Testing**. Radiographs must have a density of at least 2.5 and no more than 3.5, as a radiographer confirms. The density in any single radiograph showing a continuous area of constant thickness must not vary in this area by more than 0.5. Use only ASTM System Class I radiographic film as described in ASTM E1815. Use low-stress stencils to make radiograph and location identification marks on the steel.

3.2.5.2. **Ultrasonic Testing**. Have UT equipment calibrated yearly by an authorized representative of the equipment manufacturer or by an approved testing laboratory.

3.2.5.3. **Magnetic Particle Testing**. Use half-wave rectified DC when using the yoke method. Welds may be further evaluated with prod method for detecting centerline cracking.

3.2.6. **Testing of Galvanized Weldments**. If problems develop during galvanizing of welded material, TxDOT may require a test of the compatibility of the combined galvanizing and welding procedures in accordance with this Section and may require modification of one or both of the galvanizing and welding procedures.

Prepare a test specimen with a minimum length of 12 in. using the same base material, having the same joint configuration, and using the welding procedure proposed for production Work if testing is required. Clean and galvanize this test specimen using the same conditions and procedure that will be applied to the production galvanizing.

Examine the test specimen after galvanizing. There must be no evidence of excessive buildup of zinc coating over the weld area. Excessive zinc coating buildup will require modification of the galvanizing procedure.

Remove the zinc from the weld area of the test specimen and visually examine the surface. There must be no evidence of loss of weld metal or any deterioration of the base metal due to the galvanizing or welding procedure. Modify the galvanizing or welding procedure as required if there is evidence of deterioration or loss of weld metal, and run a satisfactory retest on the modified procedures before production Work. Report procedures and results on the galvanized weldment worksheet provided by TxDOT.

3.3. **Bolt Holes**. Detail holes on shop drawings 1/16 in. larger in diameter than the nominal bolt size shown on the Design Documents unless another hole size is shown on the Design Documents.

Thoroughly clean the contact surfaces of connection parts in accordance with Item 447, "Structural Bolting," before assembling them for hole fabrication. Make holes in primary members full-size (by reaming from a subsize hole, drilling full-size, or punching full-size where permissible) only in assembly.

Ream and drill with twist drills guided by mechanical means. If subpunching holes, punch them at least 3/16 in. smaller than the nominal bolt size. Submit the proposed procedures for approval to accomplish the Work from initial drilling or punching through check assembly when numerically

controlled (N/C) equipment is used. Perform all thermal cutting in accordance with Section 441.3.5.1., "Thermal Cutting."

Slightly conical holes that naturally result from punching operations are acceptable provided they do not exceed the tolerances of S2.1. The tolerance for anchor bolt hole diameter for bridge bearing assemblies is +1/8 in., −0.

3.4. **Dimensional Tolerances**. Meet tolerances of the applicable AWS specifications and S2.1 except as modified in this Section.

3.4.1. **Rolled Sections**. Use ASTM A6 mill tolerances for rolled sections, except D1.5 camber tolerances apply to rolled sections with a specified camber.

3.4.2. **Flange Straightness**. Ensure flanges of completed girders are free of kinks, short bends, and waviness that depart from straightness or the specified camber by more than 1/8 in. in any 10 ft. along the flange. Rolled material must meet this straightness requirement before being laid out or worked. Plates must meet this requirement before assembly into a member. Inspect the surface of the metal for evidence of fracture after straightening a bend or buckle.

3.4.3. **Alignment of Deep Webs in Welded Field Connections**. For girders 48 in. deep or deeper, the webs may be slightly restrained while checking compliance with tolerances of S2.1 for lateral alignment at field-welded connections. In the unrestrained condition, webs 48 in. deep or deeper must meet the tolerances of Table 2. Girders under 48 in. deep must meet the alignment tolerances of S2.1.

Table 2

Web Alignment Tolerances for Deep Girders

Web Depth (in.)	Maximum Web Misalignment (in.)
48	1/16
60	1/8
72	1/4
84	5/16
96	5/16
108	3/8
120	7/16
132	7/16
144	1/2

3.4.4. **Bearings**. Correct bearing areas of shoes, beams, and girders using heat, external pressure, or both. Grind or mill only if the actual thickness of the member is not reduced by more than 1/16 in. below the required thickness.

3.4.4.1. **I-Beams, Plate Girders, and Tub Girders**. The plane of the bearing area of beams and girders must be perpendicular to the vertical axis of the member within 1/16 in. in any 24 in.

3.4.4.2. **Closed Box Girders**. Meet these tolerances:

- The plane of the bearing areas of the box girder is perpendicular to the vertical axis of the girder within 1/16 in. across any horizontal dimension of the bearing.
- The planes of the beam supports on the box girder are true to the vertical axis of the supported beams or girders to 1/16 in. in any 24 in.

In the shop, verify the plane of all bearing areas with the box placed on its bearings to field grade, using an approved process for verification.

3.4.4.3. **Shoes**. Meet these tolerances:

- The top bolster has the center 75% of the long dimension (transverse to the girder) true to 1/32 in., with the remainder true to 1/16 in., and is true to 1/32 in. across its entire width in the short dimension (longitudinal to the girder).
- The bottom bolster is true to 1/16 in. across its diagonals.
- For a pin and rocker type expansion shoe, the axis of rotation coincides with the central axis of the pin.
- When the shoe is completely assembled, as the top bolster travels through its full anticipated range, no point in the top bolster plane changes elevation by more than 1/16 in. and the top bolster does not change inclination by more than 1 degree, for the full possible travel.

3.4.4.4. **Beam supports**. Fabricate beam support planes true to the box girder bearing to 1/16 in. in the short direction and true to the vertical axis of the nesting girders to 1/16 in.

3.4.5. **End Connection Angles**. For floor beams and girders with end connection angles, the tolerance for the length back to back of connection angles is ±1/32 in. Do not reduce the finished thickness of the angles below that shown on the shop drawings if end connections are faced.

3.5. **Other Fabrication Processes**.

3.5.1. **Thermal Cutting**. Use a mechanical guide to obtain a true profile. Hand-cut only where approved. Hand-cutting of radii for beam copes, weld access holes, and width transitions is permitted if acceptable profile and finish are produced by grinding. Provide a surface finish on thermal-cut surfaces, including holes, in accordance with D1.5 requirements for base metal preparation. Obtain approval before using other cutting processes.

3.5.2. **Oxygen-Gouging**. Do not oxygen-gouge quenched and tempered (Q&T), normalized, or thermo-mechanically controlled processed (TMCP) steel.

3.5.3. **Annealing and Normalizing**. Complete all annealing or normalizing (as defined in ASTM A941) before finished machining, boring, and straightening. Maintain the temperature uniformly throughout the furnace during heating and cooling so the range of temperatures at all points on the member is no more than 100°F.

3.5.4. **Machining**. Machine the surfaces of expansion bearings so the travel direction of the tool is in the direction of expansion.

3.5.5. **Camber**. Complete cambering in accordance with S2.1 before any heat-curving.

3.5.6. **Heat Curving**. Heat-curve in accordance with S2.1. The methods in the AASHTO bridge construction specifications are recommended. Attach cover plates to rolled beams before heat-curving only if

the total thickness of one flange and cover plate is less than 2-1/2 in. and the radius of curvature is greater than 1,000 ft. Attach cover plates for other rolled beams only after heat-curving is completed. Locate and attach connection plates, diaphragm stiffeners, and bearing stiffeners after curving, unless girder shrinkage is accounted for.

3.6. **Nonconformance Reports (NCRs).** Submit an NCR for approval when the requirements of this Item are not met. Submit NCRs in accordance with TxDOT's NCR guidelines document. Have readily available access to the services of a Registered Professional Engineer experienced in steel structures design and fabrication. This Registered Professional Engineer may be responsible for reviewing potentially structurally deficient members in accordance with the NCR guidelines document. Receive TxDOT approval before beginning repairs. Perform all repair Work in strict compliance with the approved NCR and repair procedure.

3.7. **Shop Assembly**.

3.7.1. **General Shop Assembly**. Shop-assemble field connections of primary members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, field connections of floor beams and stringers (including for railroad structures), field-bolted diaphragms for curved plate girders and railroad underpasses, and rigid frames. Field-bolted cross-frames and rolled-section diaphragms do not require shop assembly. Complete fabrication, welding (except for shear studs), and field splice preparation before members are removed from shop assembly. Obtain approval for any deviation from this procedure. Developer is responsible for accurate geometry.

Use a method and details of preassembly consistent with the erection procedure shown on the erection Construction Documents and camber diagrams. The sequence of assembly may start from any location in the structure and proceed in one or both directions. An approved method of sequential geometry control is required unless the full length of the structure is assembled.

Verify by shop assembly the fit of all bolted and welded field connections between bent cap girders and plate girders or between plate girders and floor beams.

Do not measure horizontal curvature and vertical camber for final acceptance until all welding and heating operations are completed and the steel has cooled to a uniform temperature. Check horizontal curvature and vertical camber in a no-load condition.

3.7.2. **Bolted Field Connections**. Each shop assembly, including camber, alignment, accuracy of holes, and fit of milled joints, must be approved before the assembly is dismantled.

Assemble with milled ends of compression members in full bearing. Assemble non-bearing connections to the specified gap. Ream all subsize holes to the specified size while the connections are assembled, or drill full size while the connections are assembled. Adding or increasing the thickness of shims or fill plates in bearing connections requires approval. Use drift pins and snug-tight bolts during the drilling process to ensure all planes of the connection (webs and flanges) can be assembled simultaneously. Do not use tack welds to secure plates while drilling.

Secure parts not completely bolted in the shop with temporary bolts to prevent damage in shipment and handling. Never use tack welds in place of temporary bolts.

Match-mark connecting parts in field connections using low-stress stencils in accordance with the diagram in the erection drawings.

3.7.3. **Welded Field Connections**. Mill or grind bevels for groove welds. Do not cut into the web when cutting the flange bevel adjacent to the web. End preparation, backing, and tolerances for girder splices must be in accordance with Item 448, "Structural Field Welding." Details for all other field-welds must conform to the applicable AWS code.

In the shop, prepare ends of beams or girders to be field-welded taking into account their relative positions in the finished structure due to grade, camber, and curvature. Completely shop-assemble and check each splice. Match-mark the splice while it is assembled with low-stress stencils in accordance with the diagram in the erection drawings.

3.8. **Finish and Painting**.

3.8.1. **Shop Painting**. Perform shop painting as required in DMS-8104, "Paint, Shop Application for Structural Steel." Grind corners on new steel items to be painted (except for the coatings on box and tub girder interiors) that are sharp or form essentially 90° angles to an approximately 1/16 in. flat surface before blast cleaning. (A corner is the intersection of two plane faces.) This requirement does not apply to punched or drilled holes. Do not omit shop paint to preserve original markings.

Ensure painted faying surfaces meet the required slip and creep coefficients for bolted connections as outlined in DMS-8104, "Paint, Shop Application for Structural Steel."

Use a Class A slip (minimum slip coefficient of 0.33) if no slip coefficient or corresponding surface condition is specified Perform all required testing.

Surface preparation and painting the interiors of Tub Girders and Closed Boxes is in accordance with DMS-8104, "Paint, Shop Application for Structural Steel."

3.8.2. **Not Used**.

3.8.3. **Machined Surfaces**. Clean and coat machine-finished surfaces that are in sliding contact, particularly pins and pinholes, with a non-drying, water-repellent grease-type material containing rust-inhibitive compounds. Ensure the coating material contains no ingredients that might damage the steel. Protect machined surfaces from abrasive blasting.

3.9. **Handling and Storage of Materials**. Prevent damage when storing or handling girders or other materials. Remove or repair material damaged by handling devices or improper storage by acceptable means in accordance with ASTM A6 and the applicable AWS code.

Place stored materials on skids or acceptable dunnage above the ground. Keep materials clean. Shore girders and beams to keep them upright and free of standing water. Place support skids close enough to prevent excessive deflection in long members such as columns. Do not stack completed girders or beams at the jobsite.

Protect structural steel from salt water or other corrosive environments during storage and transit.

3.10. **Marking and Shipping**. Mark all structural members in accordance with the erection drawings. If a surface is painted, make the marks over the paint. Do not use impact-applied stencils to mark painted surfaces.

Mark the weight directly on all members weighing more than 3 tons.

Keep material clean and free from injury during loading, transportation, unloading, and storage. Pack bolts of each length and diameter, and loose nuts or washers of each size, separately and ship them in boxes, crates, kegs, or barrels. Plainly mark a list and description of the contents on the outside of each package.

3.11. **Field Erection**. Do not lift and place any steel member, including girders and diaphragms, over an open highway or other open travel way. Do not allow traffic to travel under erected members until sufficiently stable as shown on approved erection drawings.

3.11.1. **Pre-Erection Conference**. Schedule and attend a pre-erection conference at least 7 Days before commencing steel erection operations. Do not install falsework or perform any erection operations before the meeting.

3.11.2. **Methods and Equipment**. Do not tack-weld parts instead of using erection bolts. Do not tack-weld parts to hold them in place for bolting. Provide falsework, tools, machinery, and appliances, including drift pins and erection bolts. Provide enough drift pins, 1/32 in. larger than the connection bolts, to fill at least 1/4 of the bolt holes for primary connections. Use erection bolts of the same diameter as the connection bolts.

Securely tie, brace, or shore steel beams or girders immediately after erection as shown on the erection drawings. Maintain bracing or shoring until the diaphragms are in place and as specified in the erection drawings. Protect railroad, roadway, and marine traffic underneath previously erected girders or beams from falling objects associated with other construction activities.

Only welders certified or working directly under the supervision of a foreman certified in accordance with Item 448, “Structural Field Welding,” may handle torches when applying heat to permanent structural steel members.

3.11.3. **Falsework**. Construct falsework in accordance with the erection plan. Construct foundations for shore towers as shown on erection drawings. Do not use timber mats with deteriorated timbers or soil to construct shore tower foundations. Obtain approval of completed falsework before opening roadway to traffic or starting girder erection activities. Ensure falsework is protected from potential vehicle impact. Inspect and maintain falsework daily. Use screw jacks or other approved methods to control vertical adjustment of falsework in order to minimize the use of shims.

3.11.4. **Handling and Assembly**. Accurately assemble all parts as shown on the Design Documents and the approved shop drawings. Verify match-marks. Handle parts carefully to prevent bending or other damage. Do not hammer if doing so damages or distorts members. Do not weld any member for transportation or erection.

3.11.4.1. **Welded Connections**. Weld flange splices to 50% of their thickness and meet the minimum erection bracing and support requirements before releasing the erection cranes, as shown on the Design Documents and on the approved erection Construction Documents. Field-weld in accordance with Item 448, “Structural Field Welding.”

3.11.4.2. **Bolted Connections**. Before releasing the erection cranes:

- install 50% of the bolts in the top and bottom flanges and the web with all nuts finger-tight,
- meet the minimum erection bracing and support requirements shown on the Design Documents and on the approved erection Construction Documents, and
- install top lateral bracing across the connection for tub girders, and fully tension the bolts connecting the bracing to the top flanges.

Install high-strength bolts, including erection bolts, in accordance with Item 447, "Structural Bolting." Clean bearing and faying surfaces for bolted connections in accordance with Item 447, "Structural Bolting." Clean the areas of the outside ply under washers, nuts, and bolt heads before bolt installation. Ensure the required faying surface condition is present at the time of bolting.

3.11.5. **Misfits**. Correct minor misfits. Ream no more than 10% of the holes in a plate connection (flange or web), and ensure no single hole is more than 1/8 in. larger than the nominal bolt diameter. Submit proposed correction methods for members with defects that exceed these limits or prevent the proper assembly of parts. Straighten structural members in accordance with S2.1. Make all corrections in the presence of TxDOT. Do not remove and reweld gusset plates without approval.

3.11.6. **Bearing and Anchorage Devices**. Place all bearing devices such as elastomeric pads, castings, bearing plates, or shoes on properly finished bearing areas with full and even bearing on the concrete. Place metallic bearing devices on 1/4 in.-thick preformed fabric pads manufactured in accordance with DMS-6160, "Water Stops, Nylon-Reinforced Neoprene Sheet, and Elastomeric Pads," to the dimensions shown on the Design Documents. Provide holes in the pad that are no more than 1/4 in. larger than the bolt diameter.

Build the concrete bearing area up to the correct elevation once it has been placed below grade using mortar that meets Item 420, "Concrete Substructures," and provide adequate curing. Use only mortar for build-ups between 1/8 in. and 3/8 in. thick. Use galvanized steel shims or other approved shim materials in conjunction with mortar if the bearing area must be raised more than 3/8 in.

Provide at least 75% contact of flange to shoe with no separation greater than 1/32 in. for beams and girders. Make corrections using heat or pressure in accordance with S2.1, or with galvanized shims. Correct small irregularities by grinding.

Provide at least 85% contact between the rocker plate and the base plate. Adjust the location of slotted holes in expansion bearings for the prevailing temperature. Adjust the nuts on the anchor bolts at the expansion ends of spans to permit free movement of the span. Provide lock nuts or burr the threads.

Remove all foreign matter from sliding or machine-finished surfaces before placing them in the structure.

Restore distorted bearing pads or expansion bearings to an equivalent 70°F position after completion of all welded or bolted splices, using an approved method of relieving the load on the bearing devices.

3.11.7. **Erecting Forms**. Do not erect forms until all welding or bolting is complete and the unit is positioned and properly set on the bearings.

3.11.8. **Field Finish**. Paint in accordance with Item 446, "Field Cleaning and Painting Steel." Feather out touched-up areas over several feet. Do not use acids to remove stains or scales.

Item 442

29. Metal for Structures

1. DESCRIPTION

Provide structural steel, high-strength bolts, forgings, steel castings, iron castings, wrought iron, steel pipe and tubing, aluminum castings and tubing, or other metals used in structures, except reinforcing steel and metal culvert pipe.

2. MATERIALS

Furnish mill test reports (MTRs), supplemental test documentation, and certifications required by this and other pertinent Items.

2.1. Structural Steel.

2.1.1. **Bridge Structures**. Provide the grade of ASTM A709 steel shown on the Design Documents. Grade 50S may be substituted for Grade 50. Use Zone 1 if no AASHTO temperature zone is shown on the Design Documents.

2.1.2. **Non-Bridge Structures**.

2.1.2.1. **Steel Classifications**. Provide the types and grades of steel listed in this Section.

2.1.2.1.1. **Carbon Steel**. Meet ASTM A36.

2.1.2.1.2. **Low-Alloy Steel**. Meet the requirements of one of the following standards:

- ASTM A529 Grade 50;
- ASTM A572 Grade 50 or 55;
- ASTM A588;
- ASTM A709 Grade 50, or 50S; or
- ASTM A992.

Specify ASTM A6 supplemental requirement S18, “Maximum Tensile Strength,” for material used for sign, signal, and luminaire supports.

2.1.2.2. **Impact Testing**. Tension members and components of the following structure types, if more than 1/2 in. thick. Other members designated on the Design Documents must meet the Charpy V-notch (CVN) requirements of Table 1:

- base plates for roadway illumination assemblies, traffic signal pole assemblies, high mast illumination poles, camera poles, and overhead sign supports;
- pole mounting plates, arm mounting plates, and clamp-on plates for traffic signal pole assemblies;
- arm stiffeners, pole gussets, and stiffeners for traffic signal pole long mast arm assemblies (50 ft. to 65 ft.);
- pole shafts, ground sleeves, and handhole frames for high mast illumination poles;

- W-columns, tower pipes, multiple-sided shafts, tower pipe and multiple-sided shaft connection plates, chord angles, chord splice plates or angles, and truss bearing angles for truss type overhead sign supports; and
- pipe posts, pipe arms, post and arm flange plates, and handhole frames for monotube overhead sign supports.

Table 1

CVN Requirements for Non-Bridge Steel

Material	Thickness	Minimum CVN Toughness
ASTM A36, A53, A242, A500, A501, A709 Gr. 36, any other steel with minimum specified yield point below 40 ksi	up to 4"	15 ft.-lb. at 70°F
ASTM A572[1], A588[1], A633[1], any other steel with minimum specified yield point between 40 and 65 ksi, inclusive	up to 2"	15 ft.-lb. at 70°F
	over 2" to 4", mechanically fastened	15 ft.-lb. at 70°F
	over 2" to 4", welded	20 ft.-lb. at 70°F
Any steel with minimum specified yield point over 65 ksi and under 90 ksi[2]	up to 2-1/2"	20 ft.-lb. at 50°F
	over 2-1/2" to 4", mechanically fastened	20 ft.-lb. at 50°F
	over 2-1/2" to 4", welded	25 t.-lb. at 50°F

1. Reduce the testing temperature by 15°F for each 10-ksi increment or fraction thereof above 65 ksi if the yield point of the material given on the MTR exceeds 65 ksi.

2. Reduce the testing temperature by 15°F for each 10-ksi increment or fraction thereof above 85 ksi if the yield point of the material given on the MTR exceeds 85 ksi.

Use the (H) frequency of testing for material with minimum specified yield point up to 50 ksi. Use the (P) frequency of testing for material with minimum specified yield point over 50 ksi. Ensure steel is sampled and tested in accordance with ASTM A673.

2.1.3. **Other Components**.

2.1.3.1. **Miscellaneous Bridge Components**. Provide steel that meets ASTM A36, A709 Grade 36, or A500 Grade B for members such as steel bearing components not bid under other Items, steel diaphragms for use with concrete bridges, and armor and finger joints.

2.1.3.2. **Shear Connectors and Anchors**. Provide cold-drawn bars for stud shear connectors, slab anchors, and anchors on armor and finger joints that meet the requirements of ASTM A108, Grade 1010, 1015, 1018, or 1020, either semi-killed or killed, and have the tensile properties given in Table 2 after drawing or finishing. Determine tensile properties in accordance with ASTM A370.

Table 2

Minimum Tensile Properties for Bar Stock

Tensile strength	60 ksi
Yield strength	50 ksi
Elongation	20% (2")
Reduction of area	50%

Provide certification from the manufacturer that the studs or anchors as delivered have the required material properties.

2.1.3.3. **Fasteners**. Provide high-strength bolts that meet ASTM A325 or A490 as shown on the Design Documents. TxDOT may sample high-strength bolts, nuts, and washers for structural connections in accordance with Tex-719-I.

Follow the requirements of Item 447, "Structural Bolting," for tests, test reports, and supplemental requirements for high-strength bolts, nuts, and washers.

Use bolts that meet ASTM A307 and nuts that meet ASTM A563 when ASTM A325 or A490 bolts are not shown on the Design Documents.

2.1.3.4. **Slip-resistant Deck Plates**. Furnish steel for deck plates that meets ASTM A786 and one of A242, A588, or A709 Gr. 50. State the type and trade name of material to be used on the shop drawings.

2.1.3.5. **Rail Posts**. Provide material for rail posts that meets ASTM A36 or ASTM A709 Grade 36.

2.2. **Steel Forgings**. Provide steel forgings for pins, rollers, trunnions, or other forged parts that meet ASTM A668, Class C, D, F, or G, as shown on the Design Documents. For pins 4 in. or smaller in diameter for non-railroad structures, material that meets ASTM A108, Grades 1016 to 1030, with a minimum yield strength of 36 ksi, may be used instead.

2.3. **Steel Castings**. Provide steel castings that meet ASTM A27, Grade 70-36.

2.4. **Iron Castings**. Provide iron castings that are 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; and meet the standards shown in Table 3.

Table 3

Standards for Iron Castings

Casting Material	ASTM Standard	Grade or Class
Gray iron	A48	35B
Malleable iron	A47	32510
Ductile iron	A536	70-50-05

2.5. **Steel Tubing**. Provide steel tubing that meets ASTM A500, Grade B. Tubing that meets API Standard 5L, Grade X52 may be used if produced by a mill listed in the standard API specifications as authorized to produce pipe with the API monogram. Hydrostatic tests are not required for API 5L steel, and instead of an MTR, the manufacturer may furnish a certificate for each lot or shipment certifying the tubing meets the requirements of this Section.

2.6. **Pipe Rail**. "Pipe" includes special extruded and bent shapes. Provide pipe that is rolled, extruded, or cold-pressed from a round pipe or flat plate, and of the section shown on the Design Documents.

Ensure the design of the cold press and dies results in a pipe of uniform section-free from die marks. Cut the pipe to the lengths required once it has been formed to the required section. Make the end cuts and notches at the angles to the axis of the pipe required to produce vertical end faces and plumb posts when required by the Design Documents. Provide a neat and workmanlike finish when cutting and notching pipe.

2.7. Aluminum. Provide aluminum materials that meet the standards shown in Table 4.

Table 4

Aluminum Standards

Material	ASTM Standard	Alloy-Temper
Castings	B108	A444.0-T4
Extrusions	B221	6061-T6
Sheet or plate	B209	6061-T6

When testing is required, cut test specimens from castings from the lower 14 in. of the tension flange, but not at the junction of the rib or base. Flatten the curved surfaces before machining. Provide standard test specimens in conformance with ASTM E8.

3. CONSTRUCTION

3.1. **Fabrication, Erection, and Painting**. Fabricate, weld, and erect structural metal in accordance with Item 441, "Steel Structures," Item 447, "Structural Bolting," Item 448, "Structural Field Welding," and the applicable AWS welding code. Paint in accordance with Item 446, "Cleaning and Painting Steel." Aluminum or galvanized steel members do not require painting.

3.2. **Galvanizing**. Galvanize fabricated steel items, steel castings, bolts, nuts, screws, washers, and other miscellaneous hardware in accordance with Item 445, "Galvanizing." Galvanizing is not required.

Item 445

30. Galvanizing

1. DESCRIPTION

Galvanize or repair galvanizing on metal items.

2. MATERIALS

Provide galvanized metal items that meet the standards in Table 1.

Table 1

Galvanizing Standards

Item	Standard
Fabricated items, rolled, pressed, or forged steel shapes, plates, pipes, tubular items, and bars	ASTM A123
Steel or iron castings	ASTM A153, Class A
Bolts, nuts, screws, washers, and other miscellaneous hardware	ASTM A153, Class C or D or ASTM B695, Class 50
Miscellaneous fasteners	ASTM B633, Class Fe/Zn 8
Rail Elements for metal beam guard fence or bridge railing	AASHTO M 180
Permanent metal deck forms, supporting angles, and incidental items	ASTM A653, Coating Designation G165

3. CONSTRUCTION

3.1. **General**. Provide for proper filling, venting, and draining during cleaning and galvanizing if fabricated members or assemblies are required to be hot-dip galvanized. Provide drain holes or slots as required, except where prohibited by the Design Documents. Provide a surface finish on the thermal-cut surfaces when thermal cutting drain holes or slots in accordance with AWS D1.1 requirements for base metal preparation. Drain to the small end of the section if assembling tapered members using slip-joint splices. Ensure cleaning and galvanizing does not produce hydrogen embrittlement.

Remove weld flux, weld slag, and any other weld residue or impurities before galvanizing. Before galvanizing material 1/4 in. or greater in thickness:

- remove all sharp burrs and
- chamfer to approximately 1/16 in. all edges.

3.2. **Painting Galvanized Materials**. Provide a paint system if painting is specified on galvanized materials in accordance with DMS-8102 “Paint Systems for Galvanized Steel.” Follow all manufacturer instructions for surface preparation and application including the following:

3.2.1. **Surface Preparation**. Do not water-quench or chromate-quench galvanized surfaces to be painted. Prepare the surface in accordance with ASTM D6386. Apply coating within 12 hr. of cleaning. Re-clean the surface if more than 12 hr. elapse before initial painting.

3.2.2. **Coating Application**. Ensure the coating is smooth, even, continuous, and free of drips, runs, sags, holidays, wrinkles, or other coating defects. Ensure the coating has a uniform appearance within all portions of the painted piece and all related pieces and components of a project. Ensure all repairs are smooth, even, and visually match the remainder of the coated piece by use of feathering and other appropriate techniques to avoid sharp transitions.

3.3. **Galvanizing Weldments**. If problems develop during galvanizing of welded material, TxDOT may require a compatibility test of the combined galvanizing and welding procedures in accordance with Section 441.3.2.6., "Testing of Galvanized Weldments," and may require modification of one or both of the galvanizing and welding procedures.

3.4. **Workmanship**.

3.4.1. **Coverage**. Bare spots no more than 1/8 in. across are acceptable unless numerous. Repair larger bare spots in accordance with Section 445.3.5., "Repairs." Local runs or drips of zinc coating are acceptable unless they interfere with the intended use of the product. Carefully remove plainly visible excessive zinc accumulations.

3.4.2. **Adhesion**. Tap the coated area with a small hammer to test coating adhesion. The coating is acceptable if it is not brittle and does not scale or flake.

3.4.3. **Appearance**. Fabricate poles in accordance with this Item and the Design Documents. Alternate designs are not permitted.

3.4.3.1. **White Rust**. A white powdery residue indicates moisture. Remove heavy layers of white rust that have caused the coating to pit. Light coatings may remain. Remove white rust from articles that will be in direct contact with soil.

3.4.3.2. **Red Rust**. Red rust on galvanized items indicates uncoated areas. See Section 445.3.4.1., "Coverage," for acceptance criteria.

3.4.3.3. **Alligator Cracking or Spider Webbing**. The composition of the base metal may cause dark lines resembling alligator skin. (See Section 445.3.4.2., "Adhesion," to determine whether the coating is acceptable.)

3.4.3.4. **Dull Gray Coating**. The composition of the base metal can cause a dull gray color. (See Section 445.3.4.2., "Adhesion," to determine whether the coating is acceptable).

3.4.4. **Coating Thickness**. Galvanize to the thickness specified. Use Tex-728-I to determine coating thickness.

3.5. **Repairs**. Use zinc-based solders, sprayed zinc, or zinc-rich paints for repairs in accordance with this Section.

3.5.1. **Materials**.

3.5.1.1. **Zinc-Based Solders**. Solders used in rod form or as powders:

zinc-tin-lead alloys with liquidus temperatures in the range of 446°F to 500°F or
zinc-cadmium alloys with liquidus temperatures in the range of 518°F to 527°F.

3.5.1.2. **Sprayed Zinc (Metallizing)**. Zinc coating applied by spraying with droplets of molten metal using wire, ribbon, or powder processes.

3.5.1.3. **Organic Zinc-Rich Paints**. Zinc-rich paints based on organic binders that meet the requirements of DMS-8103, "Galvanizing Repair Paint." TxDOT maintains a list of approved repair paints for galvanized coatings.

3.5.2. **Repair Processes**.

3.5.2.1. **Zinc-Based Solders**. Remove moisture, oil, grease, dirt, corrosion products, and welding slag or flux from surfaces to be repaired. Clean surface to white metal by wire-brushing, light grinding, or mild blasting extending into the surrounding undamaged galvanized coating. Preheat cleaned areas to at least 600°F, but not more than 750°F. Wire-brush while heating and evenly distribute a layer of zinc solder. Flush the repaired area with water or wipe with a damp cloth to remove flux residue when repair is completed.

3.5.2.2. **Sprayed Zinc (Metallizing)**. Remove oil, grease, corrosion products, and any welding slag or flux from surfaces to be repaired, and ensure the surfaces are dry. Clean surface to white metal by wire-brushing, light grinding, or mild blasting extending into the surrounding undamaged galvanized coating. Apply coating by metal-spraying pistols fed with either zinc wire, ribbon, or powder. Provide a coating that is uniform and free of lumps, coarse areas, or loose particles.

3.5.2.3. **Organic Zinc-Rich Paints**. Remove oil, grease, corrosion products, and welding slag or flux from surfaces to be repaired, and ensure the surfaces are clean and dry. Clean surface to near-white metal by wire- brushing, light grinding, or mild blasting extending into the surrounding undamaged coating to provide a smooth repair. Spray or brush-apply the paint to the prepared area in accordance with the paint manufacturer's instructions to attain the required dry-film thickness. Provide multiple passes when using spray application.

3.6. **Repair Coating Thickness**. Measure thickness in the repaired area using Tex-728-I after completing repair and cooling or curing. The minimum thickness required is the same as that required for the specified galvanizing. However, if the repair uses zinc-rich paints, the minimum coating thickness is 50% higher than the specified galvanizing thickness but not greater than 4.0 mils.

Item 446

31. Field Cleaning and Painting Steel

1. DESCRIPTION

Prepare steel surfaces for painting and apply paint.

2. MATERIALS

Provide the paint system (surface preparation, primer, intermediate, and appearance coats as required) shown on the Design Documents. Provide System II if no system specified. Provide a concrete gray appearance coat (Federal Standard 595C, color 35630). Use differing colors for each individual coat with enough contrast between colors to distinguish the various steps in the painting process, including differing the color of the stripe coat relative to the primer and intermediate coat.

2.1. **Paint Systems**. Standard paint systems for painting new and existing steel include the following:

2.1.1. **System I-A (Overcoating, One Coat)**. Provide an overcoating system in accordance with DMS-8105, "Paint, One-coat Overcoat," and the manufacturer's specifications.

2.1.2. **System I-B (Overcoating, High Corrosion Environment)**. Provide paint in accordance with DMS-8101, "Structural Steel Paints—Performance." Provide a penetrating sealer, intermediate prime coat on bare steel areas, and an appearance coat in accordance with manufacturer's specifications.

2.1.3. **System II**. Provide #810 Prime Coat meeting DMS-8100, "Structural Steel Paints—Formula," and acrylic latex appearance coat meeting DMS-8101, "Structural Steel Paints—Performance."

2.1.4. **System III-A**. Provide paint in accordance with DMS-8101, "Structural Steel Paints—Performance." Provide organic zinc (OZ) prime coat, epoxy intermediate stripe coat, epoxy intermediate full coat and urethane appearance coat.

2.1.5. **System III-B**. Provide paint in accordance with DMS-8101, "Structural Steel Paints—Performance." Provide inorganic zinc (IOZ) prime coat, epoxy intermediate, and urethane appearance coat. Provide epoxy zinc prime coat, as recommended by the IOZ manufacturer, for touchup of IOZ.

2.1.6. **System IV**. Provide paint in accordance with DMS-8101, "Structural Steel Paints—Performance." Provide IOZ prime coat and acrylic latex appearance coat. Provide epoxy zinc prime coat, as recommended by the IOZ manufacturer, for touchup of IOZ.

2.2. **Paint Inside Tub Girders and Closed Boxes**. In accordance with Item 441, "Steel Structures."

2.3. **Paint over Galvanizing**. In accordance with Item 445, "Galvanizing."

2.4. **Special Protection System**. Provide the type of paint system shown on the Design Documents. Special Protection System paints must have completed NTPEP Structural Steel Coatings (SSC) testing regimen as a complete system, with full data available through NTPEP.

3. EQUIPMENT

Ensure spray equipment:

- has adequate capacity and sufficient gauges, filters, agitators, regulators, and moisture separators to ensure delivery of clean dry air at the proper pressure and volume;
- is adequate for the type of paint being used;
- has spray heads that provide a smooth, uniform coat of paint;
- will remove moisture from air stream in contact with the paint; and
- has no dried coatings, solvents, or other foreign matter on surfaces that paint is likely to contact.

Maintain all equipment and accessories in good working order.

Keep paint pots no more than 20 ft. above or below the level of spray application of paint during painting operations. Do not allow fluid hoses to sag more than 10 ft. below the level of the bottom of the paint pot or actual spraying operations, whichever is the lowest point. Keep hoses serviceable with no cracks or deterioration. Equip paint pots (or other containers from which the paint is dispensed) with agitators that operate whenever paint is in the pot.

3.1. **Airless Spray Equipment**. Use regulator and air or fluid pressure gauges. Use fluid hoses with at least 1/4-in. inside diameter (I.D.) and a maximum length of 75 ft.

3.2. **Conventional Spray Equipment**. Use independent fluid pressure and atomization pressure regulators and gauges. Use fluid and air hoses with at least 1/2-in. I.D. and a maximum length of 75 ft.

4. CONSTRUCTION

4.1. **Qualification.** Certification of the cleaning and painting contractor, Subcontractor, or fabricator is required as follows:

Submit documentation verifying SSPC QP 1 certification for Work requiring the removal or application of coatings. Additionally, submit documentation verifying SSPC QP 2-Cat A certification when Work requires removal of coatings containing Hazardous Materials. Maintain certifications throughout the Project. No Work may be performed without current and active certifications.

TxDOT may waive certification requirements, when stated on the Design Documents, for the purpose of qualification in the SSPC QP program if the SSPC has accepted the project as a qualification project as part of the process for obtaining SSPC QP 1 or QP 2-Cat A certification. Submit SSPC QP applications and proof of acceptance before beginning Work or provide SSPC QP 7 certification when required on the Design Documents.

Inform TxDOT within 1 Business Day of all scheduled or unannounced inspections or audits by SSPC, OSHA, EPA, TCEQ, or other agencies or organizations. Furnish a complete copy of all inspection and audit reports and any SSPC DAC actions within 7 Days of receipt.

4.2. **Responsibility for Hazards**. Some paints and cleaning products are harmful to health. Handle all paints and cleaning products in accordance with the information on the manufacturer's safety data sheet (MSDS) and all applicable federal and State regulations. Comply with all worker and public safety

protection measures including 29 CFR 1926.62 when cleaning requires removing paint containing Hazardous Materials such as lead or chromium. Monitor permissible exposure limits (PEL) in accordance with OSHA requirements.

4.3. **Access**. Provide safe access to all parts of the Work for proper inspection. Do not place rigging, scaffolds, etc., in contact with previously painted surfaces until the previously applied coating has fully cured. Protect previously painted and cured surfaces with an approved padding to minimize damage when rigging, scaffolds, etc., will be placed on or hung from those surfaces. Avoid and minimize coating damage to the extent possible. Repair all coating damaged as a result of rigging or scaffolding.

Remove tree limbs, bushes, grass, and other items that will interfere with the cleaning and painting operations. Remove vertical clearance signs, and erect and maintain temporary ground-mounted signs matching the content and letter size on the existing sign. Re-attach permanent clearance signs.

4.4. **Steel to be Painted**. Clean and paint all structural steel,. Structural steel includes all main members, bearing apparatus, diaphragms, floor beams, rivets, bolts, lateral bracing, etc., where applicable. Paint the rolling faces of rockers and base plates, all surfaces of bearing plates, and all surfaces of iron or steel castings, whether or not the surfaces are milled unless exempted in this Item. Perform the initial cleaning and application of required prime and intermediate coatings on new steel before shipment of the steel to the jobsite unless otherwise provided in the Contract.

4.5. **Special Protection System**. Apply paint as shown on the Design Documents.

4.6. **Cleaning and Painting New Steel**. Clean and prime new steel in accordance with Item 441, “Steel Structures,” before erection or installation of repair pieces. Clean and paint unpainted areas of newly erected steel, including bolts, nuts, washers, and areas where the shop-applied paint has been damaged or fails to meet specification requirements, in accordance with the method required under the paint system specified and Section 446.4.7.3.1., “General Preparation.” Water blast exposed surfaces of all newly erected steel. Provide Tool Cleaning surface preparation to all repair areas. Prepare all unpainted areas with Abrasive Blast Cleaning. Repair primer coat and apply remaining coats after erection and maintenance Work is complete. Prevent paint and overspray from coming in contact with passing traffic, private and public property, and areas of the bridge not designated to be painted.

4.7. **Cleaning and Painting Existing Steel**.

4.7.1. **Hold Points**. No Work may proceed beyond the listed hold point until receiving provisional approval. Provide the following hold points at a minimum:

- at containment completion,
- following any surface preparation,
- immediately before each coating application,
- after coating application,
- after each coat has cured, and
- after preparation of areas for repair.

4.7.2. **Containment**. Submit a plan that details the procedures and type and size of equipment proposed to keep public property, private property, and the environment from being adversely affected by the cleaning and painting operations. Approval of the plan is required before cleaning and painting

operations begin. Containment is not required for painting newly erected, shop primed steel other than to comply with Section 446.4.6., “Cleaning and Painting New Steel.”

Submit a containment plan and engineering analysis, when required on the Design Documents, showing the loads, including wind loads, added to the existing structure by the containment system and waste materials. Verify the forces and stresses induced in the members from these loads do not result in overstress of the members. Have a Registered Professional Engineer sign, seal, and date the submittal.

Provide containment during all cleaning and painting operations of existing steel structures. Obtain approval of the constructed containment system before beginning cleaning and painting.

Construct and maintain a structure meeting the following minimum requirements:

- SSPC Guide 6, Class 1A, Level 1 Emissions;
- ability to withstand winds up to 30 mph;
- enclosure of all sides of area with air-impenetrable walls;
- illumination meeting SSPC Guide 12;
- rigid, watertight floor formed from minimum 20 gauge steel;
- overlapping seams and entryways; and
- exhaust air filtration system capable of creating negative pressure inside the enclosure causing the sides of the containment to have a concave appearance and demonstrating minimum 100 ft. per minute cross draft air flow and minimum 50 ft. per minute downdraft air flow in all areas within the containment.

In place of a full containment structure, a modified containment system may be proposed for the following situations:

- when using abrasive blasting equipment equipped with negative pressure able to contain all blast refuse. Demonstrate, for approval, the equipment’s ability to contain all blast refuse.
- when using hand tools for spot cleaning only, provide a system that will contain all removed paint, rust, and other debris. Place an airtight membrane below the member being cleaned to collect all falling debris.
- when using power hand tools for spot cleaning only that are equipped with high-efficiency particulate air (HEPA) filter vacuums that will capture all removed paint, rust, and other debris. Otherwise, provide an airtight membrane below the member being cleaned to collect all falling debris.

Provide a system meeting SSPC Guide 6, Class 1W, when using water blasting.

Store, characterize, and dispose of all recovered debris in accordance with 30 TAC 335, “Industrial Solid Waste and Municipal Hazardous Waste.” Alternatively, Universal Waste rules may be utilized. Discharge liquids in accordance with the TCEQ Texas Pollution Discharge Elimination Program (30 TAC 305, “Effluent Guidelines and Standards for TPDES Permits”) and Texas Surface Water Quality Standards (30 TAC 307). Alternatively, liquids may be captured, stored, and characterized for disposal at an authorized facility in accordance with 30 TAC 315, “Pretreatment Regulation for Existing and New Sources of Pollution,” or 30 TAC 335, “Industrial Solid Waste and Municipal Hazardous Waste.”

Use a skimmer when cleaning and painting over bodies of water. Remove any blast or paint material the skimmer collects the day the release occurs. Correct the containment problem that allowed the release before continuing Work.

Ensure air is clear of dust and remove all blast refuse from the floor and cleaned members before the inspector enters the containment to inspect the cleaned surfaces. Remove all blast refuse from the containment before ending Work for the day.

4.7.3. **Preparation of Surfaces**. Prepare surfaces before applying paint.

4.7.3.1. **General Preparation**. Clean far enough into any shop-applied paint to ensure removal of all contaminants. Feather edges of sound paint around cleaned areas.

Ensure all surfaces to be painted are completely free of oil, grease, moisture, dirt, sand, overspray, welding contamination (slag or acid residue); loose or flaking mill scale, rust, or paint; weld spatter; and any other conditions that will prevent the paint from forming a continuous, uniform, tightly adhering film. Remove all hackles, splinters weld spatter, sharp edges, fins, slag, or other irregularities which may interfere with proper paint adhesion to the steel. Remove all steel splinters (hackles) raised or evident during cleaning. Reblast areas from which hackles are removed when abrasive blast cleaning is required.

Remove grease-like contaminants with clean petroleum solvents or other approved methods before other cleaning operations. Contain solvents and removed material as approved. Dispose of properly or reuse solvents as approved. This requirement applies to all coats.

Blast all flame-cut edges, when abrasive blast cleaning is required, to produce a visible anchor pattern over the entire flame-cut surface.

Completely remove the protective coating on machined surfaces and pins.

Do not damage adjacent materials such as concrete during surface preparation or painting.

Feather all sound, tightly adhered coating edges surrounding cleaned or repaired areas a minimum of 1 in. and ensure a smooth, blended transition.

Round all corners and edges to a 1/16-in. radius. Reblast as needed. Remove pack rust to depth of at least 0.5 in.

4.7.3.2. **Classes of Cleaning**. The requirements of Section 446.4.7.3.1., “General Preparation,” apply whether or not a class of cleaning is specified. Use an approved abrasive for abrasive blasting as shown on the Design Documents. Do not use steel shot. Use an abrasive recycling system with an approved recyclable abrasive when abrasive blast cleaning is used to remove existing paint containing lead or chromium. Abrasive will be considered recyclable if it is separated from the dust and paint debris before being reused. All abrasives must meet SSPC-AB1, AB2, or AB3 as appropriate.

All paint systems require water blasting to remove contaminants before any other surface preparation. Both System I-A and I-B require tool cleaning for defective areas of disbonded coating or rust. All other paint systems require abrasive blast cleaning.

4.7.3.2.1. **Abrasive Blast Cleaning**. Meet the surface preparation requirements of SSPC-SP 10. Ensure a minimum profile of 1.5 mils. Do not add depth to existing profile when the surface profile exceeds 4.0 mils. Measure surface profile in accordance with ASTM D4417, Method C, "Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel." Containment mounting points and other repair areas under 1 sq. ft. may be tool-cleaned to SSPC SP-11 with at least a minimum 2 mil profile.

4.7.3.2.2. **Tool Cleaning**. Meet the requirements of SSPC-SP2 or SP3. Probe the perimeter of peeled areas of paint with a putty knife to ensure remaining paint is tightly adhered.

4.7.3.2.3. **Water Blasting**. Meet the requirements of SSPC-SP WJ-4. Tight mill scale and tightly adhered rust and paint are permitted. Probe the perimeter of peeled areas of paint with a putty knife to ensure remaining paint is tightly adhered.

4.7.3.3. **Tape Test**. Perform the tape test, as necessary to determine cleanliness, on any surface before painting as follows:

- Press a strip of filament tape onto the surface by rubbing with moderate thumb pressure four times, leaving approximately 2 in. of one end of the tape free from the surface.
- Grasp the free end and remove the tape from the surface with a sharp pull.

The surface shall be considered to be contaminated and not adequately cleaned if visible particles cling to the tape.

4.7.4. **Painting**.

4.7.4.1. **Paint Condition**. Thoroughly mix and strain paints to be applied. Mix by mechanical methods. Provide continuous mechanical agitation during painting operations to prevent settling. Ensure the paint is a completely homogeneous mixture free of lumps, skins, and agglomerates and contains all pigments, vehicle solids, and thinners required in the original formulation. Keep paint containers tightly covered and protected from weather when not in use.

4.7.4.2. **Thinning**. Adjust paint to the correct application consistency by using suitable thinners or by using properly applied heat up to 150°F. Using heat to thin paints may decrease their useful pot life.

4.7.4.3. **Paint System Requirements**. Ensure all coatings in the paint system, including shop-applied coats, are from the same manufacturer.

4.7.4.4. **Stripe Coat**. All stripe coat, when specified, shall be unthinned and worked in by brush to achieve a contiguous film over all edges, corners, bolts, nuts, threads, rivets, and weld seams, extending at least 1 in. onto adjacent steel.

4.7.4.5. **Paint Systems**.

4.7.4.5.1. **System I-A (Overcoating, One Coat)**. Apply at least 4.0 mils dry film thickness (DFT) maintenance overcoat to all surfaces to be painted.

4.7.4.5.2. **System I-B (Overcoating, High Corrosion Environment)**.

4.7.4.5.2.1. **Penetrating Sealer**. Apply 0.5–1.0 mil DFT of penetrating sealer to all surfaces to be painted.

4.7.4.5.2.2. **Prime Coat**. Apply 4.0–8.0 mils DFT of primer to areas that have received tool cleaning and to other areas where there is no existing primer.

4.7.4.5.2.3. **Appearance Coat**. Apply 2.0–6.0 mils DFT of appearance coat.

4.7.4.5.3. **System II**.

4.7.4.5.3.1. **Prime Coat**. Apply 3.5–10.0 mils DFT of primer in at least 2 coats.

4.7.4.5.3.2. **Appearance Coat**. Apply 2.0–5.0 mils DFT of appearance coat.

4.7.4.5.4. **System III-A**.

4.7.4.5.4.1. **Prime Coat**. Apply at least 3.5 mils DFT of epoxy zinc primer.

4.7.4.5.4.2. **Stripe Coat**. Apply stripe coat of epoxy intermediate coating.

4.7.4.5.4.3. **Intermediate Coat**. Apply at least 2.0 mils DFT of epoxy intermediate coating.

4.7.4.5.4.4. **Appearance Coat**. Apply at least 2.0 mils DFT of appearance coating.

4.7.4.5.5. **System III-B**.

4.7.4.5.5.1. **Prime Coat**. Apply at least 3.0 mils DFT of inorganic zinc primer to new steel in accordance with Item 441, “Steel Structures.” Spot-clean all damaged and unpainted areas in accordance with Section 446.4.6., “Cleaning and Painting New Steel.” Apply at least 3.0 mils DFT of epoxy zinc primer to the spot cleaned areas.

4.7.4.5.5.2. **Stripe Coat**. Apply stripe coat of epoxy intermediate coating.

4.7.4.5.5.3. **Intermediate Coat**. Apply at least 2.0 mils DFT of epoxy intermediate coating.

4.7.4.5.5.4. **Appearance Coat**. Apply at least 2.0 mils DFT of appearance coat.

4.7.4.5.6. **System IV**.

4.7.4.5.6.1. **Prime Coat**. Apply at least 3.0 mils DFT of inorganic zinc primer to new steel in accordance with Item 441, “Steel Structures.” Spot-clean all damaged and unpainted areas in accordance with Section 446.4.6., “Cleaning and Painting New Steel.” Apply at least 3.0 mils DFT of epoxy zinc primer to the spot cleaned areas.

4.7.4.5.6.2. **Appearance Coat**. Apply at least 2.0 mils DFT of appearance coat.

4.7.4.5.7. **Special Protection System**. Apply paint as shown on the Design Documents.

4.7.4.6. **Temperature**. Do not apply #810 Prime Coat when the steel or air temperature is below 50°F or when the steel or air temperature is expected to drop below 50°F within 2 hr. after application. Follow product data sheets for temperature requirements for all other paints.

4.7.4.7. **Application**. Clean steel surfaces or surfaces of previously applied coats of paint immediately before painting by blowing with clean compressed air, brushing, or both to remove traces of dust or other foreign particles. Wash the surfaces of previously applied coatings either with clean, fresh water or with a mild detergent and water mixture followed by a complete and thorough rinse with clean, fresh water when directed.

Do not apply paint to any surface with discernible moisture. Do not apply paint to any surface when steel is within 5°F of the dewpoint. Do not apply any paint when impending weather conditions might result in injury to fresh paint.

Provide environmental controls such as dehumidification, heaters, or additional containment measures as needed to control and maintain favorable atmospheric conditions in all areas of the containment. Provide environmental controls.

Apply each coat of paint to clean, dry, firm surfaces complying with all specification requirements. Ensure surfaces to be painted are free of all forms of contamination. Ensure each coat fully cures to form a smooth, continuous, tightly adhering film of uniform thickness and appearance, free of sags, runs, pinholes, holidays, overspray, or other defects before applying the next coat. Apply all coats by spray, except brush-applied stripe coats.

Repair all runs, sags, and other defects in each coat of paint before application of subsequent coats.

Measure the dry film thickness of coatings in accordance with Tex-728-I.

Discontinue painting if there is an objectionable amount of dust in the atmosphere, or take necessary precautions to prevent dust and dirt from coming in contact with freshly painted surfaces or with surfaces before the paint is applied.

Provide full coverage of the steel with the concrete surface when painting steel that is in contact with concrete. Do not extend the paint more than 4 in. onto the concrete surfaces. Ensure when painting is complete the only visible paint on concrete surfaces is the finish coat. Remove excessive or objectionable paint on concrete surfaces in an approved manner.

Cure the primer, when System II is specified, in accordance with Table 1 before applying appearance coat.

Table 1

System II Primer Cure Times

Temperature	Days Cure, Min.
77°F and above	2
65–77°F	3
55–65°F	4
40–55°F	5

Clean coated surfaces by an approved method that does not damage the paint to remove all dirt, grease, concrete, overspray, and any other substance that may impair adhesion before the application of the next coat.

Provide an even and uniform appearance throughout the painted portion of the structure.

4.7.4.8. **Workmanship**. Perform all painting with skilled painters who can adjust equipment and application techniques as dictated by the type of paint, weather conditions, environment, and size and shape of the surface being painted. Painters who, in the opinion of TxDOT, do not adjust equipment to apply coatings in a uniform, full wet coat free of runs, sags, holidays, and overspray will not be considered skilled painters.

Apply sprayed coatings essentially 90° to the surface and between 10 and 18 in. from the surface as necessary to apply a full wet coat of paint free of overspray, runs, sags, and holidays. Any spray painter who does not consistently spray in this manner or extends the spraying stroke so paint is applied to the surface at an angle of less than 80° will not be allowed to spray paint. Brush application for touchup is acceptable as long as the paint is mixed in the appropriate proportions by weight and is agitated continuously during the painting operation.

4.7.5. **Handling and Shipping**. Pad the blocks, chains, slings, braces, clamps, etc., used for handling, moving, storing, and shipping painted members so the paint will not be damaged.

4.8. **Paint Improperly Applied.** To uncover evidence of improperly applied paint, TxDOT may at any time during construction explore underneath the surface of any paint coats already applied. Repair these areas of investigation.

Repair or completely remove and replace all paint that has been applied improperly, has been applied to improperly cleaned surfaces, fails to dry and harden properly, fails to adhere tightly to underlying metal or other paint film, or does not have a normal, workmanlike appearance in conformance with this Item. When the final field coat does not have a uniform color and appearance throughout the structure, correct it by the use of whatever additional coats or other corrective measures are required. Remove freshly applied paint that has not yet set with the use of suitable solvents. Remove dried paint films with blast cleaning, scraping, or flame torches, as approved.

4.9. **Storage and Disposal.** Collect all waste generated by cleaning and painting operations as necessary to prevent release into the environment. At a minimum, collect all waste before leaving the jobsite each day. Handle and store the waste as if it was hazardous or Universal Waste until classification is made. Follow the requirements of 30 TAC 335 for on-site handling of the waste. Store waste collected in containers that comply with 49 CFR 178. Seal containers containing waste each day before leaving the jobsite.

Test a representative sample of waste using EPA Test Method 1311, “Toxicity Characteristic Leaching Procedure” (TCLP), to determine existing metal and organic content. Handle and dispose of non-hazardous waste as a “Special Waste” as defined in 30 TAC 330.2. Provide documentation showing disposal of the waste was done in a suitable landfill holding permits to handle this type of material. Dispose of hazardous waste in compliance with applicable waste rules and regulations. Transport hazardous waste using a permitted transporter and dispose of in an authorized hazardous waste facility.

When the Design Documents specify the existing coating to be removed contains Hazardous Materials and steel grit is used as the abrasive, the waste generated is classified as hazardous or Universal Waste regardless of the results of the TCLP. For manifesting purposes, TxDOT is considered the waste generator for paint removal wastes generated from structures owned or controlled by the State. Dispose of this waste in compliance with applicable waste rules and regulations as specified above and by the Contract.

Provide copies of all test reports and transportation manifests to TxDOT before shipping waste. Provide signed original manifests to TxDOT verifying all steps of the handling and disposal process were correctly handled.

Miscellaneous. Stencil on the exterior face of the outside beam the control, section, and structure number upon completion of the painting operations for each structure. Stencil on the interior face of the outside beam the completion date of the painting operation. Do this Work at each end of the structure where painting is specified.

Item 447

32. Structural Bolting

1. DESCRIPTION

Furnish and install high-strength bolts for structural connections.

2. MATERIALS

2.1. **General**. Use the same Supplier for bolts and nuts to ensure proper fit. Have the manufacturer or distributor perform rotational-capacity (R-C) tests in accordance with Tex-452-A on all bolt, nut, and washer assemblies. Test each combination of bolt production lot, nut lot, and washer lot as an assembly and assign an R-C lot number to each lot tested. Test 2 samples from each assigned R-C lot.

Furnish a manufacturer's certified test report (MCTR) or a distributor's certified test report (DCTR) for each R-C lot supplied. Include in the MCTR or DCTR:

- results of the R-C tests,
- R-C lot number,
- manufacturing location for assembly components,
- date and location of tests, and
- a statement that the materials represented by the test report conform to the specifications.

2.2. **Bolt Assemblies**. Provide bolts, nuts, and washers meeting the type, grade, and finish requirements in Table 1.

Use ASTM A325 Type 1 galvanized bolts.

Provide bolts long enough for the installed bolt end to be flush with or outside the face of the nut.

Ensure galvanized nuts are lubricated with a lubricant containing a dye of a color that contrasts with the color of the galvanizing. Order ASTM A563 nuts with supplemental requirement S2 if they will be galvanized.

Table 1

ASTM Type, Finish, and Grade for Structural Bolts, Nuts, and Washers

	ASTM Designation	Bolt Type	Bolt Finish	ASTM A563 Nut Grade and Finish	ASTM F436 Washer Type and Finish
Heavy-Hex Bolts	A325	1	Galvanized	DH[1]; galvanized and lubricated	1; galvanized
		3	Plain	C3 and DH3; plain	3; plain
		A490	3	Plain	DH3; plain
Tension-Control Bolts			Galvanized	DH[1]; galvanized and lubricated	1; galvanized
		3	Plain	C3 and DH3; plain	3; plain
	F2280	3	Plain	DH3; plain	3; plain
ASTM A194 Heavy Hex Grade 2H nuts may be substituted.					

2.3. **Washer-Type Indicating Devices**. Use compressible-washer-type direct tension indicators that meet ASTM F959 if allowed. Provide detailed testing, installation, and inspection requirements prepared by the manufacturer.

2.4. **Storage**. Protect all bolts and nuts from dirt and moisture at the jobsite. Remove from protected storage only those bolts and nuts anticipated to be installed during a workday. Return unused fasteners to protected storage at the end of the day. Do not clean fasteners of lubricant present in the as-delivered condition. Perform a field R-C test in accordance with Tex-452-A on any lot of fasteners that shows signs of rust, dirt, or loss of lubrication. Apply additional lubrication and rerun the R-C test before installing bolts if the fasteners fail the R-C test. Replace any fasteners that cannot be re-lubricated to pass the field R-C test. Tension control bolts may only be re-lubricated by the manufacturer.

2.5. **Sampling and Testing**. Sample high-strength bolts, nuts, and washers in accordance with Tex-719-I. Perform field R-C tests in accordance with Tex-452-A. Perform installation verification tests required in Section 447.4.1., “Verification Testing.”

2.6. **Fitup Bolts and Erection Pins**. Provide heavy-hex fitup bolts of the same diameter as the connection bolts. Do not use washer-type indicating devices for fitups. Do not reuse galvanized bolts or ASTM A490 bolts that have been used as fitup bolts. Provide a sufficient number of erection or drift pins, 1/32 in. larger than the bolt diameter.

2.7. **Paint Markers**. Provide white or yellow paint markers for marking bolts or nuts for wrench calibration, R-C Tests, and bolt installation.

3. EQUIPMENT

3.1. **Testing Equipment**. Provide a calibrated tension-measuring device (Skidmore-Wilhelm or equivalent), calibrated torque wrench, and other accessories necessary to perform the installation verification test and the R-C test and to calibrate hydraulic or electric torque wrenches.

3.2. **Wrenches**. Furnish either of the following types of wrenches.

3.2.1. **Air-Driven Impact Wrenches**. Furnish air-driven impact wrenches, air compressors, and related accessories of sufficient capacity to properly tension high-strength bolts. Impact wrenches should be of sufficient size and capacity to be able to tension fully a bolt in less than 15 seconds. Repair or replace any wrenches that are unable to apply full tension to a bolt within this time.

3.2.2. **Calibrated Torque Wrenches**. Furnish calibrated hydraulic or electric torque wrench and related accessories capable of properly tensioning high-strength bolts. Calibrate the wrench to stall out or cut out completely when the bolt tension reaches 1.05 times the tension specified in Table 2. Calibrate the wrench by tensioning 3 bolts of each size in a calibrated tension-measuring device (Skidmore-Wilhelm or equivalent). Mark each bolt and verify the rotation from snug-tight when calibrating the wrench as specified in Section 447.4.5.3.1., "Turn-of-the-Nut Method." Calibrate the wrench at least once each Business Day. Recalibrate the wrench for changes in bolt diameter; changes in bolt length greater than two bolt diameters; significant differences in the surface condition of the bolts, threads, nuts, or washers; or changes in the equipment or hose length.

4. CONSTRUCTION

4.1. **Verification Testing**. Have each member of the bolting crew that will perform the actual Work complete an acceptable pre-installation verification test in the presence of TxDOT. Only crewmembers that have demonstrated proper workmanship via verification testing may perform production bolting Work.

4.1.1. **Air-Driven Impact Wrench**. Perform an installation verification test on 3 complete fastener assemblies of each combination of diameter, length, grade, and lot to be installed before beginning bolting. Follow the bolt-tensioning procedures in Section 447.4.5.3., "Tension Bolts." Use a calibrated tension-measuring device (Skidmore-Wilhelm or equivalent) to verify and demonstrate that the method for estimating the snug-tight condition and controlling the turns from snug-tight develops a tension greater than 1.05 times the tension specified in Table 2. The snug-tight condition is defined as the tightness that exists when the plies of the joint are in firm contact.

4.1.2. **Calibrated Torque Wrench**. Calibrate the wrench before beginning bolting in accordance with Section 447.3.2.2., "Calibrated Torque Wrenches." Use the bolting crew that will perform the actual Work for the calibration and calibrate the wrench in the presence of TxDOT. Follow the bolt-tensioning procedures in Section 447.4.5.3., "Tension Bolts."

4.1.3. **Direct-Tension Indicator**. Use a calibrated tension-measuring device for compression-type indicators to verify the gap is not less than 0.015 in. or the job inspection gap specified by the manufacturer when tension in the bolt reaches 1.05 times the tension specified in Table 2.

Follow the manufacturer's instructions for pre-installation verification testing methods and frequency for alternative washer-type indicating devices deemed acceptable.

4.2. **Workmanship**. TxDOT will disqualify any crewmembers not adhering to proper installation methods during production Work. Disqualified crew may not perform further bolting Work until they complete an additional pre-installation verification test suitable to TxDOT.

4.3. General. Ensure all material within the grip of the bolt is steel. Do not allow any compressible material such as gaskets or insulation within the grip. Ensure the slope of parts in contact with the bolt head or nut does not exceed 1:20 with respect to a plane normal to the bolt axis. Prepare all joint surfaces, including those in contact with the bolt heads, nuts, or washers, so that the surfaces are free of dirt, loose rust, loose mill scale, burrs, and other matter that would prevent solid seating of the parts.

Replace any bolts and nuts installed for shipping purposes unless the shop drawings indicate the shop-installed bolts are to be fully tensioned in the shop. Do not tension bolts that have been installed snug-tight in the shop. Remove any bolts installed snug-tight in the shop and replace

them with new bolts. Inspect and prepare the joint surfaces after removing shop-installed bolts that are not fully tensioned in the shop.

Provide a hardened washer for heavy-hex and tension-control bolts under either the nut or the bolt head, whichever is turned during tensioning. Install hardened washers under both the nut and bolt head of ASTM A490 bolts when the outer plies being fastened have a yield strength less than 40 ksi.

Install an ASTM F436 washer for direct tension indicators as follows:

- under the nut when the nut is turned and the direct tension indicator is located under the bolt head;
- between the nut and the direct tension indicator when the nut is turned and the direct tension indicator is located under the nut;
- under the bolt head when the bolt head is turned and the direct tension indicator is located under the nut; and
- between the bolt head and the direct tension indicator when the bolt head is turned and the direct tension indicator is located under the bolt head.

Tension all bolts to provide the minimum bolt tension values given in Table 2.

Erect steel in conformance with Item 441, “Steel Structures.” Do not tack-weld any parts to eliminate fitup bolts or to hold parts together while bolting.

Remove lubricant from bolt assemblies on painted structures after tensioning and before coating the connections.

Re-tighten the nuts or tack weld the nuts to the bolts when bolts are used to temporarily support welded diaphragms after completing the welding operations if the diaphragms are over vehicular or pedestrian traffic.

Table 2

Bolt Tension

Nominal Bolt Size, in.	Minimum Tension (kips)	
	ASTM A325 Bolts	ASTM A490 Bolts
1/2	12	15
5/8	19	24
3/4	28	35
7/8	39	49
1	51	64
1-1/8	56	80
1-1/4	71	102
1-3/8	85	121
1-1/2	103	148

4.4. **Preparation of Faying Surfaces**. Perform blast cleaning or painting of faying surfaces in accordance with Item 441, "Steel Structures."

Roughen galvanized faying surfaces by hand wire-brushing. Do not use power wire brushes to roughen galvanized faying surfaces.

4.5. **Bolt Installation.** Use the following procedure for bolt installation of a complete connection:

4.5.1. **Fair-Up Holes**. Use a minimum number of erection or drift pins in the holes to “fair-up” all holes.

4.5.2. **Install Bolts**. Install bolts in all remaining holes of the connection. Do not use excessive force, which results in damage to the threads, to install the bolts. Increase the number of erection or drift pins as necessary to align the holes if force is required to install the bolts. Do not ream the holes. Ream the holes in accordance with Section 441.3.11.5., “Misfits,” if approved. Remove the erection or drift pins and install bolts in these holes. Bring the connection to a full snug-tight condition by snugging systematically from the most rigid part of the connection to the free edges. The snug-tight condition is defined as the tightness that exists when the plies of the joint are in firm, full contact and all of the bolts in the joint have been tightened sufficiently to prevent the removal of the nuts without the use of a wrench. A snug-tight condition can usually be attained by a few impacts of an impact wrench or the full effort of a worker using an ordinary spud wrench as demonstrated in the installation verification test. As necessary, re-snug previously snugged bolts that may have relaxed as a result of the subsequent snugging of adjacent bolts to ensure all bolts are simultaneously snug-tight and the connection plates are in full contact.

Fully tighten a minimum number of bolts until the plies are in full contact if snugging does not bring the plies of the joint into full contact. Mark these bolts as fitup bolts. Use a non-galvanized

ASTM A325 bolt of the same diameter as a fitup bolt in connections requiring the use of galvanized ASTM A325 bolts or ASTM A490 bolts. Re-snug all remaining bolts.

Do not use washer-type indicating devices to bring the connection to a snug-tight condition. Rather, install heavy-hex bolt assemblies in a sufficient number of holes (approximately 20%) to attain firm, full contact between plies. Remove the heavy-hex bolts and install the washer-type indicating device assemblies after firm contact is established by connections in surrounding bolt holes.

4.5.3. **Tension Bolts**. Loosen all fitup bolts after tensioning all the other bolts in the connection. Ungalvanized ASTM A325 bolts used as fitup bolts may be reused in a connection using this type of bolt. Replace all galvanized bolts and ASTM A490 bolts used as fitup bolts. Tension these remaining untensioned bolts in accordance with this paragraph. Ensure the Element not turned by the wrench (bolt head or nut) does not rotate.

4.5.3.1. **Turn-of-the-Nut Method**. Match-mark the nuts and the protruding bolt ends after the bolts have been brought up to snug-tight condition and before final tensioning so that actual rotation can be determined. Tension all bolts in the connection to their final tension by the amount of rotation specified in Table 3. Start final tensioning at the center or most rigid part of the connection and progress toward the free edges.

4.5.3.2. **Calibrated Wrench Method**. Use a calibrated hydraulic torque wrench to tension all bolts to 1.05 times the tension given in Table 1 after they have been brought to the snug-tight condition. Calibrate the wrench in accordance with Section 447.3.2.2., “Calibrated Torque Wrenches.” Start tensioning at the most rigid part of the connection and proceed to the free edges. Return the wrench to re-tension previously tensioned bolts that may have relaxed as a result of the subsequent tensioning of adjacent bolts. Place marks on the socket at one-third points so the amount of rotation can be visually determined.

4.5.3.3. **Washer-Type Indicating Devices**.

4.5.3.3.1. **Compressible-Washer-Type Direct Tension Indicators**. Ensure the direct-tension indicator arches are oriented away from the Work and that they bear against the hardened bearing surface. Confirm the appropriate feeler gage is 1) accepted in at least half the spaces between protrusions before tensioning, and 2) refused entry in at least half the spaces between protrusions after tensioning.

4.5.3.3.2. **Alternative Washer-Type Indicating Devices**. Follow the procedures prepared by the manufacturer. Verify proper installation after tensioning.

4.5.4. **Bolt Reuse**. Do not re-use ASTM A490 or galvanized ASTM A325 bolts,. Ungalvanized ASTM A325 bolts may be re-used one time if the threads have not been damaged. Re-tensioning previously tensioned bolts loosened by the tensioning of adjacent bolts is not considered to be reuse.

Tension all bolts in a connection within 10 Days of installation. Bolts not tensioned within 10 Days of installation are subject to field R-C testing. Re-lubricate or replace any installed bolts that do not have sufficient lubrication as determined by the field R-C test.

Table 3

Nut Rotation from Snug-Tight Condition[1]

Bolt length (underside of head to end of bolt)	Disposition of Outer Face of Bolted Parts		
	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped less than 1:20 (beveled washer not used)	Both faces sloped less than 1:20 from bolt axis (beveled washer not used)
Up to and including 4 bolt diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 bolt diameters up to and including 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 bolt diameters up to and including 12 diameters[2]	2/3 turn	5/6 turn	1 turn

1. Nut rotation is relative regardless of the Element (nut or bolt) being turned. The tolerance is –0°, +30° for bolts installed by 1/2 turn or less and –0°, +45° for bolts installed by 2/3 turn or more.

2. Determine the required rotation for bolt lengths greater than 12 diameters using the installation verification test in a simulated connection of solidly fitted steel.

Item 448

33. Structural Field Welding

1. DESCRIPTION

Field-weld metal members using the shielded metal arc or flux cored arc welding processes.

2. MATERIALS

Provide electrodes for shielded metal arc welding (SMAW) conforming to the requirements of the latest edition of ANSI/AWS A5.1 or ANSI/AWS A5.5.

Provide electrodes for flux cored arc welding (FCAW) conforming to the requirements of the latest edition of ANSI/AWS A5.20 or ANSI/AWS A5.29.

Provide electrodes and flux-electrode combinations named on the approved list maintained by TxDOT. To request that a product be added to this list or to renew an expired approval, Developer or the consumable manufacturer must submit certified reports of all tests required by the applicable AWS A5 specification according to the applicable welding code to TxDOT. For most structural steel construction, the applicable welding code is AASHTO/AWS D1.5 or ANSI/AWS D1.1. For reinforcing steel, the applicable code is ANSI/AWS D1.4. Tests must be conducted on electrodes of the same class, size, and brand and manufactured by the same process and with the same materials as the electrodes to be furnished. Resubmit electrodes or flux-electrode combinations every 12 months for renewal.

Table 1 shows the classes of electrodes required. Use electrodes with the type of current, with the polarity, and in the positions permitted by AWS A5.1 and A5.5 for SMAW. AWS A5.20 and A5.29 specifications govern for FCAW. Obtain approval for electrode use on steel not listed in Table 1.

Table 1

Classification of Electrodes Permitted

Type of Steel (ASTM Standards)	Electrode Specification	Process	Filler Metal Requirements
Steel piling Armor joints A500 A501	AWS A5.1 or A5.5	SMAW	E60XX E70XX or E70XX-X
	AWS A5.20 or A5.29	FCAW	E6XTX-X E7XTX-X (except -2, -3, -10, -GS)
A36 A572 Gr. 50 A588 A242 A709 Gr. 36. 50, or 50S	AWS A5.1 or A5.5	SMAW	E7016 E7018 E7028
	AWS A5.20 or A5.29	FCAW	E7XT-1 E7XT-5 E7XT-6 E7XT-8
Reinforcing steel Grade 40	AWS A5.1 or A5.5	SMAW	E70XX
Reinforcing steel Grade 60	AWS A5.5	SMAW	E90XX
Permanent metal deck forms	AWS A5.1 or A5.5	SMAW	E6010 E6011 E6013 E7018

Note—Low-hydrogen electrodes applicable to the lower strength base metal may be used in joints involving base metals of different yield points or strengths.

Use E7010 and E8010 electrodes when welding the root passes of beam and girder splices if the requirements of Section 448.4.3.5.1., “High-Cellulose Electrodes for Root Passes,” are met.

Use electrodes meeting the diffusible hydrogen requirements for fracture-critical welding in AASHTO/AWS D1.5 when welding fracture-critical applications.

Use gas or gas mixtures that are welding grade and have a dew point of −40ºF or lower for gas-shielded FCAW. Furnish certification that the gas or gas mixture is suitable for the intended application and will meet the dew point requirements.

3. EQUIPMENT

Provide electrode drying and storing ovens that can maintain the required temperatures specified in Section 448.4.3.1., “Electrode Condition.” Each oven must have a door that is sealed and can be latched. Each oven must have a small port that may be opened briefly to insert a

thermometer or the oven must be equipped with a thermometer that allows for direct reading of temperature inside the oven without opening the oven. Provide equipment able to preheat and maintain the temperature of the base metal as required and as shown on the Design Documents. Provide approved equipment (e.g., temperature indicator sticks or infrared thermometer) for checking preheat and interpass temperatures at all times while welding is in progress. Provide welding equipment meeting the requirements of the approved welding procedure specifications (WPS), if required, and capable of making consistent high-quality welds.

4. CONSTRUCTION

4.1. **Procedure Qualification**. Use the proper classification and size of electrode, arc length, voltage, and amperage for the thickness of the material, type of groove, welding positions, and other circumstances of the Work.

Submit WPSs for FCAW, qualified in accordance with AASHTO/AWS D1.5 for approval before any field welding on a project.

4.2. **Welder Qualification**. Provide TxDOT certification papers for each welder and for each welding process to be used before welding, except for miscellaneous welds described in Section 448.4.2.1.1., "Miscellaneous Welding Applications." Certification is issued by TxDOT as described in Section 448.4.2.2., "Certified Steel Structures Welder."

4.2.1. **Miscellaneous Welding**. A qualified welder is an experienced welder who is capable of making welds of sound quality but does not have TxDOT certification papers. TxDOT will check the welder's ability by conducting a jobsite test in accordance with Section 448.4.2.1.2., "Miscellaneous Weld Qualification Test," before welding begins. Furnish all materials and equipment necessary for this test.

4.2.1.1. **Miscellaneous Welding Applications**. A welder certified for structural or reinforcing steel or a qualified welder may make miscellaneous welds of the following types:

- 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 to reinforcing bars in drilled shaft cages;
- permanent metal deck forms;
- additional 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.

4.2.1.2. **Miscellaneous Weld Qualification Test**. A qualified welder must pass a jobsite Miscellaneous Weld Qualification Test before welding:

- Make a single-pass fillet weld of 1/4 in. maximum size in the vertical position approximately 2 in. long on 1/2-in. plate in the location shown in Figure 1. Use the same electrode proposed for the Work.
- TxDOT will visually inspect the fillet weld for a reasonably uniform appearance and then rupture the weld as shown in Figure 2 with a force or by striking it with a hammer.

- The fractured surface of the weld shall be inspected to ensure complete penetration into the root of the joint, complete fusion to the base metal, and no inclusion or porosity larger than 3/32 in. in its greatest dimension.

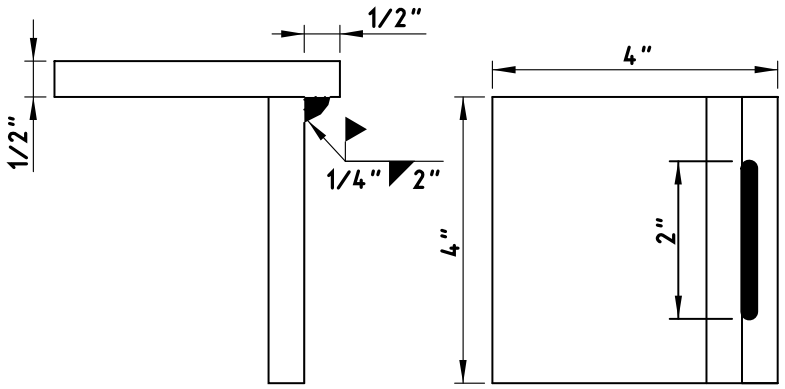


Figure 1

Miscellaneous qualification—fillet weld break specimen.

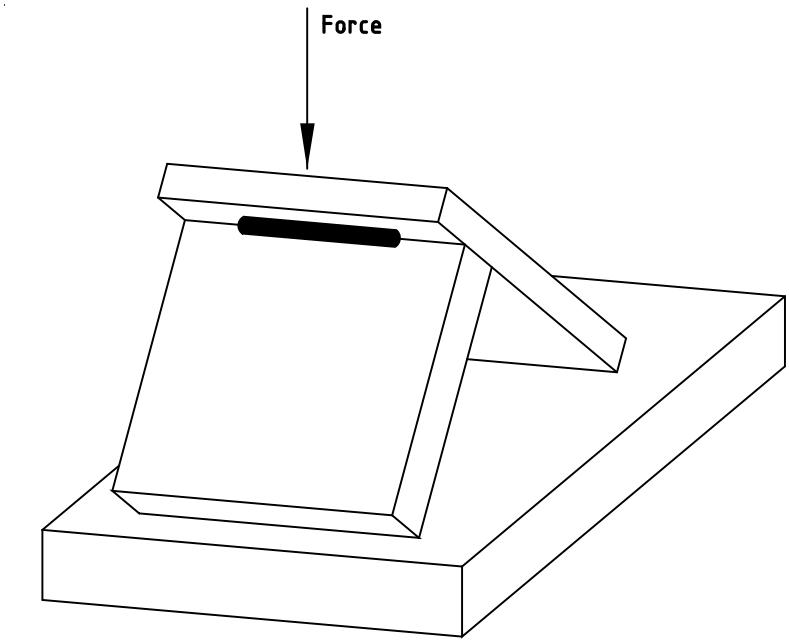


Figure 2

Miscellaneous qualification—method of rupturing specimen.

A welder who fails the Miscellaneous Weld Qualification Test may take a retest under the following conditions:

- The retest occurs immediately and consists of 2 test welds as described above with both test specimens meeting all of the requirements.

- The retest occurs after 30 Days if the welder provides evidence of further training or practice. In this case the test consists of a single test weld.

Qualification by the Miscellaneous Weld Qualification Test is effective immediately upon satisfactory completion of the test and remains in effect for the duration of a project.

4.2.2. **Certified Steel Structures Welder**. Before making non-miscellaneous welds on structural steel, a welder must pass the AASHTO/AWS D1.5 qualification test for groove welds for plates of unlimited thickness in the vertical (3G) and overhead (4G) positions with the following additional requirements:

- Use metal for test plates that meets Item 442, "Metal for Structures," with a minimum yield point of 36 ksi. The minimum width of test plate must be sufficient to accommodate the radiograph inspection of 5-1/4 continuous inches of the weld, not counting the ends of the weld.
- Use approved electrodes meeting the required class in accordance with Table 1 and, in the case of FCAW, in accordance with the approved WPS.
- Have a radiographic inspection performed on the weld on each test plate. Any porosity or fusion-type discontinuity with greatest dimension larger than 1/16 in. found in the weld will result in failure of the test. Discontinuities with greatest dimension less than 1/16 in. are acceptable provided the sum of their greatest dimensions does not exceed 3/8 in. in any inch of weld.
- Have two side-bend specimens prepared, tested, and inspected for each test plate.

The test must be administered by an approved laboratory and welding observed by laboratory personnel. Submit 2 copies of the certification issued by the laboratory, all accompanying test papers, and the radiographic films to TxDOT for review. TxDOT issues certification papers if the laboratory's certification is approved. A welder must also demonstrate a thorough knowledge of the required welding procedures together with the ability and desire to follow them and make welds of sound quality and good appearance. The certification issued by an approved laboratory is accepted for 1 mo. from the time of certification, during which time the welder may work on TxDOT projects if the Work is satisfactory. Certification papers issued by TxDOT remain in effect as long as the welder performs acceptable Work as determined by TxDOT. The certification may be cancelled at any time if the welder's work is not acceptable.

For SMAW, a welder certified using EXX18 electrodes is qualified to weld with all approved SMAW electrodes up to E90XX to join metals with a maximum specified yield strength of 65 ksi.

4.3. **Welding Steel Structures**.

4.3.1. **Electrode Condition**.

4.3.1.1. **SMAW**. Dry electrodes with low-hydrogen coverings in conformance with AWS A5.1and the manufacturer's written drying instructions or for at least 2 hours between 450°F and 500°F. Dry electrodes with low-hydrogen coverings in conformance with AWS A5.5 for at least 1 hr. between 700°F and 800°F or as specified by the electrode manufacturer. If using electrodes from a newly opened, undamaged, hermetically sealed container, drying is not required. Store electrodes in ovens held at a temperature of at least 250°F immediately after drying or removal from hermetically sealed container. Elapsed time permitted between removal of an electrode from the storage oven or hermetically sealed container and use of the electrode is given in

Table 2. If the electrodes have the moisture resistance designator "R" and are being used on steel with minimum specified yield strength of 50 ksi or less, exposure time may be increased up to 9 hr.

Table 2

SMAW Electrode Exposure Limits

Electrode Type	Exposure Time (hr.)
E70	4
E80	2
E90	1

Leave electrodes in the holding oven for at least 4 hr. at 250°F before reusing if they are placed back in it before the times given in Table 2 have lapsed. Do not redry electrodes more than once. Do not use electrodes with flux that has been wet, cracked, or otherwise damaged.

4.3.1.2. **FCAW**. Protect or store welding wire coils removed from the original package to keep their characteristics or welding properties intact. Do not use coils or portions of coils that are rusty.

4.3.1.3. **Special Applications**. Dry electrodes for fracture-critical applications or when welding steel not shown in Table 1 in accordance with the manufacturer's specifications and AASHTO/AWS D1.5.

4.3.2. **Environmental Conditions**. Do not weld when the air temperature is lower than 20°F; when surfaces are wet or exposed to rain, snow, or wind; or when operators are exposed to inclement conditions. Provide wind breaks to protect welding operations from winds greater than 5 mph.

4.3.3. **Assembly and Fitup**. Verify that ends of members to be welded are prepared in accordance with the welded joint detail specified. See Figures 3, 4, and 5 for proper end preparation and weld details of girder splices.

Bring the parts to be joined by fillet welds into as close contact as possible, not separated more than 3/16 in. Increase the leg of the fillet weld by the amount of the separation if the separation is 1/16 in. or more. Keep the separation between faying surfaces of lap joints and of butt joints landing on backing strips to no more than1/16 in.

Make suitable allowance for shrinkage, and never restrain the joint on both sides in any welding process.

Use the following fitup procedure for groove welds for butt joints:

- Align splices of beams and girders joined by groove welds with the center of gravity of both cross-sections coinciding or each flange vertically offset equally. Fit beams and girders with offset webs with the webs aligned and the flanges offset laterally. Make the joint with a smooth transition between offset surfaces and with a slope of no more than1:4 when flanges are offset or abutting parts differ in thickness or width by more than 1/8 in.
- Space members to provide a 3/16-in. root opening at the nearest point. At other points of the joint when the spacing provides up to a 7/16-in. opening, correction may be made by buildup up to 1/8 in. on each bevel nose. Rebevel openings exceeding 7/16 in. and move the

parts to be joined closer together to bring the joint within the maximum buildup limits. Allow buildups to cool to the maximum preheat and interpass temperatures before welding the joint.

- Bring all members into correct alignment and hold them in position by acceptable clamps while welding.

Complete all butt splices before welding diaphragms or sway bracing in a particular section of a unit. Diaphragms and sway bracing may be welded in a unit behind the splice welding to provide stability except where such welding interferes with butt splice adjustments, such as at a drop-in segment of a continuous unit. Complete all splices before welding beams or girders to shoes.

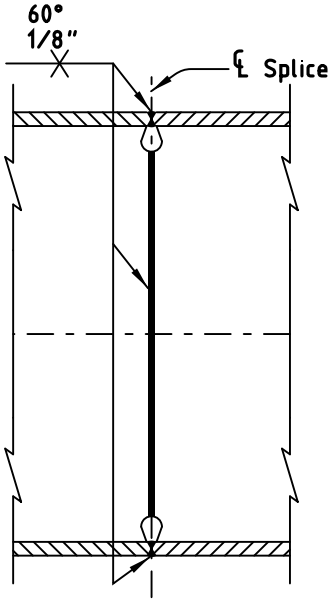


Figure 3

Girder splice details.

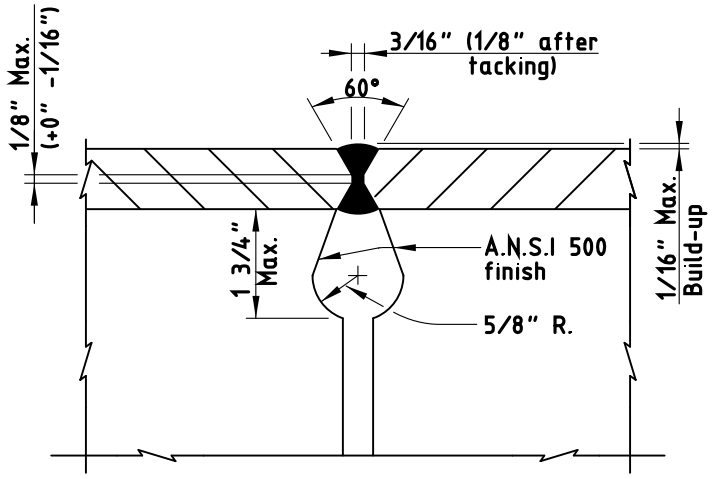


Figure 4

Girder splice details (flange).

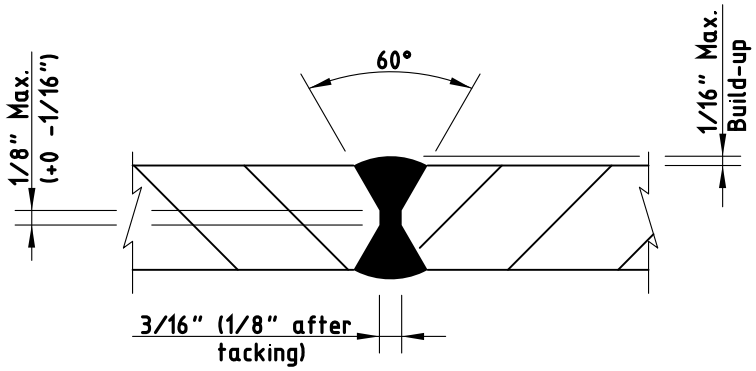


Figure 5

Girder splice details (web).

4.3.4. **Preheat**. Preheat ahead of welding both groove and fillet welds (including tack welding) to the temperatures shown in Table 3. Keep preheat and interpass temperatures high enough to prevent cracks. The preheat temperatures shown in Table 3 are minimums, and higher preheats may be necessary in highly restrained welds. Preheat the base metal when it is below the required temperature so that parts being welded are not cooler than the specified temperature within 3 in. of the point of welding.

Measure preheat temperature on the side opposite to which the heat is applied at points approximately 3 in. away from the joint.

Completely weld a joint before allowing it to cool below the specified temperature. Always deposit enough weld to prevent cracking before allowing a joint to cool. Do not allow preheat and interpass temperatures to exceed 400°F for thickness up to 1-1/2 in. and 450°F for greater thicknesses.

Table 3

Minimum Preheat and Interpass Temperature for Welding with Low-Hydrogen Electrodes

Thickest Part at Point of Welding	Temperature
Up to 3/4 in., inclusive	50°F
More than 3/4 in. up to 1-1/2 in., inclusive	70°F
More than 1-1/2 in. up to 2-1/2 in., inclusive	150°F
More than 2-1/2 in.	225°F

Preheat the material in accordance with Table 4 when E7010 or E8010 electrodes are used for tacking or temporary root pass.

Table 4

Minimum Preheat Temperature for Welding with E7010 or E8010 Electrodes

Thickest Part at Point of Welding	Temperature
1/2 in. and less	150°F
9/16 in. through 3/4 in.	200°F
13/16 in. through 1-1/2 in.	300°F
More than 1-1/2 in.	400°F

Use preheat and interpass temperatures for the thicker plate thickness when joining steels of different thickness.

Preheat base metal to at least 70°F when the base metal temperature is below 32°F. and maintain this minimum temperature during welding. Preheat base metal to 200°F before starting to weld if it is moist.

Preheat fracture-critical applications in accordance with AASHTO/AWS D1.5.

4.3.5. **Welding Practice**. Use an approved procedure to control shrinkage and distortion. Weld FCAW in accordance with an approved WPS. Weld as required by the Contract or erection drawings. Do not change the location or size of welds without approval. Do not make temporary welds for transportation, erection, or other purposes on main members except as shown on the Design Documents or approved. Use a crayon, paint, or other approved method to mark each groove weld to identify the welder who performed the Work.

Use the stringer-bead technique where possible for groove welds. Progress upward in vertical welding passes using a back-step sequence keeping the end of the low-hydrogen electrode contained within the molten metal and shield of flux unless the electrode manufacturer's specifications indicate otherwise.

Begin and terminate groove welds at the ends of a joint on extension bars. Make edge preparation and thickness of extension bars the same as that of the member being welded but extending at least 2 in. beyond the joint. Remove extension bars with a cutting torch or arc-air gouging, and grind the flange edges smooth after the weld is completed and cooled. Clean any defects exposed by the grinding, fill them with weld metal, and regrind them to a uniform finish. Grind so that grind marks are parallel to the flange, and avoid excess grinding of the parent metal. Clean and fuse tack welds thoroughly with the final weld. Remove defective, cracked, or broken tack welds.

Gouge, chip, or otherwise remove the root of the initial weld to sound metal for all groove welds, except those produced with the aid of backing or those on steel piling or armor joints, before welding is started on the second side. Clean the back side thoroughly before placing the backup pass. Fuse the weld metal thoroughly with the backing, and use backing that is continuous for the full length of the weld. Make a continuous length of backing by welding shorter sections together only under the following conditions:

- All splices in the backing are complete joint penetration (CJP) groove welds made with the same controls as similar CJP groove welds in the structure.

- The welds are radiographed and examined as described in Section 448.4.3.7., “Radiographic Inspection” to ensure weld soundness.
- All welding and testing of the backing is complete before the backing is used to make the structural weld.

4.3.5.1. **High-Cellulose Electrodes for Root Passes**. Use E7010 and E8010 electrodes when welding the root passes of beam and girder splices if the Work is preheated in accordance with Table 4. Remove the E7010 or E8010 electrode pass completely by arc-air gouging, and replace it using a low-hydrogen electrode after the root passes are backed up.

4.3.5.2. **Welding Sequence**. Make beam and girder splices using the sequences shown in Figure 6. (Some members will require fewer or more passes than Figure 6 shows.) Alternate welds from flat to overhead to prevent heat buildup along bevel edge. Arrange the passes between the top and bottom flange to maintain balance and symmetry.

Place passes 1, 2, and 3 in the top flange, followed by passes 4, 5, and 6 in the bottom flange (see Figure 6) for rolled I-beams and built-up girders. Gouge out and replace passes 1 and 4, which always are placed in the overhead position. Next, place passes 7, 8, and 9 in the top flange, followed by passes 10, 11, and 12 in the bottom flange. Continue with placing passes 13–17 in the top flange, followed by passes 18–22 in the bottom flange. Continue to alternate welding between top and bottom flange with a maximum of 5 passes per flange until the flange splices are complete. Tack weld web after aligning girder webs with short tacks as required to obtain proper alignment. Place pass 23 and pass 24 on the web. Gouge out and replace pass 23. Finish web splice with pass 25.

Remove all slag for each layer, bead, and the crater area, and clean the weld and adjacent base metal before welding over previously deposited metal. Avoid arc strikes, and if they occur, grind resulting cracks and blemishes out to a smooth contour, checking them visually to ensure soundness.

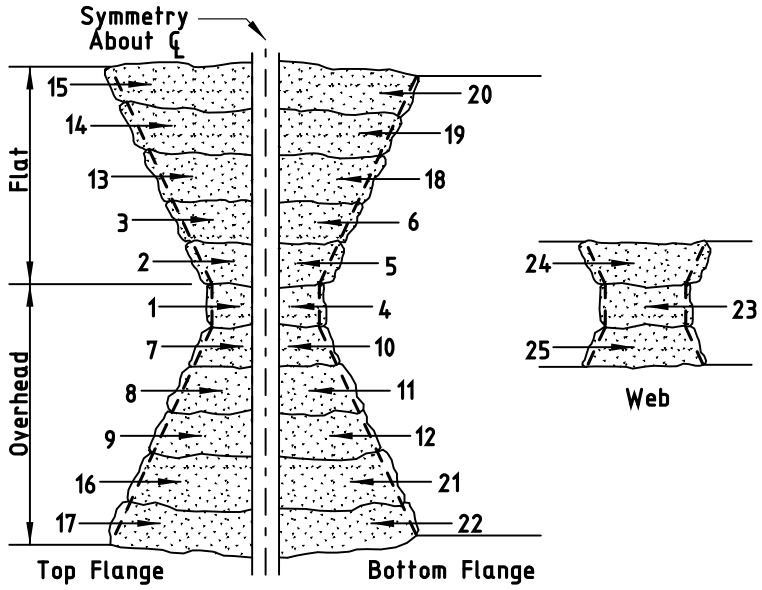


Figure 6

Welding sequence for splices for material up to 50,000-psi yield strength.

Deviation from the above sequence of weld passes requires approval. Obtain approval from TxDOT for welding procedures and sequences for special connections.

4.3.5.3. **Electrode Size and Weld Layer Thickness**.

4.3.5.3.1. **SMAW**.

4.3.5.3.1.1. **Electrode Size**. Use electrodes with the following maximum size:

1/4 in. for all welds made in the flat position except root passes,
1/4 in. for horizontal fillet welds,
1/4 in. for root passes of fillet welds made in the flat position and of groove welds made in the flat position with backing and with a root opening of 1/4 in. or more,
5/32 in. for welds made with low-hydrogen electrodes in the vertical and overhead positions, and
3/16 in. for all other welds.

4.3.5.3.1.2. **Weld Size and Layer Thickness**. Make the root pass large enough to prevent cracking. Make layers subsequent to the root pass in fillet welds and all layers in groove welds of the following maximum thickness:

1/4 in. for root passes of groove welds;
1/8 in. for subsequent layers of welds made in the flat position; and
3/16 in. for subsequent layers of welds made in the vertical, overhead, and horizontal positions.

Make fillet welds passes using no larger than:

3/8 in. in the flat position,
5/16 in. in the horizontal or overhead positions, and
1/2 in. in the vertical position.

4.3.5.3.2. **FCAW**.

4.3.5.3.2.1. **Electrode Size**. Use electrodes with the following maximum size:

- 5/32 in. for the flat and horizontal positions,
- 3/32 in. for the vertical position, and
- 5/64 in. for the overhead position.

4.3.5.3.2.2. **Weld Size and Layer Thickness**. Make weld layers, except root and surface layers, no thicker than 1/4 in. Use a multiple-pass split-layer technique when the root opening of a groove weld is 1/2 in. or wider. Use the split-layer technique to make all multiple-pass welds when the width of the layer exceeds 5/8 in.

Ensure each pass has complete fusion with adjacent base metal and weld metal and that there is no overlap, excessive porosity, or undercutting.

Do not use FCAW with external gas shielding in a draft or wind. Furnish an approved shelter of material and shape to reduce wind velocity near the welding to a maximum of 5 mph.

Make fillet weld passes using no larger than:

- 1/2 in. in the flat position,

- 3/8 in. in the horizontal or overhead positions, and
- 5/16 in. in the vertical position.

4.3.6. **Weld Quality**. Provide welds that are sound throughout with no cracks in the weld metal or weld pass. Completely fuse the weld metal and the base metal and each subsequent pass. Keep welds free from overlap, and keep the base metal free from undercut more than 1/100 in. deep when the direction of undercut is transverse to the primary stress in the part that is undercut. Fill all craters to the full cross-section of the welds.

4.3.7. **Radiographic Inspection**. Conduct radiographic testing (RT) as required in the field by an agency or individual registered and licensed to perform industrial radiography. Follow all applicable rules and regulations for radiographic operations. Testing includes furnishing all materials, equipment, tools, labor, and incidentals necessary to perform the required testing. TxDOT may require further tests and may perform additional testing, including other methods of inspection.

Perform RT in accordance with AASHTO/AWS D1.5. Iinterpret the resulting radiographs in accordance with AASHTO/AWS D1.5. All radiographs become the property of TxDOT.

Radiographically inspect the full flange width of all flange splices and the top and bottom 1/6 of the web at each splice for field-welds of splices in beams or girders. Radiographically retest repaired welds. Make necessary repairs before any further Work is done. RT of particular welds required by the Design Documents is in addition to the RT required by this Item.

Meet the requirements specified in Section 441.3.2.5.1., “Radiographic Testing” for radiograph film quality.

4.3.8. **Corrections**. When welding is unsatisfactory or indicates inferior workmanship, perform corrective measures and obtain approval of the subsequent corrections.

Use oxygen gouging or arc-air gouging when required to remove part of the weld or base metal. Back-gouge splices in beams and girders or cut out defective welds using arc-air gouging by a welder qualified to make beam and girder splices.

Slope the sides of the area to be welded enough to permit depositing new metal were corrections require depositing additional weld metal.

Use a smaller electrode than that used for the original weld where corrections require depositing additional weld metal. Clean surfaces thoroughly before re-welding.

Remove cracked welds completely and repair. Remove the weld metal for the length of the crack if crack length is less than half the length of the weld plus 2 in. beyond each end of the crack, and repair.

Restore the original conditions where Work performed after making a deficient weld has made the weld inaccessible or has caused new conditions making the correction of the deficiency dangerous or ineffectual by removing welds, members, or both before making the necessary corrections; otherwise, compensate for the deficiency by performing additional Work according to a revised and approved design.

Cut apart and re-weld improperly fitted or misaligned parts.

Straighten members distorted by the heat of welding using mechanical means or the carefully supervised application of a limited amount of localized heat. Do not let heated areas exceed 1,200°F as measured by temperature-indicating crayons or other approved methods for steel up to 65,000-psi yield strength. Do not let heated areas exceed 1,100°F for higher-strength steels. Keep parts to be heat-straightened substantially free of stress from external forces except when mechanical means are used with the application of heat. Before straightening, submit a straightening procedure for approval.

Correct defective or unsound welds either by removing and replacing the entire weld or as follows:

4.3.8.1. **Excessive Convexity**. Reduce to size by grinding off the excess weld metal, leaving a smooth profile.

4.3.8.2. **Shrinkage Cracks, Cracks in Base Metal, Craters, and Excessive Porosity**. Remove defective portions of base and weld metal down to sound metal, and replace with additional sound weld metal.

4.3.8.3. **Undercut, Undersize, and Excessive Concavity**. Clean and deposit additional weld metal.

4.3.8.4. **Overlap and Incomplete Fusion**. Remove and replace the defective portion of weld.

4.3.8.5. **Slag Inclusions**. Remove the parts of the weld containing slag, and replace them with sound weld metal.

4.3.8.6. **Removal of Base Metal during Welding**. Clean and form full size by depositing additional weld metal using stringer beads.

4.4. **Shear Stud Welding**. Weld shear studs to steel surfaces and perform preproduction and production tests as required in AASHTO/AWS D1.5.

4.5. **Welding Reinforcing Steel**. Splice reinforcing steel by welding only at locations shown on the Design Documents.

4.5.1. **Base Metal**. Provide weldable reinforcing steel in conformance with Item 440, “Reinforcement for Concrete.”

4.5.2. **Preheat and Interpass Temperature**. Minimum preheat and interpass temperatures are shown in Table 5. Preheat reinforcing steel when it is below the listed temperature for the size and carbon equivalency range of the bar being welded so that the cross-section of the bar is above the minimum temperature for at least 6 in. on each side of the joint. Allow bars to cool naturally to ambient temperature after welding is complete. Do not accelerate cooling.

Table 5

Minimum Preheat and Interpass Temperature for Reinforcing Steel

• Carbon Equivalent Range (%)	• Size of Reinforcing Bar (no.)	• Temperature (°F)
Up to and including 0.40	Up to 11 inclusive	None
	14 and 18	50
0.41 through 0.45 inclusive	Up to 11 inclusive	None
	14 and 18	100
0.46 through 0.55 inclusive	Up to 6 inclusive	None
	7 to 11 inclusive	50
	14 and 18	200
Unknown	Up to 18 inclusive	500

Base the preheat and interpass temperatures for widening projects on the existing reinforcing steel and the requirements of Table 5.

4.5.3. **Joint Types**. Use butt splices for all No. 7 and larger bars. Use lap splices for No. 6 and smaller bars.

Make groove welds in lap splices at least 4 in. long, and weld them on each side of the lap joint as shown in Figure 7.

Make all butt splices in the flat position. Make all welds for butt splices, except horizontal welds on vertical bars, as shown in Figures 8 and 9. The back-up strip is required when access to the splice is from the top only. When bars can be rotated or access to the splice is available from two sides, the double bevel splice may be used, and this type weld requires gouging out the root pass similar to a flange splice on structural steel. The root pass may be made using E7010 or E8010 electrodes for all double beveled splices. Preheat the steel to 400°F, if using E7010 or E8010 electrodes, and then completely remove the root pass before welding the opposite side. Make horizontal splices on vertical bars as shown in Figure 10. Provide alignment strips as shown in Figures 9 and 10 to hold bars during welding operation. Trim alignment strips after welding is complete.

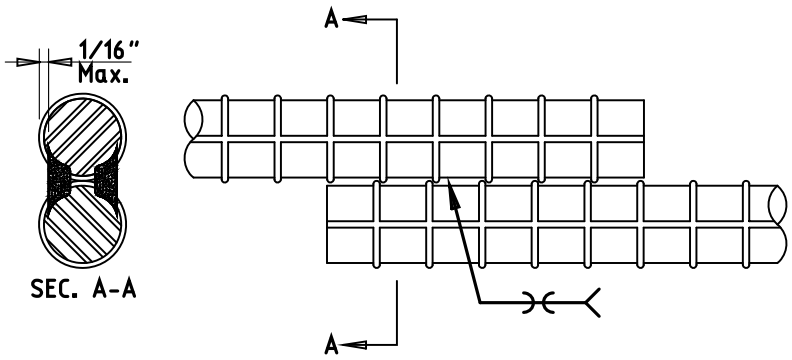


Figure 7

Direct lap joint with bars in contact.

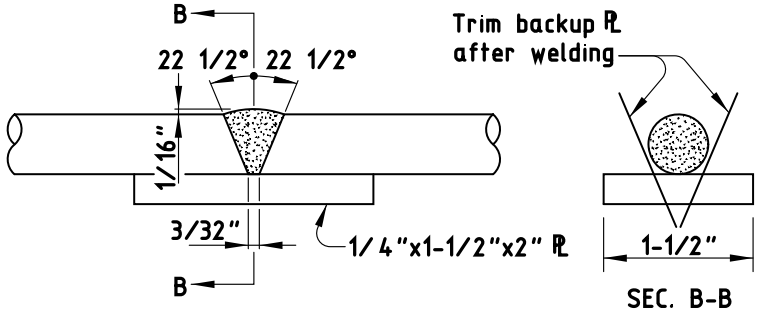


Figure 8

Single bevel V-groove weld in horizontal position.

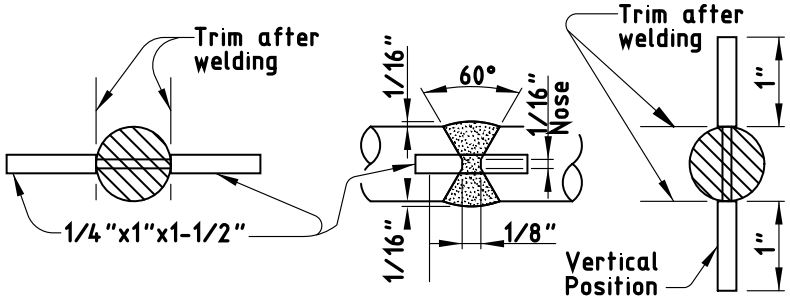


Figure 9

Double bevel V-groove weld in horizontal position.

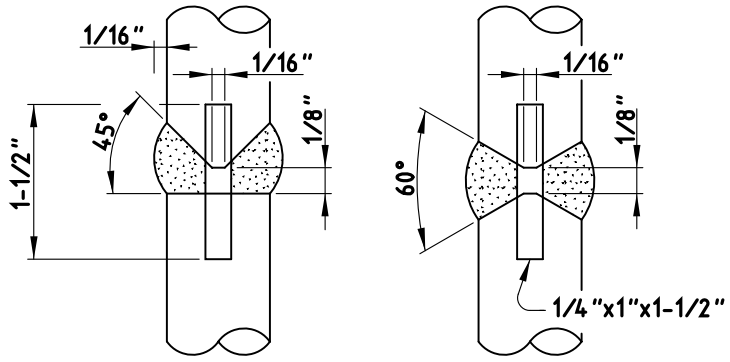


Figure 10

Double bevel V-groove weld in vertical position.

4.5.4. **Radiographic Inspection**. Radiograph welded butt splices when designated on the Design Documents. Follow all applicable rules and regulations for radiographic operations. Ensure welds have no cracks and that the sum of the greatest dimensions of porosity and fusion-type defects do not exceed 1/10 of the nominal bar diameter. Radiographs shall become the property of TxDOT.

Item 449

34. Anchor Bolts

1. DESCRIPTION

Fabricate and install anchor bolts to be embedded in or attached to concrete. Anchor bolts are also referred as anchor rods.

2. MATERIALS

2.1. **Bolts and Nuts. Provide bolts and nuts that meet the standards given in Table 1.**

Table 1

Bolt and Nut Standards

Specified Anchor Bolt Category	Bolt Standards	Nut Standards
Mild steel	ASTM A307 Gr. A, F1554 Gr. 36, or A36	ASTM A563
Medium-strength, mild steel	ASTM F1554 Gr. 55 with supplementary requirement S1	ASTM A194 Gr. 2 or A563 Gr. D or better
High-strength steel	ASTM A325 or A449[1]	ASTM A194 or A563, heavy hex
Alloy steel	ASTM A193 Gr. B7 or F1554 Gr. 105	ASTM A194 Gr. 2H or A563 Gr. DH, heavy hex

If headed bolts are specified, ASTM A449 bolts must be heavy hex head.

Provide a mill test report or manufacturer's certification indicating the material conforms to these requirements. Provide a test report or certification attesting to the heat-treating process for alloy steel anchor bolts if applicable. Provide mild steel anchor bolts and nuts that meet the standards given in Table 1 if no specific bolt category is indicated on the Design Documents.

2.2. **Washers**. Use washers that meet ASTM F436.

2.3. **Threads.** Provide anchor bolts with rolled or cut threads of UNC or 8UN series in accordance with ASME B1.1. Anchor bolts 1-3/4 in. in diameter and larger must have UNC series threads. Ensure the diameter of the unthreaded portion (of bolts with rolled threads) is neither less than the minimum pitch diameter nor more than the maximum major diameter of the threads. Ensure the diameter of the unthreaded portion (of bolts with cut threads) is not less than the minimum major diameter of the threads. Ensure all threads for bolts and nuts have Class 2 fit tolerances in accordance with ASME B1.1.

3. CONSTRUCTION

3.1. **Fabrication.** Welded splicing of anchor bolts is not permitted.

Provide an anchorage device with each anchor bolt consisting of a standard bolt head, a threaded bolt with nuts, or, if shown on the Design Documents, a 90° bend. Make the inside-bend diameter approximately 2 times the anchor bolt diameter, but at no point along the bend greater than 3 times the bolt diameter. Hot bending is permissible provided the temperature does not exceed 1,100°F.

Tack weld the anchorage nuts to the template in the shop if the anchor bolts will be installed in a template embedded in concrete. Perform this welding with appropriate jigs to ensure the anchor bolt is perpendicular to the template.

Weld only on the nut face at the unstressed end of the bolt when embedded templates are not specified and nuts are welded to the end of anchor bolts for anchorage. Ensure no welding, arc, or other potential notch-producing effects occur in the stressed portion of the bolt.

Shipping of the anchor bolt cage in its assembled condition is not required.

3.2. **Finish.** Galvanize in accordance with Item 445, “Galvanizing.”

3.2.1. **Anchor Bolts Embedded in Concrete**. Galvanize the exposed end of the thread length plus a minimum of 6 in..

3.2.2. **Anchor Bolts Extending Through Concrete**. Galvanize the complete length of the bolt.

3.2.3. **Nuts**. Galvanize exposed nuts. Galvanize the untapped blanks before cutting the threads.

3.2.4. **Washers**. Galvanize exposed washers.

3.3. **Installation**. Hold the anchor bolt and template assembly rigidly in position during concrete placement. Use wood templates or other positive means to ensure correct positioning of anchor bolts not requiring steel templates. Positioning devices may be tack welded to the steel templates but not to any portion of the anchor bolts.

3.3.1. **Anchor Bolt Thread Lubricant Coating**. Coat anchor bolt threads before installing nuts with an electrically conducting lubricant compound described in Section 449.3.3.2.1., “Definitions,” for traffic signal poles, roadway illumination poles, high mast illumination poles, and overhead sign support structures. Coat anchor bolt threads for other structures with pipe joint compound or beeswax. Repair galvanizing damage on bolts, nuts, and washers after installing nuts in accordance with Section 445.3.5., “Repairs.”

3.3.2. **Anchor Bolt Tightening Procedure**. Tighten anchor bolts for traffic signal poles, shoe base and concrete traffic barrier base roadway illumination poles, high mast illumination poles, and overhead sign support structures in accordance with this Section. This procedure covers the tightening of nuts on a double-nut anchor bolt system using anchor bolts with 55 ksi or 105 ksi minimum yield strength and UNC or 8UN thread series to secure structures to drilled shaft foundations.

3.3.2.1. **Definitions**. The following definitions apply to the anchor bolt tightening procedure:

- **Double-nut anchor bolt system.** An anchor bolt with 2 nuts that sandwich the structure's base plate. The bottom nut is positioned under the base plate to level, support, and provide the reaction for the force applied by tightening the top nut positioned above the base plate.
- **Electrically conducting lubricant.** A compound commonly used in the electrical industry to coat threads of field-cut rigid metal conduit and suitable for exposure to weather.
- **Impact tightening.** The tightening of nuts with a box end "slug" or "knocker" wrench and a sledgehammer. The wrench, matching the size of the nut to be tightened, is driven with the sledgehammer to rotate the nut.
- **Static tightening.** The tightening of nuts with a "spud" wrench and a pipe or extension handle. The wrench, matching the size of the nut to be tightened, may be turned with more than one worker to rotate the nut.
- **Snug-tight.** The condition when the nut is in full contact with the base plate. It may be assumed the full effort of a worker on a 12-in. wrench results in a snug-tight condition.
- **Turn-of-the-nut method.** The tightening of top nuts to snug-tight condition then establishing reference positions by marking one flat on each nut with a corresponding reference mark on the base plate at each bolt. Each nut is then turned to the prescribed rotation from the referenced snug-tight position.

3.3.2.2. **Anchor Bolt Tightening**. Perform the following procedure:

- Coat the threads of the anchor bolts with electrically conducting lubricant.
- Install the bottom nuts on the bolts, 1 on each bolt.
- Level the top template (using it as a guide) by adjusting the bottom nuts so the template rests on each nut and the distance between the top of the concrete shaft and the bottom surface of the bottom nut is approximately 1/2 in.
- Remove the template.
- Coat the bearing surfaces of the bottom nuts and washers with electrically conducting lubricant.
- Install bottom washers on bolts, 1 on each bolt.
- Erect and plumb the structure as specified. Adjust the bottom nuts so each is bearing equally on the washer or base plate. The truss for cantilever overhead sign support structures and the mast arm for traffic signal poles must be removed during anchor bolt tightening.
- Coat the bearing surfaces of the top nuts and washers with electrically conducting lubricant while the plumbed structure is supported by a crane. Install 1 washer and 1 top nut on each bolt. Turn the top nuts onto the bolts so each is hand-tight against the washer or base plate.
- Turn each bottom nut to a snug-tight condition using a wrench.
- Verify the structure is still plumb and still supported by the crane. Begin turn-of-the-nut method by turning each top nut down to the same snug-tight condition. Prevent rotation of the bottom leveling nut during all top nut tightening. Establish reference marks for turn-of-the-nut method once snug-tight condition is achieved, and then tighten the top nuts by turning each nut 1/12 turn (1/2 of a nut flat) past snug-tight using either static or impact tightening. Turn each top nut an additional 1/12 turn until each nut has been tightened 1/6 total turn past snug-tight.

Item 450

35. Railing

1. DESCRIPTION

Construct railing of concrete, steel, aluminum, or a combination of these materials, including necessary anchorage for the railing on bridges, culverts, walls, or other structures as shown on the Design Documents.

2. MATERIALS

Use materials that conform to requirements of the following Items.

- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcement for Concrete”
- Item 441, “Steel Structures”
- Item 442, “Metal for Structures”
- Item 445, “Galvanizing”

Provide an approved Type III, Class C epoxy or an epoxy of the type and class stated on the Design Documents where epoxy anchors are allowed or required for installing drilled and epoxied rail anchorage reinforcement or rail anchor bolts in accordance with DMS-6100, “Epoxies and Adhesives.” Use other materials if shown on the Design Documents. Provide only dual cartridge epoxy systems mixed with a static mixing nozzle supplied by the epoxy adhesive manufacturer and dispensed with a tool supplied by the epoxy adhesive manufacturer. Do not use bulk epoxies. Drill and install anchorage reinforcement or anchor bolts to the embedment depth shown on the Design Documents or the depth the manufacturer recommends, whichever is deeper. Select an embedment depth capable of developing the yield strength of the steel anchor based on the product literature for the epoxy and steel anchor being used if no resistance or embedment depth is specified on the Design Documents. Use 60 ksi as the yield strength for reinforcing steel.

3. CONSTRUCTION

Construct railing in accordance with details, alignment, and grade designated on the Design Documents. Do not place railing until falsework or formwork, if any, for the span has been released. Adhere to the schedule restrictions for Placing Bridge Rails and Opening to Construction Traffic in Item 422, “Concrete Superstructures.” Obtain approval of Work before proceeding to the next step: placing rail reinforcement; pre-pour clear cover checks.

Ensure expansion joints in the railing will function properly prior to placing concrete.

Furnish either steel or aluminum, but not both, for the entire Contract if the Design Documents allow either steel or aluminum options for a particular railing type.

Install epoxy adhesive anchorages in accordance with the manufacturer's instructions including hole size, drilling equipment and method, hole cleaning equipment and method, mixing and dispensing epoxy, and anchor insertion. Do not alter the manufacturer's mixing nozzle or dispenser. Anchorage bars or bolts must be clean and free of grease, oil, or any other foreign material. Demonstrate hole cleaning method for approval and continue the approved process for all anchorage locations. Do not weld to an anchor bar or anchor bolt that is anchored with epoxy adhesive. Do not expose rail to traffic until epoxy adhesive has obtained full cure in accordance with manufacturer's specifications.

3.1. **Metal Railing**.

3.1.1. **General**. Fabricate and erect metal railing according to the pertinent provisions of Item 441, "Steel Structures," and the requirements of this Item.

Prepare and submit for approval the required shop or erection drawings in accordance with Item 441, "Steel Structures," when the Design Documents require. Show all splice locations and details on the shop or erection drawings. Splice members only as provided on the Design Documents.

Field-weld when required in accordance with Item 448, "Structural Field Welding."

3.1.2. **Fabrication**. Fabricate metal railing and post panels in sections conforming to the details shown on the Design Documents and field-verified lines and grades. Fabricate adjacent sections so they will accurately engage each other in the field. Match-mark each pair of sections so they can be erected in the same position they were fabricated.

Fabricate metal rail Elements included as part of the railing system to the dimensions and cross-sections shown on the Design Documents and within a tolerance of 1/4 in. per 10 feet in the straightness of either edge. Joint and connect metal rail Elements to the rail posts as shown on the Design Documents, lapping metal rail Elements in the direction of traffic in the adjacent lane. Bolts and nuts for metal railing should meet requirements of ASTM A307 and be galvanized in accordance with Item 445, "Galvanizing."

Fabricate aluminum in accordance with AWS D1.2.

Heat aluminum materials other than castings to a temperature up to 400°F for no more than 30 min. to facilitate bending or straightening.

3.1.3. **Castings**. Provide permanent mold castings of the materials specified that are true to pattern in form and dimensions and of uniform quality and condition. Castings must be free from cracks and defects such as blowholes, porosity, hard-spots, or shrinkage that could affect their suitability for use. Repair minor defects in aluminum castings by an approved inert gas-welding process. Ensure finished castings are free of burrs, fins, discoloration, and mold marks and that they have a uniform appearance and texture.

Produce castings under radiographic control sufficient to establish and verify a product free from harmful internal defects. Heat-treat the entire lot of castings to the specified temper when required.

Permanently mark the heat or lot number on the web or top of the base of all castings. Furnish mill test reports showing the heat or lot number, chemical composition, tensile strength, elongation, and number of pieces for each casting heat or lot. For aluminum castings, a heat or lot should consist of at least 1,000 lb. of trimmed castings when produced from batch type furnaces, or 2,000 lb. when produced from a continuous furnace during a period of no more than 8 consecutive hours. Furnish the entire number of acceptable posts cast from each heat or lot except when a portion is required to complete a project.

3.1.4. **Corrosion Protection**. Provide protective coating for all metal railing. Galvanize all portions of steel railing after fabrication in accordance with Item 445, "Galvanizing." Provide the paint system shown on the Design Documents when specified on the Design Documents. Apply paint in accordance with either Item 441, "Steel Structures," for non-galvanized railing or Item 445, "Galvanizing," for painted, galvanized railing. Repair any damaged galvanizing after erection in accordance with Item 445, "Galvanizing."

Aluminum railing and galvanized steel railing do not require field painting. Clean extrusion marks, grease, and dirt from the railing before final acceptance.

3.1.5. **Storage**. Store railing materials above the ground on platforms, skids, or other supports, and keep them free from grease, dirt, and contact with dissimilar metals. Avoid scratching, marring, denting, discoloring, or otherwise damaging the railing.

3.2. **Concrete Railing**. Provide concrete portions of railing in accordance with the requirements of Item 420, "Concrete Substructures," and Item 422, "Concrete Superstructures." Construct forms so the railing line and grade can be checked after the concrete has been placed but before initial set. Do not disturb the form alignment during finish floating of the railing tops. Exercise particular care in other construction to avoid disturbing or vibrating the span with the newly placed railing.

Provide precast members conforming to Item 424, "Precast Concrete Structures (Fabrication)."

Slipform construction of railing is permitted. Demonstrate slipforming method showing line and grade of concrete surfaces can be consistently obtained and clear cover outside reinforcing steel be maintained at all times. Stop slipforming railing if specified concrete clear cover is not obtained or appearance of rail is off line and grade.

Do not slipform railing with cast-in-place anchor bolts.

Provide additional reinforcing as needed to prevent movement of the reinforcement cage. Clear cover and epoxy coating requirements for additional reinforcement are the same as shown for the rail reinforcement. The rail reinforcing cage may be tack welded to the rail anchorage reinforcement provided the rail and anchorage reinforcement are not epoxy coated and weld locations measured along the rail are no closer than 3 ft. Tie all bar intersections if epoxy coated reinforcement is required for the railing proposed to be slipformed. Provide a wire line to maintain vertical and horizontal alignment of the slipform machine. Attach a grade line gauge or pointer to the machine so a continuous comparison can be made between the rail being placed and the established grade line. Rails or supports at the required grade are allowed instead of sensor controls. Make one or more passes with the slipform over the rail segment to ensure proper operation and maintenance of grades and clearances before placing concrete. Provide slipformed rail within a vertical and horizontal alignment tolerance of ±1/4 in. per 10 feet. Construct rail with a smooth and uniform appearance. Consolidate concrete so it is free of

honeycomb. Provide concrete with a consistency that will maintain the shape of the rail without support. Minimize starting and stopping of the slipform operation by ensuring a continuous supply of concrete.

Do not exceed the manufacturer's recommended speed for the slipform machine. Stop slipforming and take remedial action if slipforming causes movement of the reinforcement such that plan clearances are not achieved. Remove and replace unsatisfactory slipformed rail.

Form cure, membrane cure, or water cure concrete for 4 consecutive Days. Apply curing immediately following finishing operations for slipform railing or utilize an evaporation retardant to keep concrete from drying out, as approved.

3.3. **Tests**. Sample cast aluminum posts for testing in accordance with Tex-731-I to verify the material requirements of Item 442, "Metal for Structures." Metal beam rail Elements may be sampled in accordance with Tex-713-I. TxDOT may sample bolts and nuts in accordance with Tex-708-I for galvanized coating testing.

Select three anchor bars or bolts from the first day's production to be tested after the epoxy has cured. Test the bars or bolts in the presence of TxDOT in accordance with ASTM E1512, using a restrained test, to evaluate the epoxy adhesive's bond strength. Verify the anchor bars or bolts develop the required pullout resistance on the Design Documents or 75% of the yield strength of the bars or bolts, whichever is less, without a bond failure of the epoxy. Perform corrective measures to provide adequate capacity if any of the tests do not meet the required test load. Repair damage from testing.

Item 451

36. Retrofit Railing

1. DESCRIPTION

Retrofit or replace railing.

2. MATERIALS

Use materials that conform to requirements of the following Items.

- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcement for Concrete”
- Item 441, “Steel Structures”
- Item 442, “Metal for Structures”
- Item 445, “Galvanizing”

3. CONSTRUCTION

Remove existing railing to the lines and grades shown on the Design Documents. Do not damage any portion of the structure that is to remain in place. Replace any concrete removed beyond the neat lines or other established lines. Remove bolts to disassemble steel members. Incorporate reinforcing steel into the new concrete railing with at least 1-1/2 in. of clear cover if indicated on the Design Documents. Cut off existing reinforcing steel at least 1 in. below the finished surface of the concrete if it cannot be reused as dowels. Repair any concrete damaged from making the cut-off. Refinish the top of the concrete slab where the railing is removed, but not replaced to leave a neat surface as specified on the Design Documents and in accordance with Item 429, “Concrete Structure Repair.”

Dispose of removed material off the right of way in accordance with federal, State, and local regulations. Carefully dismantle rail by unbolting steel members when Design Documents specify to salvage rail members. Deliver materials to be retained by TxDOT to the location shown on the Design Documents. Block up salvaged steel materials off the ground.

Construct replacement railing in accordance with Item 450, “Railing.”

Item 454

37. Bridge Expansion Joints

1. DESCRIPTION

Furnish and install bridge expansion joints.

2. MATERIALS

Provide materials in accordance with the requirements of the following Items.

Item 442, “Metal for Structures”
DMS-6140, “Polymer Concrete for Bridge Joint Systems”
DMS-6310, “Joint Sealants and Fillers”
ASTM D5973

Use primers recommended by the manufacturer of the sealant when required. Use backer rods compatible with the sealant that do not react or bond together.

3. CONSTRUCTION

Place expansion joints to conform to the finished grade of the roadway surface. Set the joint opening at the dimension shown on the Design Documents for 70°F, adjusted for the temperature at the time of installation. Place the seal for the full length of the joint for sealed joint openings and, when required, extend it into the parapet wall on the low side or sides of the bridge.

3.1. **Sealed Expansion Joint (SEJ).** Choose an approved joint system that conforms to the joint type and the design requirements shown on the Design Documents. Secure each side of the joint by welding it to the adjacent reinforcing steel or other attachments as approved. Remove any connection holding the joint halves together immediately after each joint half is secured in place. Install the neoprene seal as a continuous piece to form a watertight seal.

3.2. **Armor Joint**. Place steel armor plates as shown on the Design Documents. Secure each side of the joint by welding it to adjacent reinforcing steel or other attachments as approved. Remove any connection holding joint halves together immediately after each joint half is secured in place.

Seal the joint when specified. Abrasive blast clean the vertical faces of the steel plates where the sealant will be in contact to remove all visible rust, paint, mill scale, and other forms of contamination, leaving a white metal appearance. Clean the concrete in contact with the sealant by an approved method in accordance with the manufacturer’s specifications before placing sealant. After cleaning, air blast the joint to remove all dust. Place sealant in accordance with the manufacturer’s specifications and as shown on the Design Documents. Repair damage to paint protection system above the seal when shown on the Design Documents for steel armor plates to be painted.

3.3. **Header-Type Expansion Joint**. Meet with the manufacturer’s representative to discuss the required installation procedures of the materials before beginning the Work. Perform the Work in accordance with the

manufacturer's printed instructions and as discussed in the meeting. Additionally, TxDOT may request the presence of the manufacturer's representative for additional training if work personnel are not adequately following manufacturer's installation directions.

3.3.1. **Header**. Provide an approved polymer concrete from DMS-6140, "Polymer Concrete for Header Joint Systems." Create the required void in the concrete surface or asphalt overlay to accept the header material in accordance with the details shown on the Design Documents. Extend the depth of the void in the asphalt overlay to sound concrete. Remove any unsound steel or concrete and repair concrete in accordance with Item 429, "Concrete Structure Repair." Use header material as repair material only when approved. Clean the voided region of all materials that could inhibit the bond between the header material and concrete or steel. Form the joint opening to the required width shown on the Design Documents.

Place materials once approved. Place material on a clean, sound, and dry base when the ambient temperature is at least 45°F and rising or as required by the manufacturer. Do not place material on wet substrate or when raining.

Cure for the duration required by the manufacturer's data sheets before opening to traffic.

Tool or grind the upper corner of the header adjacent to the opening to a 1/4-in. radius.

3.3.2. **Sealant**. Provide an approved Class 1 or Class 7 joint sealant from DMS-6300, "Joint Sealants and Fillers." Clean the joint opening of forming material, existing seal, and other material that will inhibit the bond between the header material and the sealant. Abrasive blast clean surfaces in contact with the sealant. Place an approved backer rod and the sealant as shown on the Design Documents. Place sealant primer and sealant when ambient temperature is rising and is between 55°F and 85°F to provide for adequate joint opening and compression of the sealant during curing.

Item 458

38. Waterproofing Membranes for Structures

1. DESCRIPTION

Furnish and place waterproofing membranes on concrete and steel bridge decks of railroad and other types of structures.

2. MATERIALS

2.1. **Materials to be Furnished**. Furnish waterproofing materials listed below in accordance with DMS-6300, "Waterproofing":

- asphalt for mopping above ground,
- asphalt for mopping below ground,
- asphaltic primer,
- treated cotton fabric,
- self-adhering polyethylene,
- coal-tar-modified urethane,
- rubberized asphalt with preformed board membrane,
- asphalt plank,
- asphalt mat,
- rubberized asphalt with plastic film,
- asphaltic panels,
- plastic cement, and
- cold asphalt base emulsion.

Furnish butyl rubber membrane and ethylene-propylene-diene terpolymer (EPDM) sheeting in accordance with ASTM D6134.

Deliver materials requiring sampling and testing to the worksite a minimum of 3 weeks before use. Test and obtain approval for waterproofing materials before delivery to the worksite when authorized.

2.2. **Types**. Provide the following types of waterproofing as shown on the Design Documents.

2.2.1. **Type 1**. Butyl rubber membrane applied to a surface with a proper adhesive without protective planking and in accordance with the details shown on the Design Documents. Provide a minimum thickness of 1/16 in.

2.2.2. **Type 2**. A single asphaltic primer coat and 1 mopping of asphalt.

2.2.3. **Type 3**. A single asphaltic primer coat and 2 moppings of asphalt. Supplement with 2 layers of treated cotton fabric with a third mopping of asphalt placed over the outer layer of fabric at construction joints of foundation structures when shown on the Design Documents.

2.2.4. **Type 4**. Self-adhering polyethylene with a rubberized asphalt mastic material.

2.2.5. **Type 5**. Single-component, coal-tar-modified urethane coating.

2.2.6. **Type 6**. Self-adhering built-up membrane of rubberized asphalt formed on a preformed board with cold-applied asphaltic primer.

2.2.7. **Type 10**. Any of Type 1, Type 4, Type 5, or Type 6 waterproofing.

2.2.8. **Type RR-1**. Butyl rubber or EPDM membrane with a protective course of asphalt plank or asphalt mat of the specified thickness, as specified on the Design Documents.

3. CONSTRUCTION

3.1. **General**. Store waterproofing material in a manner that will prevent damage. Keep material dry at all times, and store in a warm area before using in cold weather and out of direct sunlight in hot weather. Store asphalt planks, asphalt mats, and asphaltic panels in a manner that will prevent warping and breaking.

Provide a wood float finish to concrete decks and other unformed concrete surfaces to be waterproofed. Cure concrete surfaces to be waterproofed for at least 7 Days before applying waterproofing, by the waterproofing materials manufacturers.

Ensure steel or concrete deck surfaces to be waterproofed are clean, dry, smooth, and free of fins, sharp edges, and loose material. Use grinders, if necessary, to remove protrusions that would puncture waterproofing membrane. Ensure surfaces are free of contaminants such as form-release agents, wax base curing compounds, oil, and grease. Remove any contaminants by abrasive blast cleaning. Ensure there are no depressions or pockets in horizontal surfaces of finished waterproofing.

Fill expansion joints and other grooves with plastic cement conforming to the requirements of DMS-6300, “Waterproofing.” Ensure joints are dry and clean when filled. Overfill slightly to allow for shrinkage in drying.

Sweep, vacuum, or air-blow the area to be waterproofed thoroughly to remove dust, dirt, and loose foreign material. Maintain the deck in a clean condition until completion of waterproofing.

Do not allow vehicular or equipment traffic on the bridge after the deck waterproofing Work has started or until after the Work is complete, cover sheets are in place, and an adequate ballast cushion has been placed on the deck. Protect the waterproofing against damage from any source.

Use asphalt for mopping below ground as defined in DMS-6300, “Waterproofing,” when asphalt waterproofing is shown as a protection for back of abutments, retaining walls, or footings. Use asphalt for mopping above ground as defined in DMS-6300, “Waterproofing,” for waterproofing on bridge decks.

3.2. **Type 1**. Do not apply waterproofing in wet weather or when the ambient temperature is below 50°F. Ensure the rubber membrane is free from punctures, pockets, or folds.

Turn the membrane into drainage holes and castings without break. Take special care to make the waterproofing effective along the sides and ends of members to be waterproofed.

Install the butyl rubber membrane by first applying the adhesive as recommended by the membrane manufacturer. Apply the adhesive to the surface to be waterproofed and at necessary splices, in a solid area extending approximately 36 in. back from the edges. Apply the membrane by pressing it firmly and uniformly in place against the previously applied adhesive, avoiding wrinkles and buckles. Make splices, laps, and flashing in accordance with the membrane manufacturer's recommended procedures.

3.3. **Type 2**. Place the asphalt primer at least 24 hr. before the asphalt mopping. Ensure the primer is dry before the mopping. Work in the primer to give a uniform coating. Heat the asphalt for mopping in kettles equipped with armored thermometers, but do not heat above 350°F. Stir the asphalt frequently while heating. Apply the mop coating at a rate of at least 4 gal. per 100 square feet of surface. Apply additional coatings, if imperfections appear, until corrected.

3.4. **Type 3**. Place the asphalt primer at least 24 hr. before the asphalt mopping. Ensure the primer is dry before the mopping. Work in the primer to give a uniform coating. Heat the asphalt for mopping in kettles equipped with armored thermometers, but do not heat above 350°F. Stir the asphalt frequently while heating. Use a minimum coverage rate for each mop coating of 4 gal. per 100 square feet of surface. Apply additional coatings, if imperfections appear, until corrected.

Mop the surfaces to be waterproofed in sections at construction joints. Lay a 15-in. wide strip of cotton fabric on the first mopping while the asphalt is still hot and press into place. Apply subsequent moppings to completely cover and seal the cotton fabric. Make the end laps of the cotton fabric at least 12 in.

3.5. **Type 4**. Unwrap the roll of waterproofing and press the adhesive surface into contact with the concrete horizontally. Secure the free end and then unroll slowly, using hand pressure to smooth the membrane into place and help make a tight bond with the concrete. Overlap adjacent strips a minimum of 1 in. over the previously laid strip. Backfilling may be started as soon as the initial horizontal strip has been applied.

3.6. **Type 5**. Apply waterproofing in 2 coats to produce a minimum cured film thickness of 1/16 in. Apply using a roller, squeegee, brush, or spray equipment. Apply the second coat within 16 hr. after the initial coat. Follow the manufacturer’s instructions with regard to the maximum time allowed between coats and any treatment of the initial coat required if this maximum time is exceeded. The minimum ambient temperature at the time of waterproofing application is 40°F. Do not begin backfilling until the second coat of waterproofing has cured sufficiently to prevent damage by the backfilling operation.

3.7. **Type 6**. Apply the primer at a rate of 1 gal. per 100 square feet of surface or at the rate recommended by the manufacturer if different. Allow to dry to a tacky surface before placing the waterproofing membrane. Apply the primer and waterproofing membrane board panels only when the substrate temperature is above 50°F.

Seal joints by centering 6-in. gusset tape over the joint and pressing firmly into position. Roll in the panels and jointing tape with sufficient pressure to assure maximum adhesion, conformance to substrate, and elimination of air bubbles. Follow the manufacturer’s recommendations for installation.

Begin backfilling as soon as the application of the waterproofing is complete. Complete backfilling within 48 hr. after the waterproofing material is applied to a non-horizontal surface.

3.8. **Type RR-1**. Apply waterproofing to dry surfaces and only when the ambient temperature is above 50°F. Ensure the butyl rubber or EPDM membrane is free from punctures, pockets, or folds. Turn the membrane into

drainage castings without break. Take special care to make the waterproofing effective along the sides and ends of girders and at stiffeners, gussets, etc. Fill grooves with plastic cement.

Install the butyl rubber or EPDM membrane by first applying the adhesive as recommended by the membrane manufacturer to ballast retainers, ends of deck, and at necessary splices in a solid area extending from the edges back about 36 in. Apply the membrane and press it firmly and uniformly in place against the previously applied adhesive, avoiding wrinkles and buckles. Make splices, laps, and flashing in accordance with the membrane manufacturer's recommended procedures.

Place the protective cover as soon as practicable after placement of the membrane. Clean the membrane surface of dirt and other foreign material before placing the cover material. Apply a coating of cold asphalt emulsion over the membrane at a minimum rate of 4 gal. per 100 square feet of surface. Place the asphalt plank or mat on the coating of cold asphalt emulsion.

Provide a minimum thickness of protection of 1 in., consisting of asphalt plank or asphalt mat. Coat the edges and ends of adjacent planks already laid with cold asphalt emulsion as successive planks are laid. Lay the planks tightly against those previously laid so the emulsion will completely fill the joints and be squeezed out the top. Fill any joints not completely full after planks have been laid with emulsion. Offset the vertical joints of the second layer at least 4 in. transversely and 1 ft. longitudinally from the joints in the lower layer when 2 layers of planks are used to obtain the required 1-in. cover thickness.

Apply asphalt mat protection in the same manner except stagger the longitudinal butt joints in a single layer by approximately 2 ft. Follow the same procedure with all vertical joints offset by at least 1 ft. when more than 1 thickness of asphalt mat is required Place a follow-up coating of asphalt emulsion approximately 6 in. wide over all joints of the top layer.

Use asphalt for mopping above ground as defined in DMS-6300, “Waterproofing,” where deck waterproofing is carried over the back wall and down the back of the abutment for only several feet to provide a proper flashing for the deck waterproofing.

Item 459

39. Gabions and Gabion Mattresses

1. DESCRIPTION

Furnish and install gabions and gabion mattresses.

2. MATERIALS

This Item uses the following Items:

Gabion. A wire fabric or mesh container, filled with stone, with a height of 1 ft. or greater.

Gabion Mattress. A wire fabric or mesh container filled with stone and with a height of 6, 9, or 12 in. Referred to as "revet mattress" in ASTM A975.

Furnish welded wire gabions and gabion mattresses in accordance with ASTM A974. Furnish Style 1 or 2 when galvanized wire coating is specified or Style 5 when PVC wire coating is specified.

Furnish twisted wire gabions and gabion mattresses in accordance with ASTM A975. Furnish Style 1 when galvanized wire coating is specified or Style 3 when PVC wire coating is specified.

Furnish producer or Supplier certification that wire baskets, stiffeners, lacing wire, and spiral connectors conform to the applicable ASTM specification.

Furnish producer or Supplier certification that any alternative wire fasteners that are proposed conform to the strength requirements in Table 1 when tested in accordance with the applicable ASTM specification. Submit certification for approval before beginning Work.

Table 1

Minimum Panel-to-Panel Connection Strength

Application	Strength (lb./ft.)
Gabions, galvanized	1,400
Gabions, PVC-coated	1,200
Gabion mattress, galvanized and PVC-coated	700

Provide filler stone consisting of clean, hard, durable stone that does not contain shale, caliche, or other soft particles. Stone appearing to contain such particles shall be tested for soundness. Stone with 5-cycle magnesium sulfate soundness of more than 18% when tested in accordance with Tex-411-A shall be rejected. Use stones that are between 4 and 8 in. in their least dimension for gabions and between 3 and 6 in. for gabion mattresses. Prevent contamination when storing and handling stone. Use stone with a minimum bulk specific gravity of 2.50 as determined by Tex-403-A.

Provide Type 2 filter fabric when required in accordance with DMS-6200, “Filter Fabric.”

Provide filter material when required consisting of hard, durable, clean sand or gravel with a maximum particle size of 3/8 in.

3. CONSTRUCTION

At the start of construction, the gabion and gabion mattress manufacturer must have a qualified representative available for consultation as needed throughout the gabion and gabion mattress construction.

3.1. **Foundation Preparation**. Excavate the foundation to the extent shown on the Design Documents. Remove all loose or otherwise unsuitable materials. Carefully backfill all depressions to grade with suitable materials from adjacent required excavation or another approved source, and compact the backfill to a density at least equal to the adjacent foundation. Remove any buried debris protruding from the foundation that will impede the proper installation and final appearance of the gabion or gabion mattress, and carefully backfill and compact voids as specified above. Inspect the prepared foundation surface immediately before gabion placement.

3.2. **Filter Placement**. Spread filter material, when required, uniformly on the prepared foundation surface to the slopes, lines, and grades indicated on the Design Documents. Do not place filter material by methods that tend to segregate particle sizes. Repair all damage to the foundation surface that occurs during filter placement before proceeding with the Work. Compaction of the filter material is not required; but, finish the material to present a reasonably even surface without mounds or windrows.

3.3. **Filter Fabric Placement**. Place filter fabric as shown on the Design Documents when required. Any defects, rips, holes, flaws, or damage to the material may be cause for rejection. Place the material with the long axis parallel to the centerline of the structure, highway, or dam. Place securing pins in the lapped longitudinal joints, spaced on approximately 10-ft. centers. Keep the fabric material free of tension, stress, folds, wrinkles, or creases. Lap the material at least 3 ft. along the longitudinal joint of material, or lap the joints 1 ft. and sew them. Lap the ends of rolls at joints by at least 3 ft. Repair torn or punctured fabric by placing a layer of fabric over the damaged area, overlapping at least 3 ft. beyond the damaged area in all directions.

Place securing pins through both strips of material at lapped joints at approximately the midpoint of the overlap. Place additional securing pins as necessary to hold filter fabric in position. Store filter fabric out of direct sunlight. Cover filter fabric as soon as possible after placing, but within 3 Days.

3.4. **Assembly and Installation**. Place PVC-coated materials, if wire coating is specified, when the ambient temperature and the temperature of the coated wire are no more than 15°F above the brittleness temperature of the PVC.

Assemble empty gabion or gabion mattress units individually, and place them on the approved surface to the lines and grades shown on the Design Documents with the sides, ends, and diaphragms erected to ensure all creases are in the correct position, the tops of all sides are level, and all sides that are to remain exposed are straight and plumb. Fill the basket units after transporting them to their final position in the Work.

Place the front row of gabion or gabion mattress units first and successively construct units toward the top of the slope or the back of the structure. Place the initial line of basket units on

the prepared surface, and partially fill them to provide anchorage against deformation and displacement during subsequent filling operations. Stretch and hold empty basket units as necessary to remove kinks and provide a uniform alignment. Connect all adjoining empty gabion or gabion mattress units with lacing, wire spiral binders, or approved fasteners along the perimeter of their contact surface to obtain a monolithic structure before filling. Provide continuous stitching with alternating single and double loops at intervals of no more than 5 in. if lacing wire is used. Securely fasten all lacing wire terminals.

Provide connections meeting the joint strength requirements of Article 459.2., “Materials.” These requirements apply to all connections including attachment of end panels, diaphragms, and lids.

Join twisted wire baskets through selvage-to-selvage or selvage-to-edge wire connection; do not use mesh-to-mesh or selvage-to-mesh wire connection except where baskets are offset or stacked, in which case join each mesh opening where mesh wire meets selvage or edge wire.

arefully fill the basket units with stone, using hand placement to avoid damaging wire coating, to ensure as few voids as possible between the stones and to maintain alignment. Machine placement of stone will be allowed if approved. Correct excessive deformation and bulging of the mesh before further filling. Fill the basket units in a row in stages consisting of maximum 12 in. courses to avoid localized deformation. Do not at any time fill a cell to a depth exceeding 1 ft. more than its adjoining cell. Do not drop stones into the basket units from a height greater than 36 in.

Place 2 uniformly spaced internal connecting wires between each stone layer in all front and side gabion units, connecting the back and the front faces of the compartments for gabion units more than 2 ft. high. Loop connecting wires or preformed stiffeners around 2 twisted wire-mesh openings or a welded wire joint at each basket face, and securely twist the wire terminals to prevent loosening.

Place the outer layer of stone carefully along all exposed faces and arrange it by hand to ensure a neat and compact appearance. Overfill the last layer of stone uniformly by 1 to 2 in. for gabions and 1 in. for gabion mattresses to compensate for future settlement in rock while still allowing for the proper closing of the lid and providing an even surface with a uniform appearance. Make final adjustments for compaction and surface tolerance by hand. Stretch lids tight over the stone fill, using an approved lid-closing tool, until the lid meets the perimeter edges of the front and end panels. Do not use crowbars or other single-point leverage bars for lid closing. Close the lid tightly along all edges, ends, and internal-cell diaphragms with spiral binders or lacing wire or with other wire fasteners if approved. Ensure all projections or wire ends are turned into the baskets. Cut, fold, and wire the basket unit together to suit site conditions where a complete gabion or gabion mattress unit cannot be installed because of space limitations, as shown on the Design Documents,. Fold the mesh back and neatly wire it to an adjacent basket face. Complete the assembling, installation, filling, lid closing, and lacing of the reshaped gabion or gabion mattress units in accordance with this Section.

Item 460

40. Corrugated Metal Pipe

1. DESCRIPTION

Furnish and install corrugated metal pipes, materials for constructing corrugated metal pipe culverts, or corrugated metal storm drain mains, laterals, stubs, and inlet leads.

2. MATERIALS

2.1. **Fabrication. Furnish corrugated metal pipe in accordance with Table 1.**

Table 1

Specifications for Corrugated Metal Pipe

Pipe Type	AASHTO Specification
Galvanized steel and aluminized steel	M 36
Aluminized Type 2	M 36
Polymer Coated	M 36 & M 245
Asphalt Coated	M 36
Aluminum	M 196

The pipe type and corresponding AASHTO designations are shown in Table 2.

Table 2

Corrugated Metal Pipe Types

Pipe Type	AASHTO Classification
Circular	Type I
Circular, smooth-lined	Type IA
Circular, spiral rib	Type IR
Arch	Type II
Arch, smooth-lined	Type IIA
Arch, spiral rib	Type IIR

Provide corrugated metal pipe of all types with annular corrugations, helical corrugations, or spiral ribs (corrugations) projecting outward. Provide pipe with helical end corrugations only when necessary to join new pipe to existing pipe with helical end corrugations.

Provide a minimum polymer coating thickness of 10 mils on each side for pre-coated galvanized steel pipe. Sample and test galvanized metal sheets and coils used for galvanized corrugated metal pipe in accordance with Tex-708-I.

Repair damaged galvanized coating in accordance with Section 445.3.5., "Repairs." Repair damaged aluminized or polymer coating in accordance with AASHTO M 36 and M 245 respectively.

2.2. **Protective Coating**. Furnish bituminous coating, when required, that meets AASHTO M 190 and that tightly adheres to the metal, does not chip off in handling, and protects the pipe from deterioration as evidenced by samples prepared from the coating material successfully meeting the Shock Test and Flow Test in accordance with Tex-522-C.

Coat the pipe uniformly inside and out to a minimum thickness of 0.05 in. measured on the crests of the corrugations. Coat the pipe with additional material applied to the full inner circumference to form a smooth inside lining with a minimum thickness of 1/8 in. above the crest of the corrugations when smooth lining is specified.

2.3. **Design**. The diameter, permissible corrugations, and required gauges for full-circle pipe shall be shown. The design size and permissible corrugations for pipe arch shall be shown. The required gauges of the shell and the liner for smooth lined pipe shall also be shown. Furnish the shape and minimum gauge for steel pipe arch in accordance with Tables 3, 4, 5, or 6 for the specified design size and corrugation. Use Table 7 or 8 for aluminum pipe arch. Refer to U.S. Standard Gauge for uncoated sheets where reference is made to gauge of metal.

Measure dimensions from the inside crests of the corrugations. A tolerance of ±1 in. or 2% of the equivalent circular diameter, whichever is greater, is allowed for span and rise.

Table 3
Steel Pipe Arch

2-2/3 × 1/2-in. Corrugations

Design Size	Span (in.)	Rise (in.)	Min. Cover (in.)	Min. Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
1	17	13	12	16	0.064	15
2	21	15	12	16	0.064	18
2A	23	19	12	16	0.064	21
3	28	20	12	16	0.064	24
4	35	24	12	16	0.064	30
5	42	29	12	14	0.079	36
6	49	33	12	14	0.079	42
7	57	38	12	12	0.109	48
8	64	43	12	12	0.109	54
9	71	47	12	10	0.138	60

Table 4

Steel Pipe Arch

3 × 1-in. Corrugations

Design Size	Span (in.)	Rise (in.)	Min. Cover (in.)	Min. Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
7	53	41	12	14	0.079	48
8	60	46	12	14	0.079	54
9	66	51	12	14	0.079	60
10	73	55	12	14	0.079	66
11	81	59	12	14	0.079	72
12	87	63	12	14	0.079	78
13	95	67	12	12	0.109	84
14	103	71	18	12	0.109	90
15	112	75	18	12	0.109	96
16	117	79	18	12	0.109	102
17	128	83	24	10	0.138	108
18	137	87	24	10	0.138	114
19	142	91	24	10	0.138	120

Table 5
Steel Pipe Arch

5 × 1-in. Corrugations

Design Size	Span (in.)	Rise (in.)	Min. Cover (in.)	Min. Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
11	81	59	12	12	0.109	72
12	87	63	12	12	0.109	78
13	95	67	12	12	0.109	84
14	103	71	18	12	0.109	90
15	112	75	18	12	0.109	96
16	117	79	18	12	0.109	102
17	128	83	24	10	0.138	108
18	137	87	24	10	0.138	114
19	142	91	24	10	0.138	120

Table 6
Steel Pipe Arch, Spiral Rib

7-1/2 × 3/4 × 3/4-in. Corrugations

Design Size	Span (in.)	Rise (in.)	Min. Cover (in.)	Min. Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
2	20	16	12	16	0.064	18
2A	23	19	12	16	0.064	21
3	27	21	12	16	0.064	24
4	33	26	12	16	0.064	30
5	40	31	12	14	0.064	36
6	46	36	12	12	0.064	42
7	53	41	12	12	0.079	48
8	60	46	12	12	0.079	54
9	66	51	15	12	0.079	60

Table 7
Aluminum Pipe Arch
2-2/3 × 1/2-in. Corrugations

Design Size	Span (in.)	Rise (in.)	Min. Cover (in.)	Min. Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
1	17	13	12	16	0.060	15
2	21	15	12	16	0.060	18
2A	23	19	12	16	0.060	21
3	28	20	12	14	0.075	24
4	35	24	12	14	0.075	30
5	42	29	18	12	0.105	36
6	49	33	18	12	0.105	42
7	57	38	18	10	0.135	48
8	64	43	18	10	0.135	54
9	71	47	18	8	0.164	60

Table 8
Aluminum Pipe Arch, Spiral Rib

7-1/2 × 3/4 × 3/4-in. Corrugations

Design Size	Span (in.)	Rise (in.)	Min. Cover (in.)	Min. Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
2	20	16	12	16	0.064	18
2A	23	19	12	16	0.064	21
3	27	21	15	16	0.064	24
4	33	26	18	16	0.064	30
5	40	31	18	14	0.075	36
6	46	36	18	12	0.105	42
7	53	41	21	12	0.105	48
8	60	46	18	10	0.135	54
9	66	51	21	10	0.135	60

2.4. **Coupling Bands**. Furnish coupling bands and other hardware for galvanized or aluminized steel pipe in accordance with AASHTO M 36 for steel pipe and AASHTO M 196 for aluminum pipe. Use coupling bands that are no more than 3 nominal sheet thicknesses lighter than the thickness of the pipe to be connected or no lighter than 0.052 in. for steel or 0.048 in. for aluminum. Provide coupling bands made of the same base metal and coating as the pipe.

3. CONSTRUCTION

3.1. **Designation of Type**. The types of pipes shall be indicated on the Design Documents by the following descriptions:

- Pipe type: Corrugated metal pipe (CMP), corrugated metal pipe arch (CMP ARCH), spiral rib corrugated metal pipe (SRCMP), or spiral rib corrugated metal pipe arch (SRCMP ARCH);
- Type of material: Galvanized steel, aluminum-coated (Type 2), or aluminum;
- Pipe coating: Bituminous coated or polymer coated;
- Special requirements: Paved invert or smooth lining; and
- Pipe size: Diameter or design number.

Furnish any of the material types specified above when pipe is designated as “Corrugated Metal Pipe” without a type of material or pipe coating designation.

3.2. **Excavation, Shaping, Bedding, and Backfill**. Excavate, shape, bed, and backfill in accordance with Item 400, “Excavation and Backfill for Structures,” except where jacking, boring, or tunneling methods are shown on the Design Documents or permitted. Jack, bore, or tunnel in accordance with Item 476, “Jacking, Boring, or Tunneling Pipe or Box.”

Provide uniform backfill material and uniformly compacted density throughout the length of the structure so equal pressure is provided. Allow no heavy earth-moving equipment over the structure until a minimum of 4 ft. of compacted fill (permanent or temporary) has been placed over the top of the structure. Inspect the inside periphery of the structure for local or unequal deformation caused by improper construction methods before adding each new layer of loose backfill material. Continue inspections until a minimum of 24 in. of cover is obtained. Evidence of

such deformation shall be reason for corrective measures. Remove and replace pipe damaged by Developer.

3.3. **Laying Pipe**. Lay pipes on the bedding from the outlet end and join the separate sections firmly together with outside laps of annular joints pointing upstream and longitudinal laps on the sides. Coat any metal in joints not protected by galvanizing or aluminizing with a suitable asphalt paint. Lower sections of pipe into the trench without damaging the pipe or disturbing the bedding and the sides of the trench. Remove and re-lay pipe that is not in alignment or shows excessive settlement after laying.

Lay multiple installations of corrugated metal pipe and pipe arches with the centerlines of individual barrels parallel. Maintain the clear distances between outer surfaces of adjacent pipes given in Table 9.

Table 9

Required Pipe Clear Distances

Diameter Full-Circle Pipe (in.)	Pipe Arch Design Size	Clear Distance Between Pipes (Full-Circle Pipe and Pipe Arch)
18	2	1 ft. 2 in.
21	2A	1 ft. 3 in
24	3	1 ft. 5 in.
30	4	1 ft. 8 in.
36	5	1 ft. 11 in.
42	6	2 ft. 2 in.
48	7	2 ft. 5 in.
54	8	2 ft. 10 in.
60 to 84	9	3 ft. 2 in.
90 to 120	10 and over	3 ft. 5 in.

3.4. **Jointing**. Provide field joints that maintain pipe alignment during construction and prevent infiltration of side material during the life of the installation. Provide one of the following jointing systems**.**

3.4.1. **Coupling Bands**. Use coupling bands with annular corrugations only with pipe with annular corrugations or with helical pipe or spiral rib pipe in which the ends have been rerolled to form annular corrugations. Provide bands with corrugations that have the same dimensions as the corrugations in the pipe end or are designed to engage the first or second corrugation from the end of each pipe. The band may also include a U-shaped channel to accommodate upturned flanges on the pipe.

Field-join pipe with helically corrugated bands or bands with projections (dimples) when helical end corrugations are allowed.

Coupling bands with projections may be used with pipe that has annular or helical end corrugations or spiral ribs. Provide bands formed with the projections in annular rows with

1 projection for each corrugation of helical pipe or spiral rib pipe. Provide 2 annular rows for bands 10-1/2 in. or 12 in. wide and 4 annular rows of projections for bands 16-1/2 in. or 22 in. wide.

Use a coupling band width that conforms to Table 10. Connect the bands using suitable galvanized devices in accordance with AASHTO M 36. Lap coupling bands equally on each of the pipes to form a tightly closed joint after installation. Provide at least the minimum coupling band width recommended by the manufacturer for corrugations not shown in Table 10.

Table 10

Coupling Band Width Requirements

Nominal Corrugation Size[1] (in.)	Nominal Pipe Inside Diameter[2] (in.)	Minimum Coupling Band Width (in.)		
		Annular Corrugated Bands	Helically Corrugated Bands	Bands with Projections
2-2/3 by 1/2	12 to 36	7	12	10-1/2
	42 to 72	10-1/2	12	10-1/2
	78 to 84[3]	10-1/2	12	16-1/4
3 by 1	36 to 72	12	14	10-1/2
	78 to 120	12	14	16-1/4
5 by 1	36 to 72	20	22	12
	78 to 120	20	22	22
7-1/2 by 3/4 by 3/4	18 to 60	10-1/2	12	10-1/2
	66 to 102	10-1/2	12	16-1/4

For helically corrugated pipe or spiral rib pipe with rerolled ends, the nominal size refers to the dimensions of the end corrugations in the pipe.

Equivalent circular diameter for Type II pipe.

Diameter through 120 in. for annular corrugated bands used on rerolled ends of helically corrugated pipe or spiral rib pipe.

The minimum diameter of bolts for coupling bands is 3/8 in. for pipe diameters 18 in. and less and 1/2 in. for pipe diameters 21 in. and greater. Provide at least 2 bolts for bands 12 in. wide or less. Provide at least 3 bolts for bands wider than 12 in.

Provide galvanized hardware in accordance with Item 445, “Galvanizing.”

3.4.2. **Bell and Spigot**. Attach the bell to one end of the corrugated metal pipe at the manufacturing plant before shipment. Provide a bell with a minimum 6-in. stab depth. Install the gasket on the spigot end and apply lubricant in accordance with the manufacturer’s recommendations. Provide gaskets that meet ASTM F477 with Type A Shore durometer hardness of 45 ±5. Do not use thermoplastic

elastomer as the basic polymer. Push the spigot end of the pipe into the bell end of the previously laid pipe during laying of the pipe.

3.4.3. **Pipe Connections and Stub Ends**. Make connections of pipe to existing pipe or appurtenances as shown on the Design Documents. Mortar or concrete the bottom of the existing structure, if necessary, to eliminate any drainage pockets created by the new connection.

Insulate portions of aluminum pipe that are to be in contact with metal other than aluminum by a coating of bituminous material meeting the requirements of Section 460.2.2., “Protective Coating.” Extend the coating a minimum of 1 ft. beyond the area of contact.

Restore any damage that results from making the connection when connecting pipe into existing structures that will remain in service. Seal stub ends for connections to future Work not shown on the Design Documents by installing watertight plugs into the free end of the pipe.

Item 461

41. Structural Plate Structures

1. DESCRIPTION

Furnish and install structural plate pipes, pipe arches, arches, underpasses, box culverts, and special shapes.

2. MATERIALS

2.1. **General**. Furnish materials in accordance with the following.

- Item 420, “Concrete Substructures”
- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcement for Concrete”
- Item 442, “Metal for Structures”
- Item 445, “Galvanizing”
- Item 447, “Structural Bolting”

Provide galvanized steel plates conforming to AASHTO M 167. Provide aluminum plates conforming to AASHTO M 219.

Use Class C concrete for footings.

Fabrication. Use structural units of corrugated galvanized metal for steel plates. Furnish single plates in standard sizes to permit structure length increments of 2 ft. Provide plates with an approximate 2-in. lip beyond each end crest. Design and construct footings for arches to accommodate this additional length. Fabricate galvanized steel inverts, toe walls, footings, and closure plates when required in accordance with the requirements for the galvanized steel structural plate structure.

Use structural units of corrugated aluminum alloy for aluminum plates. Furnish cut plates on structure ends to permit structure length increments of 1 ft. for aluminum alloy structures. Provide plates with an approximate 2-in. lip beyond each end crest. Design and construct footings for arches to accommodate this additional length. Fabricate aluminum alloy inverts, toe walls, footings, and closure plates in accordance with the requirements for the aluminum structural plate structure when required.

Form plates to provide bolted lap joints. Punch bolt holes so all plates with like dimensions, curvature, and number of bolts per foot of seam will be interchangeable. Curve each plate to the proper radius to provide cross-sectional dimensions of the finished structure as shown on the Design Documents. Stagger joints so no more than 3 plates are joined at any one point.

Provide bolt holes along the edges of the plates that will form longitudinal seams in the finished structure as follows:

- Stagger holes in rows 2 in. apart, with one row in the valley and one on the crest of the corrugations and at least 4 bolts per foot for galvanized steel structures.

- Provide holes in rows 1-3/4 in. apart with 2 bolts in each valley and on each crest and at least 16 bolts per 3 feet for aluminum alloy structures.

Provide bolt holes at a maximum spacing of 12 in. along the edges of the plates that will form circumferential seams in the finished structure. Ensure a minimum distance from center of hole to edge of plate of at least 1-3/4 times the diameter of the bolt. Provide bolt holes in the longitudinal seams with a hole diameter that does not exceed the diameter of the bolt by more than 1/8 in. Finish burned edges so they are galvanized and free from oxide and burrs and present a satisfactory appearance. Place legible identification marks on each plate to designate its proper position in the finished structure.

Furnish an itemized statement of the number and size of plates in each shipment and furnish erection drawings showing the position of the plates in the structure. Furnish copies of mill test reports for the base metal. Provide samples of the plates in accordance with Tex-708-I, "Sampling Galvanized Metal Products for Coating Weight," when directed.

Provide metal headwalls that comply with the details shown on the Design Documents.

2.2. **Design**. The gauge or minimum thickness and permissible corrugations of metal plates to be furnished for each structure shall be shown on the Design Documents.

3. CONSTRUCTION

3.1. **Designation of Type**. The type of structure shall be indicated on the Design Documents by the following descriptions:

- Structure type: structural plate pipe, structural plate pipe arch, structural plate arch, structural plate underpass, or structural plate box culvert.
- Type of material: galvanized steel or aluminum.
- Structure size: diameter or horizontal and vertical dimensions.
- When the type of material is not specified: either galvanized steel or aluminum.

3.2. **Foundations**. Construct substructure for structural plate arches as shown on the Design Documents. Form and finish footings to established true lines and grades. Set anchors or box culvert slots to true line and grade when placing concrete for each substructure unit. Place substructure units in accordance with Item 420, "Concrete Substructures," and Item 440, "Reinforcement for Concrete."

Place footings entirely on hard materials such as rock or shale or on firm soil or compacted soil cushion. Undercut and replace rock with a minimum 12 in. thick compacted soil cushion when only a portion of the founding area is rock. Remove the soil when a thin layer is partially covering rock within the bearing area and place the footings directly on rock in accordance with details shown on the Design Documents.

3.3. **Erection**. Coat any steel in joints not protected by galvanizing with suitable asphalt paint. Handle pipes and plates carefully to avoid damage to any protective coating.

Provide hot-dip galvanized anchor bolts with a minimum 3/4-in. diameter and 6-in. length spaced at maximum 19-in. centers for anchoring plates to headwalls or other concrete end treatment. Place plates for arch structures after the substructure has cured a minimum of 3 Days.

Insert all bolts not already in place when all plates are in position, and tighten all nuts progressively and uniformly, beginning at one end of the structure. Tighten all nuts a second time to a torque between 150 and 300 ft. lb. for steel bolts and between 100 and 150 ft. lb. for aluminum bolts. Check at least 20% of the bolts with a torque wrench when using an impact wrench. Replace all service bolts used in drawing the plates together with standard bolts.

The tolerance for span and rise during erection is 2% of design measurements or 5 in., whichever is less.

3.4. **Workmanship**. Repair minor damage to galvanized coating in accordance with Section 445.3.5., "Repairs". All other structural plates on which the galvanized coating has been damaged or that show defective workmanship shall be rejected. This requirement applies not only to the individual plates but also to the shipment as a whole. The presence of any of the following defects shall be cause for rejection:

- uneven laps;
- elliptical shape (unless specified);
- variation from a straight line;
- ragged edges;
- loose bolts;
- uneven bolt lines or spacing;
- illegible brand;
- bruised, scaled, or broken galvanized coating; or
- dents or bends in the metal.

3.5. **Excavation and Backfill**. Excavate and backfill or construct the embankment around and over the structural plate structure in accordance with Item 400, "Excavation and Backfill for Structures," except as modified in this Section. Furnish acceptable devices for monitoring the horizontal and vertical shape of the structure. The tolerance for span and rise during backfilling operations is 2% of design measurements or 5 in., whichever is less.

For arches (except pipe arches), if the headwalls are built after backfilling the arch, place the first material midway between the ends of the arch, forming as narrow a ramp as possible until the top of the arch is reached. Construct the ramp evenly from both sides, and thoroughly compact the backfill as it is placed. Deposit the remainder of the backfill from the top of the arch both ways from the center to the ends and as evenly as possible on both sides of the arch after constructing the two ramps to the top of the arch. If the headwalls are built before backfilling the arch, place the fill material first adjacent to one headwall until the top of the arch has been reached and then from the top of the arch toward the other headwall. Deposit the material evenly on both sides of the arch.

Perform the same backfill phases for all structures more or less simultaneously. Do not drop backfill from such a height or concentrate it in such an amount before distribution over the top arch that it will damage the flexible structure. Compact this backfill with hand-operated tamps or other acceptable equipment.

Use only hand-operated, mechanical tamping equipment within vertical planes 2 ft. beyond the horizontal limits of the structure until a minimum of 2 ft. of cover has been compacted over the structure. Ensure all large construction equipment is kept a minimum of 3 ft. from the center of the span to prevent local deformations of the plates due to concentrated loads. Do not use heavy earth-moving equipment over the structure until a minimum of 4 ft. of permanent or temporary

compacted fill has been placed over the structure. Check with the structure manufacturer before crossing the structure with any construction equipment with a 75,000 lb. or greater single-axle load. Additional cover beyond 4 ft. may be required to accommodate these vehicles. Remove and replace damaged plates or structures.

Inspect the inside periphery of the structure for local or unequal deformation caused by improper construction methods before adding each new layer of loose backfill material. Continue inspections until a minimum of 24 in. of cover is obtained. Evidence of such deformation shall be reason for corrective measures.

Item 462

42. Concrete Box Culverts and Drains

1. DESCRIPTION

Furnish, construct, and install concrete box culverts and drains.

2. MATERIALS

2.1. **General**. Furnish materials in accordance with the following.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"
- Item 464, "Reinforced Concrete Pipe"

Provide cast-in-place or precast, formed or machine-made, box culverts, and drains. Use Class S concrete for top slabs of cast-in-place concrete culverts for culverts with overlay, a 1- to 2-course surface treatment or a top slab that is the final riding surface. Use Class C concrete for the rest of the culvert and for all other cast-in-place boxes. Culverts with fill do not require Class S concrete.

Furnish material for machine-made precast boxes in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Box Culvert Fabrication and Plant Qualification."

2.2. **Fabrication**.

2.2.1. **Cast-in-Place**. Meet Item 420, "Concrete Substructures" and Item 422, "Concrete Superstructures."

2.2.2. **Formed Precast**. Meet Item 424, "Precast Concrete Structural Members (Fabrication)."

2.2.3. **Machine-Made Precast**. Machine-made precast box culvert fabrication plants must be approved in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Box Culvert Fabrication and Plant Qualification." TxDOT maintains a list of approved machine-made precast box culvert plants. Fabricate machine-made precast boxes in accordance with DMS-7310.

2.3. **Testing**.

2.3.1. **Cast-in-Place**. Provide test specimens that meet Item 421, "Hydraulic Cement Concrete."

2.3.2. **Formed Precast**. Make, cure, and test compressive test specimens in accordance with Tex-704-I.

2.3.3. **Machine-Made Precast**. Make, cure, and test compressive test specimens in accordance with DMS-7310.

2.3.4. **Testing Equipment**. The producer must furnish all equipment required for testing concrete for boxes produced in a precasting plant.

2.4. **Lifting Holes**. Provide no more than 4 lifting holes in each section for precast boxes. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate lifting

devices based on the size and weight of the box section. Use lifting holes no larger than 3 in. in diameter. Cut no more than 5 in. in any direction of reinforcement per layer for lifting holes.

2.5. **Marking**. Mark precast boxes with the following:

- name or trademark of fabricator and plant location;
- ASTM designation;
- date of manufacture;
- box size;
- minimum and maximum fill heights;
- designated fabricator's approval stamp;
- boxes to be used for jacking and boring (when applicable);
- designation "SR" for boxes meeting sulfate-resistant concrete plan requirements (when applicable); and
- match-marks for proper installation, when required under Section 462.2.6., "Tolerances."

Mark 1 end of each box section, for boxes without lifting holes, on the inside and outside walls to indicate the top or bottom as it will be installed.

Indent markings into the box section or paint them on each box with waterproof paint.

2.6. **Tolerances**. Ensure precast sections meet the permissible variations listed in ASTM C1577 and that the sides of a section at each end do not vary from being perpendicular to the top and bottom by more than 1/2 in. when measured diagonally between opposite interior corners.

Ensure wall and slab thicknesses are not less than shown on the Design Documents except for occasional deficiencies not greater than 3/16 in. or 5%, whichever is greater. If proper jointing is not affected, thicknesses in excess of plan requirements are acceptable.

Deviations from the above tolerances will be acceptable if the sections can be fitted at the plant or jobsite and the joint opening at any point does not exceed 1 in. Use match-marks for proper installation on sections that have been accepted in this manner.

2.6.1. **Boxes for Jacking Operations**. Use boxes for jacking operations (as defined in Item 476, "Jacking, Boring, or Tunneling Pipe or Box,") meeting the following additional requirements:

- The box ends must be square such that no point deviates more than 3/8 in. from a plane placed on the end of the box that is perpendicular to the box sides, and
- The slab and wall thicknesses must not be less than specified on the Design Documents and must not exceed the specified thickness by more than 1/2 in.

2.7. **Defects and Repair**. Fine cracks on the surface of the member that do not extend to the plane of the nearest reinforcement are acceptable unless the cracks are numerous and extensive. Repair cracks that extend into the plane of the reinforcing steel in an approved manner. Excessive damage, honeycomb, or cracking shall be subject to structural review. Boxes that are soundly repaired, properly finished, and cured in conformance with pertinent specifications are acceptible. Discontinue further production of precast sections when fine cracks on the surface indicate poor curing practices until corrections are made and proper curing is provided.

Repair machine-made precast boxes in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Box Culvert Fabrication and Plant Qualification."

2.8. **Storage and Shipment**. Store precast sections on a level surface. Do not place any load on the sections until design strength is reached and curing is complete. Shipment of sections is permissible when the design strength and curing requirements have been met.

Store and ship machine-made precast boxes in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Box Culvert Fabrication and Plant Qualification."

3. CONSTRUCTION

3.1. **Excavation, Shaping, Bedding, and Backfill**. Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures," except where jacking, boring, or tunneling methods are shown on the Design Documents or permitted. Jack, bore, or tunnel in accordance with Item 476, "Jacking, Boring, or Tunneling Pipe or Box." Immediate backfilling is permitted for all box structures where joints consist of materials other than mortar. Take precautions in placing and compacting the backfill to avoid any movement of the boxes or damage to the joints. Remove and replace boxes damaged by Developer.

3.2. **Placement of Boxes**. Place the box sections in conformance with the Design Documents when precast boxes are used to form multiple barrel structures. Place material to be used between barrels as shown on the Design Documents. Start the laying of boxes on the bedding at the outlet end and proceed toward the inlet end with the abutting sections properly matched. Fit, match, and lay the boxes to form a smooth, uniform conduit true to the established lines and grades. Lower the box sections into the trench, for trench installations, without damaging the box or disturbing the bedding and the sides of the trench. Carefully clean the ends of the box before it is placed. Prevent the earth or bedding material from entering the box as it is laid. Remove and re-lay boxes that are not in alignment or show excessive settlement after laying. Form and place cast-in-place boxes in accordance with Item 420, "Concrete Substructures."

3.3. **Jointing**. Use any of the jointing materials in accordance with the joint requirements specified in Item 464, "Reinforced Concrete Pipe." Box joints for rubber gasketed material may be substituted for tongue and groove joints, provided they meet the requirements of ASTM C1677 for design of the joints and permissible variations in dimensions.

3.4. **Connections and Stub Ends**. Make connections of boxes to existing boxes, pipes, drains, or drain appurtenances as shown on the Design Documents. Mortar or concrete the bottom of existing structures if necessary to eliminate any drainage pockets created by the connections. Connect boxes to any required headwalls, wingwalls, safety end treatments or riprap, or other structures as shown on the Design Documents. Repair any damage to the existing structure resulting from making the connections. Finish stub ends for connections to future Work not shown on the Design Documents by installing watertight plugs into the free end of the box.

Fill lifting holes with mortar or concrete and cure for precast boxes. Precast concrete or mortar plugs may be used.

Item 464

43. Reinforced Concrete Pipe

1. DESCRIPTION

Furnish and install reinforced concrete pipe, materials for precast concrete pipe culverts, or precast concrete storm drain mains, laterals, stubs, and inlet leads.

2. MATERIALS

2.1. **Fabrication**. Fabrication plants must be approved by TxDOT in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification," before furnishing precast reinforced concrete pipe for TxDOT projects. TxDOT maintains a list of approved reinforced concrete pipe plants.

Furnish material and fabricate reinforced concrete pipe in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.2. **Design**.

2.2.1. **General**. The class and D-load equivalents are shown in Table 1. Furnish arch pipe in accordance with ASTM C506 and the dimensions shown in Table 2. Furnish horizontal elliptical pipe in accordance with ASTM C507 and the dimensions shown in Table 3. For arch pipe and horizontal elliptical pipe the minimum height of cover required is 1 ft.

Table 1

Circular Pipe

ASTM C76 & ASTM C655

Class	D-Load
I	800
II	1,000
III	1,350
IV	2,000
V	3,000

Table 2

Arch Pipe

Design Size	Equivalent Diameter (in.)	Rise (in.)	Span (in.)
1	18	13-1/2	22
2	21	15-1/2	26
3	24	18	28-1/2
4	30	22-1/2	36-1/4
5	36	26-5/8	43-3/4
6	42	31-5/16	51-1/8
7	48	36	58-1/2
8	54	40	65
9	60	45	73
10	72	54	88

Table 3

Horizontal Elliptical Pipe

Design Size	Equivalent Diameter (in.)	Rise (in.)	Span (in.)
1	18	14	23
2	24	19	30
3	27	22	34
4	30	24	38
5	33	27	42
6	36	29	45
7	39	32	49
8	42	34	53
9	48	38	60
10	54	43	68

2.2.2. **Jacking, Boring, or Tunneling**. Design pipe for jacking, boring, or tunneling considering the specific installation conditions such as the soil conditions, installation methods, anticipated deflection angles, and jacking stresses. Provide design notes and drawings signed and sealed by a Registered Professional Engineer when requested.

2.3. **Marking**. Furnish each section of reinforced concrete pipe marked with the following information specified in DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

- class or D-load of pipe,
- ASTM designation,
- date of manufacture,
- pipe size,
- name or trademark of fabricator and plant location,
- designated fabricator's approval stamp,
- pipe to be used for jacking and boring (when applicable), and
- designation "SR" for pipe meeting sulfate-resistant concrete plan requirements (when applicable).

Clearly mark 1 end of each section during the process of manufacture or immediately thereafter for pipe with elliptical reinforcement. Mark the pipe on the inside and outside of opposite walls to show the location of the top or bottom of the pipe as it should be installed unless the external shape of the pipe is such that the correct position of the top and bottom is obvious. Mark the pipe section by indenting or painting with waterproof paint.

2.4. **Inspection**. Provide access for inspection of the finished pipe at the Project site before and during installation.

2.5. **Causes for Rejection**. Individual section of pipe may be rejected for any of the conditions stated in the Annex of DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.6. **Repairs**. Make repairs if necessary as stated in the Annex of DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.7. **Jointing Materials**. Use any of the following materials for the making of joints. Furnish a manufacturer's certificate of compliance for all jointing materials except mortar.

2.7.1. **Mortar**. Provide mortar for joints that meets the requirements of Section 464.3.3., "Jointing."

2.7.2. **Cold-Applied, Plastic Asphalt Sewer Joint Compound**. Provide a material that consists of natural or processed asphalt base, suitable volatile solvents, and inert filler. Ensure the consistency is such that the ends of the pipe can be coated with a layer of the compound up to 1/2 in. thick by means of a trowel. Provide a joint compound that cures to a firm, stiff plastic condition after application. Provide a material of a uniform mixture. Stir any small separation found in the container into a uniform mix before using.

Provide a material that meets the requirements of Table 4 when tested in accordance with Tex-526-C.

Table 4

Cold-Applied, Plastic Asphalt Sewer Joint Compound Material Requirements

Composition	Analysis
Asphalt base, 100%–% volatiles–% ash, % by weight	28–45
Volatiles, 212°F evaporation, 24 hr., % by weight	10–26
Mineral matter, determined as ash, % by weight	30–55
Consistency, cone penetration, 150 q, 5 sec., 77°F	150–275

2.7.3. **Rubber Gaskets**. Provide gaskets that conform to ASTM C1619 Class A or C. Meet the requirements of ASTM C443 for design of the pipe joints and permissible variations in dimensions.

2.7.4. **Pre-Formed Flexible Joint Sealants**. Pre-formed flexible joint sealants may be used for sealing joints of tongue-and-groove concrete pipe. Provide flexible joint sealants that meet the requirements of ASTM C990. Use flexible joint sealants that do not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. Supply in extruded rope form of suitable cross-section. Provide a size of the pre-formed flexible joint sealant in accordance with the manufacturer's recommendations and large enough to properly seal the joint. Protect flexible joint sealants with a suitable wrapper able to maintain the integrity of the jointing material when the wrapper is removed.

3. CONSTRUCTION

3.1. **Excavation, Shaping, Bedding, and Backfill**. Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures," except where jacking, boring, or tunneling methods are permitted. Jack, bore, or tunnel the pipe in accordance with Item 476, "Jacking, Boring, or Tunneling Pipe or Box." Immediate backfilling is permitted if joints consist of materials other than mortar. Take special precautions in placing and compacting the backfill to avoid any movement of the pipe or damage to the joints. Do not use heavy earth-moving equipment to haul over the structure until a minimum of 4 ft. of permanent or temporary compacted fill has been placed over the structure. Remove and replace pipe damaged by Developer.

3.2. **Laying Pipe**. Start the laying of pipe on the bedding at the outlet end with the spigot or tongue end pointing downstream, and proceed toward the inlet end with the abutting sections properly matched, true to the established lines and grades. Fit, match, and lay the pipe to form a smooth, uniform conduit. Cut cross trenches in the foundation to allow the barrel of the pipe to rest firmly upon the bedding where bell-and-spigot pipe is used. Cut cross trenches no more than 2 in. larger than the bell ends of the pipe. Lower sections of pipe into the trench without damaging the pipe or disturbing the bedding and the sides of the trench. Carefully clean the ends of the pipe before the pipe is placed. Prevent the earth or bedding material from entering the pipe as it is laid. Lay the pipe in the trench, when elliptical pipe with circular reinforcing or circular pipe with elliptical reinforcing is used, so the markings for the top or bottom are not more than 5° from the vertical plane through the longitudinal axis of the pipe. Remove and re-lay pipe that is not in alignment or shows excessive settlement after laying.

Lay multiple lines of reinforced concrete pipe with the centerlines of the individual barrels parallel. Use the clear distances between outer surfaces of adjacent pipes shown in Table 5. Use the equivalent diameter from Table 2 or Table 3 for arch pipe or horizontal elliptical pipe to determine the clear distance requirement in Table 5.

Table 5

Minimum Clear Distance between Pipes

Equivalent Diameter	Min. Clear Distance
18 in.	9 in.
24 in.	11 in.
30 in.	1 ft. 1 in.
36 in.	1 ft. 3 in.
42 in.	1 ft. 5 in.
48 in.	1 ft. 7 in.
54 in.	1 ft. 11 in.
60 to 84 in.	2 ft.

3.3. **Jointing**. Make available an appropriate rolling device similar to an automobile mechanic's "creeper" for conveyance through small-size pipe structures.

3.3.1. **Joints Sealed with Hydraulic Cement Mortar**. Use Type S mortar meeting the requirements of ASTM C270. Clean and wet the pipe ends before making the joint. Plaster the lower half of the bell or groove and the upper half of the tongue or spigot with mortar. Pack mortar into the joint from both inside and outside the pipe after the pipes are tightly jointed. Finish the inside smooth and flush with adjacent joints of pipe. Form a bead of semicircular cross-section over tongue-and-groove joints outside the pipe, extending at least 1 in. on each side of the joint. Form the mortar for bell-and-spigot joints to a 45° fillet between the outer edge of the bell and the spigot. Cure mortar joints by keeping the joints wet for at least 48 hr. or until the backfill has been completed, whichever comes first. Place fill or backfill once the mortar jointing material has cured for at least 6 hr. Conduct jointing only when the atmospheric temperature is above 40°F. Protect mortared joints against freezing by backfilling or other approved methods for at least 24 hr.

Driveway culverts do not require mortar banding on the outside of the pipe.

Furnish pipes, with approval, that are large enough for a person to enter with the groove between 1/2 in. and 3/4 in. longer than the tongue. Such pipe may be laid and backfilled without mortar joints. Clean the space on the interior of the pipe between the end of the tongue and the groove of all foreign material, thoroughly wet and fill with mortar around the entire circumference of the pipe, and finish flush after the backfilling has been completed.

3.3.2. **Joints Using Cold-Applied, Plastic Asphalt Sewer Joint Compound**. Ensure both ends of the pipes are clean and dry. Trowel or otherwise place a 1/2–in. thick layer of the compound in the groove end of the pipe covering at least 2/3 of the joint face around the entire circumference. Shove home the tongue end of the next pipe with enough pressure to make a tight joint. Remove any excess mastic projecting into the pipe after the joint is made. Backfill after the joint has been inspected and approved.

3.3.3. **Joints Using Rubber Gaskets**. Make the joint assembly according to the recommendations of the gasket manufacturer. Make joints watertight when using rubber gaskets. Backfill after the joint has been inspected and approved.

3.3.4. **Joints Using Pre-Formed Flexible Joint Sealants**. Install pre-formed flexible joint sealants in accordance with the manufacturer's recommendations. Place the joint sealer so no dirt or other deleterious materials come in contact with the joint sealing material. Pull or push home the pipe with enough force to properly seal the joint. Remove any joint material pushed out into the interior of the pipe that would tend to obstruct the flow. Store pre-formed flexible joint sealants in an area warmed naturally or artificially to above 70°F in an approved manner when the atmospheric temperature is below 60°F. Apply flexible joint sealants to pipe joints immediately before placing pipe in trench, and connect pipe to previously laid pipe. Backfill after the joint has been inspected and approved.

3.4. **Connections and Stub Ends**. Make connections of concrete pipe to existing pipes, pipe storm drains, or storm drain appurtenances as shown on the Design Documents.

Mortar or concrete the bottom of existing structures if necessary to eliminate any drainage pockets created by the connections. Repair any damage to the existing structure resulting from making the connections.

Make connections between concrete pipe and corrugated metal pipe with a suitable concrete collar and a minimum thickness of 4 in.

Finish stub ends for connections to future Work not shown on the Design Documents by installing watertight plugs into the free end of the pipe.

Fill lift holes with concrete, mortar, or precast concrete plugs after the pipe is in place.

Item 465

44. Junction Boxes, Manholes, and Inlets

1. DESCRIPTION

Construct junction boxes, manholes and inlets, complete in place or to the stage detailed, including furnishing and installing frames, grates, rings, and covers.

2. MATERIALS

Furnish materials in accordance with the following:

- Item 420, “Concrete Substructures”
- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcement for Concrete”
- Item 471, “Frames, Grates, Rings, and Covers”

Cast-in-place junction boxes, manholes, inlets, risers, and appurtenances are acceptable. Alternate designs for cast-in-place items must be acceptable to TxDOT and must conform to functional dimensions and design loading. Alternate designs must be designed and sealed by a Registered Professional Engineer.

2.1. **Concrete**. Furnish Class H concrete for formed precast junction boxes, manholes, and inlets. Furnish concrete per DMS-7310, “Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification,” for machine-made precast junctions boxes, manholes, and inlets. Air-entrained concrete will not be required in precast concrete members. Furnish Class C concrete for cast-in-place manholes and inlets.

2.2. **Mortar**. Furnish mortar conforming to DMS-4675, “Cementitious Grouts and Mortars for Miscellaneous Applications.”

2.3. **Timber**. Provide sound timber that is a minimum of 3 in. nominal thickness and reasonably free of knots and warps for temporary covers when used with Stage I construction (see Article 465.3., “Construction”).

2.4. **Other Materials**. Use commerical-type hardware as approved.

3. CONSTRUCTION

Build all types of junction boxes, manholes, and inlets either complete or in 2 stages, described as Stage I and Stage II.

Construct the Stage I portion of junction boxes, manholes, and inlets as shown on the Design Documents or as specified in this Item. Furnish and install a temporary cover as approved .

Furnish and install the storm drain pipe and a temporary plug for the exposed end of the storm drain pipe from the storm drain to a point below the top of curb indicated on the Design Documents for Stage I construction of cast iron or steel inlet units.

Construct Stage II after the pavement structure is substantially complete.

Construct the remaining wall height and top of junction box, manhole, or inlet for Stage II, and furnish and install any frames, grates, rings and covers, curb beams, or collecting basins required.

Construct cast-in-place junction boxes, manholes, and inlets in accordance with Item 420, "Concrete Substructures." Forms shall be required for all concrete walls. Outside wall forms for cast-in-place concrete may be omitted with approval if the surrounding material can be trimmed to a smooth vertical face.

3.1. **Precast Junction Boxes, Manholes, and Inlets**. Construct formed precast junction boxes, manholes, and inlets in accordance with Item 420, "Concrete Substructures," except as otherwise noted in this Item. Construct machine-made precast junction boxes, manholes, and inlets in accordance with ASTM C478 except as otherwise noted in this Item. Mix and place concrete for machine-made junction boxes, manholes, and inlets per the requirements of DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification." Conform to the product permissible variations and rejection criteria stated in ASTM C478 for machine-made precast junction boxes, manholes, and inlets. Cure all precast units in accordance with Item 424, "Precast Concrete Structures (Fabrication)."

Multi-project fabrication plants (as defined in Item 424, "Precast Concrete Structures (Fabrication)") that produce manholes and inlets will be approved by TxDOT in accordance with DMS-7340, "Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Manholes and Inlets." TxDOT maintains a list of approved multi-project plants.

3.1.1. **Lifting Holes**. Provide no more than 4 lifting holes in each section for precast units. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate lifting devices based on the size and weight of the section. The maximum hole diameter is 3 in. at the inside surface of the wall and 4 in. at the outside surface. Cut no more than 5 in. in any direction of reinforcement per layer for lifting holes. Repair spalled areas around lifting holes.

3.1.2. **Marking**. Clearly mark each precast junction box, manhole, and inlet unit with the following information:

name or trademark of fabricator and plant location;
product designation;
ASTM designation (if applicable);
date of manufacture;
designated fabricator's approval stamp; and
designation "SR" for product meeting sulfate-resistant concrete plan requirements (when applicable).

3.1.3. **Storage and Shipment**. Store precast units on a level surface. Do not ship units until design strength requirements have been met.

3.2. **Excavation, Shaping, Bedding, and Backfill**. Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Immediate backfilling is permitted for all junction box, manhole, and inlet structures where joints consist of rubber boots, rubber gaskets, or bulk or preformed joint sealant. Take precautions in placing and compacting the backfill to avoid any movement of junction boxes, manholes, and inlets. Remove and replace junction boxes, manholes, and inlets damaged by Developer.

3.3. **Junction Boxes, Manholes, and Inlets for Precast Concrete Pipe Storm Drains**. Construct junction boxes, manholes, and inlets for precast concrete pipe storm drains prior to completion of storm drain lines into or through the junction box, manhole, or inlet. Neatly cut all storm drains at the inside face of the walls of the junction box, manhole, or inlet.

3.4. **Junction Boxes, Manholes, and Inlets for Box Storm Drains**. Place bases or risers of junction boxes, manholes, and inlets for box storm drains prior to or in conjuction with placement of the storm drain. Backfill the junction box, manhole, or inlet and storm drain as a whole.

3.5. **Inverts**. Shape and route floor inverts passing out or through the junction box, manhole, or inlet as shown on the Design Documents. Shape by adding and shaping mortar or concrete after the base is placed or by placing the required additional material with the base.

3.6. **Finishing Complete Junction Boxes, Manholes, and Inlets**. Complete junction boxes, manholes, and inlets in accordance with the Design Documents. Backfill to original ground elevation in accordance with Item 400, "Excavation and Backfill for Structures."

3.7. **Finishing Stage I Construction**. Complete Stage I construction by constructing the walls to the elevations shown on the Design Documents and backfilling to required elevations in accordance with Item 400, "Excavation and Backfill for Structures."

3.8. **Stage II Construction**. Construct subgrade and base course or concrete pavement construction over Stage I junction box, manhole, or inlet construction. Excavate to expose the top of Stage I construction and complete the junction box, manhole or inlet in accordance with the Design Documents and these Specifications, including backfill and cleaning of all debris from the bottom of the junction box, manhole, or inlet.

3.9. **Inlet Units**. Install cast iron or steel inlet units in conjunction with the construction of concrete curb and gutter. Set the inlet units securely in position before placing concrete for curb and gutter. Form openings for the inlets and recesses in curb and gutter as shown on the Design Documents. Place and thoroughly consolidate concrete for curb and gutter adjacent to inlets and around the inlet castings and formed openings and recesses without displacing the inlet units.

Item 466

45. Headwalls and Wingwalls

1. DESCRIPTION

Furnish, construct, and install concrete headwalls and wingwalls for drainage structures and underpasses.

2. MATERIALS

2.1. **General**. Furnish materials in accordance with the following.

- Item 420, “Concrete Substructures”
- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcement for Concrete”

Use Class C concrete for cast-in-place and precast concrete units. Furnish cast-in-place or precast headwalls and wingwalls.

2.2. **Fabrication**.

2.2.1. **General**. Fabricate cast-in-place concrete units and precast units in accordance with Item 420, “Concrete Substructures.” Use the following definitions for headwalls and wingwalls:

- “Headwalls” refers to all walls, including wings, at the ends of single-barrel and multiple-barrel pipe culvert structures.
- “Wingwalls” refers to all walls at the ends of single-barrel or multiple-barrel box culvert structures.

2.2.2. **Lifting Holes**. Provide no more than 4 lifting holes in each section for precast units. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate lifting devices based on the size and weight of the section. The maximum hole diameter is 3 in. at the inside surface of the wall and 4 in. at the outside surface. Cut no more than 1 longitudinal wire or 2 circumferential wires per layer of reinforcing steel when locating lift holes. Repair spalled areas around lifting holes.

2.2.3. **Marking**. Clearly mark each precast unit before shipment from the casting or fabrication yard with the following:

- the date of manufacture,
- the name or trademark of the manufacturer, and
- the type and size designation.

2.2.4. **Storage and Shipment**. Store precast units on a level surface. Do not place any loads on precast concrete units until design strength is reached. Do not ship units until design strength requirements have been met.

2.2.5. **Causes for Rejection**. Precast units may be rejected for not meeting any one of the specification requirements. Individual units may also be rejected for fractures or cracks passing through the

wall or surface defects indicating honeycombed or open texture surfaces. Remove rejected units from the Project, and replace them with acceptable units meeting the requirements of this Item.

2.2.6. **Defects and Repairs**. Occasional imperfections in manufacture or accidental damage sustained during handling may be repaired. The repaired units will be acceptable if they conform to the requirements of this Item and the repairs are sound, properly finished, and cured in conformance with pertinent specifications.

3. CONSTRUCTION

3.1. **General**. Remove portions of existing structures and drill, dowel, and grout in accordance with Item 420, "Concrete Substructures."

3.2. **Excavation, Shaping, Bedding, and Backfill**. Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Take special precautions in placing and compacting the backfill to avoid any movement or damage to the units. Bed precast units on foundations of firm and stable material accurately shaped to conform to the bases of the units.

3.3. **Placement of Precast Units**. Provide adequate means to lift and place the precast units. Fill lifting holes with mortar or concrete and cure. Precast concrete or mortar plugs may be used.

3.4. **Connections**. Make connections to new or existing structures in accordance with the details shown on the Design Documents. Furnish jointing material in accordance with Item 464, "Reinforced Concrete Pipe."

Remove a length of the existing pipe from the headwall to the joint when removing existing headwalls as shown on the Design Documents. Re-lay the removed pipe if approved, or furnish and lay a length of new pipe.

Item 467

46. Safety End Treatment

1. DESCRIPTION

Furnish, construct, and install safety end treatments for drainage structures.

2. MATERIALS

2.1. **General**. Furnish materials in accordance with the following.

- Item 420, “Concrete Substructures”
- Item 421, “Hydraulic Cement Concrete”
- Item 432, “Riprap”
- Item 440, “Reinforcement for Concrete”
- Item 442, “Metal for Structures”
- Item 445, “Galvanizing”
- Item 460, “Corrugated Metal Pipe”
- Item 464, “Reinforced Concrete Pipe”

Use Class C concrete for cast-in-place and precast concrete units. Furnish cast-in-place or precast safety end treatments. Furnish Class B concrete for concrete riprap. Provide galvanized steel for prefabricated metal end sections in accordance with Item 460, “Corrugated Metal Pipe.”

Furnish pipe runners in accordance with the following:

- ASTM A53, Type E or S, Grade B;
- ASTM A500, Grade B; or
- API 5L, Grade X42.

Furnish plates and angles in accordance with ASTM A36. Furnish nuts and bolts in accordance with ASTM A307. Galvanize pipes, plates, angles, nuts, and bolts in accordance with Item 445, “Galvanizing.”

2.2. **Fabrication**. Fabricate cast-in-place concrete units and precast units in accordance with Item 420, “Concrete Substructures.” Provide either prefabricated metal end sections or mitered CMP when specified for the pipe structure.

Provide one of the following when reinforced concrete pipe (RCP) is specified for the pipe structure:

mitered RCP or

precast safety end treatment (SET) units. Provide riprap only if the Design Documents specifically require it for this alternative.

2.2.1. **SET Types**.

2.2.1.1. **Type I**. Provide Type I SET consisting of reinforced concrete headwalls or wingwalls and pipe runners in accordance with the details shown on the Design Documents when required.

2.2.1.2. **Type II**. Provide Type II SET in accordance with the details shown on the Design Documents consisting of the following:

- CMP or RCP mitered to the proper slope, concrete riprap and pipe runners, when required;
- prefabricated metal end sections, concrete riprap and pipe runners, when required; or
- precast SET units, concrete riprap, when required, and pipe runners, when required.

2.2.2. **Lifting Holes**. Provide no more than 4 lifting holes in each section for precast units. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate lifting devices based on the size and weight of the section. The maximum hole diameter is 3 in. at the inside surface of the wall and 4 in. at the outside surface. Cut no more than 1 longitudinal wire or 2 circumferential wires per layer of reinforcing steel when locating lift holes. Repair spalled areas around lifting holes.

2.2.3. **Marking**. Clearly mark the following on each precast unit, mitered CMP, mitered RCP, or metal end section before shipment from the casting or fabrication yard:

the date of manufacture,

the name or trademark of the manufacturer, and

the type and size designation.

2.2.4. **Storage and Shipment**. Store precast units on a level surface. Do not place any loads on precast units until the design strength is reached. Do not ship units until design strength requirements have been met.

2.2.5. **Causes for Rejection**. Precast units may be rejected for not meeting any one of the specification requirements. Individual units may also be rejected for fractures or cracks passing through the wall or surface defects indicating honeycombed or open texture surfaces. Remove rejected units from the Project and replace with acceptable units meeting the requirements of this Item.

2.2.6. **Defects and Repairs**. Occasional imperfections in manufacture or accidental damage sustained during handling may be repaired. The repaired units will be acceptable if they conform to the requirements of this Item and the repairs are sound and properly finished and cured in conformance with pertinent specifications. Repair damaged galvanizing in accordance with Section 445.3.5., “Repairs.”

3. CONSTRUCTION

3.1. **General**. Remove portions of existing structures in accordance with Section 420.4.8., “Extending Existing Substructures.” Drill, dowel, and grout in accordance with Item 420, “Concrete Substructures.” Furnish concrete riprap in accordance with Item 432, “Riprap.”

Provide riprap on all prefabricated metal end sections.

3.2. **Excavation, Shaping, Bedding, and Backfill**. Excavate, shape, bed, and backfill in accordance with Item 400, “Excavation and Backfill for Structures.” Take special precautions in placing and compacting the backfill to avoid any movement or damage to the units. Bed precast units on foundations of firm and stable material accurately shaped to conform to the bases of the units.

3.3. **Placement of Precast Units**. Provide adequate means to lift and place the precast units. Fill lifting holes with mortar or concrete and cure. Precast concrete or mortar plugs may be used.

3.4. **Connections**. Make connections to new or existing structures in accordance with the details shown on the Design Documents. Furnish jointing material in accordance with Item 464, “Reinforced Concrete Pipe.”

Also remove a length of the existing pipe from the headwall to the joint when removing existing headwalls as shown on the Design Documents. Re-lay the removed pipe if approved, or furnish and lay a length of new pipe.

Item 471

47. Frames, Grates, Rings, and Covers

1. DESCRIPTION

Furnish and install frames, grates, rings, and covers for inlets, manholes, and other structures.

2. MATERIALS

2.1. **Frame, Grate, Ring, and Cover Castings**. Provide clean castings conforming to the shape and dimensions shown on the Design Documents. Ensure all gray and ductile iron castings conform to the AASHTO Designation M 306. Cast or machine the bearing surfaces for traffic service castings between manhole rings and covers and between grates and frames with such precision as to prevent rocking.

Provide gray iron castings in accordance with ASTM A48 Class 35B and AASHTO M 306 for traffic service applications. Provide gray iron castings in accordance with ASTM A48 Class 35B for sidewalk or pedestrian applications. Provide ductile iron castings in accordance with ASTM A536, Grade 70-50-05. Provide steel castings in accordance with ASTM A27, Grade 70-36. Ensure all traffic service castings and gratings meet or exceed the H20 proof-load requirements of AASHTO M 306. Load test results and material certifications must be made available upon request.

Ensure all traffic service (heavy duty) rated castings and grating meet the proof-load testing requirements of AASHTO M 306. Ensure all load tests are conducted with a calibrated NIST certified load cell. Ensure materials are loaded with a 9 × 9-in. load block to an applied load of 40,000 lb. for one minute without deformation or failure. Load test results and material certifications must be made available upon request.

Provide castings within ±1/16 in. per foot of plan dimensions, and within ±5% of plan weight.

2.2. **Welded Steel Grates and Frames**. Provide welded steel grates and frames as an assembly in accordance with the member size, dimensions, and details shown on the Design Documents. Fabricate these assemblies in accordance with Item 441, “Steel Structures.” Use steel that meets ASTM A36 or equivalent.

2.3. **Documentation**. Furnish a manufacturer’s certification stating the casting meets the proof-load testing requirements of AASHTO M 306 for traffic service castings.

3. CONSTRUCTION

Construct and install frames, grates, rings, and covers in accordance with the details shown on the Design Documents. Weld in accordance with Item 448, “Structural Field Welding.” Tack weld grates and covers to the frame or ring when directed.

Galvanize steel castings, welded steel grates, and frames in accordance with Item 445, "Galvanizing." Galvanizing is not required for iron castings unless used in conjunction with structural steel shapes or shown on the Design Documents.

Provide galvanized bolts and nuts in accordance with Item 445, "Galvanizing."

Item 472

48. Removing and Re-Laying Culvert

1. DESCRIPTION

Remove, transport, clean, and re-lay existing culvert and storm drain pipe.

2. MATERIALS

Bituminous coating must meet the requirements of Section 460.2.2., “Protective Coating.”

3. CONSTRUCTION

Culvert and storm drain pipe to be removed and re-laid shall be shown on the Design Documents. Remove debris and sediment within the culvert and storm drain pipe. Clean joints to facilitate proper re-laying. Install concrete pipe in accordance with Item 464, “Reinforced Concrete Pipe” Install corrugated metal pipe in accordance with Item 460, “Corrugated Metal Pipe.” Excavate, bed, and backfill in accordance with Item 400, “Excavation and Backfill for Structures.” Prevent damage to the pipe and fittings. Make connections to existing structures as shown on the Design Documents and in conformance to the requirements for connections as described in pertinent pipe specifications. Connect reinforced concrete pipe to corrugated metal pipe with a suitable concrete collar with a minimum thickness of 4 in.. Use a coating of bituminous material to insulate portions of aluminum pipe that are to be in contact with metal other than aluminum. Extend coating at least 1 ft. beyond area of contact. Mark the top and bottom of reinforced concrete pipe before removal and reinstall in the same position. Reuse headwall, aprons, or other appurtenances by severing from the culvert and moving to the new position if shown on the Design Documents. Make connections for joining sections of pipes in accordance with pertinent Items.

Replace any items designated for reuse with new material or restore them to previous condition, as approved. Developer may remove and dispose of existing structures and construct new structures in accordance with pertinent specifications and designs shown on the Design Documents.

Item 474

49. Linear Drains

1. DESCRIPTION

Furnish and install linear drains of the sizes and descriptions shown on the Design Documents as cast-in-place trench drain, precast trench drain, or slotted drain.

2. MATERIALS

Provide materials conforming to the pertinent requirements of the following Items:

2.1. **Cast-in-Place Trench Drain**. Provide a trench with a slope as shown on the Design Documents. Furnish forms capable of maintaining proper alignment during the concrete placement. Ensure connections to structures do not restrict the hydraulic flow of the trench drain. Use Class C Concrete conforming to Item 421, "Hydraulic Cement Concrete."

Furnish trench drain rails fabricated with structural steel meeting the requirements of ASTM A36, with a minimum cross-section of 2 × 2 × 3/16 in. Furnish trench drain rails with 1/4-in. minimum diameter steel anchoring rods at a maximum spacing of 20 in. between each rod, measured in the direction of travel, and a means for securing adjoining trench rails. Furnish steel that is galvanized per ASTM A123 after fabrication.

Fabricate trench drain grates from ductile iron in accordance with ASTM A536, Grade 65-45-12, and meet an AASHTO proof-load rating of AASHTO M 306. Provide galvanized grates per ASTM A123,after fabrication.

Furnish stainless grate retainers and rails that withstand the following loads:

- Vertical up-1,000 lbs
- Transverse-6,000 lbs
- Longitudinal-6,000 lbs

Furnish trench drain grates that have a minimum of 66% open space of total top surface area and are held in place with a non-rigid, four-point locking system in the four corners of the grate. Provide approved trench drain grate retaining devices that do not obstruct the flow area of the trench. Furnish removable trench grates.

Provide shop drawings sealed by a Registered Professional Engineer stating the trench drain system meets loading requirements. Submit documents showing design loadings if using a proprietary system.

Furnish documentation in accordance with Section 471.2.3., “Documentation.”

2.2. **Precast Trench Drains**. Furnish precast trench drains for TxDOT from pre-approved manufacturers in accordance with DMS-4370, “Precast Trench Drain.” TxDOT maintains a list of approved manufactures and their products. Unapproved precast trench drains will not be accepted.

Furnish materials conforming to the following where required.

- Item 420, “Concrete Substructures”
- Item 421, “Hydraulic Cement Concrete,” Class C
- Item 440, “Reinforcement for Concrete”

2.3. **Slotted Drains**. Fabricate and furnish materials in accordance with Item 460, “Corrugated Metal Pipe” Furnish galvanized steel or aluminized steel (AASHTO M 36, Type 2) pipe with a minimum thickness of 16 gauge.

Slotted drains consist of a drain guide assembly attached to a longitudinal opening in a corrugated metal pipe. Fabricate slotted drains using either of the following drain guide assemblies.

2.3.1. **Type A**. Provide bearing bars and crossbar spacers meeting the requirements of ASTM A36, welded to the longitudinal opening in the corrugated metal pipe. Galvanize the drain guide assembly after fabrication in accordance with Item 445, “Galvanizing.” Clean and repair welded areas and heat-affected zones in accordance with Section 445.3.5., “Repairs.”

2.3.2. **Type B**. Machine-form the drain guide assembly from 14 gauge or thicker galvanized steel sheeting that meets the requirements of Item 460, “Corrugated Metal Pipe.”

2.4. **Slotted Drain Outfalls**. Slotted drain outfalls consist of the corrugated metal pipe that connects the slotted drain to the main drainage line.

2.5. **Backfill**. Provide cement-stabilized backfill in accordance with Item 400, “Excavation and Backfill for Structures,” or high-slump, low-strength concrete with a minimum of 180 lb. of cement per cubic yard.

3. CONSTRUCTION OF CASTIN PLACE TRENCH DRAINS

Perform excavation in accordance with Item 400, “Excavation and Backfill for Structures.” Construct trench with a slope as shown on the Design Documents. Submit shop drawings that provide enough detail to ensure seamless installation of the trench drain adjacent to the proposed or existing pavement structure.

Provide shop drawings, if using a proprietary system, that contain the manufacturer’s installation guidelines and any sequential order of construction. Construct the trench drain with a maximum allowable tolerance of ±1/16 in. for dimensional accuracy and rail co-planarity. Provide a smooth finish on the surface of the trench that will convey runoff. Make connections to new or existing structures as shown on the Design Documents.

Remove trench drain forms and dispose of properly. Install grates with retaining pins on each of the four corners. Remove all construction debris from the trench drain.

4. CONSTRUCTION OF PRECAST TRENCH DRAINS

Place precast trench drains in concrete pavement or encased in a concrete grade beam and subgrade designed to support H-20 wheel loading.

Perform excavation in accordance with Item 400, “Excavation and Backfill for Structures.” Construct trench with a slope as shown on the Design Documents. Use interconnecting end

profiles on adjoining channels to maintain channel alignment within ± 1/16 in. Use non-sloping sections where shown on the Design Documents.

Assemble and install precast trench drains in accordance with approved shop drawings and manufacturer's recommendations at the locations directed on the Design Documents. Provide shop drawings containing the manufacturer's installation guidelines.

Encase precast trench drains, not cast in concrete pavement, in concrete grade beams, as shown on the Design Documents and suitable to support the trench drain and retain the trench grate from pull out. Ensure the grade and alignment of the installed grates matches the grade and alignment of the surrounding pavement.

Do not provide removable trench drain grates at any location where wheeled vehicles may drive over them including roadway lanes, shoulders, and driveways.

Remove all construction debris from the trench drain.

5. CONSTRUCTION OF SLOTTED DRAINS

Install slotted drains and slotted drain outfalls in accordance with details on the Design Documents and the requirements of Item 460, "Corrugated Metal Pipe." Excavate and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Backfill trenches as shown on the Design Documents. Furnish slotted drains in 20-ft. lengths, minimizing the number of joints required.

Item 476

50. Jacking, Boring, or Tunnelling Pipe or Box

1. DESCRIPTION

Furnish and install pipe or box by jacking, boring, or tunneling.

2. MATERIALS

Use the following types of pipe or box:

- corrugated metal pipe meeting Item 460, "Corrugated Metal Pipe," of the size, type, design, and dimension shown on the Design Documents;
- reinforced concrete pipe meeting the special requirements for jacking, boring, or tunneling of Item 464, "Reinforced Concrete Pipe," of the size, strength, and dimension shown on the Design Documents;
- reinforced concrete box meeting Item 462, "Concrete Box Culverts and Drains," of the size and type shown on the Design Documents; or
- other types specified by the Design Documents.

3. CONSTRUCTION

Excavate suitable shafts or trenches for conducting the jacking, boring, or tunneling operations and for placing end joints of the pipe or box if the grade at the jacking, boring, or tunneling end is below the ground surface. Maintain a 3:1 slope from edge of pavement on the shaft side of the road. Provide a positive barrier when the shaft location is within the clear zone of the roadway. Protect excavations deeper than 5 ft. as specified in Item 402, "Trench Excavation Protection" or Item 403, "Temporary Special Shoring."

Install pipe or box so there is no interference with the operation of street, highway, railroad, or other facility and no embankment or structure is weakened or damaged.

Repair any pipe or box damaged in jacking, boring, or tunneling. Remove and replace any pipe or box damaged beyond repair.

Backfill shafts or trenches excavated to facilitate jacking, boring, or tunneling immediately after installation of pipe or box.

3.1. **Jacking**. Provide jacks suitable for forcing the pipe or box through the embankment. Use even pressure to all jacks during operation. Provide a suitable jacking head and suitable bracing between the jacks and the jacking head to apply uniform pressure around the ring of the pipe or circumference of the box. Use joint cushioning of plywood or other approved material. For plywood cushioning material, use 1/2-in. minimum thickness for pipe diameter 30 in. or less, and use 3/4-in. minimum thickness for pipe diameter greater than 30 in. Use 3/4-in. minimum thickness for all boxes. Use cushioning rings of single or multiple pieces. Provide a suitable jacking frame or backstop. Set the pipe or box to be jacked on guides that support the section of the pipe or box, and direct it on the proper line and grade. Place the entire jacking assembly in line with the

direction and grade of the pipe or box. In general, excavate the embankment material just ahead of the pipe or box, remove the material through the pipe or box, and force the pipe or box through the embankment with jacks into the space bored or tunneled.

Furnish a plan showing the proposed method of jacking for approval. Include the design for the jacking head, jacking support or backstop (thrust block), arrangement and position of jacks, and guides in the plan.

Ensure excavation for the underside of the pipe for at least 1/3 of the circumference of the pipe conforms to the contour and grade of the pipe. Ensure the excavation for the bottom slab of the box conforms to the grade of the box. Over-excavate, if desired, to provide no more than 2 in. of clearance for the upper portion and sides of the pipe or box. Taper this clearance to zero at the point where the excavation conforms to the contour of the pipe or box. Carry out jacking without interruption to prevent the pipe from becoming firmly set in the embankment. Monitor volume of soil excavated to avoid any appreciable over excavation. Pressure-grout any over excavation of more than 1 in. Pressure-grout between the carrier pipe and casing when shown on the Design Documents.

The distance the excavation extends beyond the end of the pipe or box must not exceed 2 ft. Decrease this distance as necessary to maintain stability of the material being excavated.

Jack the pipe or box from the low or downstream end. The final position of the pipe or box must not vary from the line and grade shown on the Design Documents by more than 1 in. in 10 ft. Variation must be regular and in one direction, and the final flow line must be in the direction shown on the Design Documents.

Use a shield or cutting edge of steel plate around the head end of the pipe or box extending a short distance beyond the end if desired. The minimum distance for parallel pipe or box jacking or tunneling is 3 ft. or 2 times the diameter of the pipe or width of box, whichever is greater.

3.2. **Boring or Tunneling**. Bore from a shaft in an approved location provided for the boring equipment and workmen.

Dispose of excavated material using an approved method. Use water or other appropriate drilling fluids in connection with the boring operation only as necessary to lubricate cuttings and pipe or box; do not use jetting.

Use a gel-forming colloidal drilling fluid consisting of high-grade, carefully processed bentonite to consolidate cuttings of the bit in unconsolidated soil formations. Seal the walls of the bore hole and furnish lubrication for subsequent removal of cuttings and immediate installation of the pipe.

Allowable variations from line and grade are specified in Section 476.3.1., “Jacking.” Pressure-grout any over excavation of more than 1 in.

3.2.1. **Larger Diameter Boring Methods.** Use the pilot hole or auger method for drainage and large utility borings. Pressure-grout any over excavation of more than 1 in. Pressure-grout between the carrier pipe and casing when shown on the Design Documents.

3.2.1.1. **Pilot Hole Method**. Bore a 2-in. pilot hole the entire length of the crossing, and check it for line and grade during the boring or tunneling operation on the opposite end of the bore from the work shaft. This pilot hole will serve as centerline for the larger diameter hole to be bored.

3.2.1.2. **Auger Method**. Use a steel encasement pipe of the appropriate diameter equipped with a cutter head to mechanically perform the excavation. Use augers of large enough diameter to convey the excavated material to the work shaft.

3.2.2. **Electrical and Communication Conduit Boring.** Limit over excavation to the dimensions shown in Table 1 for electrical and communication conduit borings. Increased boring diameters will be allowed for outer diameters of casing and couplings. Pressure-grouting will not be required for electrical and communication conduit borings.

Table 1

Allowable Bore Diameter for Electrical or Communication Conduit or Casing

Single Conduit Bores		**Multiple Conduit Bores**	
Conduit Size (in.)	Maximum Allowable Bore (in.)	Conduit Size (in.)[1]	Maximum Allowable Bore (in.)
2	4	4	6
3	6	5	8
4	6	6	10
6	10	7	12
		8	12

1. The diameter of multiple conduits is the sum of the outside diameter of the two largest conduits for placement of up to 4 conduits in one bore. Submit boring diameters for approval when more than 4 conduits are to be placed in a bore.

3.3. **Tunneling**. Use an approved tunneling method where the characteristics of the soil, the size of the proposed pipe, or the use of monolithic pipe would make the use of tunneling more satisfactory than jacking or boring, or when shown on the Design Documents.

Ensure the lining of the tunnel is strong enough to support the overburden when tunneling is permitted. Submit the proposed liner method for approval. Approval does not relieve Developer of the responsibility for the adequacy of the liner method.

Pressure-grout the space between the liner plate and the limits of excavation.

Pressure-grout between the carrier pipe and liner plate when shown on the Design Documents.

3.4. **Joints**. Make joints by field bolting or connecting bands, whichever is feasible if corrugated metal pipe is used. Make the joints in accordance with Item 464, “Reinforced Concrete Pipe” if reinforced concrete pipe is used. Make the joints in accordance with Item 462, “Concrete Box Culverts and Drains” if reinforced concrete box is used.

Item 479

51. Adjusting Manholes and Inlets

1. DESCRIPTION

Adjust or cap existing manholes or inlets. Drainage junction boxes will be classified as manholes.

2. MATERIALS

Reuse removed manhole and inlet rings, plates, grates, and covers if they are in good condition as determined by TxDOT. Provide additional materials in accordance with Item 465, "Manholes and Inlets.". Use single- or multiple-piece prefabricated metal, polymer, plastic, or rubber extension rings for the adjustment of manholes as approved. Limit the height of flexible extension rings to 3 in. Provide concrete that meets Item 421, "Hydraulic Cement Concrete."

Ensure frames and grates, or rings and covers, above grade are of single-piece cast iron manufactured in compliance with Item 471, "Frames, Grates, Rings, and Covers." Provide steel riser material compliant with ASTM A36. Provide steel adjustable risers that include a stainless steel adjustable stud with positive lock that adjusts the diameter ±3/8 in. Provide steel risers that include a minimum of 3 allen head set screws that lock the riser to the manhole or catch basin frame. Ensure seating surfaces are flat and true and provide a non-rocking seating surface.

3. CONSTRUCTION

Perform all Work in accordance with Item 465, "Manholes and Inlets." Excavate and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Carefully remove manhole and inlet rings, covers, plates, and grates to be reused. Clean mortar and grease from the contact areas of all reused items. Dispose of unused removed material. Use construction methods described in Section 479.3.1., "Lowering the Top of a Manhole or Inlet," and Section 479.3.2., "Raising the Top of a Manhole or Inlet."

3.1. **Lowering the Top of a Manhole or Inlet**. Remove a sufficient depth of brick courses or concrete to permit reconstruction on a batter not exceeding 1 in. horizontal to 2 in. vertical. Clean the mortar from the top course of brick where brickwork is present. Rebuild the manhole or inlet to the original top dimensions or to the dimensions shown on the Design Documents. Install the manhole or inlet ring and the cover, plate, or grate to conform to the proposed new surface contour.

3.2. **Raising the Top of a Manhole or Inlet**. Clean the top surface of brick or concrete. Construct to the proper new elevation using new rubber extension rings, concrete rings, or Class A concrete. Provide rubber manhole and catch basin risers of minimum 80% by weight recycled rubber and minimum 10% by volume recycled RFL coated fiber. Provide rubber manhole and catch basin adjustment risers that are of uniform quality, free from cracks, holes, and any other surface defects. Construction must be suitable for AASHTO H20 live loads. Load certifications for materials shall be made available upon request. Install the manhole or inlet ring and the cover, plate, or grate to conform to the proposed new surface contour. Install prefabricated extension rings in accordance with manufacturer's instructions.

3.3. Capping an Inlet or Manhole. Remove the inlet or manhole to a minimum of 1 ft. below subgrade elevation. Cap as shown on the Design Documents.

Item 480

52. Cleaning Existing Culverts

1. DESCRIPTION

Remove all extraneous material from existing culvert barrels and pipes.

2. WORK METHODS

Expose all inside surfaces of the specified culverts. Do not move or damage the culvert. Dispose of material in accordance with federal, State, and local regulations. Place on roadway slopes when approved.

Perform cleaning to maintain drainage during construction.

Item 481

53. Pipe for Drains

1. DESCRIPTION

Furnish and install pipe for drains.

2. MATERIALS

Furnish polyvinyl chloride (PVC) pipe meeting the requirements of ASTM D1785, Schedule 40, and furnish PVC fittings meeting the requirements of ASTM D2466. PVC pipe and fittings meeting the requirements of ASTM D3034, Type SDR 35 may be used for installations encased in concrete or buried in soil.

Furnish a manufacturer's certification stating the material meets the appropriate ASTM specification.

Furnish pipe marked with:

- manufacturer's name or trademark and code;
- nominal size;
- PVC cell classification (example: 12454-B);
- schedule, size, or other legend (example: SDR-35 PVC Sewer Pipe); and
- specification designation (example: ASTM D1785).

Furnish fittings marked with:

- manufacturer's name or trademark;
- nominal size;
- material designation (example: PVC);
- schedule, size, or other legend (example: Schedule 40); and
- specification designation (example: ASTM D3034).

Furnish solvent meeting the requirements of ASTM D2564 for solvent-welding of fittings.

Provide other types of pipe and fittings as indicated.

Provide fittings, hangers, clamps, straps, anchors, and guard plates in accordance with the details shown on the Design Documents.

3. CONSTRUCTION

Excavate and backfill for pipe installation in accordance with Item 400, "Excavation and Backfill for Structures." Install pipe as shown on the Design Documents. Solvent-weld all fittings, including splice fittings, to provide a watertight fit. Do not splice straight sections of pipe at intervals shorter than 20 ft.

Degrease all exposed PVC pipe and fittings, and apply an acrylic water-based primer followed by a coating of the same color used for adjacent concrete surface.

Follow manufacturer's specifications for installation of other types of pipe (material other than PVC) when indicated.

Item 483

54. Concrete Bridge Deck Surfacing

1. DESCRIPTION

Surface concrete bridge deck as specified to provide prepared substrate for concrete overlay or to remediate a finished surface.

2. EQUIPMENT

Use equipment within the maximum allowed legal load or provide analysis showing equipment will not overstress the bridge. Use machines equipped with dust controls measures and shielding to prevent flying debris from leaving the work area.

2.1. **Milling**. Use concrete milling equipment capable of maintaining constant depth of cut as specified. Equip machine with automated debris collection system.

2.2. **Hydro-Demolition**. Use equipment consisting of ultra-high pressure water jets (>10,000 psi) capable of removing concrete to depth specified. Provide machine that can to be calibrated to remove an incremental depth of uniform strength concrete.

2.3. **Shot Blasting**. Use self-propelled shot blasting equipment utilizing steel abrasive being propelled at the concrete surface and equipped with a self-contained vacuum system to collect all removed debris.

2.4. **Diamond Grinding**. Use self-propelled diamond grinding equipment capable of removing concrete surface and producing corduroy type texture. Provide machine equipped with dual longitudinal controls capable of operating on both sides automatically from any longitudinal grade reference and have cutting wheel containing 50 to 60 diamond blades per foot. Minimize dust escaping into environment by equipping machine with self-contained vacuum system to collect all debris removed.

2.5. **Saw Grooving**. Use sawing equipment capable of cutting grooves in completed bridge slabs and top slabs of direct traffic culverts. Provide grooves that are 1/8 to 3/16 in. deep, nominally 1/8 in. wide, and spaced at 1 in. Use sawing equipment capable of cutting grooves in hardened concrete to within 18 in. of the barrier rail or curb.

3. CONSTRUCTION

Protect bridge joints, drains, and other appurtenances from surfacing operations. Following surfacing, clean the surface to remove all cuttings and debris. Dispose of all cuttings and debris properly.

Use chipping tools and other smaller approved concrete surfacing equipment in small areas not accessible to the large surfacing equipment.

Approval to begin Work is not an endorsement of proposed equipment. If equipment fails to meet specification requirements, replace equipment.

Perform concrete bridge deck surfacing as specified in accordance with the following listed methods:

3.1. Milling. Mill the existing deck to remove concrete to the depth specified. Provide a uniformly rough surface with a chipped appearance suitable for bonding a concrete overlay. Scarify at locations shown on the Design Documents to the depths shown on the Design Documents. Measure the depth from the level of the existing surface to the high points on the scarified surface.

Ensure damage does not occur to the bridge slab reinforcing steel, armored joints, slab joints, drainage hardware, and other appurtenances. Stop milling operations if reinforcing steel is encountered. Proceed with further milling only when approved to do so.

Establish and maintain independent grade control for concrete scarifying operations when appropriate or required.

Use chipping tools to remove concrete in small areas not accessible to the mechanical scarifier.

3.2. **Hydro-Demolition**. Submit for approval water disposal plan associated with the Work. Follow all water disposal requirements per federal, State, and local Law. Temporarily plug all bridge drains near the area of work to prevent runoff as a result of the Work from being released. Protect surrounding property and traffic from water spray and material dislodged.

Demonstrate hydro-demolition on test areas as designated to calibrate machine to obtain concrete removal depth and finish as specified and as approved. At a minimum, calibrate machine to remove all unsound concrete and sound concrete to the specified depth.

Remove additional concrete to obtain a minimum of 3/4” around the bars by hydro-demolition or other approved method if reinforcing steel is exposed.

Stop and recalibrate machine when depth of removal or surface roughness is different than approved.

3.3. **Shot Blasting**. Demonstrate shot blasting on test areas as designated to calibrate machine to obtain depth of surface removal required and to obtain finish as specified and as approved.

Do not alter grade or cross slope.

Maintain and adjust machine calibration to produce surfacing required.

3.4. **Diamond Grinding**. Demonstrate diamond grinding on designated area and obtain approval of finish produced.

Perform grinding in longitudinal direction. Grind surfaces on both sides of transverse joints to be flush (same elevation). Eliminate minor depressions by extra grinding.

Produce a uniform surface with a longitudinal corduroy type texture that eliminates joint and crack faults. Maintain transverse cross slope to provide drainage across surface.

Repeat grinding until surface grade and cross slope satisfies ride requirements. Minimum ride requirements are 1/4 in. in 10 ft.

Saw-cut transversely the ground areas to provide grooved surface in accordance with Section 483.3.5., “Sawing Grooving.”

3.5. **Sawing Grooving**. Cut grooves into concrete surface perpendicular to the structure centerline. Cut grooves across the slab to within 18 in. of the barrier rail, curb, or median divider. At skewed metal expansion joints in bridge slabs, adjust groove cutting by using narrow-width cutting heads so all grooves end within 6 in. of the joint, measured perpendicular to the centerline of the metal joint. Leave no ungrooved surface wider than 6 in. adjacent to either side of the joint. Ensure 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, is 1 in. Cut grooves continuously across construction joints or other joints in the concrete less than 1/2 in. wide. Apply the same procedure described above where barrier rails, curbs, or median dividers are not parallel to the structure centerline to maintain the 18-in. maximum dimension from the end of the grooves to the gutter line. Cut grooves continuously across formed concrete joints.

Item 496

55. Removing Structures

1. DESCRIPTION

Remove and either dispose of or salvage structures.

2. CONSTRUCTION

2.1. **Demolition Construction Documents**. Follow the demolition sequence shown on the Design Documents for bridge structures to be removed, or submit a demolition Construction Document if indicated on the Design Documents. Include in the required demolition plan the type and location of equipment to be used, the method and sequence of removal of the structural Elements, and a narrative indicating the stability of the partially demolished structure is maintained throughout the demolition process. Have these Construction Documents signed and sealed by a Registered Professional Engineer when demolished structure intersects active roadways and as otherwise shown on the Design Documents. Submit required demolition Construction Documents at least 14 Days before starting Work. TxDOT approval of these Construction Documents is not required, but TxDOT reserves the right to request modifications to the Construction Documents when Work could affect the safety of the traveling public and when around other transportation facilities to remain in place. Notify TxDOT 30 Days before starting any bridge demolition Work to allow for required notifications to other agencies.

2.2. **Removal.**

2.2.1. **Pipes**. Avoid damaging appurtenances determined to be salvageable.

2.2.2. **Concrete, Brick, or Stone Structures**. Portions of structures that will not interfere with the proposed construction may remain in place 2 ft. or more below the permanent ground line. Square off remaining structures and cut reinforcement flush with the surface of the concrete.

2.2.3. **Steel Structures**. Dismantle steel to be retained by TxDOT or re-erected by cold-cutting fastener heads and punching or drilling the remaining portion of the fastener, air-arc gouging welded connections, and flame-cutting beams along a straight line. Cut beams at the locations shown on the Design Documents. Match-mark steel to be re-erected with paint in accordance with the erection drawings. Remove steel piles or cut off 2 ft. or more below the permanent ground line.

2.2.4. **Timber Structures**. Remove all fasteners from timber determined to be salvageable. Remove timber piles or cut off 2 ft. or more below the permanent ground line.

2.3. **Salvage**. Avoid damage to materials shown on the Design Documents to be salvaged. Deliver materials to be retained by TxDOT to the location shown on the Design Documents. Block up salvaged steel materials off the ground.

2.4. **Disposal**. Material removed that is not deemed to be salvageable is the property of Developer. Dispose of removed material off the right of way in accordance with federal, State, and local regulations.

2.5. **Backfill**. Backfill excavation and voids to the original ground line if resulting from the removal of structures. Place backfill that will support any portion of the roadbed or embankment to the same

requirements for placing embankment. Backfill other areas in 10 in. layers, loose measurement, and compact to the density of adjacent undisturbed material.

Item 499

56. Adjusting Steel Shoes

1. DESCRIPTION

Adjust and reset steel shoes as shown on the Design Documents.

2. CONSTRUCTION

Remove the existing welds between the shoes and the girder flanges by arc-air gouging. Loosen or remove anchor bolt nuts as required to allow free vertical movement before raising. Jack the girders up to free the shoes and allow the pin between the top and bottom bolsters to rotate freely. Drive out the pin if it does not rotate freely, then clean and lubricate it before reinstalling. Reset the shoes relatively plumb for a temperature of 70°F. Lower the girders and reweld the shoes in this position. Use the same weld size as the original weld. Weld and grind smooth any excess gouges caused by weld removal. Grind any original weld metal not removed by arc-air gouging. Grind all exposed corners to a 1/16-in. radius.

Use jacks with a capacity adequate to raise the girders free of the shoes without exceeding a bearing pressure on the concrete cap of 1,500 psi. Use jacks with a capacity of at least 1.5 times the shoe design load. Repair any concrete spalls caused by Developer's operations in accordance with Item 429, "Concrete Structure Repair."

Replace any shoes or parts of shoes as shown on the Design Documents. Repair or replace anchor bolts, nuts, or other steel Elements damaged during the shoe adjustment in accordance with Item 442, "Metal for Structures," and Item 448, "Structural Field Welding."

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

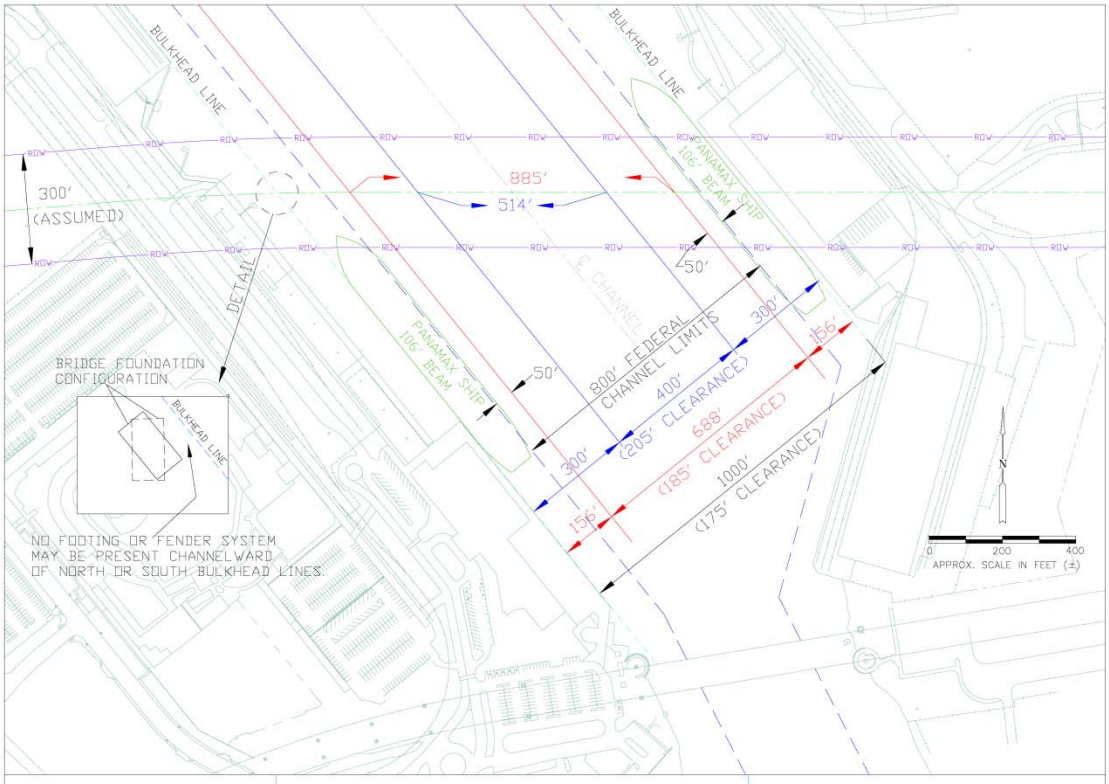
US 181 HARBOR BRIDGE PROJECT

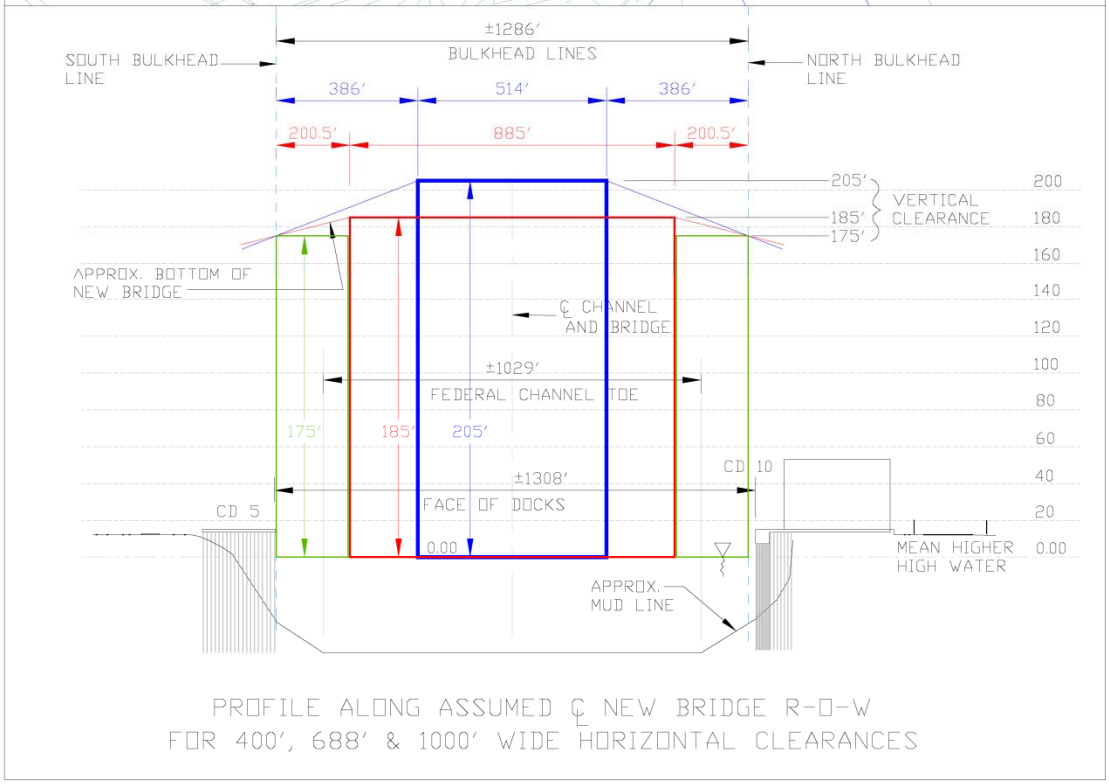
Design-Build Project

ATTACHMENT 13-2
NEW HARBOR BRIDGE CLEARANCE REQUIREMENTS

Bridge Clearance Requirements

This attachment was used for planning purposes and contains information that is preliminary in nature. For the purposes of this attachment, only the location of the bulkhead lines and vertical clearance envelop are contractual. For all other items, see the Contract Documents.





PROFILE ALONG ASSUMED ℄ NEW BRIDGE R-O-W
FOR 400', 688' & 1000' WIDE HORIZONTAL CLEARANCES

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 13-3
SECURITY PERFORMANCE REQUIREMENTS

(Included in Confidential RID)

Attachment 14-1
Amendments for the TxDOT's Traffic Operations Manual, Railroad Operations Volume, February 2000

AMENDMENTS FOR THE:
TxDOT Traffic Operations Manual – Railroad Operations Volume, February 2000

Manual Notices
Delete

Chapter 1 – Introduction

Section	Subheading	Modification
3	Operations Involving Railroads	Replace text with "The Developer and TxDOT will jointly enter into agreements with railroad companies. The Developer shall be responsible for all costs related to force account work for construction or maintenance requirements during the term of project. Where the Manual refers to actions the state normally takes, Developer shall perform those actions."

Chapter 2 – Railroad Agreements – General

Section	Subheading	Modification
1	Overview	Replace text with "Developer shall be responsible for all costs normally assigned to TxDOT."
2	Railroad Force Account Work	Replace text with "Developer and TxDOT will jointly enter into agreements with railroad companies. The Developer shall be responsible for all costs related to force account work for construction or maintenance requirements during the term of project. Where the Manual refers to actions the state normally takes, Developer shall perform those actions."
3	District Responsibilities	For reference only
3	District Responsibilities	In all subsequent subheadings, where the text includes work to be performed by the District or TRF, Developer shall perform.
4	TRF Responsibilities	Replace all text with the following: "The Developer shall provide all documents, estimates, and other information required by the TxDOT Traffic Operations Division (TRF) to prepare railroad agreements for the project."

Chapter 3 – Highway-Rail Grade Crossing Surfaces (Construction and Reconstruction)

Section	Subheading	Modification
1	Overview	Delete
2	Plan Layout	Replace "District" and "TxDOT" with "Developer". Under **Instruction**, delete "to be performed by TxDOT, TxDOT's contractor".
3	Agreement and Negotiating	Replace references to "Traffic Operations Division", "TRF", and "TxDOT" with the word "Developer". Delete **Construction and Maintenance** except for the 1st sentence. Under **Insurance Claims** delete all except the 1st sentence. Replace the word "contractor with the word "Developer". Delete "Payment Clause", "Solicitations of Bids" clause and "Conditions". Delete "Negotiating" and "After Execution".
4	Project Execution	Replace the words "District", "TxDOT's Contractor" and "TxDOT" with the word "Developer". Delete the section **Completion Letter**.

Chapter 4 – Grade Crossing Replanking Program
Delete

Chapter 5 – Spur Tracks
Delete

Chapter 6 – Warning Signals and Devices
Delete

Chapter 7 – Traffic Signal Preemption
Delete

Chapter 8 – Grade Separation
Delete

Chapter 9 – Drainage Structures and Common Ditches
Delete

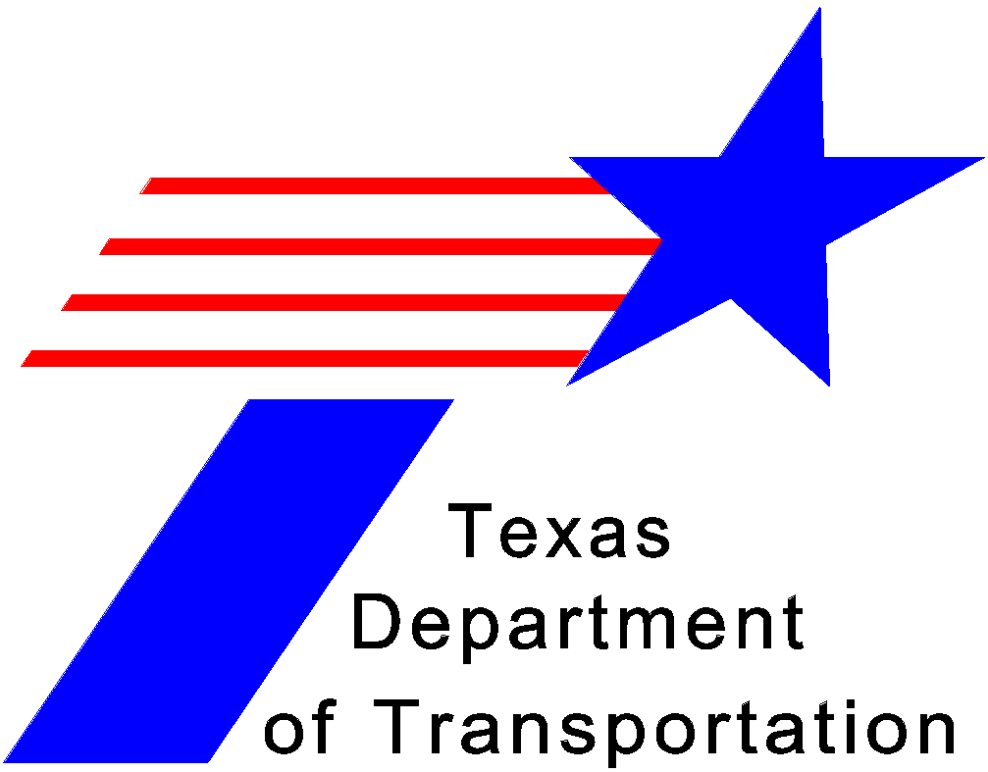
Chapter 10 – Other Railroad Agreements
Delete

Chapter 11 – Crossing Closure, Relocation, and Consolidation
Delete

Appendix A – Forms
Delete

Traffic Operations Manual

Railroad Operations Volume



February 2000

Railroad Operations Volume
February 2000

Manual Notices

Manual Notice 98-1

To: Recipients of Subject Manual

From: Charles W. Heald
Executive Director

Manual: *Railroad Operations Volume*
of the *Traffic Operations Manual*

Date: May 18, 1998

Purpose

This volume of the *Traffic Operations Manual* provides information on and internal procedures and practices related to TxDOT's operations involving railroads.

Supersedes

This volume supersedes:

- Part VI of the *Bridge Division Operation and Planning Manual*: "Operations Involving Railroad Companies"
- Administrative Circular No. 99-83, "Common Ditch Agreement with Railroad Companies"
- Administrative Circular No. 99-82, "1983 Railroad Replanking Program"
- Administrative Circular No. 74-75, "Railroad Advance Warning Sign and Signal"
- Administrative Circular No. 139-70 "Railroad Grade Crossing Subgrade."

Contents

This distribution of the *Railroad Operations Volume* contains:

- this manual notice
- Table of Contents
- Chapters 1 through 11
- Appendix A
- Index
- divider tabs
- a front cover insert
- a spine insert.

Instructions

This is a new volume. Insert these chapters and related matter with tabs into a three-ring binder.

Effective Date

This manual notice is effective as of July 1, 1998.

Contact

Address questions concerning information contained in this manual notice to Darin Kosmak, Traffic Operations Division (TRF), 512/416-2200 or fax 512/416-3206.

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Chapter 1
Introduction

Contents:

Section 1
General

Introduction

Highway-railroad grade crossings represent the physical intersection of two distinctly different modes of transportation, which vary considerably in their equipment, traveled ways, and methods of control and operation. Proper design and construction of new grade crossings helps ensure safe and efficient operation. This includes proper selection, design, and location of signs, pavement markings, and warning devices. Proper maintenance of existing crossings and associated warning devices helps to achieve continued safety and efficiency.

Since 1917 it has been necessary to make arrangements with the railroad companies to cross their privately owned right-of-way with roadways. After a series of condemnation lawsuits both parties realized it would be unproductive to continue disputing over the state's right to cross the rights-of-way. Also as spur tracks were built, railroad companies realized they had to cross public roadways to reach their customers. It became mutually advantageous to develop guidelines about grade crossings and grade separations so that lawsuits between the state and railroad companies could be avoided.

Purpose

This volume addresses highway-railroad grade crossing safety, replanking, and agreements. This volume outlines the procedures used by TxDOT employees in operations involving railroad companies, work on railroad right-of-way, and the development and execution of railroad programs managed by the Traffic Operations Division (TRF).

Users of this Volume

This volume is intended for use by Texas Department of Transportation (TxDOT) personnel.

Section 2
Authority and Policy

Introduction

This section lists statutes and policy instruments pertaining to operations between TxDOT and railroad companies at highway-railroad grade crossings. Copies of these documents (except for the statutes) and other historical information on the origin of these programs may be obtained from the Traffic Operations Division (TRF).

Governing Statutes (summaries)

The following state laws (codified in Vernon's Texas Civil Statues [V.T.C.S.]) pertain to operations between TxDOT and a railroad company at highway-railroad grade crossings. Brief summaries of each article are provided.

- ***Art. 6320, V.T.C.S. Streams of Water.*** When a railroad company approaches TxDOT proposing to cross an existing roadway on the designated state highway system, all costs associated with the proposed crossing shall be paid by the railroad company. This normally only occurs when a railroad company desires to construct a spur track across an existing roadway on the state highway system. (See Chapter 4 of this volume for information on spur track permit agreements.)
- ***Art. 6327, V.T.C.S. Crossings of Public Roads.*** When TxDOT approaches a railroad company proposing to cross an existing rail line or modify an existing crossing, all costs associated with the crossing shall be paid by TxDOT from state or federal funds or both. This statute also requires a railroad company to maintain crossings in a reasonable state to permit the passage of vehicles.
- ***Transportation Code, Section 471.002: "Signs at Cross-roads."*** Requires railroad companies to erect a sign (crossbuck signs) with large, distinct letters giving notice to the proximity of the railroad and warning persons of the necessity to look out for the railroad trains.
- ***Transportation Code, Section 471.004: "Warning Sign Visibility at Railroad Grade Crossings."*** Requires TxDOT to place retroreflectorized material on the back of each crossbuck sign and around the support post at each public railroad grade crossing to improve nighttime visibility. See also Texas Administrative Code (TAC), 43 TAC, Sections 25.70 – 25.73.

(continued...)

Governing Statutes (summaries) *(continued)*

- ***Transportation Code, Section 471.005: "Dismantling of Railroad Grade Crossing Warning Signals Located on an Active Rail Line."*** Requires operators of short line railroad companies to obtain a permit from the responsible road authority prior to dismantling railroad grade crossing warning signals located on an active rail line. For more information, see Texas Administrative Code (TAC), 43 TAC Sections 25.70 – 25.73.
- ***Transportation Code, Section 545.252.*** Gives TxDOT and local governments specific statutory authority to place traffic control devices at grade crossings on the roads they maintain, but no duty or minimum standards are imposed.
- ***Transportation Code, Section 471.003: "Telephone Service to Report Malfunctions of Mechanical Safety Devices at Crossings."*** Requires TxDOT to furnish and install railroad signal malfunction signs providing the telephone number, explanation of its purpose, and the crossing number at each intersection of a railroad track and a public road maintained by the state or a municipality. At each intersection of a railroad track and a public road not maintained by the state or a municipality (county roads), TxDOT shall furnish the political subdivision the sign to affix to the railroad signal device. A railway company shall permit personnel to affix the sign to the railroad warning device located on the company's property.

Policy Instruments

The following policy instruments pertain to railroad grade crossings:

- Texas Transportation Commission Minute Order No. 74227, dated March 27, 1978, (canceled Minute Order No. 60140). Re-authorized the annual state funded grade crossing protection program and increased the unit cost of the railroad signal maintenance payment program.
- Texas Transportation Commission Minute Order No. 106784, dated March 28, 1996. Authorized use of federal railroad signal program funds to make roadway and operational improvements to address changed traffic flow patterns resulting from closings of railroad grade crossings rather than installing active warning devices.
- Texas Transportation Commission Minute Order No. 107279, dated September 25, 1997. Established goals for TxDOT's railroad safety program and all projects involving the upgrade of highway-rail intersections.
- The *Texas Manual on Uniform Traffic Control Devices (TMUTCD).* Applicable portions include (but are not limited to) Part VIII, "Grade Crossings."

Texas Attorney General Opinions

The following Texas Attorney General opinions pertain to railroad grade crossings:

- Texas Attorney General Opinion No. M-525. Re: Authority of State Highway Department [now TxDOT] to make expenditures request to qualify for projects under 23 U.S.C. Section 405, dated February 13, 1976. TxDOT authority to expend state matching funds for federal-aid railroad grade crossing warning signal projects off the state highway system.
- Texas Attorney General Opinion No. M-108. Re: Validity of appropriation to the Texas Highway Department [now TxDOT] to construct and maintain railroad protective devices, dated July 24, 1967. Authority to expend state funds on railroad grade crossing projects on the designated state highway system (non-federal-aid projects).

Federal Policy

The *Federal-Aid Policy Guide (FAPG)* Title 23, CFR Part 140, Subpart I and 23 CFR, Part 646, Subpart A & B. All projects undertaken by TxDOT and agreements with railroads where federal funds will be used shall meet the requirements of the *FAPG*.

Railroad Practices

TxDOT complies with the following railroad practices pertaining to railroad grade crossings:

- TxDOT complies with the practices found in the *Association of American Railroads, Communication and Signal Division, Signal Manual of Recommended Practice,* Volume 1, Section 3, "Highway Grade Crossing Warning Systems."
- The *Railroad-Highway Grade Crossing Handbook — Second Edition,* published by the U.S. Department of Transportation, Federal Highway Administration, provides general information on highway-rail grade crossing characteristics and the physical and operational improvements that can be made to enhance safety and operation of both highway and rail traffic over crossing intersections. The guidelines and alternative improvements presented in the handbook have proven to be effective and are accepted nationwide.

Section 3
Operations Involving Railroads

Maintenance Responsibilities

In Texas, the road authority and railroad company assume both separate and joint maintenance responsibilities at highway-rail grade crossings. The track and signals are always maintained by the rail operator, because they are located within railroad right-of-way and are intrinsic to the safe operation and passage of trains. While local, state, and federal governmental entities may provide funds for the replacement or upgrade of crossing surfaces and crossing signals, the railroad operator is generally responsible for performing the work within railroad right-of-way.

Railroad companies are responsible for maintaining crossing surfaces between the cross ties of the track structure. Crossties typically extend two feet outside of each rail. The road authority is responsible for maintaining the roadway approaches up to the edge of the crossing surface, advanced signing, and pavement markings. Maintenance of crossbuck signs and warning signal devices located within railroad right-of-way is the responsibility of the railroad operator.

Working on Railroad Right-of-Way

An agreement between TxDOT and the operating railroad company must be in place giving TxDOT permission to enter into and perform work on railroad right-of-way. The state's contractor must have railroad protective liability insurance in place with the operating railroad company prior to entering into and performing work on railroad right-of-way.

Any work performed by state forces on railroad right-of-way should be closely coordinated with the operating railroad company.

Railroad Payment

The state normally reimburses the railroad for force account work, except where an existing highway is crossed by a new railroad. For new railroads, most crossing agreements provide for the railroad to assume the entire cost. Reimbursement is limited to the work detailed in the state-railroad agreement and attached exhibits. Cost related to the improvement or maintenance of railroad property will not be reimbursed. The railroad bears the expense and responsibility of maintaining crossing warning signal systems, crossbuck signs, and crossing surfaces.

(continued...)

Railroad Payment *(continued)*

Reimbursable (Funded)Work. Railroad force account work (work performed by the railroad company) is funded and work is performed in conjunction with an approved highway construction project.

The state normally reimburses the railroad for force account work, except where an existing highway is crossed by a new railroad. In this case, most crossing agreements provide for the railroad to assume the entire cost. Reimbursement is limited to the work detailed in the state-railroad agreement and attached exhibits.

The railroad normally sends their bills to Finance Division (FIN) for payment.

Non-Reimbursable (Unfunded) Work. Cost related to the improvement or maintenance of railroad property is not reimbursed. The railroad bears the expense and responsibility of maintaining crossing warning signal systems, crossbuck signs, and crossing surfaces.

Section 4
Terminology

Types of Railroad Tracks

Like highways, railroad track is categorized according to function. These categories include the following:

main tracks — Tracks that handle through train movements between and through stations and terminals, as opposed to switching or terminal movements. (This definition applies for the purposes of highway-rail safety programs.)

NOTE: The majority of highway-rail intersection collisions occur at main track crossings. This can be attributed to the fact that there are more main track intersections with highways than there are side track (or switching track) intersections. Also, main tracks typically experience higher train volumes and train speeds.

branch line — A railroad line that typically carries freight from its origin to a main line.

passing track (or siding) — A track used for meeting and passing trains.

side track, **switching track**, and **industrial track** — Track used for the loading, unloading, and storage of rail cars.

Track Gauge

Railroad track gauge (the distance between the two rails) has been standardized in the United States since the late 1800s. The U.S. standard track gauge is four feet, eight and one-half inches (4' 8½").

Sight Distance

The number of tracks and the length of the roadway between multiple sets of tracks are important considerations in determining sight distance requirements for highway-rail intersections.

Joint Use

When TxDOT obtains a "license to cross" railroad right-of-way with its highway facilities, a "joint use" highway-rail intersection is created.

Preemption

"Preemption" refers to the interconnection of railroad signal devices with traffic signals at adjacent highway-highway intersections. When an approaching train activates the railroad signal devices, a relay in the railroad signal cabinet preempts the normal traffic signal phasing with special phasing sequence.

Section 5
DOT/AAR Grade Crossing Inventory

Background

The United States Department of Transportation (DOT) and the Association of American Railroads (AAR) developed the National Rail-Highway Crossing Inventory in the early 1970s. It was developed with the cooperative effort of the Federal Highway Administration, the Federal Railroad Administration (FRA), individual states, and individual railroads. All at-grade and grade-separated crossings, both public and private, in the United States were surveyed, and data were recorded on inventory forms. The inventory contains data on the location of each crossing, the amount and type of train traffic, traffic control devices, and other physical elements of the highway-rail intersection.

NOTE: TxDOT maintains its own inventory as well, with many of the same types of data found in the national inventory.

Identification Numbering System

Each crossing listed in the national inventory is assigned a unique identification number consisting of six numeric characters and an alphabetic character.

EXAMPLE: 123456A

The crossing identification number (DOT No.) was originally installed at each crossing by nailing or strapping a temporary tag to a crossbuck or flashing light post. Today, the more common practice with the railroads is to stencil the number on the warning device support post.

Maintenance of the Inventory System

The FRA voluntarily serves as custodian of the national inventory file. Data in the inventory are kept current through the voluntary submission of information by the states and railroads. Numerous states and railroads update the national inventory. Systematic and uniform procedures are required to assist the FRA in processing the data.

The data contained in the national inventory and state inventory should be verified in the field by appropriate engineering studies. The national inventory is used not only by the states and railroads in conducting their crossing improvement programs, but also by national and federal agencies in assessing crossing improvement needs and conducting research. Thus, it is vital that this valuable information be kept up-to-date.

(continued...)

Maintenance of the Inventory System *(continued)*

Districts should make periodic reviews of all public crossings in their districts to ensure that information reported in the inventory is reasonably accurate. Districts should recommend deletions or additions based on discrepancies or changes in vehicle traffic, rail traffic, type of warning device in place, or accident data reported in the inventory. Railroad companies also have the opportunity to make recommendations and corrections.

Railroad companies and local governments should coordinate updates to the crossing inventory through the district offices. Local governmental entities may request that traffic counts be conducted by the district offices at any public highway-rail grade crossing. All updates to the crossing inventory should be forwarded to TxDOT's Transportation Planning and Programming Division (TPP) and to the Traffic Operations Division (TRF) in Austin. TPP is the office of record for all updates to the DOT/AAR Grade Crossing Inventory and is responsible for coordinating these updates with the railroad companies and the FRA.

Chapter 2
Railroad Agreements -- General

Contents:

Section 1
Overview

Financial Responsibility

Responsibility for undertaking work at highway-railroad grade crossings is defined in the Texas Administrative Code (43 TAC 25.76). Financial responsibility for costs associated with new crossings, or improvements or adjustments to existing crossings, depends on whose property is being crossed. If TxDOT needs to cross or originally crossed an existing railroad, TxDOT pays for any necessary warning signals, crossing surfaces, and other work. If the railroad wants to cross or originally crossed an existing highway on the state system, the railroad pays for any necessary warning signals, crossing surfaces, or other work.

In the more common situation where TxDOT approaches the railroad to cross their tracks, a "license to cross," rather than an easement, is granted by formal agreement and without cost to either party. The agreement specifies the construction and maintenance responsibilities of the two parties at the crossing. Since railroads are most often not required to bear any of the costs of federal-aid and state funded projects, their contribution to state projects should be the license to cross them and, if necessary, occupy small portions of their right-of-way for the state's structure or roadway. This arrangement is of particular benefit to the railroad for work involving the elimination of hazards at highway-rail grade crossings.

Agreements Required

An agreement between TxDOT and the railroad must be executed before any work on railroad right-of-way is done. The type of agreement necessary depends on the nature of the work and the source of funding. The following chapters of this volume explain the specific types of work and circumstances under which various agreements are required.

Section 2
Railroad Force Account Work

Program Overview

Railroad force account work is work performed by railroad forces or the railroad's contractor. Generally, railroad force account work is funded and work is performed in conjunction with an approved highway construction project. This work may involve:

- planking (road crossing surfaces)
- track adjustments
- installation of warning devices
- relocation of existing warning devices
- installation or extension of drainage structures under tracks
- wire line adjustments
- flagging for train operations
- other related work.

Financing

All railroad force account work necessary to accomplish a highway construction project let to contract by the state must be funded and paid under that project. Construction funds should not be mixed with railroad safety or maintenance dedicated program funds.

NOTE: The railroad force account work is funded through the construction budget activity, and any state force account work is funded through budgeted district Activity 202.

Implementation

Implementation of railroad force account work normally proceeds as follows:

1. The district submits a request for the crossing work to the Traffic Operations Division (TRF) along with an 11 x 17 inch plan layout, marked "Exhibit A." (See Section 3 of this chapter.)
2. TRF prepares an agreement and submits it to the railroad.
3. After the agreement is executed and an estimate for railroad force account work is approved by TRF, railroad forces perform the work upon receipt of a work order from the district office

Reimbursement

The state normally reimburses the railroad for force account work, except where an existing highway is crossed by a new railroad. Reimbursable force account work is limited to the work detailed in the state-railroad agreement and attached exhibits. *Cost related to the improvement or maintenance of railroad property cannot be reimbursed*. The railroad bears the expense and responsibility of maintaining crossing warning signal systems, crossbuck signs, and crossing surfaces, because these appurtenances are located on railroad right-of-way.

Section 3
District Responsibilities

Project Lead Time

The district should coordinate the timing of the railroad crossing work with the approved highway program. Since securing an agreement from a railroad company normally requires six to twelve months, or longer, the district's letter of request, exhibits, and other necessary data must be submitted to the Traffic Operations Division (TRF) as early as possible.

As examples, pavement overlay and stripping work are usually handled by a letter agreement and can be approved by the railroad more quickly because they involve little or no railroad force account work. More complex projects (new crossings, widening existing crossings, or constructing grade separations) require more time — not just for the railroad — but also for TRF and Design Division (DES) review and approval. Underpass projects require the most detailed review by the railroad because the structure will be carrying trains and shoofly tracks are usually necessary during construction. The following table shows minimum lead times for these types of projects.

Minimum Project Lead Times

Project Type	Minimum Lead Time
Road Jobs	6 months
New Crossings, Complex Road Jobs, and Overpasses	9 months
Underpasses and Projects Involving Track Construction or Relocation.	12 months

These lead time requirements mean that all plan layouts and agreements must be completed so they can be submitted to the railroad in advance of the contract letting date.

TRF normally notifies the district if a project is in jeopardy of meeting the letting date and advises the district of the consequences.

Plan Layout (Exhibit A) Preparation

The district performs all studies and surveys necessary to prepare the plan layout, title sheet, and supporting information required for Exhibit A of the agreement.

To minimize revisions, Exhibit A should be as complete as possible. Revisions increase the time needed to obtain an agreement and could delay letting if the railroad objects to the revisions.

NOTE: All plan layouts prepared by the district must be signed, sealed, and dated by a registered professional engineer.

Work Order

The district issues the work order to the railroad for all projects except those involving the installation of new warning signal devices. TRF issues work orders for the installation of new warning signal devices contracted under terms of a signal agreement separate from the agreement for the crossing work.

Pre-construction Meeting

For overpass, underpass, and road construction projects of a critical nature, the district or its contractor should host a pre-construction meeting. Representatives from the railroad, TxDOT's contractor, and TxDOT should attend the meeting. The construction schedule and individual points of contact are discussed.

Construction Inspection

The district advises the railroad on the status of construction work on a regular basis and provides construction inspection while railroad forces are performing work.

The district issues the completion letter for the project.

Section 4
TRF Responsibilities

Securing Agreements

TRF is responsible for preparing, negotiating, and obtaining the agreement before the contract letting, based on the plan layouts and information submitted by the districts.

Liaison Role

TRF serves as the liaison between the districts and railroad companies. In this role, TRF is responsible for negotiations with the railroad companies in connection with the preparation of agreements and the securing and approval of force account estimates based on the information furnished by the districts.

Coordination with DES

TRF also coordinates agreements for railroad grade separations and spur track permits through the Design Division (DES) during the preliminary plan layout and PS&E review stages of project development.

Work Order

TRF issues the work order to the railroad company for all projects involving the installation of new warning signal devices contracted for under terms of a separate agreement.

Chapter 3
Highway-Rail Grade Crossing Surfaces (Construction and Reconstruction)

Contents:

Section 1
Overview

Introduction

When the limits of a highway construction project involve the construction or reconstruction of a highway-rail grade crossing, TxDOT must execute an agreement with the operating railroad company prior to entering or performing any work on the railroad right-of-way. The agreement gives TxDOT license and permission to cross railroad right-of-way and establishes the rights and responsibilities of each party in the construction, maintenance, and operation of the highway-rail intersection. Most railroad rights-of-way are owned by a privately held company and TxDOT must act accordingly.

Importance of Timing

Timing and coordination between the district, divisions, and railroad company are essential to meet contract letting schedules and avoid delays or conflicts during construction.

On projects requiring a significant amount of railroad force account work, the railroad should be contacted during the advance stages of project development. Contact with the railroad should be coordinated through the district railroad coordinator and the Traffic Operations Division (TRF).

Project Financing

Highway construction projects involving any of the following are financed under the construction budget for each particular highway construction project:

- new highway-rail grade crossings
- the extension or re-construction of existing highway-rail grade crossings
- any other adjustments to a highway facility located within railroad right-of-way.

Replanking Program. Stand-alone projects for the replanking (resurfacing) of existing highway-rail grade crossing surfaces on the state highway system are considered under the state Grade Crossing Replanking Program (see Chapter 4 of this volume).

Project Process Overview

Projects involving highway-rail grade crossings normally proceed as follows:

1. The district furnishes to the Traffic Operations Division (TRF) complete plan layout (known as "Exhibit A") showing the critical details for the modification of the existing roadway or construction of new roadway. (See Section 2 of this chapter for critical details to be included in Exhibit A.)

   NOTE: Exhibit A should be submitted *at least* nine months before letting.

2. TRF prepares the agreements necessary for the license to cross railroad right-of-way, which covers construction and maintenance of the work to be performed. TRF also negotiates with the railroad companies involved. The railroad furnishes an estimate to TRF showing all reimbursable work, as indicated in the agreement, to be performed by the railroad. TRF reviews and approves the estimate, attaches it to the executed copies of the agreement, and forwards the railroad's copy back to them. The district and the Finance Division (FIN) also receive a copy of the executed agreement and estimate. (See Section 3 of this chapter for details on the agreement and negotiations.)

3. After the agreement is signed, the district issues a work order to the railroad. This may occur after the project is let or when requested by the railroad. The district also conducts pre-construction meetings, inspects the work, and issues completion letters. (See Section 4 of this chapter for more information on these activities.)

   NOTE: TRF issues work orders for warning signal work contracted under terms of a signal agreement separate from the agreement for the crossing work. See Chapter 6 of this volume.)

Sub-base Work

Materials. TxDOT or its contractor may provide materials needed for the sub-base work under the new crossing or the widened portion of the roadway, when widening is needed.

Timing of Work. On new railroad crossings construction projects, sub-base work performed by TxDOT or its contractor is usually completed *before* the railroad performs its work. On projects involving the reconstruction, widening, or replanking of existing crossings, sub-base work performed by TxDOT or its contractor is done *during* the railroad's work and, therefore, must be carefully coordinated to avoid delays.

Section 2
Plan Layout (Exhibit A)

Introduction

The district prepares the plan layout (known as Exhibit A) for the project in sufficient detail to show all work to be performed by TxDOT, TxDOT's contractor, and the railroad. Exhibit A includes:

- project data
- a title block
- right-of-way requirements
- a work list
- general notes
- warning signal device location.

Discussions of each of these items follow.

NOTE: All plan layouts prepared by the district must be signed, sealed, and dated by a registered professional engineer.

Project Data

Project data include:

- the county
- county number
- project description
- project number
- control-section-job (CSJ)
- railroad mile post (RRMP)
- highway station
- highway number or road name.

Title Block

The title block includes:

- the railroad company name and DOT No. (if available)
- crossing location
- railroad milepost and highway station at each location
- the words "Exhibit A."

Right-of-Way Requirements

If the roadway is being widened, the plan layout should indicate if additional railroad right-of-way will be required. This is necessary for preparation of a new "license to cross" article in the agreement.

Work List

The work list provides a breakdown of all work to be performed by TxDOT, TxDOT's contractor, and the railroad. The type of work to be performed on the railroad's ROW should also be listed. When coring is involved, it is important to show where the coring will be performed in relation to the railroad tracks.

General Notes

General notes should include:

- number and speed of "through" trains per day
- number and speed of switching moves per day
- average daily traffic (ADT)
- posted speed limit of vehicle traffic.

Warning Signal Device Location

On roadway modification projects, if railroad warning signal devices exist, their existing location and the proposed new location of the warning signals and appurtenances must be shown.

NOTE: If widening of the roadway involves relocating or upgrading the existing railroad warning signal devices, it is important to include pictures of the location.

On new road construction projects, the railroad warning signal devices are installed under terms of a separate agreement with the railroad company prepared by the Traffic Operations Division (TRF). The district should submit one additional copy of the Exhibit A to TRF for preparing the signal agreement and developing the railroad warning signal device portion of the project. A diagnostic inspection is normally conducted prior to determining the type and location of the railroad warning signal devices to be installed (see Chapter 6, Section 6, of this volume for details). TRF schedules the diagnostic inspection, which involves representatives from the district, the railroad company, and local government (as necessary).

Section 3
Agreement and Negotiations

Introduction

Using the Exhibit A plan layout furnished by the district, the Traffic Operations Division (TRF) prepares the necessary agreement and forwards it to the railroad company. TRF coordinates any questions or revisions resulting from the railroad company review with the district.

Agreement Contents

The agreement contains:

- project data
- a license clause
- scope of work
- construction and maintenance conditions
- insurance clauses
- payment clause
- solicitation of bids clause
- conditions
- fiber optic clause.

Discussions of each of these items follow.

Project Data

Project data include:

- the county
- control-section-job (CSJ)
- highway
- project number
- DOT No. (if available)
- the city.

License Clause

The license clause gives TxDOT license and permission to construct, maintain, and use the new roadway across railroad ROW. If the roadway is being widened and no additional railroad ROW is required, the license clause does not need to be included.

Scope of Work

The scope of work includes all work to be performed by TxDOT, TxDOT's contractor, and the railroad. It spells out the responsibilities of both the railroad and TxDOT.

Construction and Maintenance

The construction and maintenance clause describes to the railroad the conditions of work. The railroad must begin work within 30 days after having been issued a work order from TxDOT and must proceed without delay to completion. (See Section 4 of this chapter for more information on the work order.) The railroad will not be paid for any work performed at the job site prior to the work order date. The railroad company is given the authority to assemble all materials for the project sufficiently in advance to assure prompt delivery to the job site.

Insurance Clauses

The insurance clauses specifies the type of insurance the contractor will need to purchase on behalf of the state and railroad. All work performed on the railroad right-of-way by the TxDOT contractor requires railroad protective liability insurance in an amount of not less than two million dollars for bodily injury and property damage and not less than six million dollars aggregate for all occurrences. The railroad protective liability insurance must be carried until all work on the railroad property is completed. Insurance requirements are included in a Special Provision to Item 007 of TxDOT's contractor's bid specifications. If state forces perform the work, no insurance provisions are required in the agreement because TxDOT is self-insured.

Payment Clause

The payment clause specifies when and under which conditions TxDOT will reimburse the railroad. Reimbursement is made to the railroad only if a work order has been issued to begin work. The railroad is reimbursed for work performed and materials furnished in accordance with the provisions of the *Federal Aid Policy Guide (FAPG)*, Subchapter B, Part 140, Subpart I, as last issued by the Federal Highway Administration on April 7, 1992. The railroad is reimbursed the actual total cost of all railroad force account work performed and materials used or installed. However, upon final audit by the Audit Office of TxDOT, the railroad may be required to reimburse TxDOT any over payment that cannot be justified.

Solicitation of Bids Clause

The solicitation of bids clause is *only* included in the agreement for railroad companies that do not have their own forces to perform railroad work and must hire a contractor to perform railroad force account work. This clause notifies the railroad that they must solicit a minimum of three bids from qualified contractors to perform the railroad force account work. The railroad is also allowed to submit an estimate for administrative costs and construction inspection, which is reimbursed on an actual cost basis upon receipt of an itemized bill. Upon receipt of the bids, the railroad reviews the bids and forwards them to TRF for approval with a recommendation of the contractor they would prefer. TRF reviews the bids and awards the contract. Under state contracting policy, the contract is normally awarded to the lowest bidder, unless other mitigating factors prevail. TRF advises the railroad in writing as to which contractor was awarded the project and the cost of the work. The approved bid will be the *exact lump sum amount* paid to the railroad for the work performed. The railroad is responsible for reimbursing its contractor.

Conditions

The conditions clause describes how the agreement can be canceled at any time prior to actual letting of the contract by TxDOT. Also, any cost participation by the railroad is identified in accordance with *FAPG* requirements.

Fiber Optic Clause

Most of the major railroads have fiber optic cable buried on their right-of-way. Therefore, it is important that the railroad be contacted at a 1-800 number (which is identified in the agreement) prior to any work being performed, to determine if fiber optic cable is buried on the right-of-way. Also, the location of the fiber optic cable and who it belongs to can be identified. It is the district's responsibility to contact the fiber optic company to advise them of the proposed work and to determine if the cable will be affected by the work. This clause is important to the railroad companies, because of the very high costs associated with broken or damaged fiber optic cable.

Negotiations

TRF coordinates all negotiations concerning the agreement, including any revisions. These negotiations are coordinated with the district when corrections or revisions to the plan layout are involved.

After Execution

Upon receipt of the signed agreements, TRF forwards a copy of the executed agreement along with the railroad estimate (if available) or the approved bid to the district, the Finance Division (FIN), and the Federal Highway Administration (if it is a federal-aid project).

Section 4
Project Execution

Work Order

The district is responsible for issuing the work order to the railroad for any railroad force account work not involving installation of new railroad signal devices and coordinating work in progress on railroad right-of-way. The work order should be issued soon after the contract has been awarded to allow the railroad sufficient time to order materials and schedule work. A copy of the work order should also be sent to TRF and FIN. The work order authorizes payment to the railroad.

Pre-construction Meeting

A pre-construction meeting is recommended and is the district's responsibility. Representatives from the railroad, TxDOT's contractor, and TxDOT should attend the meeting so that work can be coordinated. The construction schedule and individual points of concern and coordination are discussed.

Inspection

The district inspects the work performed by the railroad and verifies that the work complies with the approved plan layout and specifications.

Completion Letter

The district issues the completion letter to the railroad when the project is complete. A copy of the completion letter should be sent to TRF and FIN. The completion letter authorizes final payment to the railroad.

Chapter 4
Grade Crossing Replanking Program

Contents:

Section 1
Overview

Program Background

The State Railroad Grade Crossing Replanking Program was originally authorized by the Texas Legislature in 1979 to provide dedicated State Highway Funds for replacing worn-out grade crossings located on the state highway system. The Traffic Operations Division (TRF) manages the program.

Annual Reauthorization. TRF requests program reauthorization on an annual basis through the Transportation Planning and Programming Division's (TPP) annual authorization of bank balance allocation programs. The Texas Transportation Commission reauthorizes and approves the program by minute order.

Program Funding

The Replanking Program is managed as a bank balance allocation program. Bank balance allocation means that the commission authorizes the total amount of funding and the method of project selection. This provides flexibility within each program year to cancel and add projects to the program without commission action.

Program funds are used to reimburse the railroad force account portion of the projects. State force account work is financed out of the district's maintenance budget.

Eligible Crossings

Every railroad operating in Texas can participate in the Replanking Program.

Program funds can only be used on state highway system crossings where the state highway originally crossed the railroad. Grade crossings located on city streets and county roads and most spur track crossings cannot be replanked under this program. Spur tracks not eligible for the program are those that originally crossed an existing state highway. Eligible spur tracks are those that were originally crossed by the state highway.

Crossing Surface Materials for Replanking

The standard surface materials for the replanking of railroad grade crossings are precast concrete panels with rubber headers along the rails. Timber is seldom used, as concrete has proven more durable and cost-effective. Rubber surfaces are occasionally used. Asphalt crossings are generally unacceptable and should be used only on a temporary basis. Most of the major railroad companies have adopted the use of concrete panel crossing surfaces with rubber inserts in the rail flangeway as a company standard (see Figure 4-1).

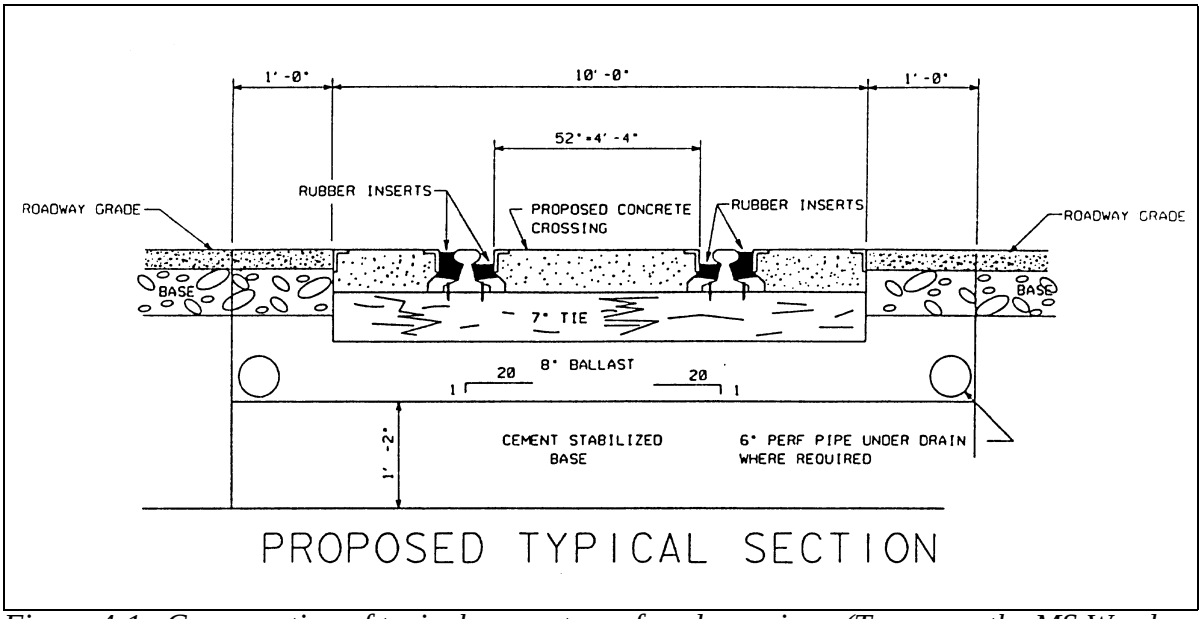


Figure 4-1. Cross section of typical concrete surfaced crossing. (To access the MS Word version of this figure from on line, click this file name: TFEG4-1.)

Section 2
Project Selection

Introduction

The Traffic Operations Division (TRF) selects projects for the Replanking Program on a statewide basis. Generally, each district is guaranteed funding for its two highest priority ranked projects. The other eligible projects are included in the program according to their priority rankings. The priority ranking is based on the project's estimated cost-per-vehicle.

Project Submission

Each year TRF sends Railroad Grade Crossing Replanking Project Submission Forms (TxDOT Form 1876) to the districts.

The district completes *one form for each crossing submitted*, ranking them according to district priority. Crossings in the worst condition should be assigned highest priority rankings. TRF strives (within funding limitations) to include each district's top two priority ranked submissions in the current year's program.

After receiving all project submissions from every district, TRF ranks the projects in order of estimated cost per vehicle.

Form Available. A sample of the Railroad Grade Crossing Replanking Project Submission Form is provided in Appendix A of the hard copy print version of this volume. This sample form may be photocopied as necessary. Copies may also be obtained from TRF. In the on-line version of this volume, an MS Word version of this form may be opened and printed out by clicking on the following file name: TFE-1876.

Figuring Estimated Cost per Vehicle

The estimated cost per vehicle for a project is derived from the total estimated cost of the project. The total estimated cost of the project is obtained by multiplying the estimated cost of materials, labor, and other associated expenses per track foot times the width of the crossing. For the purposes of this calculation, "the width of the crossing" is the length of the track traversing the roadway plus 0.914 m (3 feet) beyond edge of the pavement or curb line on either side. The estimated cost per vehicle is the total estimated cost of the project divided by the average daily traffic (ADT) at the crossing.

If there are multiple tracks at the crossing, the total combined width across the roadway of *both* tracks is used to determine the total estimated cost of the project.

(continued...)

Figuring Estimated Cost per Vehicle *(continued)*

The formulas are:

$$Total\ Project\ Cost = Cost\ per\ Track\ Foot \times Number\ of\ Tracks\ (Length\ of\ Tracks)$$

$$Cost\ per\ Vehicle = \frac{Total\ Project\ Cost}{ADT}$$

EXAMPLE: Concrete replanking is proposed at a crossing with two tracks across the roadway. Each track is 40 feet long. The ADT is 1300 vehicles per day (VPD). The current cost of concrete replanking is $457 per track foot.

$$\$457 \times 2(40) = \$36{,}560\ Total\ Project\ Cost$$

$$\frac{\$36{,}560}{1300\ VPD} = \$28.12\ per\ Vehicle$$

Project Selection

TRF pulls out each district's first and second priority ranked projects and calculates a total estimated cost for all the districts' top two priority submissions. This establishes a program subtotal. All of the other project submissions are then sorted in order of cost per vehicle These projects are added to the statewide priority list, beginning with those having the lowest cost per vehicle, until the program funding amount is expended. TRF then furnishes a list of the selected projects to each district and railroad company.

Project Cancellation

If projects are canceled for any reason (RR abandoned tracks, RR already replanked crossing, crossing is a spur track, etc.) the district from which the project was canceled can recommend another project (of equal or lesser value). This replacement project is then chosen from the submitted projects that did not previously make the program within that district. If the district in question cannot replace the canceled project, then the funds for the canceled project are used on the next highest rated project statewide that did not originally make the program.

Section 3
Plan Layout (Exhibit A)

Introduction

The district prepares complete project plan layout (known as Exhibit A), showing critical details for the proposed replanking project. The district then submits Exhibit A to the Traffic Operations Division (TRF). These exhibits should be submitted within the deadline set annually by TRF.

NOTE: All plan layouts must be signed, sealed, and dated by a registered professional engineer.

Contents of Exhibit A

Exhibit A should include:

- the plan layout (to scale with scale labeled on the layout)
- a typical section of road
- a typical section of railroad crossing
- work to be done by railroad
- work to be done by TxDOT
- general notes, including:
  - number of through trains per day
  - number of train switching moves per day
  - ADT
  - average speed of traffic at crossing
  - existing warning devices
- a title block on each sheet containing all project information
- a traffic control plan based on the *Texas Manual on Uniform Traffic Control Devices (TMUTCD)*, including any necessary detours.

All pages of the Exhibit A plan layout should be on 11×17 inch paper with a one inch margin at the top.

The Exhibit A plan layout should be stamped: "Exhibit A."

Figure 4-2 (a–c) at the end of this section shows an example Exhibit A plan layout.

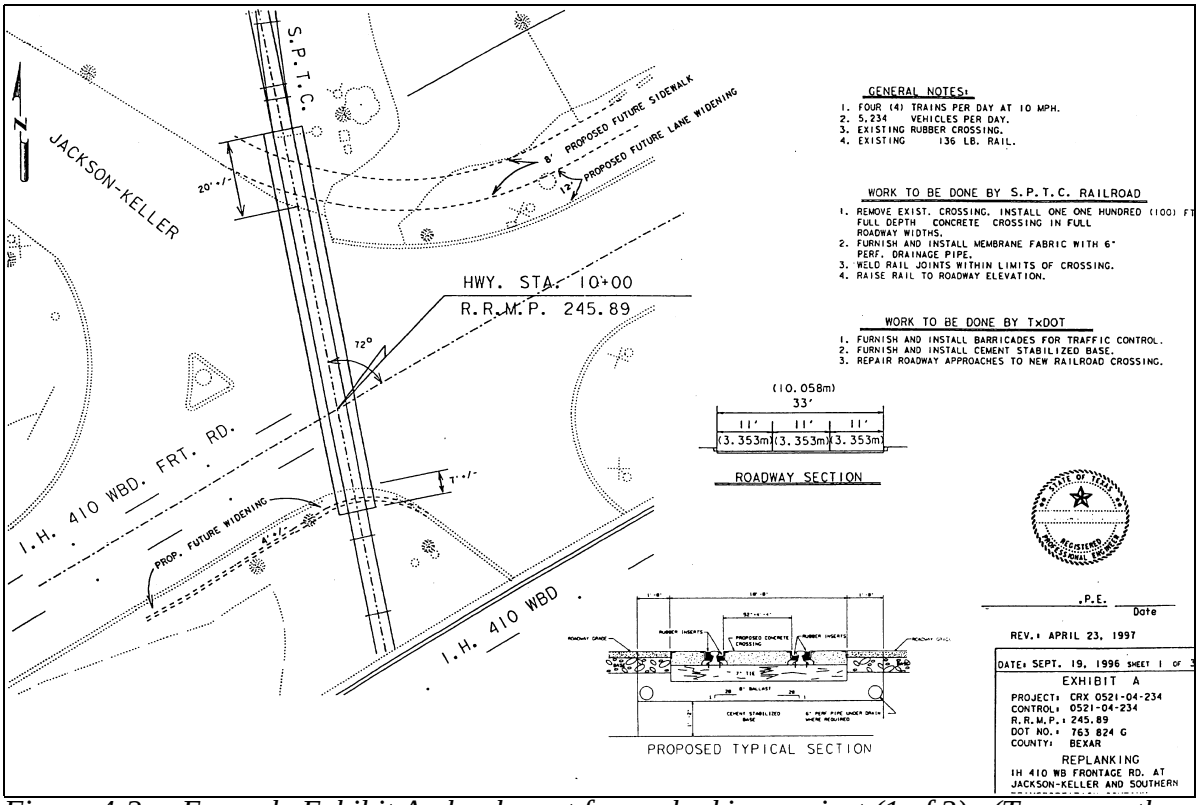


Figure 4-2a. Example Exhibit A plan layout for replanking project (1 of 3). (To access the MS Word version of all 3 panels of this figure from on line, click this file name: TFEG4-2.)

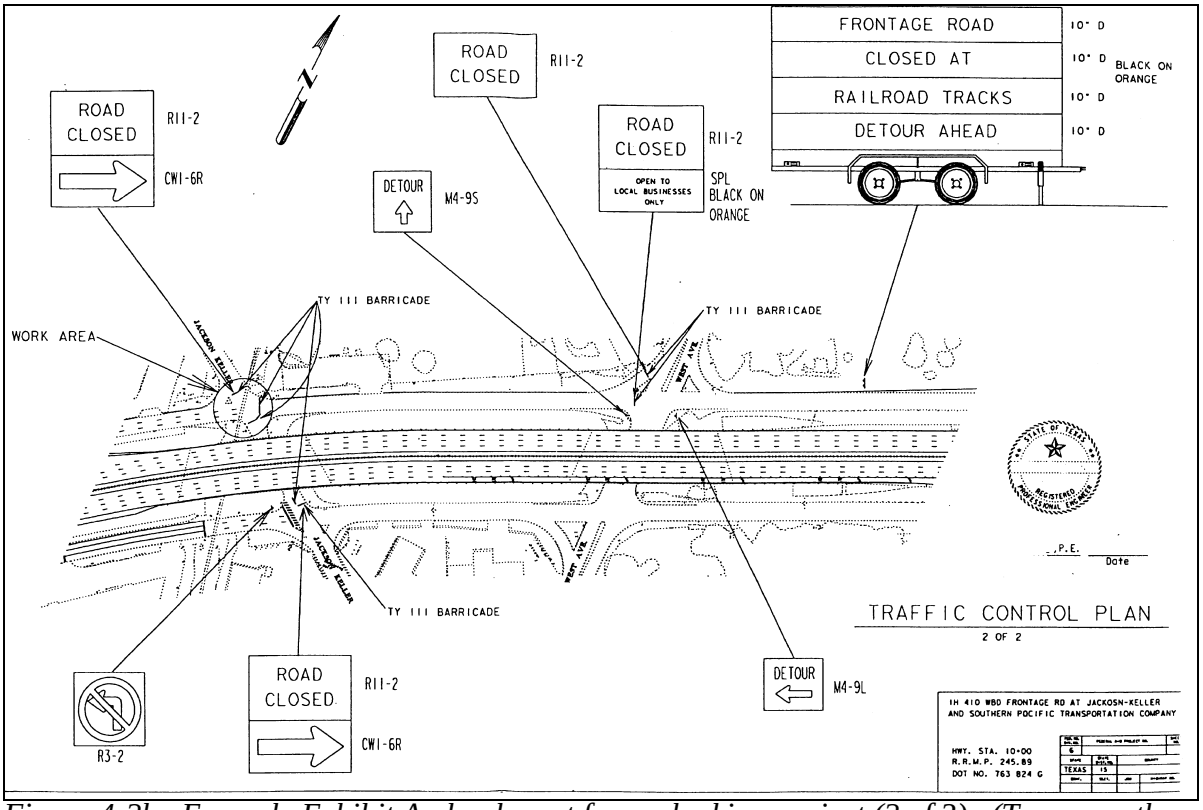


Figure 4-2b. Example Exhibit A plan layout for replanking project (2 of 3). (To access the MS Word version of all 3 panels of this figure from online, click this file name: TFEG4-2.)

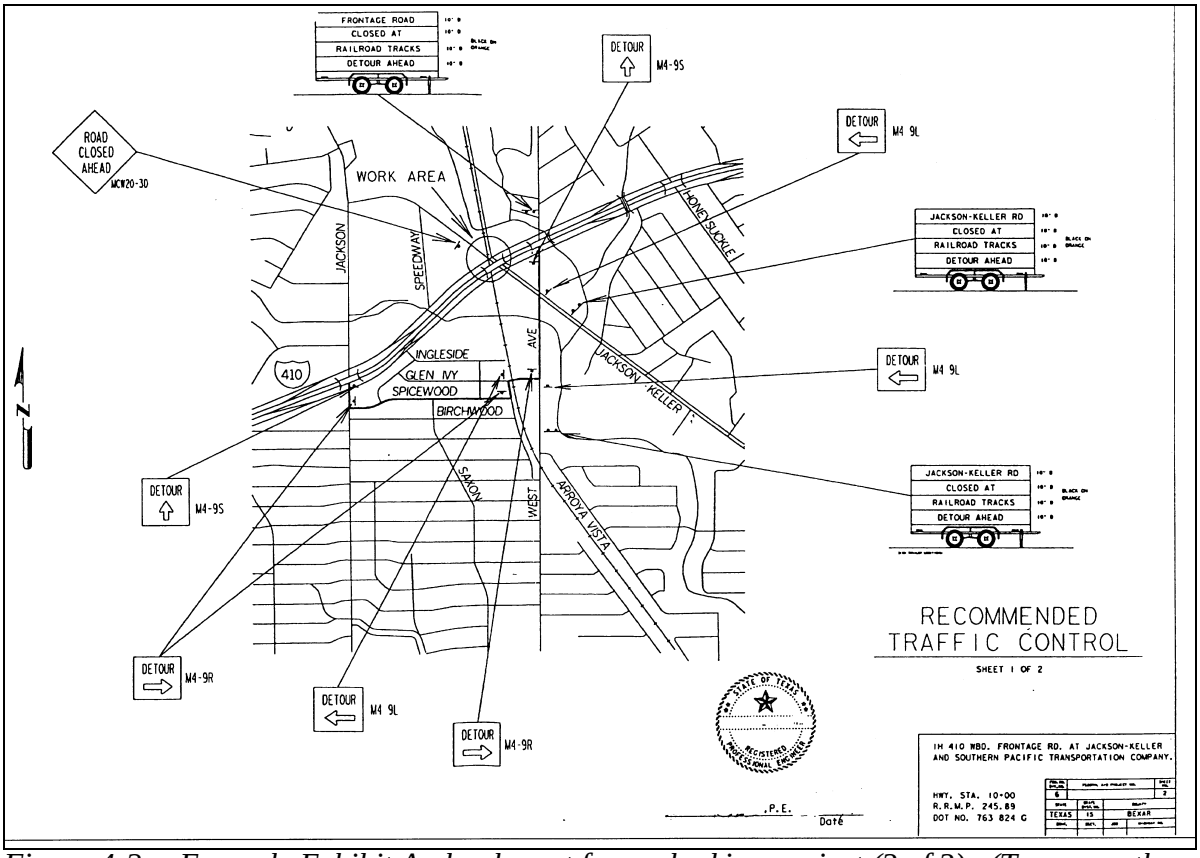


Figure 4-2c. Example Exhibit A plan layout for replanking project (3 of 3). (To access the MS Word version of all 3 panels of this figure from online, click this file name: TFEG4-2.)

Section 4
Agreements and Negotiations

Introduction

Railroads may participate in the Replanking Program by negotiating a contract with the state called a "master agreement" or by executing separate agreements for each project.

Master Agreements

Master agreements are in place with each railroad company that receives new projects on a regular basis and are the preferred contracting instrument under the railroad dedicated fund programs. Master agreements are updated each year by adding an Exhibit L (List of Projects) to the original master agreement. This eliminates the need for a separate agreement each year or for each project, saving administrative time and resources.

Master agreements contain:

- ***scope of work***, including:
  - the responsibilities of the railroad and the state
  - the quality of materials
  - the inspection of materials
  - requirement that all rail joints be welded
  - requirements for subgrade stabilization work (if necessary)
  - materials the state will not pay for (rails, tie plates, rail anchors, track spikes, and other material or labor intrinsic to maintenance of the railroad tracks)
  - railroad maintenance responsibilities
  - reference to the Exhibit A
- ***a work order clause***, explaining the requests, issuance, and receipt of work orders
- ***a payment clause***, covering:
  - conditions and guidelines for reimbursement
  - railroad submission of final bills

(continued...)

Master Agreements *(continued)*

- ***solicitation of bids clause (optional)***:
  - requiring that the railroad submit sufficiently detailed uniform proposals to qualified contractors using the Detailed Estimate for Railroad Solicitation of Bids (TxDOT Form 1891) (see "Form Available" following this list)
  - requiring the submission of at least three qualified contractors to the state for approval
  - requiring that approval of bids be contingent on sufficiency of detail, uniformity, and cost.
  - including information concerning the railroad's recommendation
  - limiting the time frame of the project notice.

Form Available. A sample Form 1891, Detailed Estimate for Railroad Solicitation of Bids, is provided in Appendix A of the hard copy print version of this volume. This sample form may be photocopied as necessary. Copies may also be obtained from the Traffic Operations Division (TRF). In the on-line version of this volume, an MS Word version of the form may be opened and printed out by clicking on the following file name: TFE-1891.

Individual Project Agreements

The railroad may also participate in the Replanking Program by negotiating a separate agreement for each project on the program. In addition to the items required in a master agreement, individual project agreements should include:

- ***project data***, including:
  - location of the project
  - county
  - control-section-job (CSJ)
  - highway number or street name
  - project number
  - DOT number (if available)
  - city
- ***a construction and maintenance clause***, specifying:
  - details relating to the request, issuance, and receipt of work orders
  - materials for which the state will not reimburse the railroad (rails, tie plates, rail anchors, track spikes, and other material or labor related to the improvement or maintenance of the railroad tracks)
  - the railroads future responsibility for maintenance after the project is complete

(continued...)

Individual Project Agreements *(continued)*

- ***conditions***, including:
  - the conditions under which the agreement may be canceled.
  - a requirement that the railroad retain adequate cost accounting records
  - provision for state inspection of construction.

Negotiations

TRF coordinates all comments from participating parties (districts, railroad companies, industries, counties, cities, etc.) and prepares all necessary agreements. TRF also acts as liaison in negotiations with all parties involved.

TRF reviews the Exhibit A plan layout and traffic control plans, and prepares and sends project notices to the railroad companies.

Section 5
Project Execution

Work Order

After all materials are assembled, delivered to the job site, and a crew is scheduled, the district issues the work order to the railroad at the railroad's request.

The district should send a copy of the work order to the Traffic Operations Division (TRF) and the Finance Division (FIN). The work order authorizes payment to the railroad.

Pre-construction Meeting

A pre-construction meeting is recommended and is the district's responsibility. Representatives from TxDOT, the railroad, and their respective contractors should attend the meeting so that work can be coordinated. The construction schedule and individual points of concern should be discussed and any scheduling conflicts identified and resolved.

Inspection

The district inspects the work performed by the railroad and verifies that the work complies with the approved plans and specifications.

Completion Letter

The district issues the completion letter to the railroad when the project is complete. A copy of the completion letter should be sent to TRF and FIN. The completion letter authorizes final payment to the railroad.

Chapter 5
Spur Tracks

Contents:

Section 1
Overview

Introduction

Spur track crossings are generally discouraged. However, under certain circumstances, TxDOT may allow both grade-separated and at-grade spur track crossings on conventional highways. On interstate and other controlled access highways, *only* grade-separated crossings may be allowed.

Grade-separated Crossings

TxDOT may allow a grade-separated crossing if the industry or railroad desiring the crossing agrees to finance and construct it.

The district, in conjunction with the Design Division (DES) and the Traffic Operations Division (TRF), determines the need for a grade separation based on the following factors:

- average daily traffic volume
- volume, type, and time of train movements
- location of proposed crossing
- safety of the traveling public
- other pertinent considerations.

Cost. The Texas Administrative Code (43 TAC §25.75) requires that the total cost of constructing a grade separation be borne by the party applying for the spur permit. (See Chapter 7 of this volume for more information on grade separations.)

At-grade Crossings

A spur track at-grade crossing may be allowed on non-interstate and non-controlled access highways if, in the opinion of the district and DES, the anticipated volumes of train and vehicular traffic and other factors indicate that the crossing will not be overly hazardous to the traveling public.

Costs. If a spur track grade crossing is allowed, all costs of the crossing pavement, highway adjustments, warning devices, and maintenance is borne by the party requesting the spur track.

Conditions may be specified whereby a change in traffic or train conditions or volumes will require a future separation of grades at no expense to TxDOT.

Request for Crossing

A railroad company, an industry, or both can request a spur track crossing. If a railroad company plans to provide rail service to the industry making the request, then both the railroad and industry should become a party to the request and agreement executed with TxDOT for the spur track permit.

Requests to cross TxDOT's right-of-way with a spur track must be submitted in writing to the district involved.

Processing a Request

Upon receiving a request for a spur track crossing, a district proceeds as follows:

1. The district investigates the possibility of the applicant (railroad or industry or both) obtaining rail service by alternate means that will not require an additional highway crossing. These means could be servicing through a different railroad company or through joint use of a nearby existing spur track crossing.
2. If an alternate plan is impracticable, the district should forward the spur track request to TRF, along with a report and recommendations. The report should include:
   - a map showing the location of the proposed spur track crossing
   - average daily traffic at this location
   - applicant's estimate of the number and length of trains anticipated to cross the highway during each 24-hour period.

Upon receiving a request and recommendations concerning a proposed spur track from the district, TRF:

1. reviews the request
2. prepares a memorandum to TxDOT administration requesting approval of the spur track permit.

Upon administrative approval, TRF:

1. forwards a copy of the approval to the district
2. prepares the necessary agreement
3. works with the district and railroad company or industry or both in preparing, negotiating, and executing the agreement.

Section 2
Plan Layout (Exhibit A)

Introduction

The applicant, with guidance from the district, should prepare plan layouts to serve as Exhibit A in the agreement. These layouts are similar to the preliminary layouts the district prepares for a diagnostic inspection (see Chapter 6, Section 6 of this volume).

Site Inspection

The Traffic Operations Division (TRF) arranges a site inspection with representatives from the district, TRF, and the applicant (railroad, industry, or both) involved to determine:

- type of traffic control devices to use
- location of signals and other appurtenances
- length and type of crossing pavement to be installed
- location and size of drainage structures, if needed
- any other features to be located in the plan layout.

Finalization of Exhibit

The applicant or district (depending on who is doing the work) adds the agreed upon features to the exhibit. If the applicant finalizes the exhibit, the applicant then furnishes a reproducible tracing to the district for review. The district then forwards it to TRF for inclusion in the agreement.

Section 3
Agreement and Negotiations

Contents

Using the plan layout furnished by the applicant through the district as Exhibit A, TRF prepares the necessary agreement and forwards it to the railroad or industry or both for their approval.

Agreement Contents

The agreement contains the following:

- project data
- permission
- scope of work
- insurance clause
- other applicable considerations.

Discussions of each of these items follow.

Project Data

Project data include the location of the project: county, highway, and city.

Permission

The permission clause gives the railroad or industry permission to construct, maintain, and operate, at its sole expense, a spur track across TxDOT's right-of-way. The clause states that the railroad or industry will perform or have performed all work pertaining to the crossing and that it will be done at no expense to and to the satisfaction of TxDOT. Also, the crossing will be maintained to TxDOT's satisfaction.

Scope of Work

The scope of work lists all work to be performed by the railroad or industry in constructing the spur track. If TxDOT performs any work, the railroad or industry will reimburse TxDOT.

Insurance Clause

The insurance clause specifies the type of insurance the railroad or industry or both must purchase on behalf of TxDOT.

Other Considerations

Other considerations that may apply to the agreement follow.

Modifications to the Highway. If TxDOT elects to modify the highway in any way that will affect the spur track grade crossing , TxDOT will have the right to make such modifications, and the railroad or industry will make the necessary changes at its own expense.

Liability. TxDOT does not assume any liability for suits, claims, or damage of any kind arising out of or incidental to the construction, maintenance, or operation of the flashing light signals or crossing.

No Abnormal Delays in Traffic Flow. No general switching of trains across the highway is permitted. Train operations crossing the highway must be conducted in a way as to not delay traffic flow for more than a normal period of time (5 minutes is the maximum time a crossing can be blocked under Texas Transportation Code). If more than the normal time is needed, the railroad or industry must notify TxDOT in writing as to the necessity and circumstances for more time.

Future need for Grade Separation. If in the future, TxDOT determines that a grade separation is required, the railroad or industry or both will finance and construct the structure. The terms of the grade separation structure will be handled under a separate agreement.

Section 4
Construction Inspection and Project Completion

Inspection

The district inspects the work performed by the railroad or industry to assure that the it meets approved plan layouts and specifications.

Upon completion of the spur track crossing, the district notifies TRF so that a joint final inspection can be conducted on both the signal and crossing installations.

Obtaining DOT Inventory Number

The railroad or industry must obtain a U.S. Department of Transportation crossing inventory number (DOT No.) for the crossing and advise the district when it is assigned. The district then advises TRF and the Transportation Planning and Programming Division (TPP).

Chapter 6
Warning Signals and Devices

Contents:

Section 1
Overview

Introduction

This chapter covers projects involving the installation and upgrading of warning signals and devices used at highway-rail crossings.

General Guidelines

The *Railroad-Highway Grade Crossing Handbook*, second edition, published by the U.S. Department of Transportation, Federal Highway Administration, provides general information on highway-rail grade crossing characteristics, and the physical and operational improvements that can be made to enhance safety and operation of both highway and rail traffic over crossing intersections. The guidelines and alternative improvements presented in the handbook have been proven effective and are accepted nationwide.

The *Texas Highway-Rail Intersection Field Reference Guide*, Research Report 1273-F, dated May 1994, provides further information. Copies are available through TxDOT's Research and Technology Transfer Office.

The type of warning system to be installed is determined during a site inspection by a diagnostic team as described in Section 6 of this chapter.

Federal Funding Requirements

All agreements between TxDOT and railroad companies involving federal funds for grade crossing warning signal projects must meet the requirements of the *Federal-Aid Policy Guide (FAPG)*, Title 23, CFR Part 140, Subpart I, and 23 CFR, Part 646, Subpart A & B.

TRF's Role

The Traffic Operations Division (TRF) handles all negotiations with the railroad companies and coordinates with the districts for installation of grade crossing warning signals and devices or upgrading of existing signals at grade crossings.

Section 2
Programs and Finances

Highway Construction Projects

Individual signal projects may be proposed for highway or street crossings on the Federal-Aid Urban Systems in cities, although these projects are generally in conjunction with roadway construction projects. These projects are *not* subject to the statewide priority system and are financed from district construction allocations.

Automatic warning devices generally should be installed or upgraded for crossings within the limits or near the terminus of a construction project. The *FAPG* Title CFR 23, Part 646B, Section 646.214 design requires the installation of automatic warning devices where one or more of the following conditions exist:

- multiple main line railroad tracks
- multiple tracks at or in the vicinity of the crossing which may be occupied by a train or locomotive so as to obscure the movement of another train approaching the crossing
- high speed train operation combined with limited sight distance at either single or multiple track crossings
- a combination of high speeds and moderately high volumes of highway and railroad traffic
- any combination of:
  - a high vehicular traffic volume
  - high number of train movements
  - substantial number of school buses or trucks carrying hazardous materials
  - unusually restricted sight distance
  - continuing crash occurrences
- a diagnostic team's recommendation.

Financing. Financing for the devices is included in construction projects at the programming stage.

Coordination. As roadway planning advances, the district should furnish TRF a letter-size location map for advancing the project with the Design Division (DES) and the Federal Highway Administration (FHWA). TRF should be advised which construction project the crossing project applies to, the project letting date, and furnished a preliminary layout showing the existing and proposed roadway.

Federal Programs

The Federal Railroad Signal Program is funded under the Surface Transportation Program (STP), Federal Section 130 of the current federal transportation act. Highway-rail grade crossing warning devices and grade crossing hazard elimination projects are funded by the safety set-aside portion of the STP. Railroad crossing hazard elimination projects may include improving roadway alignment, consolidating and closing redundant, non-essential grade crossings, removing sight distance obstructions, etc. All public highway-rail grade crossings are eligible for the Federal Railroad Signal Program, except for industry spur track crossings located on the state highway system where the spur track crossed an existing highway. (See Section 3 of this chapter for detailed information on the Federal Railroad Signal Program.)

School Bus Program. The Federal Railroad School Bus Signal Program is included as a part of the federal program of work funded by STP. All unsignalized public highway-rail grade crossings used by school buses carrying students are eligible for this program, with the exception of industry spur track crossings located on the state highway system where the spur track crossed an existing highway. Districts are responsible for furnishing updated school bus moves over public crossings to TRF for updating in the state crossing inventory. Districts should obtain this information from the school districts on an annual basis. (See Section 3 of this chapter for detailed information on the Federal Railroad School Bus Signal Program.)

Railroad Signal Maintenance Payment Program

The Railroad Signal Maintenance Payment Program is a state funded program to provide a fixed annual unit payment to the railroads for maintenance of railroad signals on the state highway system only. This program is managed under the bank balance allocation procedures and submitted for approval by Transportation Commission Minute Order in the annual Project Development Plan (PDP).

Payment is based on the type of warning device in place as of August 31st of each program year. Payment is provided based on the following schedule.

State Railroad Signal Maintenance Payment Program Schedule

Type of Warning Device	Annual Payment per DOT Numbered Location
Mast Flashers	$300
Cantilever Flashers	$400
Gates and Flashers	$800

Verification of Warning Devices

Before payment to the railroad company can be made under the Railroad Signal Maintenance Payment Program, the type of warning devices in place must be verified. TRF coordinates these verifications through the districts, the Transportation Planning and Programming Division (TPP), and the railroad companies. TRF normally requests that the districts verify the type of warning device in place at each crossing located on the state highway system between December and March, following the August 31 cut-off date to verify payment is warranted.

The district is responsible for verifying the type of warning device in place and forwarding any corrections to TRF for verification and coordination with TPP and the railroads companies.

TRF is then responsible for issuing a recommended payment amount to the railroad and requesting their concurrence in the payment amount. After the railroad acknowledges the agreed upon amount and any discrepancies are reconciled, TRF sends the approved Form 132 Billing Statement to the Finance Division (FIN) to process payment to the railroad company.

TRF furnishes corrections to the crossing inventory to TPP for updating with the Federal Railroad Administration.

Section 3
Federal Railroad Signal Program

Introduction

This section describes eligibility, funding, selection, and processing for projects under the Federal Railroad Signal Program. (For a basic description of the program, see Section 2 of this chapter.)

Eligibility

Project Eligibility. All public highway-rail grade crossings are eligible for the Federal Railroad Signal Program, except for industry spur track crossings located on the state highway system where the spur track crossed an existing highway. For more information on spur tracks, see Chapter 4 of this volume.

Eligible Work. Under the federal program, project work may include:

- improvement of roadway alignment
- consolidation and closing of redundant, non-essential grade crossings
- removal of sight distance obstructions, etc.
- upgrade of railroad warning devices.

Funding

Funding participation is 90 percent federal and 10 percent state. TxDOT does not require a local funding match for projects off the state highway system. However, local participation in these projects is encouraged and can include:

- utility adjustments
- placement or adjustment of curb and gutter sections
- drainage improvements
- roadway alignment improvements
- removing sight distance obstructions located off railroad right-of-way (for example, trimming or removing vegetation)
- maintaining pavement markings and advance warning signs.

Project Selection and Prioritization

Statewide selection and priority ranking of projects is based on the Texas Priority Index (described in Section 4 of this chapter). The formula used to calculate the index (also described in Section 4) relies on data contained in the state railroad crossing inventory. (See Chapter 1 of this volume for information on the crossing inventory.) Crossings having the highest relative priority are selected for railroad crossing signal warning devices or upgrading, as funds become available under the federal signal program.

Tentative Project List. Initially, TRF develops a tentative project list and distributes it to the districts for review and comment. The list contains projects meeting the program criteria making them eligible for modification in the next fiscal year. The districts are encouraged to make on-site investigations of all crossings on the list to determine the accuracy of the information.

After the on-site investigations, the districts should recommend deletions or additions of projects based on discrepancies or changes in vehicle traffic, rail traffic, type of warning device in place, school bus information, or crash data reported in the inventory. Railroad companies are also furnished this list and have the opportunity to make recommendations or corrections to the information.

NOTE: Districts are encouraged to make periodic reviews of all public crossings under their jurisdiction to ensure that the information reported in the inventory and used to calculate the priority indexes is reasonably accurate.

Project Processing Overview

Projects selected under the federal railroad signal programs are processed as follows:

1. The Texas Transportation Commission approves bank balance allocation program funding amount and method of project selection.
2. TRF coordinates with the districts and railroads to prioritize projects and allocate funds until the established funding is expended.
3. The FHWA obligates the funds.
4. District performs a topographic survey of location, prepares preliminary layouts, and submits them to TRF. (See Section 5 of this chapter for details on project layout preparation.)
5. TRF schedules diagnostic inspection. Diagnostic team agrees on and recommends safety improvements to be accomplished. (See Section 6 of this chapter for details of the diagnostic inspection.)

(continued...)

Project Processing Overview *(continued)*

6. District develops project layouts (to be used as Exhibit A) from diagnostic team field notes and sketches and submits them on 11×17 inch sheets with signed, sealed, and dated title and layout sheets to TRF. (See Section 5 of this chapter for details on layout sheet preparation.)
7. TRF reviews project layouts (Exhibit A) and transmits it to the railroad, requesting approval of plans, estimate, and wiring diagrams. (See Section 7 of this chapter for details.)
8. Railroad approves project layouts and prepares estimate and wiring diagrams and sends them to TRF. (See Section 7 of this chapter for details.)
9. TRF reviews estimate and wiring diagrams; prepares and approves Exhibit B set of approved plans, specifications, and estimates; and sends items to railroad and district as approved and ready for construction, following issuance of work order. (See Section 7 of this chapter for details.)
10. TRF issues work order upon request from railroad.
11. District coordinates any work to be done by the state, city, or county; stakes the project; provides fill material, signing, pavement markings, and construction inspection; and advises TRF when project is complete. (See Section 8 of this chapter for details.)
12. Railroad coordinates with district and performs the installation, then advises the district and TRF when signals are in service. (See Section 8 of this chapter for details.)
13. TRF schedules final inspection with district, city or county, and railroad and provides certification that project is complete to FHWA. (See Section 8 of this chapter for details.)
14. Railroad bills TxDOT.
15. TxDOT pays railroad.
16. FHWA reimburses TxDOT.

Section 4
The Texas Priority Index

Introduction

The Texas Priority Index is used to prioritize projects qualifying for the Federal Railroad Signal Program. This section describes the index and the formulas used to calculate it.

The Texas Priority Index is re-calculated at least once per year for every public highway-rail grade crossing eligible for federal-aid program funds. TRF is responsible for calculating the index using data maintained and furnished by the Transportation Planning and Programming Division (TPP). These data include DOT crossing inventory information, vehicle and rail traffic, types of rail service, roadway information, school bus information, and crash data provided to TPP from the Department of Public Safety. The data are used in a formula to calculate the index rating for each crossing.

Priority Index Formula

The Priority Index (PI) formula is

$$PI = V \times T \times (S \times 0.10) \times P_f \times A^{1.15} \times 0.01$$

where:

V = average daily traffic — number of vehicles per day

T = number of trains in a 24-hour period

S = speed — maximum speed of the trains

P_f = protection factor — a factor weighted according to the type of existing traffic control device as shown in the following table:

Protection Factors

Existing Traffic Control Device	Protection Factor
Gates	0.10
Cantilever Flashers	0.15
Mast Flashers	0.70
Crossbucks or Other	1.00

A = number of crashes in the last five years to the 1.15 power (when $A = 0$ or $A = 1$, then $A = 1$)

(continued...)

Priority Index Formula *(continued)*

EXAMPLE COMPUTATION:
V = 5000 v.p.d.
T = 12 trains/day
S × 0.10 = 6.0 (*S* = 60 mph)
P_f = 0.70 (mast flashers)
A = 4.92 (4 crashes in last five years to the 1.15 power)
PI = 5000 (12) (6.0) (0.70) (4.92) (0.01)
PI = 12,398

More Than One Track. At locations with more than one track where main line and switching movements occur over the same crossing and at different speeds, a priority index is calculated for both the main line traffic and switching traffic, then added together to equal the total priority index for the crossing.

School Bus Priority Index Formula

Priority ratings for unsignalized public crossings eligible for the Federal Railroad School Bus Signal Program are calculated using a special formula. (For a basic description of the program, see Section 2 of this chapter.)

The School Bus Priority Index (SBPI) formula is

$$SBPI = V \times T \times S \times A^{1.15} \times 0.01$$

where:

V = average daily school bus traffic

T = number of trains in a 24-hour period

S = speed — maximum speed of the trains

A = number of crashes in the last five years to the 1.15 power (when *A* = 0 or *A* = 1, then *A* = 1)

EXAMPLE COMPUTATION:
V = 5 SB/day
T = 12 trains/day
S = 60 mph
A = 4.92 (4 crashes in last five years to the 1.15 power)
SBPI = 5 (12) (60) (4.92) (0.01)
SBPI = 1,771

(continued...)

School Bus Priority Index Formula *(continued)*

More Than One Track. At locations with more than one track where main line and switching movements occur over the same crossing and at different speeds, a priority index is calculated for both the main line traffic and switching traffic, then added together to equal the total priority index for the crossing.

NOTE: The existing protection factor has been omitted from the school bus formula because only unsignalized crossings (crossings with crossbuck signs only) are eligible for this program.

Section 5
Project Layout (Exhibit A)

Preliminary Layout

After program approval of a warning signal project, the district prepares and submits to the Traffic Operations Division (TRF) an 11×17 inch preliminary plan layout using a 1:20 inch scale and large lettering (see Figure 6-1a & b for example title sheet and layout). This layout will become Exhibit A of the agreement. The preliminary layout should show the following information (with the numbers here corresponding to the large circled numbers on the example layout provided in Figure 6-1a & b):

(1) Project Data, including:

- county
- project
- control-section-job (CSJ)
- highway number or road name.

(2) Title Block, including:

- railroad company name
- crossing location
- crossing DOT number.

(3) Railroad milepost and highway station number at the crossing intersection.

(4) Angle between the highway and railroad.

(5) Drainage structures, utility poles, wire lines and clearances, and topography that may affect the placement of signals or the instrument case.

(6) Typical section of the highway showing

- number and width of each travel lane
- shoulders or curb (or both) and gutter
- sidewalks
- entire right of way width, if known.

(continued...)

Preliminary Layout *(continued)*

(7) Enlarged layout of approximately 30.48 m (100 feet) on either side of the crossing along the roadway and along the railroad tracks, including:

- same items listed for typical section (6).
- highways and roads within the area labeled by name (for example: Ave. K, private road, etc.)
- directional traffic arrows
- railroad tracks labeled by company and type (for example: ATSF RR – mainline, siding, etc.).

(8) Vicinity schematic layout using a scale of 1 inch = 200 feet of approximately 914.40 m (3,000 feet) of track on each side of crossing with approximate dimensions from the project location and showing all:

- tracks, switches, block signals, and railroad mile post markers
- adjacent roads that cross the tracks identified by road name, DOT number, and existing warning devices.

NOTE: In high density urban areas where numerous switches are present or in and near railroad yards, an approximate line track diagram is acceptable.

This information is needed for possible upgrade of existing railroad circuits or recommending closure of adjacent crossings.

Items to Exclude. Do not show existing or proposed signals, lens spread, instrument cabin, conduit, circuit lengths, general notes, or description of project. These things will be identified during the diagnostic inspection. Reserve a blank area for the "General Notes" (9) and for the "Description of Project" (10) to be added after the inspection.

County Base Map. Include an 8½×11 inch county base map showing the project location with the preliminary layout. Figure 6-2 shows an example county base map.

After the layout is submitted to TRF, the diagnostic inspection is scheduled. For more information on the diagnostic inspection see Section 6 of this chapter.

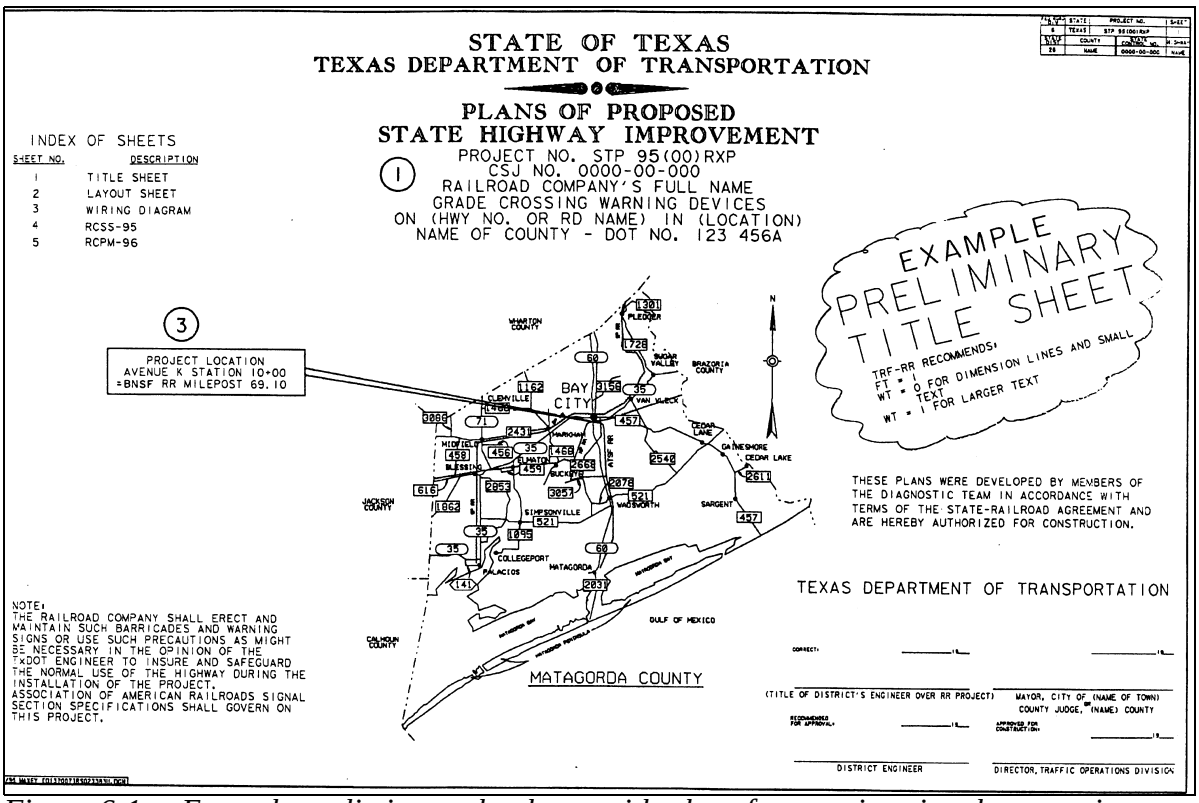


Figure 6-1a. Example preliminary plan layout title sheet for warning signal or warning device project (1 of 2). (Circled numbers explained in text.) (To access the MS Word version of both panels of this figure from on line, click this file name: TFEG6-1.)

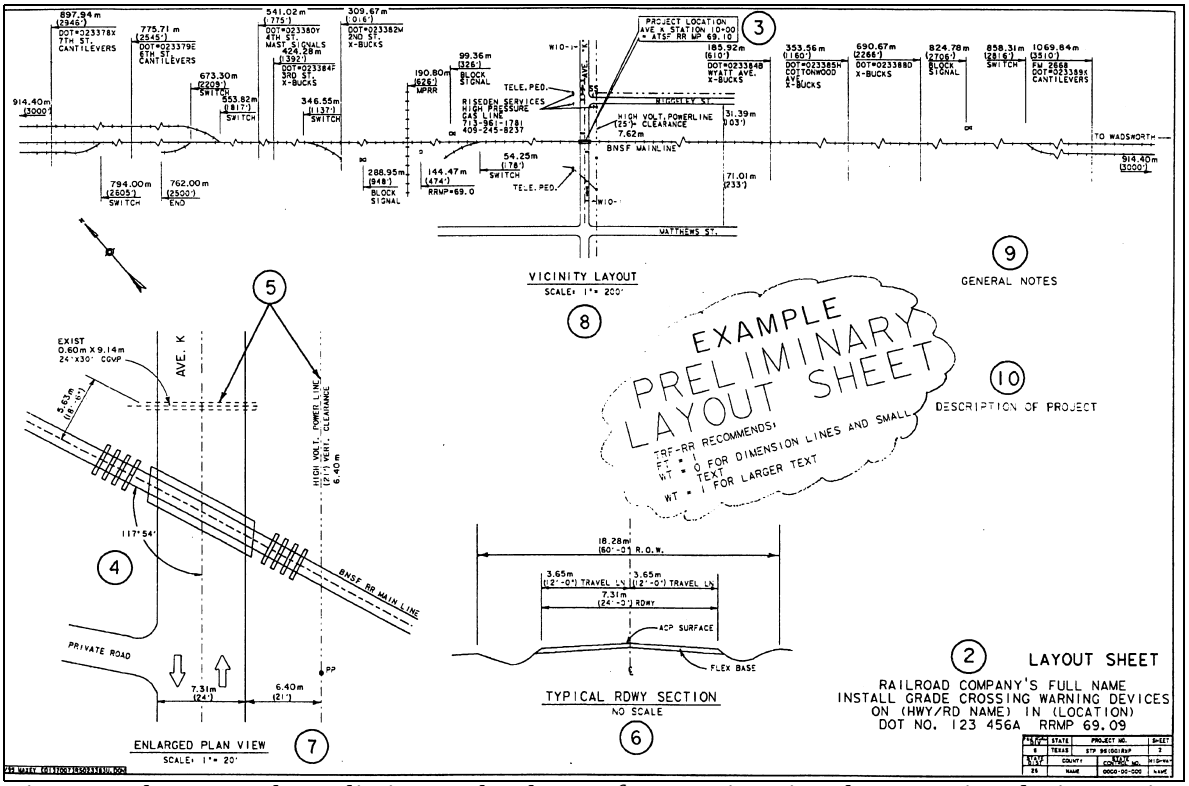


Figure 6-1b. Example preliminary plan layout for warning signal or warning device project (2 of 2). (Circled numbers explained in text.) (To access the MS Word version of both panels of this figure from on line, click this file name: TFEG6-1.)

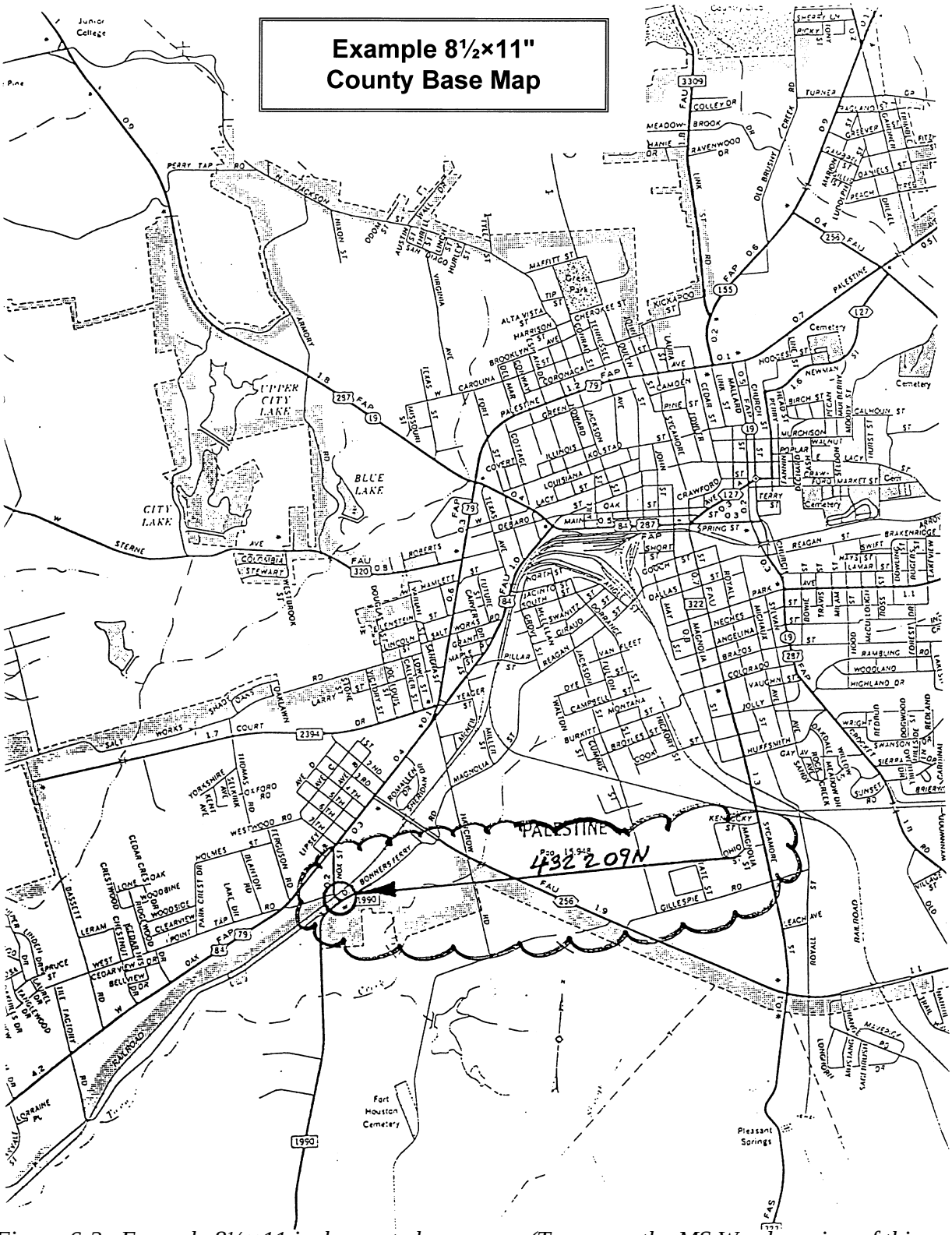


Figure 6-2. Example 8½×11 inch county base map. (To access the MS Word version of this figure from on line, click this file name: TFEG6-2.)

Post Diagnostic Inspection Additions

Following the diagnostic inspection, the district adds the following items to the layout (with the numbers here corresponding to the large circled numbers on the example layout provided in Figure 6-1b):

(9) general notes

(10) description of the project

- symbols for and locations of warning devices, instrument cabin, type and length of circuits, and other items related to the installation (not included in the preliminary layout shown in Figure 6-1b).

NOTE: All layout sheets must be signed, sealed, and dated by the registered professional engineer supervising preparation of the project layouts.

Itemized Estimate

An itemized estimate of costs showing state force account work to be done and materials to be furnished by the district for the project should be included with the completed plan layout. An example follows.

Example Itemized Cost Estimate

Item	Cost
Install stop lines, pavement markings (including RXR) and centerline striping, advance warning and malfunction signs	$2,400.00
Furnish and place fill and crushed cover rock for instrument case and signal foundations (if required)	2,000.00
Furnish and place rip-rap	2,500.00
Furnish and place reinforced concrete pipe	1,000.00
Reshape ditch	300.00
Inspection and construction engineering	1,000.00
TOTAL ESTIMATED COST:	$9,200.00

NOTE: No work should be performed by the railroad until TRF issues a work order.

After Layout Completion

The district forwards the completed project layout, title sheet, and cost estimate to TRF. For projects off the state highway system, the title sheet must be signed by the city or county or both (if more than one is involved) and signed, sealed, and dated by the professional engineer supervising preparation of the project layouts.

Section 6
Diagnostics Inspection

Purpose

The diagnostic inspection is made to determine the type of warning devices and the design of features that need to be installed at a particular location before work begins. It is also made to determine who will be responsible for the maintenance of the railroad pavement markings and signs when the project is complete.

Inspection Team Composition

The diagnostic inspection team is typically comprised of representatives from the following entities:

- the district
- the Traffic Operations Division (TRF)
- the railroad company
- city or county representatives or both (as appropriate)
- school district representatives (if applicable)
- Federal Highway Administration (FHWA) or Federal Railroad Administration (FRA) (if applicable).

District Responsibilities

Before the inspection, the district prepares the project layout used to sketch in team decisions.

The district normally contacts city, county, and school district officials as needed for the inspection and makes arrangements for their attendance.

Inspection Activities

Typically the diagnostic inspection team assembles in the field at the project location.

The diagnostic team performs the following activities:

1. considers possible elimination of the crossing
2. decides on appropriate safety enhancements
3. prepares initial project layouts
4. prepares general notes
5. determines which items of work are eligible for federal and state cost participation and reimbursement to the railroad.

Discussions of each of these items follow.

All team decisions are sketched on the project layouts prepared by the district.

Elimination of the Crossing

The diagnostic team should first consider the possibility of crossing consolidation or elimination. Closure, highway relocation, railroad relocation, and grade separation are all options for crossing elimination.

Abandoned or inactive grade crossings should be removed or appropriate signs should be placed in accordance with the *Texas Manual on Uniform Traffic Control Devices (TMUTCD)*. Warning signal devices in place at an abandoned or inactive grade crossings should be removed, covered, or turned away from the roadway.

See Chapter 11 of this volume for information on crossing closure, relocation, and consolidation and on the dismantling of warning signals.

Safety Enhancements

If the crossing is not a candidate for closure, then the diagnostic team discusses appropriate safety enhancements, such as:

- active warning devices — in most cases, train activated flashing light signals, bells, and gate arms (see *Traffic Control Standard Sheets*, "Railroad Crossing Signs and Signals")
- advance warning signs and pavement markings
- active advance warning flashers and signs, if sight distance is a factor on the crossing approach (see *Traffic Control Standard Sheets*, "Railroad Crossing Advance Warning Sign & Signal")

(continued...)

Safety Enhancements *(continued)*

- ♦ preemption of nearby traffic signals

  NOTE: Preemption is required if the intersection is within 60.96 m (200 feet) of a railroad crossing. Preemption should be considered anywhere traffic may back up over the crossing due to traffic signals or other congestion (see Chapter 7 of this volume).

- ♦ other safety enhancements, such as:
  - identifying and recommending improvements to roadway approaches and crossing surfaces
  - trimming or removing trees and vegetation, etc.
- ♦ adjustments, such as:
  - installing or modifying curb and gutter sections
  - modifying, installing, or replacing drainage structures, utility adjustments, etc.

The team determines which enhancements or combination of enhancements comprise the best solution for the safety of the traveling public at that crossing location.

Temporary STOP or YIELD Signs. The team also determines if the installation of STOP or YIELD signs would be appropriate on an interim basis until warning signal devices are in place. This recommendation is based on *TMUTCD* guidelines and an engineering study.

Initial Project Layout Preparation

After reaching a consensus on what type of safety enhancements should be implemented, the diagnostic team prepares the initial project layouts. The team decides placement locations and distances of signals, signal cabinets, signs, and other enhancements, including adjustments to existing drainage facilities and utilities. General notes are completed in the field also.

General Notes

The general notes:

- ♦ describe the type of circuitry for train activation of the warning devices
- ♦ describe upgrading of signal circuitry at adjacent signalized crossings for circuit compatibility
- ♦ assign responsibility for the specific items of work to be performed
- ♦ address the treatment of any parallel roadways.

Preliminary fill material quantities and drainage are also calculated in the field and included in the general notes.

Cost Participation and Reimbursement Eligibility

The TRF diagnostic team member is responsible for making the final determination of the items of work involved in the project eligible for federal and state cost participation and reimbursement to the railroad.

Reimbursement Methods

There are four methods for reimbursing a railroad. The appropriate method depends on the scope and complexity of the project and whether the railroad uses company forces or a contractor to perform the work.

Railroad Uses Its own Forces. If the railroad uses its own forces to perform the work, reimbursement is usually made on an actual cost basis. However, if the state and railroad agree, reimbursement can be based on a lump sum cost estimate. The lump sum payment method is more like the state accepting a bid from a contractor. Fixed costs and rates are agreed to prior to project approval. Variable costs and a total lump sum cost are approved with the Exhibit B. The lump sum cost method is only used on less complex single projects.

Railroad Uses a Contractor. If the railroad uses a contractor to perform railroad force account work, they can solicit bids from a minimum of three qualified contractors or use a contractor under a continuous agreement. The continuous agreement must be for a minimum of three years to perform all warning signal installations contracted with the state.

The agreement between the state and railroad includes the necessary contractual arrangements, as outlined in Section 7 of this chapter.

Final Project Layout Preparation

The district diagnostic team member is responsible for converting all notes and decisions made at the project inspection into a final set of construction project layouts. The district must have the title sheet signed by the appropriate district officials, as well as the city or county officials as appropriate.

Section 7
Agreement Preparation and Coordination

Overview

The Traffic Operations Division (TRF) prepares the agreement, using the completed layout prepared by the district as Exhibit A. TRF requests cost estimates and a wiring diagram from the railroad. TRF then prepares the project plans (Exhibit B) and coordinates the approval of the agreement. TRF distributes copies of the signed agreement and approved plans and estimates as appropriate.

Exhibit B Plan Preparation

TRF prepares Exhibit B of the agreement. Exhibit B normally consist of:

- a title sheet
- layout sheets (Exhibit A)
- wiring diagrams
- railroad crossing warning signal device standard and railroad crossing pavement marking standard.

The district furnishes the title sheet and layouts. The title sheet and layouts must be signed, sealed, and dated by a registered professional engineer.

The railroad furnishes the wiring diagram.

TRF adds the standard design sheets.

Distribution

TRF distributes copies of the signed agreement and approved plans and estimates (Exhibit B) to:

- the district
- the Finance Division (FIN)
- the Design Division (DES)
- the railroad
- FHWA (if required — see following subheading).

FHWA Approval

FHWA approval may be required if unusual or unique work (such as crossing consolidation or elimination of safety hazards and sight obstructions in lieu of installing warning devices)is called for.

Master Agreements

Master agreements are in place with each railroad company that receives new projects on a regular basis and are the preferred contracting instrument under the railroad dedicated fund programs. Master agreements are updated each year by adding an Exhibit L (List of Projects) to the original master agreement. This eliminates the need for a separate agreement each year or for each project, saving administrative time and resources.

The agreement covers construction and maintenance details for preparing and approving plans, specifications, and estimates; issuance of work order; sub contracting requirements; federal-aid policy guide requirements; methods of payment; and conditions for reimbursement.

Individual Project Agreements

For railroads or projects not under a master agreement, TRF prepares and negotiates a separate project agreement. In addition to the items required in a master agreement, individual project agreements should include project data (location, county, control-section-job number, highway name, project number, and DOT number). Additional condition clauses in the event the project is canceled prior to letting, etc. may also be necessary.

Negotiations

TRF coordinates all comments from participating parties (districts, railroad companies, industries, counties, cities, etc.) and prepares all necessary agreements. TRF also acts as liaison in negotiations with all parties involved.

TRF reviews the Exhibit A project layouts and traffic control plans, and prepares and sends the approved Exhibit B project plans and work order to the railroad companies.

Section 8
Project Execution

Work Order

TRF issues the work order for railroad warning signal device projects upon request by the railroad company.

Project Coordination

The district coordinates any work done by the city or county with the railroad. Such work may include:

- staking the project for placement of signals and appurtenances
- providing fill and cover material
- installation of curbing, drain pipes, culverts, etc.
- inspection during construction
- notifying TRF when work is completed.

Routine Project Inspection

The district should keep a general record of the railroad's daily labor and equipment rental. The railroad notify the district if any delays occur during construction.

Final Inspection

Unless the district is approved to do final inspections, TRF schedules and conducts the final inspection of each project upon notification by the district and railroad.

The purpose of the final inspection is to verify that all safety enhancements involved in the project have been made and all traffic control devices, signs, pavement markings, railroad appurtenances, and other items of work listed in the general notes have been installed in accordance with the approved plans. All equipment and material installed by the railroad is checked against an inventory of materials furnished by the railroad. Any discrepancies from the approved plans are noted.

Project Certification

Prior to project certification, the responsible party must correct all items noted during final inspection that were not in accordance with the approved plans. The district then furnishes a memo to TRF certifying that the project has been installed in accordance with the approved plans (see Figure 6-3 for example). TRF then certifies the project to the FHWA.

MEMORANDUM

Texas Department of Transportation

TO: Mr. Thomas D. Beeman, P.E.
Traffic Operations Division

DATE: _____

FROM: _____, P.E.

ORIGINATING OFFICE:
_____

SUBJECT: Project Certification
_____ County – DOT No. _____
CSJ _____
Project _____
Location _____ (20___)

This is to certify that all work has been completed in accordance with terms of the agreement for the above referenced railroad grade crossing location. Work, consisting of installation and/or modification of automatic warning devices and all signing and pavement markings is acceptable and in accordance with the *Texas Manual on Uniform Traffic Control Devices (TMUTCD)*. All materials installed are in compliance with the plans and specifications. A final on-site inspection was made on _____.

Attached please find the original list used to inventory materials furnished and installed by the railroad company for this project. Also, included are photographs depicting the roadway approaches and railroad track approaches for this intersection.

If you have any questions, please contact _____, telephone number _____.

__/__

Attachments

Figure 6-3. Example project certification memo. (To access the MS Word version of this figure from on line, click this file name: TFEG6-3.)

Section 9
STOP and YIELD Signs at Grade Crossings

Background

Recent legislation has made it easier to install STOP and YIELD signs. Nevertheless, the responsible authority should ensure that such installations are justified, and that they are in conformance with all applicable standards.

National and State Provisions

National* MUTCD *Revision. Section 1077 of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) granted states and local governments discretionary authority to install STOP or YIELD signs at highway-rail grade crossings that have two or more trains per day and are without automatic traffic control devices. This required the following revision of Section 8B-9 of the *National Manual on Uniform Traffic Control Devices (MUTCD)*:

> STOP or YIELD signs may be used at highway-rail grade crossings, at the discretion of the responsible state or local jurisdiction, for crossings that have two or more trains per day and are without automatic traffic control devices.

Texas MUTCD *Provisions.* The *Texas Manual on Uniform Traffic Control Devices (TMUTCD)* limits use of the STOP sign at railroad-highway grade crossings to those crossings selected after need is established by a detailed traffic engineering study. Such crossings should have the following characteristics:

- The highway should be secondary in character with low traffic counts.
- Train traffic should be substantial.
- Line of sight to an approaching train is restricted by physical features such that approaching traffic is required to reduce speed to 10 mph or less in order to stop safely.
- At the stop bar, there must be sufficient sight distance down the track to afford ample time for a vehicle to cross the track before the arrival of the train.

The engineering study may determine other compelling reasons for the need to install a STOP sign; however, such an installation should only be an interim measure until active traffic control devices can be installed. STOP signs cannot be used on primary through highways or at grade crossings with active traffic control devices.

Whenever a STOP sign is installed at a grade crossing, a STOP AHEAD sign must be installed in advance of the STOP sign.

Crossings with Passive Warning Signs

For other crossings with passive protection, STOP or YIELD signs may be used after need is established by a traffic engineering study. The study should take into consideration such factors as:

- volume and character of highway and train traffic
- adequacy of stopping sight distance
- crossing crash history
- need for active control devices.

Sign Placement

For all highway-rail grade crossings where STOP or YIELD signs are installed, the placement must conform to the requirements of *MUTCD*, Section 2B-9, "Location of STOP Sign and YIELD Sign." STOP AHEAD or YIELD AHEAD advance warning signs must also be installed.

Assessing Need for Signs

The Federal Highway Administration (FHWA) and the Federal Railroad Administration (FRA) have cooperatively developed guidelines titled "Considerations to Apply in Assessing the Need for STOP or YIELD Signs at Highway-Railroad Grade Crossings." The following guidelines are taken from these considerations.

General Factors

The FHWA and FRA recommend that the following general factors be considered when reviewing a crossing for possible STOP or YIELD sign installation:

- volume, type, and speed of highway traffic
- frequency, type, and speed of trains
- number of tracks
- intersection angles
- adequacy of stopping sight distances
- need for automated warning devices
- crossing crash history.

Specific Factors

The FHWA and FRA recommend that specific factors be applied in determining first priority with respect to new STOP sign installations. The following considerations should be met in *every* case before a STOP sign is installed:

- Local or state police and judicial officials will commit to a program of enforcement no less vigorous than would apply at a highway intersection equipped with STOP signs.
- Installation of a STOP sign would not occasion a more dangerous situation (taking into consideration both the likelihood and severity of highway-rail collisions and other highway traffic risks) than would exist with a YIELD sign.

Positive Indications

Any one of the following conditions indicate that use of STOP signs would tend to reduce risk of a highway-rail collision. These considerations should be weighed against the following opposing factors:

- Maximum train speeds equal or exceed 30 mph (a factor strongly correlated with highway-rail crash severity).
- Highway traffic mix include buses, hazardous materials carriers, or large (trash or earth moving) equipment.
- Train movements are 10 or more per day during 5 or more days of the week.
- The rail line is used by passenger trains.
- The rail line is regularly used to transport a significant quantity of hazardous material.
- The highway crosses two or more tracks, particularly where both tracks are main tracks or one track is a passing siding that is frequently used. (Note: If federal-aid funds are used for a highway-rail grade crossing improvement project with multiple main line tracks, gates and flashing lights are required.)
- The angle of approach to the crossing is skewed.
- The line of sight from an approaching highway vehicle to an approaching train is restricted such that approaching traffic is required to substantially reduce speed.

Opposing Factors

Factors to be weighed in opposition to STOP signs include:

- The highway is other than secondary in character and has an average daily traffic (ADT) count of 400 or less in rural areas or 1,500 or less in urban areas. (If any of the positive indications apply to a crossing with traffic counts in excess of these levels, strong consideration should be given to installation of automated warning devices.)
- The roadway is a steep ascending grade to or through the crossing, sight distance in both directions is unrestricted in relation to maximum closing speed, and the crossing is used by heavy vehicles. (Note: A crossing where there is insufficient time for any vehicle, proceeding from a complete stop, to safely traverse the crossing within the time allowed by maximum train speed is an inherently unsafe crossing that should be closed.)

Chapter 7
Traffic Signal Preemption

Contents:

Section 1
Overview

Introduction

Traffic signal preemption involves the interruption of the normal signal controller sequence with a special sequence (usually flashing operation) activated through an interface with nearby railroad grade crossing warning devices. Preemption may be either "simultaneous" or "advance."

Simultaneous preemption means that the traffic signal controller sequence is preempted at the same time the crossing warning devices begin to operate. Warning times and approach lengths are calculated as normal, unless more than the minimum 20 seconds is required between preemption and train arrival at the crossing. Simultaneous preemption does not provide a clear-out time for vehicles traversing the crossing prior to activation of the railroad warning signals.

Advance preemption means that the traffic signal controller sequence is preempted a set amount of time before the warning devices begin to operate. Advance preemption provides a clear-out traffic signal sequence time for traffic traversing the railroad grade crossing before activation of the railroad warning signals. The time required for the traffic signal clear-out sequence is in addition to the minimum 20-second railroad warning signal activation time prior to train arrival.

Need for Preemption

Preemption of a traffic signal by the railroad signals is required if the traffic signal is at an intersection that is within 60.96 m (200 feet) of a railroad crossing. Preemption should be considered where traffic may back up over the crossing due to traffic signals or other traffic congestion.

Project Process Overview

The following is an overview of a typical preemption project. See the referenced sections of this chapter for more information.

1. The district inspects the intersection to determine the extent of the work required. The district also coordinates with the railroad on the details of circuitry and project timing. (See Section 2 of this chapter for more information.)
2. The district prepares:
   - complete plan layouts (known as an "Exhibit A") showing the critical details for the project
   - a railroad Application for Underground Wireline Crossing form, if necessary
   - a preemption worksheet.

   (See Section 3 of this chapter for descriptions of these items and more information on plan layout preparation.)
3. The district submits the prepared plan layouts (Exhibit A) and the preemption worksheet to the Traffic Operations Division (TRF). (See Section 3 of this chapter for more information.)
4. TRF approves preemption timing and prepares the agreement using the layouts furnished by the district as Exhibit A. TRF then forwards the agreement and exhibit to the railroad company and handles all negotiations concerning the agreement, including any revisions.
5. Upon receipt of the signed agreements, TRF forwards a copy of the executed agreement along with the railroad estimate (if available) or the approved bid to the district and the Finance Division (FIN). TRF also supplies the district with a copy of the letter transmitting the agreement to the railroad for their approval and a copy of the TRF transmittal letter returning the approved agreement to the railroad.
6. After the agreement is signed, the district issues a work order to the railroad for any force account work, conducts the pre-construction meeting, inspects the work, and issues the completion letter. (See Section 4 of this chapter for more information on these activities.)

Section 2
Preliminary Inspection and Coordination

Introduction

Prior to preparing the plan layout, the district should conduct a preliminary inspection of the intersection being considered for traffic signal preemption. This inspection should address specific questions related to the intersection and the adjacent crossing. The district should also coordinate with the railroad at this time to determine the type of circuitry available and other technical details.

NOTE: If preemption for the intersection in question was considered as part of a diagnostic inspection for the nearby crossing (as described in Chapter 6 of this volume), then these considerations should be addressed at that time.

Intersection Characteristics

Several considerations relate to the specific characteristics of the intersection. The preliminary inspection should answer the following questions:

- Will simultaneous or advance preemption be required?
- Will any adjacent crossings or intersections require upgrading?
- Will there be pedestrian walkways?
- Are DO NOT STOP ON TRACKS signs needed?
- Where will loop detectors be placed? (They should be away from stop bars.)

Equipment and Circuitry

The type and compatibility of traffic signal equipment, warning signals, and the related circuitry are important considerations. The preliminary inspection and coordination with the railroad should answer the following questions:

- Are the active circuitry and warning devices compatible with the proposed traffic signals?
- Do the devices and circuitry meet current federal requirements? What year was the existing circuitry installed?
- Is there an existing relay set up in the railroad instrument cabin to hook up the signal preemption? If so, then what kind?
- Will any track shunts need to be readjusted? If so, at what distance are they currently set, and what how far out is the proposed shunt?

NOTE: The installation of traffic signals requiring preemption may require the railroad to install "constant warning circuitry." To determine if the signal circuitry needs upgrading to provide the preemption, contact the railroad company.

Cost

Estimate the cost of the project. Be sure to consider the cost of the specific type of equipment needed. Make sure there is enough money in the construction budget.

Section 3
Plan Layout (Exhibit A)

Overview

The district prepares the plan layout (known as Exhibit A) for the traffic signal preemption project to show all work to be performed by TxDOT, TxDOT's contractor, and the railroad.

NOTE: All plan layouts must be signed, sealed, and dated by a registered professional engineer.

Figure 7-1 (a–c) at the end of this section shows an example Exhibit A plan layout.

Project Data

Exhibit A project data include:

- the county
- the project
- control-section-job (CSJ)
- highway number or road name.

Title Block

The Exhibit A title block includes:

- the railroad company name and DOT No. (if available)
- milepost and highway station
- the words "Exhibit A."

Work List

The Exhibit A work list includes a breakdown of all work to be performed by TxDOT, TxDOT's contractor, and the railroad company.

If Conduit Installation is Involved

Normally conduit is installed with traffic signal preemption. This requires that a railroad Application for Underground Wireline Crossing form be filled out (along with a cover application form) and submitted as part of the railroad agreement package. The district completes the forms and submits them to the Traffic Operations Division (TRF) when requesting preparation and execution of the agreement. (Samples of these forms are provided in Appendix A of the hard copy print version of this volume. These sample forms may be photocopied as necessary. Copies may also be obtained from the Traffic Operations Division.)

The plan layouts should include a 1 inch to 200 foot vicinity layout, a 1 inch to 20 foot layout, and a typical section.

Exhibit A and the PS&E drawings should include a note indicating that TxDOT's contractor will run conduit to the proposed instrument cabin, and that TxDOT or its contractor will contact the railroad 48 hours prior to any construction in railroad right-of-way to determine the location of fiber optic cables with reference to an assigned ticket number. The railroad ticket number is assigned when the Application for Underground Wireline Crossing form is processed.

If Railroad Signals Require Upgrading

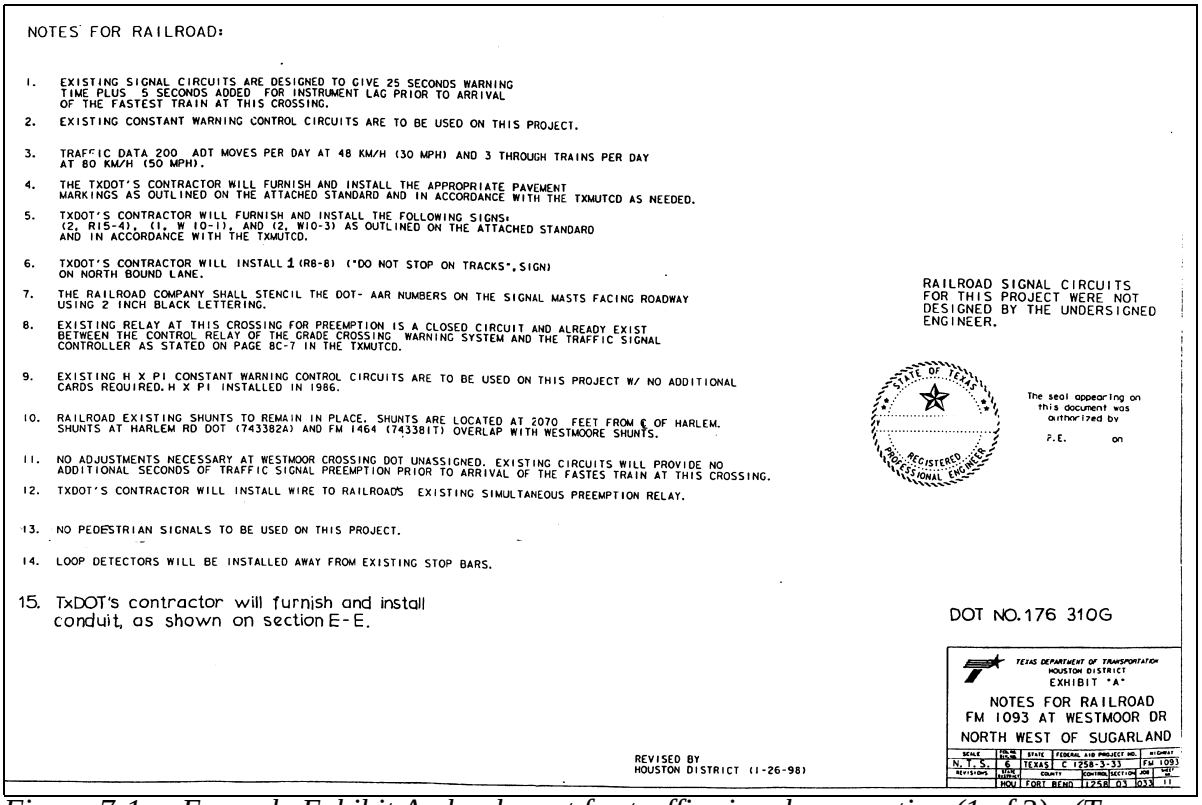
If the railroad signals require upgrading, a preliminary layout drawing should be done on the 1 inch to 20 foot layout.

Preemption Worksheet

The district also completes the preemption worksheet to determine if additional time (advance preemption) is required for the traffic signal to clear out before the railroad warning devices are activated. A sample preemption worksheet (titled "Guide for Determining Time Requirements for Traffic Signal Preemption at Highway-Rail Grade Crossings") is provided in Appendix A of the hard copy print version of this volume. This sample worksheet may be photocopied as necessary. Copies of the worksheet and detailed printed instructions on calculating preemptions may also be obtained from the Traffic Operations Division.

Accompanying Information

A vicinity layout sheet and pictures of the intersection and other intersections requiring upgrading (views looking north, south, east, and west) should also accompany the preemption package sent to TRF.



NOTES FOR RAILROAD:

1. EXISTING SIGNAL CIRCUITS ARE DESIGNED TO GIVE 25 SECONDS WARNING TIME PLUS 5 SECONDS ADDED FOR INSTRUMENT LAG PRIOR TO ARRIVAL OF THE FASTEST TRAIN AT THIS CROSSING.
2. EXISTING CONSTANT WARNING CONTROL CIRCUITS ARE TO BE USED ON THIS PROJECT.
3. TRAFFIC DATA 200 ADT MOVES PER DAY AT 48 KM/H (30 MPH) AND 3 THROUGH TRAINS PER DAY AT 80 KM/H (50 MPH).
4. THE TXDOT'S CONTRACTOR WILL FURNISH AND INSTALL THE APPROPRIATE PAVEMENT MARKINGS AS OUTLINED ON THE ATTACHED STANDARD AND IN ACCORDANCE WITH THE TXMUTCD AS NEEDED.
5. TXDOT'S CONTRACTOR WILL FURNISH AND INSTALL THE FOLLOWING SIGNS: (2, R15-4), (1, W 10-1), AND (2, W10-3) AS OUTLINED ON THE ATTACHED STANDARD AND IN ACCORDANCE WITH THE TXMUTCD.
6. TXDOT'S CONTRACTOR WILL INSTALL 1 (R8-8) ("DO NOT STOP ON TRACKS", SIGN) ON NORTH BOUND LANE.
7. THE RAILROAD COMPANY SHALL STENCIL THE DOT- AAR NUMBERS ON THE SIGNAL MASTS FACING ROADWAY USING 2 INCH BLACK LETTERING.
8. EXISTING RELAY AT THIS CROSSING FOR PREEMPTION IS A CLOSED CIRCUIT AND ALREADY EXIST BETWEEN THE CONTROL RELAY OF THE GRADE CROSSING WARNING SYSTEM AND THE TRAFFIC SIGNAL CONTROLLER AS STATED ON PAGE 8C-7 IN THE TXMUTCD.
9. EXISTING H X PI CONSTANT WARNING CONTROL CIRCUITS ARE TO BE USED ON THIS PROJECT W/ NO ADDITIONAL CARDS REQUIRED. H X PI INSTALLED IN 1986.
10. RAILROAD EXISTING SHUNTS TO REMAIN IN PLACE. SHUNTS ARE LOCATED AT 2070 FEET FROM ℄ OF HARLEM. SHUNTS AT HARLEM RD DOT (743382A) AND FM 1464 (743381T) OVERLAP WITH WESTMOORE SHUNTS.
11. NO ADJUSTMENTS NECESSARY AT WESTMOOR CROSSING DOT UNASSIGNED. EXISTING CIRCUITS WILL PROVIDE NO ADDITIONAL SECONDS OF TRAFFIC SIGNAL PREEMPTION PRIOR TO ARRIVAL OF THE FASTES TRAIN AT THIS CROSSING.
12. TXDOT'S CONTRACTOR WILL INSTALL WIRE TO RAILROADS EXISTING SIMULTANEOUS PREEMPTION RELAY.
13. NO PEDESTRIAN SIGNALS TO BE USED ON THIS PROJECT.
14. LOOP DETECTORS WILL BE INSTALLED AWAY FROM EXISTING STOP BARS.
15. TxDOT's contractor will furnish and install conduit, as shown on section E-E.

RAILROAD SIGNAL CIRCUITS FOR THIS PROJECT WERE NOT DESIGNED BY THE UNDERSIGNED ENGINEER.

STATE OF TEXAS — REGISTERED PROFESSIONAL ENGINEER

The seal appearing on this document was authorized by P.E. on

DOT NO. 176 310G

TEXAS DEPARTMENT OF TRANSPORTATION
HOUSTON DISTRICT
EXHIBIT "A"
NOTES FOR RAILROAD
FM 1093 AT WESTMOOR DR
NORTH WEST OF SUGARLAND

SCALE	FOR REPORT & ON SHEETS	STATE	FEDERAL AID PROJECT NO.	HIGHWAY
N. T. S.	6	TEXAS	C 1258-3-33	FM 1093
REVISIONS	STATE DISTRICT	COUNTY	CONTROL	SECTION	JOB	SHT. NO.
	HOU	FORT BEND	1258	03	033	11

REVISED BY HOUSTON DISTRICT (1-26-98)

Figure 7-1a. Example Exhibit A plan layout for traffic signal preemption (1 of 3). (To access the MS Word version of all three panels of this figure from on line, click this file name: TFEG7-1.)

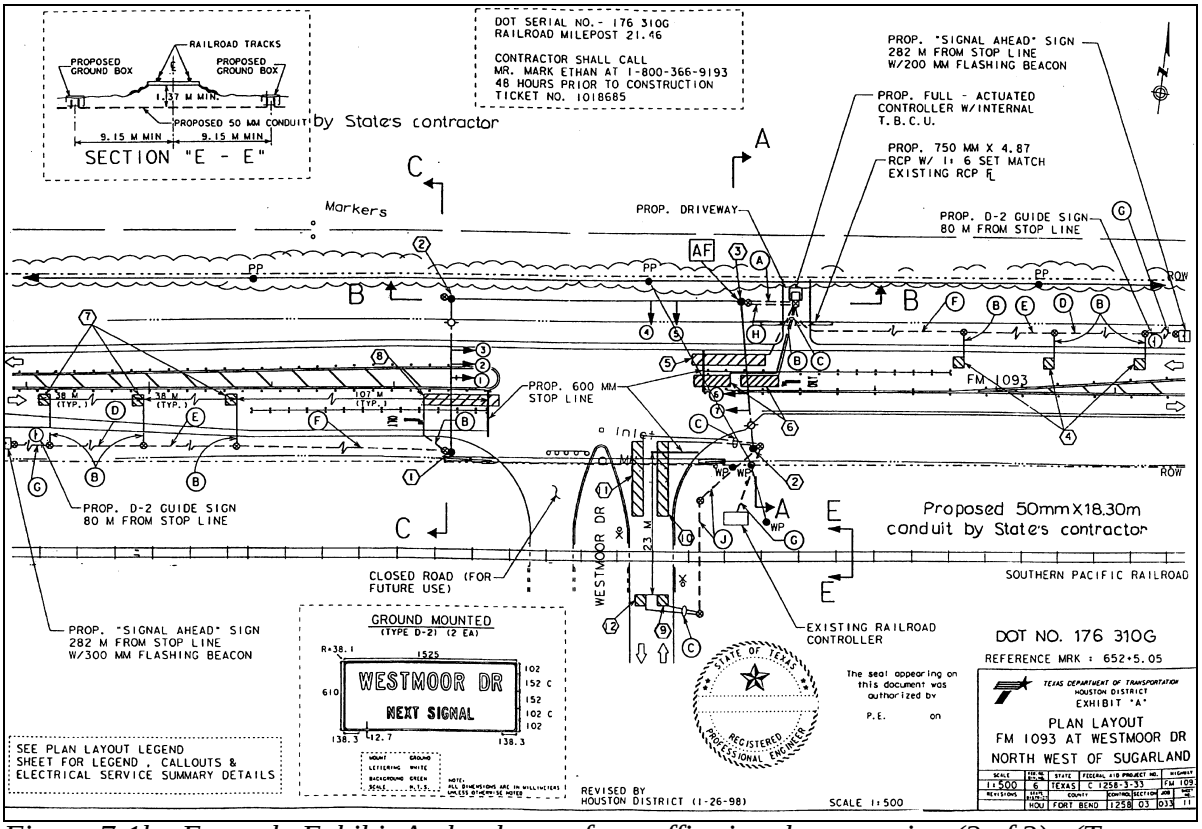


Figure 7-1b. Example Exhibit A plan layout for traffic signal preemption (2 of 3). (To access the MS Word version of all three panels of this figure from on line, click this file name: TFEG7-1.)

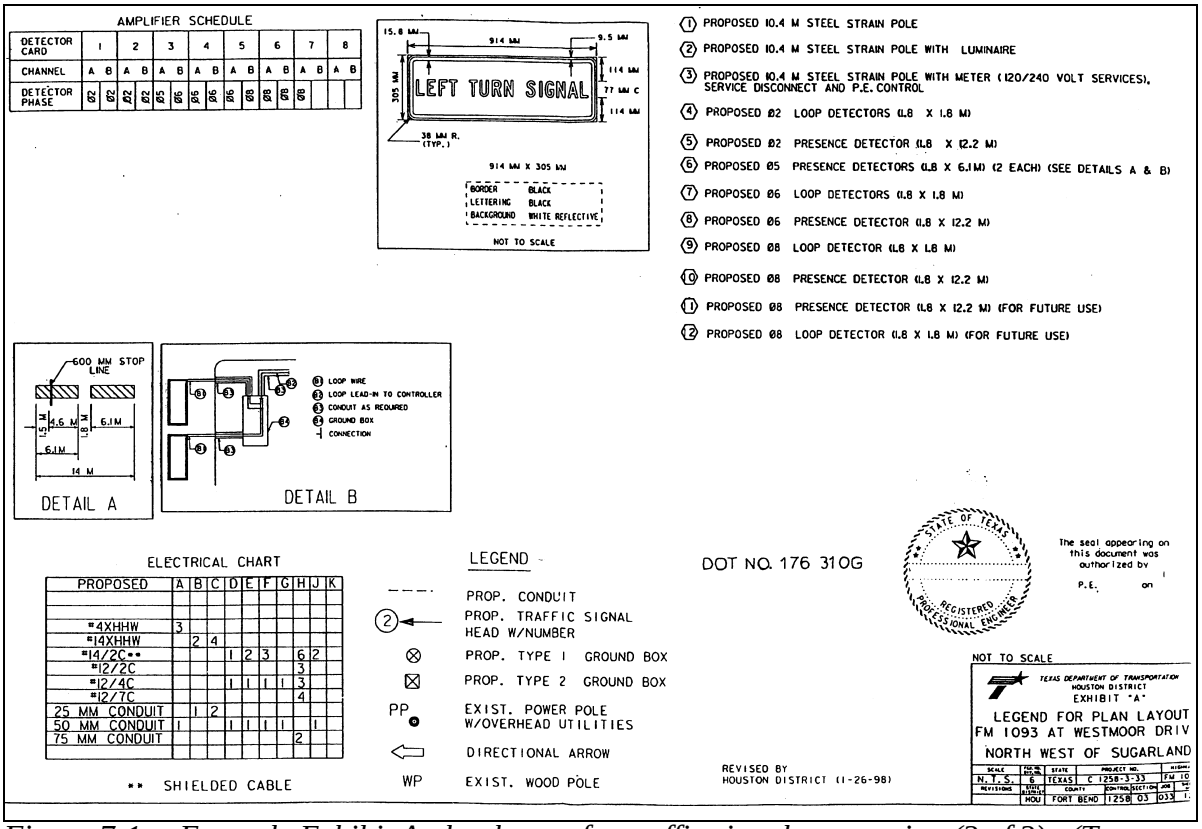


Figure 7-1c. Example Exhibit A plan layout for traffic signal preemption (3 of 3). (To access the MS Word version of all three panels of this figure from on line, click this file name: TFEG7-1.)

Section 4
Project Execution

Work Order

The district issues the work order to the railroad for any railroad force account work and keeps the railroad advised of the work in progress on their property. The work order should be issued soon after the contract has been awarded to allow the railroad sufficient time to order any necessary materials and schedule work.

The district should send a copy of the work order to the Traffic Operations Division (TRF) and the Finance Division (FIN). The work order also authorizes payment to the railroad.

Pre-construction Meeting

A pre-construction meeting is recommended so that work can be coordinated. Arranging the meeting is the district's responsibility. The following individuals should attend:

- a railroad project manager
- a city or county traffic signal representative
- a TxDOT traffic signal representative
- the TxDOT railroad liaison
- a representatives of TxDOT's contractor.

During the meeting the names of contact persons should be exchanged. The general notes, construction schedule, and any other matters of concern should be discussed.

Inspection

The district inspects the work performed by the railroad to verify that it complies to TxDOT standards and the approved plans and specifications.

Completion Letter

The district issues the completion letter to the railroad when the project is complete. A copy of the completion letter should be sent to TRF and FIN. The completion letter authorizes final payment to the railroad.

Chapter 8
Grade Separations

Contents:

Section 1
Overview

Introduction

This chapter covers agreements between TxDOT and railroad companies involving grade separation construction and reconstruction projects.

Project Process Overview

A grade separation construction or reconstruction project typically proceeds as follows:

1. Project is scheduled and funded. (See Section 2 of this chapter for information on programs and financing.)
2. The district or consultant (or both), with support from the Design Division (DES), designs the proposed structure and prepares the preliminary plan layout (including plan-profile) to be used in the agreement as Exhibit A. (See Section 3 of this chapter for details on content and preparation of Exhibit A.) The district then submits the layout to DES.

   NOTE: This submission should occur 12 months prior to the scheduled contract letting date to allow the railroad company sufficient time to review the project, address any revisions, prepare force account estimates, and sign the agreement. For railroad underpasses, design calculations should be submitted as soon as preliminary details are available. Also any details of required shoring must be accompanied by design calculations.
3. DES reviews the plan layout sheets, makes prints, and submits them to:
   - Federal Highway Administration (FHWA), if federal funds are involved
   - railroad company or companies involved, along with a request to submit the number of regular train and switching movements at the grade separation location (This information is used to prepare Addendum I to Special Provision to Item 007. Addendum I is used by TxDOT's contractor to obtain Railroad Protective Liability Insurance for work performed on railroad right-of-way.)
   - Traffic Operations Division (TRF), along with a request to develop an agreement with the railroad.

   To reduce the time needed for approval, the most current revisions should be included. (See Section 4 of this chapter for details.)
4. The FHWA, the railroad company, and TRF forward comments on and approval of the plan layout sheets to DES. (See Section 4 of this chapter for details.)

(continued...)

Project Process Overview *(continued)*

5. DES coordinates the resolution of the comments. (See Section 4 of this chapter for details.)

   NOTE: Revisions that occur after approval of the plan layout sheets increase the time needed to obtain a signed agreement from the railroad.

   NOTE: Any revisions made to the plan layouts after the district submits them to DES should immediately be sent to DES for coordination with the railroad.

6. DES and TRF coordinate the plan layout and plan-profile modifications, as necessary. The revised and approved plan layout sheets become Exhibit A of the agreement. (See Section 3 of this chapter for details.)

7. TRF prepares the agreement and negotiates with the railroad company or companies involved. (See Section 4 of this chapter for details.)

8. DES, the district, or a consultant develops bridge detail plans after all comments and changes to the geometric features of the overpass or underpass have been resolved.

9. The district prepares a complete PS&E (plans, specifications, and estimates) package and forwards it to DES for review prior to contract letting. (See Section 3 of this chapter for details.)

10. DES prepares and assembles the approved plans, specifications, and estimates (PS&E) for the portion of the project involving the railroad (this becomes Exhibit B of the agreement). DES also prepares an Addendum I to Special Provision to Item 007, which is used by the TxDOT contractor to obtain railroad protective liability insurance. (See Section 3 of this chapter for details.)

11. TRF transmits the Exhibit B approved by DES to the railroad company or companies for their approval. (See Section 5 of this chapter for details.)

12. The railroad approves the Exhibit B and returns the signed title sheet to TRF. (See Section 5 of this chapter for details.)

13. The district issues the work order to the railroad shortly after the project is let to contract. The district conducts all pre-construction meetings, inspects the work, and issues the completion letter to the railroad when the project is complete. (See Section 6 of this chapter for details.)

Section 2
Program and Finances

Federal Railroad Grade Separation Program

The Federal Railroad Grade Separation Program is financed under the Surface Transportation Program (STP) safety funds. Projects eligible for the program must be on the state highway system. The program is divided into two program areas:

- Installation of Grade Separations at Existing Highway-Rail Grade Crossings
- Replacement of Functionally Deficient Highway Underpasses.

Projects under both program areas are selected on a statewide priority basis by the Design Division (DES).

Funding. The program is managed by the Design Division (DES) under the bank balance allocation procedure. Each program receives approximately half the available funds.

Installation of Grade Separations at Existing Highway-Rail Grade Crossings

Under the Federal Railroad Grade Separation Program, projects for the construction of grade separations at an existing highway-rail grade crossings are selected on a statewide basis using a cost-benefit index (CBI). The CBI ranks the estimated savings (in millions of dollars) that would be realized over 50 years with construction of grade separation structures. The formula used to calculate CBI rankings considers:

- current average daily traffic (ADT)
- number of trains per day
- number of train-involved crashes
- casualty costs
- personnel delay costs
- highway traffic equipment delay costs.

A CBI ranking is calculated for each existing highway-rail grade crossing eligible for consideration under the program. The higher the CBI ranking, the higher the priority for selection and funding.

Replacement of Functionally Deficient Highway Underpasses

Under the Federal Railroad Grade Separation Program, selection and funding for the replacement of functionally deficient highway underpasses is also determined by a priority ranking. The ranking is based on:

- average daily traffic passing under the railroad
- relative deficiencies of the underpassing roadway width, vertical under-clearance, and lateral under-clearance.

Most data items used in the underpass replacement ranking process are available from the Bridge Inventory, Inspection, and Appraisal Program (BRINSAP) file. (Contact DES for further information.)

Other Funding Sources

All other grade separation projects are funded under road construction projects using state or federal funds or both. TxDOT adheres to the *Federal-Aid Policy Guide (FAPG)*, under 23 CFR 646, "Railroads," Subpart B, "Railroad-Highway Projects."

Shared Cost of Structures. The railroad is required to share the cost of the structure when an at-grade crossing is eliminated by the grade separation (*FAPG* 23 CFR 646B, §646.210). The railroad company's cost cannot exceed five percent of the cost of the portion of the structure that goes over the railroad tracks. If more than one railroad is involved, then the five percent cost is shared among them.

Reimbursement for Force Account Work. The railroad can be reimbursed for force account work performed on a highway-railroad grade separation. Upon completion of its part of the work, the railroad is reimbursed for up to 95 percent of the total cost of work performed. The remaining 5 percent is reimbursed upon final audit by TxDOT.

Section 3
Plan Layout (Exhibit A)

Preliminary Plan Layout

The district prepares a full-size, preliminary plan layout sheet (including the plan-profile) showing critical details proposed for the grade separation. Additional sheets may be used, if necessary. Critical details should include:

- project geometry
- layout
- vertical & horizontal clearances
- crash walls
- position of track
- any existing features and other pertinent information.
- work to be done by TxDOT
- work to be done by TxDOT's contractor
- work to be done by railroad
- general notes
- train data
- typical section
- fiber optics note
- appropriate drainage features.

The district submits the preliminary plan layout sheet to the Design Division (DES) for processing with the railroad company. It should be submitted 12 months prior to the scheduled contract letting date. The information provided on the preliminary plan layout eventually goes into Exhibit A of the agreement.

Complete Exhibit A

Following the approval of the preliminary bridge layout by the railroad, the district prepares the complete Exhibit A plan layout to show all worked performed by TxDOT, TxDOT's contractor, and the railroad. The complete Exhibit A should include:

- project data
- a title block
- design layout sheets
- a work list
- clearances and crash walls
- other pertinent information.

Discussions of each of these items follow. Figure 8-1 at the end of this section shows an example of Exhibit A plan layout.

Project Data

Project data include:

- the county and county number
- project
- project number
- control-section-job (CSJ)
- railroad mile post (RRMP)
- highway station
- highway number or road name.

Title Block

The title block includes:

- the railroad company name and DOT No. (if available)
- crossing location
- railroad milepost and highway station at each location
- the words "Exhibit A."

Design Layout Sheets

Explanations of the elements shown in the design layout sheets follow.

Alignment of Highway and Railroad. The alignment of the highway and railroad and angle of their intersection should be shown.

Fences and ROW Lines. The location of railroad fences or right-of-way lines with respect to the centerline of the main track should be shown.

Poles and Lines. The location of each pole and pole line, the number of cross arms and wires, owner of each line, and elevation of the low wires should be shown. For underpasses, it is important to show the location of poles in and near the proposed underpass in the area where a temporary shoofly track might be located.

Top-of-rail Profile. The top-of-rail profile for approximately 500 feet in each direction from the highway and for a greater distance if a change in railroad grade is proposed should be shown. If the railroad is on a curve, the profile should be taken along the high rail for overpasses and along the low rail for underpasses.

Drainage Features. Drainage features should be shown.

Overpass Drawings. For overpasses, roadway grades, line drawings, and cross section of the structure should be shown. Minimum vertical clearance together with the horizontal clearances should be shown. (See the *Bridge Design Manual* for standard clearances for railroad overpasses.)

Underpass Drawings. For underpasses, a cross section through the structure should be shown, along with a section at the underpass indicating vertical and horizontal clearances, types of curbs or medians (if required), and side slopes of roadway cuts. (See the *Bridge Design Manual* for standard clearances for underpasses.)

Railroad Facilities Requiring Adjustment. The location and description of any railroad facility that might require adjustment, including any proposed revision of railroad grade, should be shown.

Boring Data. Boring data should be plotted on the plan-profile sheet.

Roadway Geometric Features. Typical roadway geometric features, including pavement widths, shoulder widths, and embankment slopes should be indicated. For underpasses, the method for handling surface drainage should be indicated.

Shoofly Track Location. The proposed location of any shoofly track for routing rail traffic during construction of an underpass should be shown. Include a typical section through the shoofly embankment with a clear designation of what work is the responsibility of the state and which is the responsibility of the railroad company.

Work List

The work list provides a breakdown of all work to be performed by TxDOT, TxDOT's contractor, and the railroad company. The type of work to be performed on the railroad's right-of-way should be listed. The work list should include a typical section. When coring is involved, it is important to show where the coring will be performed in connection to the railroad tracks.

Clearances and Crash Walls

All vertical clearances from the top of rail and horizontal clearances from the centerline of the tracks must be clearly shown. Crash walls should also be shown.

Grade Crossings

If grade crossings are to be constructed in conjunction with an overpass or underpass, all information required for the grade crossing work should be shown on the overpass layout. For proposed automatic warning devices, a separate exhibit illustrating the grade crossing should also be supplied.

Other

Any other pertinent information, such as the cross section or plan profile of drainage structures or any pertinent information from the approval process.

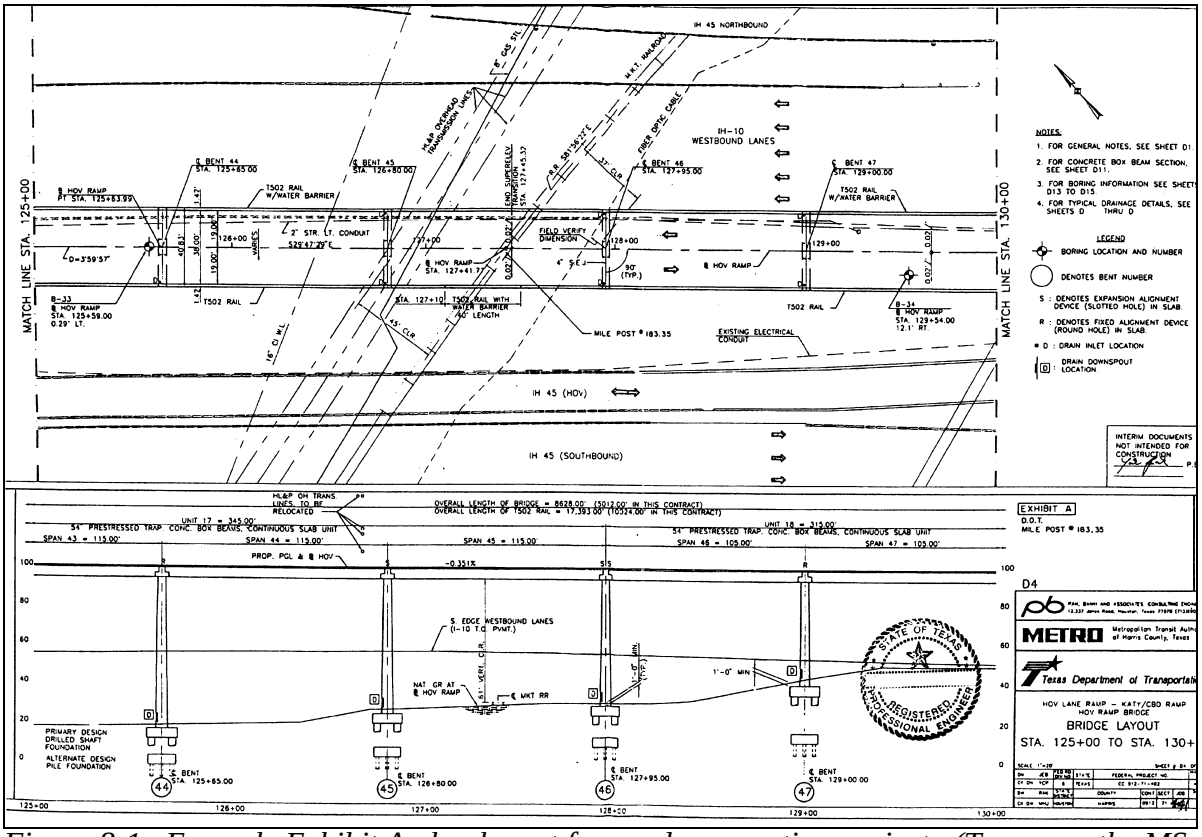


Figure 8-1. Example Exhibit A plan layout for grade separation project. (To access the MS Word version of this figure from on line, click this file name: TFEG8-1.)

Section 4
Agreements and Negotiations

Introduction

After coordinating the necessary design modifications for the construction or reconstruction of a highway-railroad grade separation, the Traffic Operations Division (TRF) and the Design Division (DES) negotiate an agreement with the railroad for all necessary force account work, including temporary adjustment of railroad fences and cattle guards and temporary and permanent pole line adjustments at the proposed structure.

The railroad performs, at state expense, any work necessary for adjustment of facilities located on railroad right of way to accommodate the construction of a grade separation.

Agreement Preparation

TRF prepares the agreement, using the plan layout furnished by the district as Exhibit A, and forwards it to the railroad.

Agreement Contents

The agreement contains:

- project data
- a license clause
- plans, estimates, construction, and maintenance
- insurance clauses
- payment clause
- conditions
- fiber optic clause.

Discussions of each of these items follow.

Project Data

Project data include the location of the project: county, CSJ, highway, project number, DOT number, and city.

License Clause

The license clause gives the state permission to construct, maintain, and use the grade separations across the railroad property.

Plans, Estimates, Construction, and Maintenance

"Plans, estimates, construction, and maintenance" includes all work to be performed by TxDOT, TxDOT's contractor, and the railroad. It spells out the responsibilities of both the railroad and the state.

Insurance Clauses

The insurance clauses specify the type of insurance the contractor will need to purchase on behalf of the state and railroad. All work performed on the railroad right-of-way by TxDOT's contractor requires railroad protective liability insurance in the amount of at least two million dollars for bodily injury and property damage; and six million dollars aggregate for all occurrences. The railroad protective liability insurance must be carried until all work on railroad property is completed. Insurance requirements are spelled out in the Special Provision to Item 007.

Payment

The payment clause specifies the conditions under which the state will reimburse the railroad and when this will occur. Reimbursement is made to railroad only if a work order has been issued to the railroad to begin work. The railroad is reimbursed for work performed and materials furnished, in accordance with the provisions of the *FAPG* Subchapter B, part 140, subpart I, issued by the Federal Highway Administration on April 7, 1992. The railroad can be reimbursed for up to 95 percent of the total cost of all railroad work through progressive billings as the work is performed. The complete balance due the railroad is paid, upon final audit by TxDOT's Audit Office.

Conditions

The conditions clause provides that the agreement can be canceled at any time prior to actual letting of the contract by TxDOT. It specifies whether the railroad is required to participate in the cost of the project.

Fiber Optic Clause

All Class I (major) railroad companies may have fiber optic cable buried on their ROW, it is important that the railroad be contacted at a 1-800 number, as shown in the agreement, prior to any work being performed to determine if fiber optic cable is buried on the ROW. By calling the 1-800 number, any fiber optic cable in the area will be identified and who the cable belongs to. It is the District's responsibility to contact that fiber optic company to advise them of the proposed work and to determine if the cable will be affected by the work. This clause is important to the railroad companies because of the very high costs associated with broken or damaged fiber optic cable.

Negotiations

TRF coordinates all negotiations concerning the agreement, including any revisions in the scope of work, with the district and railroad.

After Execution

Upon receipt of the signed agreements, the TRF forwards a copy of the executed agreement, along with the railroad estimate (if available), to the district, the Finance Division (FIN), and the Federal Highway Administration (FHWA) if required. TRF also advises DES of receipt of the executed agreement.

Section 5
Plans, Specifications, and Estimates (Exhibit B)

Introduction

The approved plans, specifications, and estimates (PS&E) for that portion of the project involving the railroad company is called Exhibit B and is part of the agreement between TxDOT and the railroad. Exhibit B is typically prepared *after* the agreement is signed.

Preparation

The district prepares the PS&E package and submits it to the Design Division (DES) for review and processing for contract letting.

NOTE: The PS&E Submission Data form (TxDOT Form 1002) should include railroad information on page 2.

NOTE: The Special Provision to Item 007 for Railroad Protective Liability Insurance should be included in the specification list.

Review and Approval

DES reviews and approves the PS&E and prepares the Exhibit B for submission to the railroad. If the fiber optics note is not shown in the plans, the note should be added to the general notes.

DES furnishes the approved Exhibit B to the Traffic Operations Division (TRF) for transmittal to the railroad company for their final approval.

Upon approval by the railroad, TRF forwards a copy of the approved Exhibit B to DES and FHWA (if required).

Section 6
Project Execution

Work Order

The work order authorizes the railroad to begin work and provides for reimbursement to the railroad. The district issues the work order to the railroad for any railroad force account work and advises the railroad of work on their property.

The work order should be issued soon after the contract has been awarded to allow the railroad sufficient time to order necessary materials and schedule work.

The district should send a copy of the work order to:

- the Traffic Operations Division (TRF)
- the Design Division (DES)
- the Finance Division (FIN).

Pre-construction Meeting

A pre-construction meeting is recommended and is a district responsibility.

Representatives from the railroad, TxDOT's contractor, and TxDOT attend the meeting. The construction schedule, inspection, and individual points of contact are discussed. Any conflicts in the work schedule should be identified and resolved prior to beginning work.

Inspection

The district inspects the work performed by the railroad and verifies that the work complies with state standards and the approved plans and specifications.

Completion Letter

The district issues the completion letter to the railroad when the project is complete. A copy of the completion letter should be sent to TRF, DES, and FIN. The completion letter authorizes final payment to the railroad, less retainage pending final audit.

Chapter 9
Drainage Structures and Common Ditches

Contents:

Section 1
Overview

Policy and Practice

When a drainage channel or some type of drainage structure on railroad right-of-way is needed, an agreement obtaining permission and concurrence from the railroad to perform such work is required. This includes grading, cleaning, and reshaping of common ditches and culverts between highway and railroad right-of-way.

Drainage Structures Under or Near Railroad

Railroad companies require that concrete box culverts or drainage pipes installed under the tracks be class V and E-80 loading. Also, the Union Pacific Railroad requires that TxDOT complete their Application for Encased Non-flammable Pipeline Crossing form and include it (along with a cover application form) as part of the agreement. The district completes the forms and submits them to the Traffic Operations Division (TRF) when requesting preparation and execution of the agreement. (Samples of the forms are provided in Appendix A of the hard copy print version of this volume. These sample forms may be photocopied as necessary. Copies may also be obtained from the Traffic Operations Division.)

When box culverts are installed under the tracks, the railroads require that hydraulic design calculations be submitted for their approval. The district develops these calculations and submits them to the Design Division (DES). DES then forwards them to TRF to be included as part of the agreement.

Common Ditch and Joint Drainage

Railroads typically require plan profiles and cross sections of common ditch projects. Plan profiles should be included with the plan layout (Exhibit A).

Preliminary Engineering and Coordination

Preliminary engineering and coordination with any local governmental entity, adjacent landowners, and the railroad is normally the responsibility of the district.

Drainage outfall into common ditch facilities or under railroad tracks should be designed to prevent any possible undermining of railroad facilities in the event of flooding.

Section 2
Plan Layout (Exhibit A)

Overview

The district prepares the plan layout (to be used in the agreement as Exhibit A) in sufficient detail to show all work to be performed by TxDOT, TxDOT's contractor, the railroad, and the railroad's contractor.

The layout includes detail plans showing proposed drainage structures, grading, and slope of ditch work. Any other pertinent information, such as the cross section or plan profile of the drainage structures, should be included in the plan layout.

Figure 9-1 (a-d) at the end of this section shows an example Exhibit A plan Layout.

Project Data

The project data included in the plan layout identify the project by:

- county
- project number
- control-section-job (CSJ)
- highway number or road name.

Title Block

The title block includes:

- the railroad name and DOT No. (if available)
- milepost and highway station
- The words "Exhibit A."

General Notes

The general notes lists all work to be performed by TxDOT, TxDOT's contractor, the railroad, and railroad's contractor.

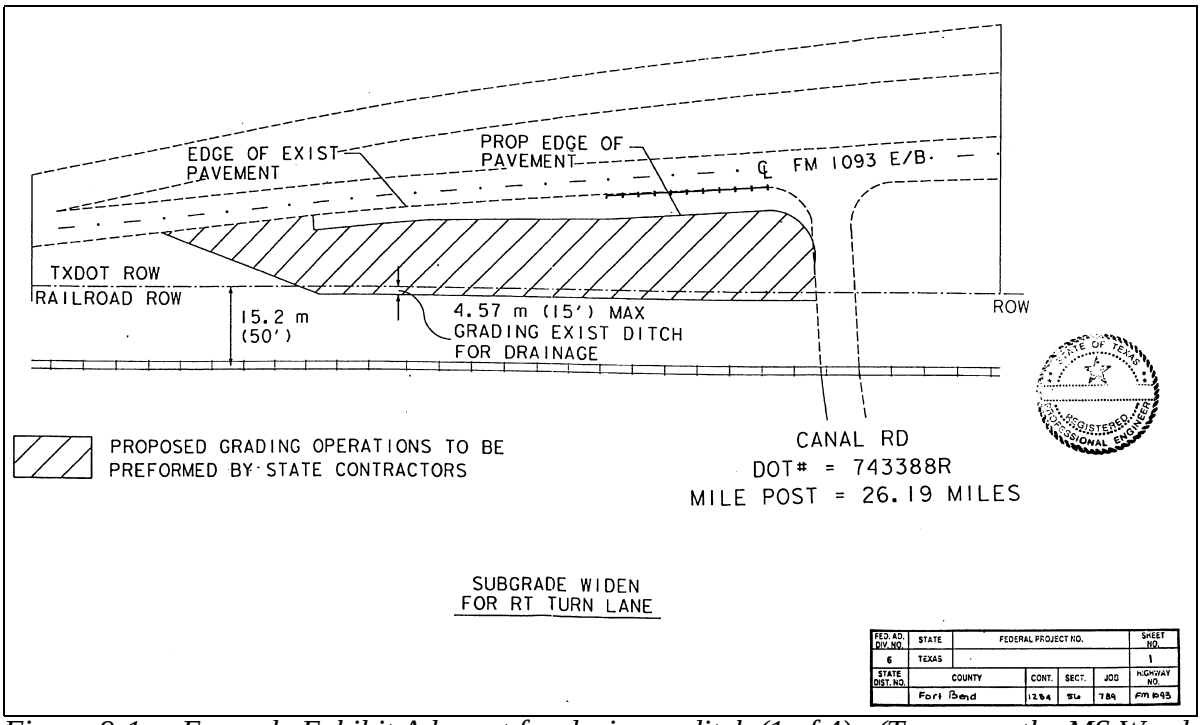


Figure 9-1a. Example Exhibit A layout for drainage ditch (1 of 4). (To access the MS Word version of all four panels of this figure from on line, click this file name: TFEG9-1.)

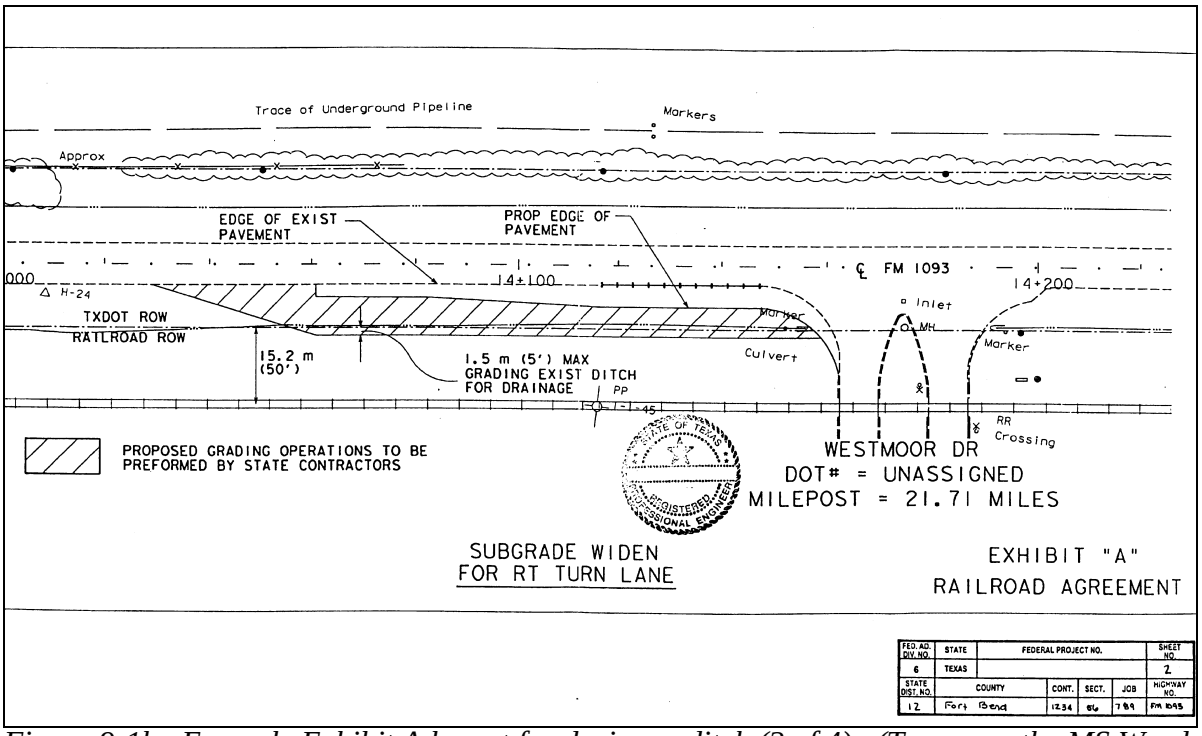


Figure 9-1b. Example Exhibit A layout for drainage ditch (2 of 4). (To access the MS Word version of all four panels of this figure from on line, click this file name: TFEG9-1.)

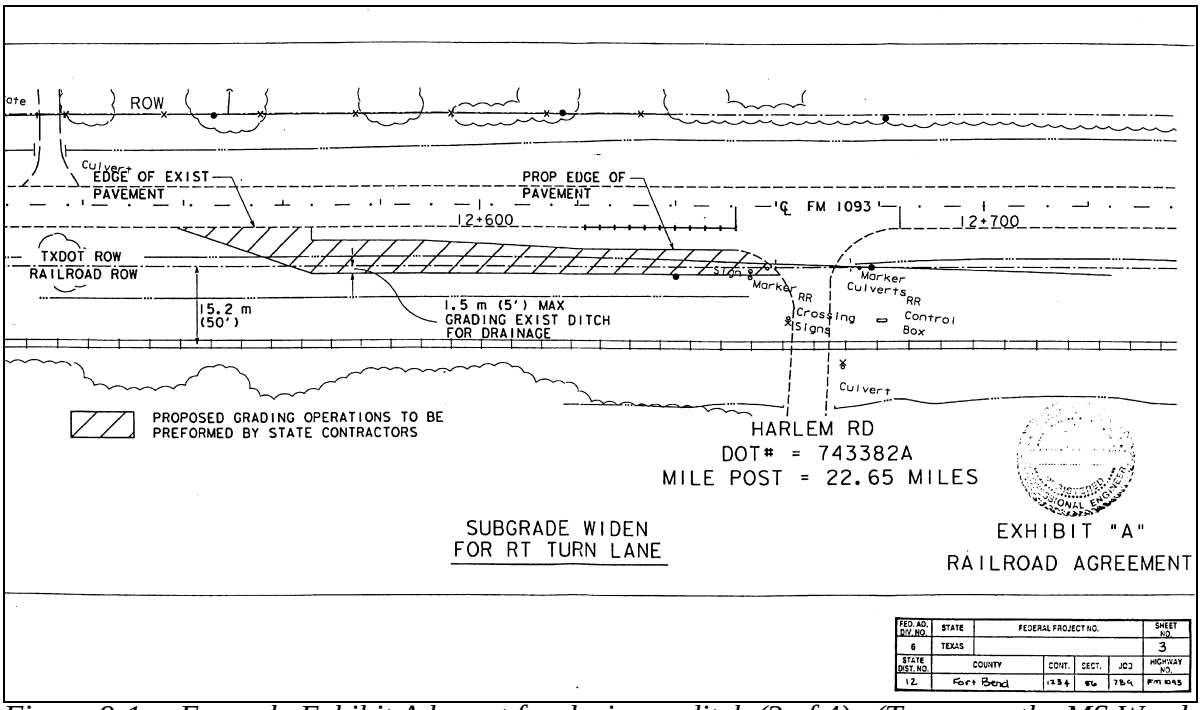


Figure 9-1c. Example Exhibit A layout for drainage ditch (3 of 4). (To access the MS Word version of all four panels of this figure from on line, click this file name: TFEG9-1.)

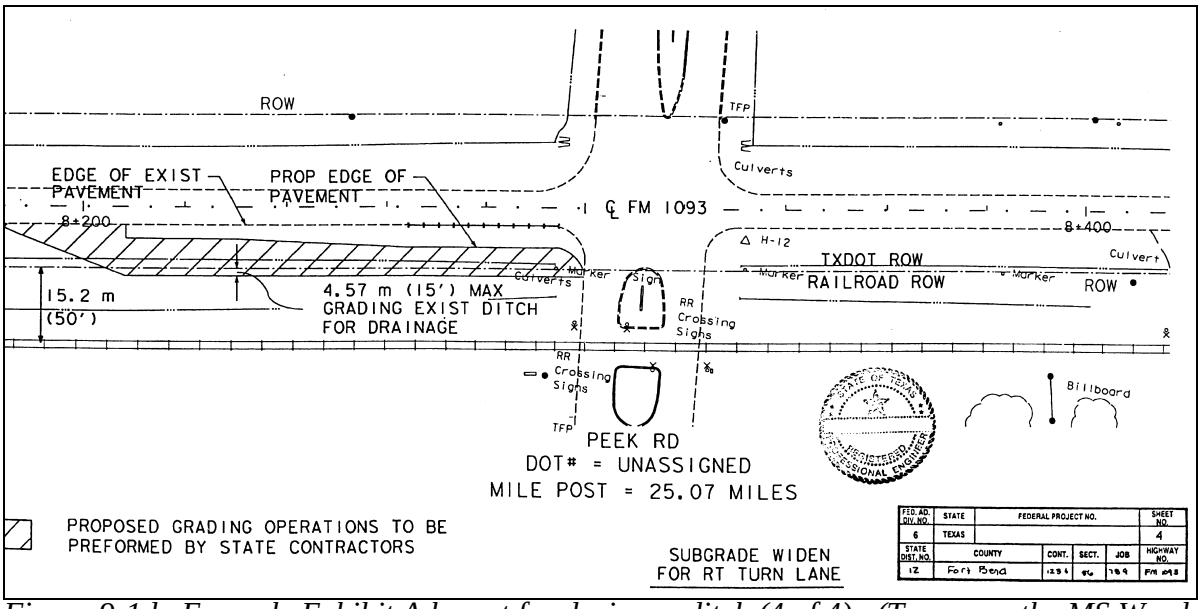


Figure 9-1d. Example Exhibit A layout for drainage ditch (4 of 4). (To access the MS Word version of all four panels of this figure from on line, click this file name: TFEG9-1.)

Section 3
Agreements and Negotiations

Introduction

Using the plan layout furnished by the district as Exhibit A, the Traffic Operations Division (TRF) prepares the necessary agreement and forwards it to the railroad company.

Negotiations and Processing

TRF coordinates all negotiations concerning the agreement, including any revisions made by the district or railroad.

The railroad furnishes an estimate (or bids solicited by the railroad) to TRF showing all reimbursable work to be performed by the railroad. TRF approves the estimate, attaches it to the executed copies of the agreement, and forwards the railroad's copy back to them. The district, the Finance Division (FIN), and FHWA (if required) each receive a copy of the executed agreement and estimate.

Agreement Contents

The agreement contains:

- project data
- a license clause
- insurance clauses
- a payment clause
- conditions
- a fiber optic cable clause.

Discussions of each of these items follow.

Project Data

The project data identifies the project by:

- county
- control-section-job (CSJ)
- highway
- project number
- DOT No. (if available)
- the city or nearest city.

License Clause

The license clause gives TxDOT license and permission to perform the necessary drainage work on the railroad right-of-way. The clause also describes the work to be performed by all parties, including flagging of trains by the railroad, if required.

Insurance Clauses

The insurance clauses specify the type of insurance the contractor needs to purchase on behalf of the state and railroad. All work performed on the railroad right-of-way by TxDOT's contractor requires railroad protective liability insurance in the amount of at least two million dollars for bodily injury and property damage six million dollars aggregate for all occurrences. The railroad protective liability insurance must be carried until all work on the railroad property is completed. Insurance requirements are spelled out in the Special Provision to Item 007.

Payment Clause

The payment clause specifies when and under which conditions TxDOT will reimburse the railroad. Reimbursement is made to the railroad only if a work order has been issued to begin work. The railroad is reimbursed for work performed and materials furnished in accordance with the provisions of the Federal Aid Policy Guide (FAPG), Subchapter B, Part 140, Subpart I, as last issued by the Federal Highway Administration on April 7, 1992. The railroad is reimbursed the actual total cost of all railroad force account work performed and materials used or installed. However, upon final audit by the Audit Office of TxDOT, the railroad may be required to reimburse TxDOT any over payment that cannot be justified.

Conditions

The conditions clause explains that the agreement can be canceled at any time prior to actual letting of the contract by TxDOT. It also details any FAPG requirements for cost participation in the project by the railroad.

Fiber Optic Clause

All Class I (major) railroad companies have fiber optic cable buried on their rights-of-way. Therefore, it is important that the railroad be contacted at a 1-800 number (which is identified in the agreement) prior to any work being performed to determine if fiber optic cable is buried on the right-of-way. Also, the location of the fiber optic cable and who it belongs to can be identified. It is the district's responsibility to contact the fiber optic cable company to advise them of the proposed work and to determine if the cable will be affected by the work. This clause is important to the railroad companies, because of the very high costs associated with broken or damaged fiber optic cable.

Section 4
Project Execution

Work Orders

The district issues the work order to the railroad for any railroad force account work and keeps the railroad advised of the work in progress on their property. The work order should be issued soon after the contract has been awarded to allow the railroad sufficient time to order materials and schedule work. A copy of the work order should also be sent to the Traffic Operations Division (TRF) and the Finance Division (FIN). The work order authorizes the railroad to go to work and to be reimbursed by the state.

Pre-construction Meeting

A pre-construction meeting is recommended and is the district's responsibility. Representatives from TxDOT, the railroad, and TxDOT and railroad contractors should attend the meeting so that work can be coordinated. The construction schedule and individual points of concern should be discussed and any scheduling conflicts identified and resolved.

Inspections

The district inspects the work performed by the railroad and verifies that it complies with TxDOT standards and approved plans and specifications.

Project Completion

The district issues the completion letter to the railroad when the project is complete. A copy of the completion letter should be sent to TRF and FIN. The completion letter authorizes final payment to the railroad.

Chapter 10
Other Railroad Agreements

Contents:

Section 1
Letter Agreements

Policy and Practices

A letter agreement is used on projects requiring minimal work on railroad right-of-way where the only thing the railroad is doing is providing flaggers. Flaggers are needed for safe operation and work conditions.

Examples of projects using letter agreements are:

- seal coat and asphaltic concrete pavement (ACP) overlay
- installation of overhead wire lines
- installation of conduit under track
- minor pavement rehabilitation
- minor maintenance
- installation of computerized traffic management system.

Discussions of these types of projects follow.

Seal Coat and ACP Overlay Projects

TRF prepares a project-specific letter agreement for each crossing affected by a seal coat and asphaltic concrete pavement (ACP) overlay project, whereby the railroad gives TxDOT permission to perform the seal coat or ACP overlay work up to the edge of the crossing. The letter agreement provides the following information:

- project data
- statement of the work
- provision for flagging
- letting date
- notification.

Installation of Overhead Wire Lines

When an overhead wire line is installed over the track, the Union Pacific Railroad requires that TxDOT complete their Application for Overhead Wireline Crossing and include it (along with a cover application form) as part of the agreement. The district completes the forms and submits them to the Traffic Operations Division (TRF) when requesting preparation and execution of the agreement. Samples of these forms are provided in Appendix A of the hard copy print version of this volume. These sample forms may be photocopied as necessary. Copies may also be obtained from the Traffic Operations Division.

Installation of Conduit Under Track

As with overhead wire lines, when conduit is installed under the track, the Union Pacific Railroad requires that TxDOT complete their Application for Underground Wireline Crossing and include it (along with a cover application form) as part of the agreement. The district completes the forms and submits them to the Traffic Operations Division (TRF) when requesting preparation and execution of the agreement. Samples of these forms are provided in Appendix A of the hard copy print version of this volume. These sample forms may be photocopied as necessary. Copies may also be obtained from the Traffic Operations Division.

Minor Pavement Rehabilitation

Minor pavement rehabilitation includes such work as:

- repair of pot holes in the roadway
- crack sealing
- seal coats
- ACP overlays.

Minor Maintenance

Minor maintenance projects can include such work as performing minor repairs on a grade separation and drainage ditches where a fully executed agreement exists requiring TxDOT to maintain the structure or drainage ditches or both.

Plan Layout (Exhibit A)

On all types of projects involving letter agreements, except seal coat projects (see following discussion), the district prepares a plan layout (Exhibit A) in sufficient detail to show all work to be performed by TxDOT, TxDOT's contractor, and the railroad. Exhibit A must be signed, sealed, and dated by a registered professional engineer and must include:

- ***project data*** include:
  - county
  - control-section-job (CSJ)
  - project
  - highway number or road name
- ***work description*** — the work to be performed by TxDOT and its contractor
- ***title block*** includes:
  - the railroad company name and DOT No. (if available)
  - crossing location
  - railroad milepost and highway station at each location
  - the words "Exhibit A."

Required Railroad Forms. Railroad application forms for overhead or underground wire lines (if required) should be attached to Exhibit A. These forms do not need to be sealed.

Seal Coat Projects. On seal coat projects, the district should provide the following as part of Exhibit A:

- location of each project including the DOT No.
- a location map of each project
- name of the railroads involved
- project data.

For seal coat projects, the Exhibit A does not need to be signed, sealed, and dated by a registered professional engineer.

The district submits Exhibit A to the Traffic Operations Division (TRF).

Agreement Preparation and Negotiations

Using the layout furnished by the district as Exhibit A, TRF prepares the letter agreement and forwards the agreements to the railroad company.

The letter agreement contains:

- ***project data*** include:
  - county
  - project
  - control-section-job (CSJ)
  - highway number or road name
- ***work description*** — the work to be performed by TxDOT and its contractor
- ***flagging clause*** — gives the railroad authority to provide flaggers and gives an estimated cost for the flagging.
- ***fiber optic clauses*** — provides the 1-800 number that TxDOT's contractor must call before any work is performed on railroad property
- ***insurance clause*** — requires TxDOT's contractor to provide railroad protective liability insurance.

TRF handles all negotiations concerning the agreement, including revisions. Upon receipt of the signed letter agreement, TRF forwards a copy of the executed agreement to the district and the Finance Division (FIN).

Work Order

The district issues the work order to the railroad for flaggers. The work order should be issued at least five days before any work is performed, so that the railroad has time to provide flaggers. A copy of the work order should also be sent to TRF and FIN. The work order authorizes payment to the railroad.

Completion Letter

The district issues the completion letter to the railroad when the project is complete and the flagger is no longer needed. A copy of the completion letter should also be sent to TRF and FIN. This letter authorizes final payment to the railroad.

Section 2
Right of Entry and Survey Agreements

Policy and Practice

When TxDOT needs to enter the railroad's right-of-way to perform core drilling, survey, or other related work, a Right of Entry Agreement or Survey Agreement with the railroad is necessary. These agreements are usually needed at the very beginning of a project, typically before plan layouts are drawn. These agreements should be negotiated as far in advance as possible so as not to delay the project.

Insurance Considerations

When TxDOT forces perform surveying or core drilling work, railroads *do not* require railroad protective liability insurance. If TxDOT's contractor performs the work, then railroad liability protective insurance *is* required. Since the cost of the insurance could exceed the cost of the survey or coring project, TxDOT forces should perform this type work.

Layout (Exhibit A)

The district prepares the layout (Exhibit A) in sufficient detail to show all work to be performed by TxDOT, TxDOT's contractor, and the railroad. Exhibit A must include:

- ***project data*** include:
  - county
  - project
  - control-section-job (CSJ)
  - highway number or road name
- ***title block*** includes:
  - control-section-job (CSJ)
  - DOT No.
  - railroad mile post
  - project number
  - county number.
  - the words "Exhibit A"
- ***work list*** — the work to be performed by TxDOT or its contractor, including the type of work to be performed on the railroad's right-of-way and, when coring is involved, where the coring will be performed in connection to the railroad tracks.

(continued...)

Layout (Exhibit A) *(continued)*

Exhibit A must be signed, sealed, and dated by a registered professional engineer.

The district submits Exhibit A to the Traffic Operations Division (TRF).

Agreement Preparation

Agreement Preparation. Using the layout furnished by the district as Exhibit A, the Traffic Operations Division (TRF) prepares the Right of Entry or Survey Agreement and forwards it to the railroad company.

The agreement contains:

- project data, which includes:
  - county
  - control-section-job (CSJ)
  - highway number or road name
  - project number
  - DOT No. (if available)
  - the city
- scope of work (description follows)
- conditions clause (description follows)
- a fiber optic clause (description follows)
- insurance clauses (description follows)
- a payment clause (description follows)
- a termination clause (description follows).

Scope of Work. The scope of work includes all work to be performed by TxDOT, TxDOT's contractor, and the railroad. It specifies the responsibilities of both the railroad and TxDOT.

Conditions Clause. The conditions clause gives TxDOT permission from the railroad to perform the necessary work. It specifies conditions that apply to TxDOT while on the railroad right-of-way.

(continued...)

Agreement Preparation *(continued)*

Fiber Optic Clause. Most of the major railroads may have fiber optic cable buried on their rights-of-way. Therefore, it is important that the railroad be contacted at a 1-800 number (which is identified in the agreement) prior to any work being performed to determine if fiber optic cable is buried on the right-of-way. Also, the location of the fiber optic cable and who it belongs to can be identified. It is the district's responsibility to contact the fiber optic cable company to advise them of the proposed work and to determine if the cable will be affected by the work. This clause is important to the railroad companies, because of the very high costs associated with broken or damaged fiber optic cable.

Insurance Clauses. If TxDOT's contractor will perform the survey or coring work, then the contractor must purchase railroad protective liability insurance in the amount of at least two million dollars for bodily injury and property damage and six million dollars aggregate for all occurrences. The railroad protective liability insurance must be carried until all work on railroad property is completed. Insurance requirements are included in a Special Provision to Item 007.

Payment Clause. The payment clause specifies the conditions under which TxDOT will reimburse the railroad and when reimbursement will be made. Reimbursement to the railroad must be in accordance with *Federal-Aid Policy Guide (FAPG)* subchapter B, part 140, subpart I, issued by the Federal Highway Administration on April 7, 1992.

Termination Clause. Some railroad companies require that a one-year termination clause be included in the agreement. This clause specifies that the agreement, after execution by all parties involved, be good for one year from the execution date. It also states that TxDOT must notify the railroad in writing at least five days prior to starting any work on railroad right-of-way.

Agreement Negotiations

TRF handles all negotiations concerning the agreement, including revisions. Upon receipt of the signed agreement, TRF forwards a copy of the executed agreement to the district and the Finance Division (FIN).

Work Order

The district issues the work order to the railroad for any flagging of trains that may be required. The work order should be issued as soon as possible after the agreement has been executed by all parties. A copy of the work order should also be sent to TRF and FIN.

Completion Letter

Upon completion of the survey or coring work, the district issues a completion letter to the railroad. This letter advises the railroad that all work on their right-of-way is complete and that they may now bill TxDOT the cost of any flagging performed in connection with the project. A copy of the completion letter should also be sent to TRF and FIN.

Chapter 11
Crossing Closure, Relocation, and Consolidation

Contents:

Section 1
Overview

Policy

The *Texas Manual on Uniform Traffic Control Devices (TMUTCD)* states:

> Any highway grade crossing for which there is not a demonstrated need should be closed. Where a railroad track has been abandoned or its use discontinued, all related traffic control devices shall be removed, and the tracks should be removed or covered.

General Considerations

Several considerations may influence the decision to eliminate a highway-rail crossing.

Railroad Use of Track. Each railroad company operating over a candidate crossing should indicate its intent for future use of that section of track. If track abandonment is anticipated, roadway closure or any crossing improvements should be held in abeyance pending resolution of the track abandonment proposal.

Effect on Roadway System. A roadway closure should not negatively affect the local transportation system. Alternative public crossings should be within a reasonable travel time and distance. The alternative crossings and connecting roadways should have sufficient capacity to accommodate the diverted traffic safely and efficiently.

Emergency Vehicle Routing. The closing of roadway crossings that serve as a direct route for vital traffic, such as ambulances, fire trucks, or other emergency vehicles, should be avoided.

Economic Consequences. The economic consequences for nearby existing or planned businesses should be considered.

Crash History and Hazard Potential. The crash history and hazard potential of the crossing should be carefully evaluated. Items to review include:

- number and severity of crashes
- type and number of trains
- train speed range
- time periods during which trains block the crossing.

Section 2
Crossing Closure

Introduction

Closure of highway-rail intersections is normally accomplished by closing the highway. Many characteristics of the community influence the number of crossings needed to carry highway traffic over a railroad. A study of highway traffic flow should be conducted to determine origin and destination points and needed highway capacity. Highway operation over several crossings may be consolidated to move over a nearby crossing with flashing lights and gates, or via a nearby grade separation. Alternative routes should be within reasonable travel time and distance from a closed crossing. The alternate routes should have sufficient capacity to accommodate the diverted traffic safely and efficiently.

Obstacles to Crossing Closure

Negative community attitudes, funding problems, or a lack of forceful state laws authorizing closure are common obstacles to crossing closure. Local opposition may sometimes be overcome through emphasis on the benefits resulting from closure, such as improved traffic flow and safety as traffic is redirected to grade separations or crossings with active traffic control devices.

Railroads often support closure, not only because of safety concerns, but also because closure eliminates maintenance costs associated with the crossings.

Systems Approach

The systems approach is useful in identifying closure candidates. This method improves several crossings in a community or rail corridor by the installation of traffic control devices at some locations while closing other crossings. A study of traffic flow in the area should be conducted beforehand to assure continued access across the railroad. Installation of more sophisticated traffic control systems at the remaining crossings and perhaps the construction of a grade separation at one of the remaining crossings may improve traffic flow in some instances.

Emergency Vehicle Routing

Access over the railroad by emergency vehicles, ambulances, fire trucks, and police must be considered in deciding whether or not to close a crossing. Crossings used frequently by emergency vehicles should not be closed. These crossings should be candidates for grade separation or the installation of active traffic control devices.

Identifying Closure Candidates

Criteria for identifying candidate crossings for closure must relate directly to existing operational and geometric characteristics. Specific criteria are difficult to establish. The number of vehicles using the crossing and the accessibility of alternate crossings are significant criteria in determining whether the elimination of a particular crossing is practical. Existing criteria and values differ among agencies. The *Traffic Control Devices Handbook* suggests the following criteria.

Criteria for Closing of Grade Crossings

Type of Track	Criteria
Branch Line	♦ less than 2,000 ADT (average daily traffic ♦ more than two trains per day ♦ alternate crossing within 0.25 miles with less than 5,000 ADT if two-lane, or less than 15,000 ADT if four-lane
Spur Track	♦ less than 2,000 ADT ♦ more than 15 trains per day ♦ alternate crossing within 0.25 miles with less than 5,000 ADT if two-lane, or less than 15,000 ADT if four-lane
Main Line	any main line section with more than five crossings within a 1.6 km (1.0 mile) segment

It is important to avoid using these criteria without objective engineering and economic assessments of the positive and negative consequences of the closure.

Removal of Devices

When a crossing is permanently closed to highway traffic, the crossing surface, pavement markings, and all traffic control devices both at the crossing and approaching the crossing should be removed. Generally, the railroad is responsible for removing the crossing surface and traffic control devices located at the crossing. The highway authority is responsible for removing traffic control devices in advance of and approaching the crossing. Nearby highway traffic signals interconnected with crossing signals located at the closed crossing should have their phasing and timing readjusted. (See Section 4 of this chapter for information on the permit required for dismantling warning signals.)

Erection of Warning and Regulatory Devices

The highway authority is also responsible for alerting motorists to the closed roadway. A Type III barricade conforming to the design criteria of Section 6C-8 of the *Texas Manual on Uniform Traffic Control Devices (TMUTCD)* may be erected, except the colors of the stripes must be reflectorized white and reflectorized red. Warning and regulatory signing may also be an appropriate means of alerting motorists to the closed roadway. These may include the ROAD CLOSED (R11-2) sign, the LOCAL TRAFFIC ONLY (R11-3) sign, or the ROAD CLOSED TO THRU TRAFFIC (R11-4) sign, plus appropriate advance warning signs applicable to the circumstances.

Notification of Alternate Routes

Consideration should also be given to advising motorists of alternate routes across the railroad. If trucks use the closed crossing, they should be given advance information of the closure at points where they can conveniently alter their route.

Section 3
Relocation and Consolidation

Introduction

Alternatives to the closing of a grade crossing are

- relocation of either the highway or the railroad track
- consolidation of two or more railroad lines into a single route.

Planning

Planning for such relocation or consolidation is complex and often controversial. These projects are also some of the most expensive options available, necessitating careful study to ensure the expenses involved are reasonably justified.

Prior to making any decisions relating to crossing improvement by either grade separation or traffic control systems, long-range plans for relocation and consolidation of railroads in urbanized areas should be reviewed. Urbanized area transportation plans and railroad studies for mergers and consolidation are two sources of information.

Railroad Relocation

Railroad relocation to the outer limits of the community may be a viable alternative for alleviating operational, safety, and environmental concerns, while retaining the economic benefits of railroad service to the community. Relocation generally involves the complete rebuilding of railroad facilities, including acquisition of new right of way and construction of track, drainage structures, signals and communications, crossings and separations, station facilities, and utilities.

Benefits. Benefits of railroad relocation extend beyond those associated with crossing safety and operations. Possible additional benefits may include:

- improved environmental quality resulting from decreased noise and air pollution
- improved land use and appearance
- improvements in the railroad's operational efficiency.
- elimination of obstructions to emergency vehicles
- safer routes for hazardous materials movement.

(continued...)

Railroad Relocation *(continued)*

Planning. Many factors exist in planning for railroad relocation. The new route should provide good alignment, minimum grades, and adequate drainage. Sufficient right of way should be available to provide the necessary horizontal clearances, additional rail facilities as service grows, and a buffer for abating noise and vibrations. The number of new highway-rail intersections should be minimal.

Zoning the property adjacent to the railroad as light and heavy industrial further isolates the railroad corridor from residential and commercial activity. Businesses and industry desiring rail service can locate in this area.

Highway Relocation

Highway relocations are implemented to provide improved traffic flow around communities and other developed areas. Planning for highway relocations should consider routes that would eliminate highway-rail intersections by avoiding the need for access over railroad tracks or by providing grade separations.

Section 4
Dismantling of Warning Signals

Introduction

A person or railroad desiring to dismantle a warning signal at a grade crossing of a railway and a state-maintained road or highway must first apply to TxDOT to determine if a permit is required under 43 TAC §25.70 – 25.73. This contains requirements and procedures for issuing such a permit. Figure 11-1 at the end of this section provides a flow chart overview of the permit process.

NOTE: A permit is also required for dismantling warning signals at a grade crossing of a railway with a road or highway maintained by an authority other than TxDOT. Consult 43 TAC §25.70 – 25.73 for details.

Application

A person or railroad company desiring to dismantle warning signals at a railroad grade crossing must make application to the Texas Department of Transportation.

Form Available. Applicants may obtain a Permit Application Form for Dismantling of Railroad Crossing Warning Signal Device (TxDOT Form 1930) from any TxDOT district office. A sample Form 1930 is provided in Appendix A of the hard copy print version of this volume. This sample form may be photocopied as necessary. Copies may also be obtained from the Traffic Operations Division. In the on-line version of this volume, an MS Word version of this form may be opened and printed out by clicking on the following file name: TFE-1930.

Application Submittal. The applicant must return the completed application form to the district office in which the warning signal is located. The application must be accompanied by a resolution from the board of directors of the entity owning the railroad certifying the reason and justification for the request for removal of the warning signal.

Determining if a Permit Is Required

Upon receiving an application, the district determines if a permit is required to remove the signal. A permit is required when all of the following conditions exist:

- the rail line is not defined as a Class I or Class II railroad by the Interstate Commerce Commission
- the rail line is active (an "active rail line" is defined as any railroad tracks which are classified by the Interstate Commerce Commission to carry freight or passenger trains and are currently being operated and maintained by a railroad company or rail carrier.)
- the cost of the signals was originally paid either entirely or partly from public funds.

The district must notify the applicant of its finding within 30 calendar days following receipt of the application.

If a Permit Is Not Required

If a permit is not required for removal of the signals the district office informs the applicant that they may dispose of the signals at their discretion.

If a Permit is Required

If a permit is required, the district proceeds according to who the entity is who maintains the roadway.

If a governmental entity other than TxDOT maintains the road or highway intersecting the rail line, the district office forwards the application to that governmental entity for further processing in accordance with 43 TAC §25.70 – 25.73. The district also informs the applicant of its findings and the forwarding.

If TxDOT maintains the road or highway intersecting the rail line, then the district informs the applicant of its findings and processes the application.

Processing the Application

The district determines whether or not removal of the warning signals would adversely affect public safety. Factors determining whether or not removal of the warning signals would adversely affect public safety include:

- vehicle traffic
- train traffic and operations
- train-involved accident history
- crossing geometrics
- other considerations as noted on the application.

If removal would adversely affect public safety, then the district informs the applicant within 90 calendar days that the application is denied.

If removal would not adversely affect public safety, then the district determines the salvage value of the warning signals and informs the applicant within 90 calendar days of its finding that the application is approved pending payment of the signals' salvage value and reimbursement of expenses incurred by TxDOT in processing the application.

Salvage Value

Salvage value is defined as any monetary value which may be derived from the signal equipment being retired or removed or from any material necessary for its operation. This may include, but is not limited to, the depreciated value of:

- any reusable electrical equipment (signal controllers, relays, rectifiers, batteries, etc.)
- signal equipment (signal heads, lenses, signal hoods and backgrounds, light bulbs, crossbuck signs, gate arm mechanisms, gate arms, lights, counterweights, etc.)
- track circuit equipment (termination shunts, capacitors, chokes, tuned joint couplers, insulated joints, etc.)
- the scrap value of these components, including all material or aluminum components (signal masts or cantilevers, gate mechanisms, counterweights, signal cabins, or signal cases).

Receipt of Payment and Permit Issuance

Upon receipt of payment for the salvage value of the signals, the district issues a permit to the applicant for dismantling the warning signals. Governmental entities other than TxDOT that collect such payment, transfer the salvage value paid for signals to the appropriate district office. The district office deposits the salvage value paid for signals into a special fund in the State Treasury known as the "Railroad Crossing Warning Signal Fund" under the State Highway Fund to be used for the maintenance and improvement of warning signals at grade crossings.

Permit Process Flow Chart

The flow chart shown in Figure 11-1 provides an overview of the permit process for dismantling warning signals at railroad crossings.

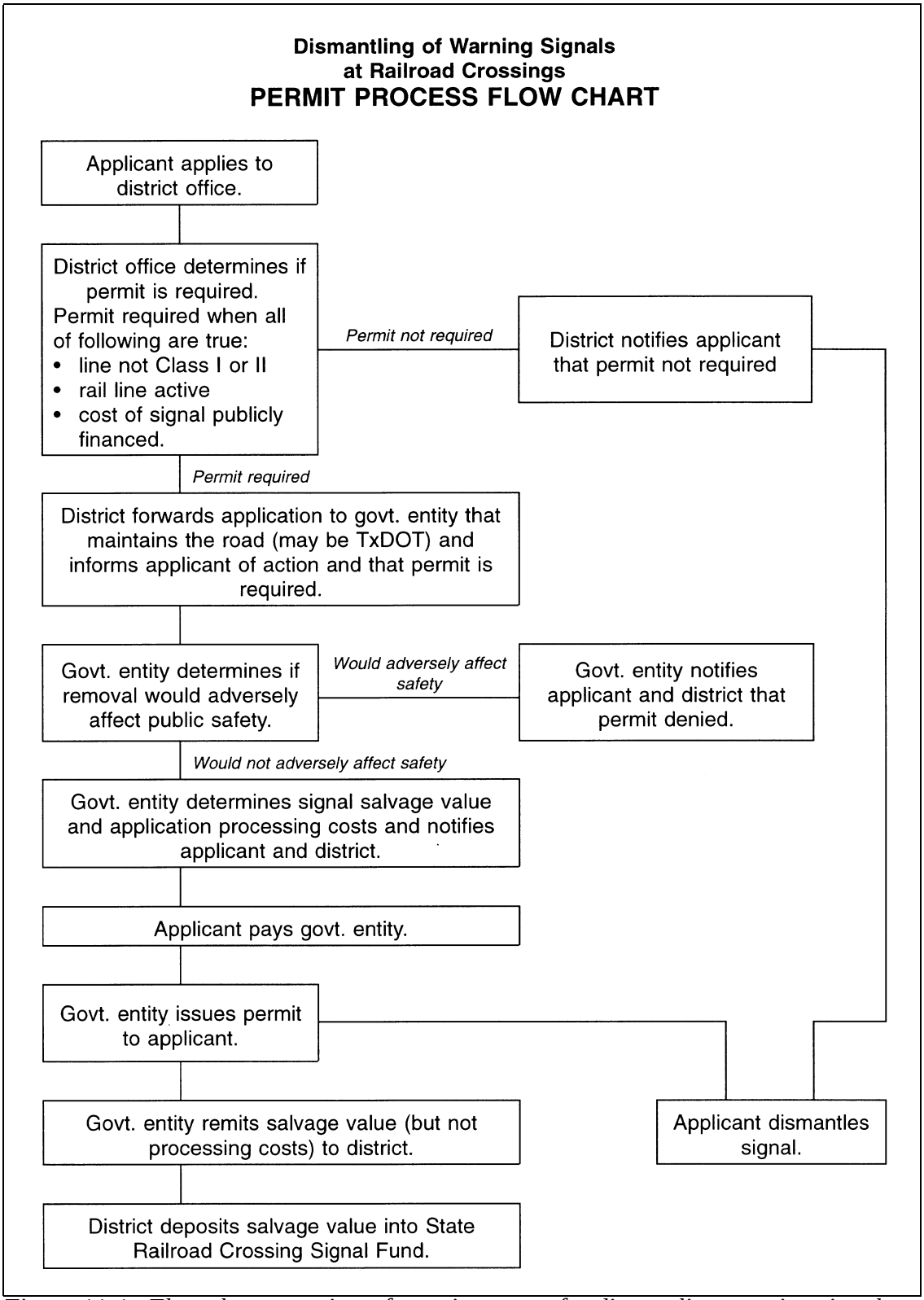


Figure 11-1. Flow chart overview of permit process for dismantling warning signals at railroad crossings. (To access the MS Word version of this figure from on line, click this file name: TFEG11-1.)

Appendix A
Forms

Introduction

This appendix lists the forms described in this volume. In the hard copy print version of this volume, this appendix contains samples of each form. These samples may be photocopied as necessary. Copies may also be obtained from the Traffic Operations Division (TRF).

MS Word versions of some of the forms are accessible through hypertext links in the on-line version of this volume, as indicated in the following list.

List of Forms

Appendix A of the hard copy print version of this volume contains the following forms in the following order:

TxDOT Forms Pertaining to Railroad Operations

TxDOT Form Number/Name		Hypertext Link (on line only)	# of Pgs.	Described in Chap.
1876	Railroad Grade Crossing Replanking Project Submission Form*	TFE-1876	2	4
1891	Detailed Estimate for Railroad Solicitation of Bids*	TFE-1891	1	4
	Preemption Worksheet (Guide for Determining Time Requirements for Traffic Signal Preemption at Highway-Rail Grade Crossings)		1	7
1930	Permit Application for Dismantling of Railroad Crossing Warning Signal Device*	TFE-1930	1	11
* Indicates that an MS Word version is available through the on-line version of this manual.				

Union Pacific Forms

Form Number/Form Name		# of Pgs.	Described in Chap.
PLX.APP	Application (used as a cover for all of the following forms)	2	–
DR-0404-F	Application for Underground Wireline Crossing — 600 Volts or Less	1	7 & 10
DR-0404-G	Application for Underground Wireline Crossing — Over 600 Volts	1	7 & 10
DR-0404-B	Application for Encased Non-flammable Pipeline Crossing	1	9
DR-0404-D	Application for Overhead Wireline Crossing — 600 Volts or Less	1	10
DR-0404-H	Application for Overhead Wireline Crossing — Over 600 Volts	1	10

Texas Department of Transportation

TECHNICAL PROVISIONS

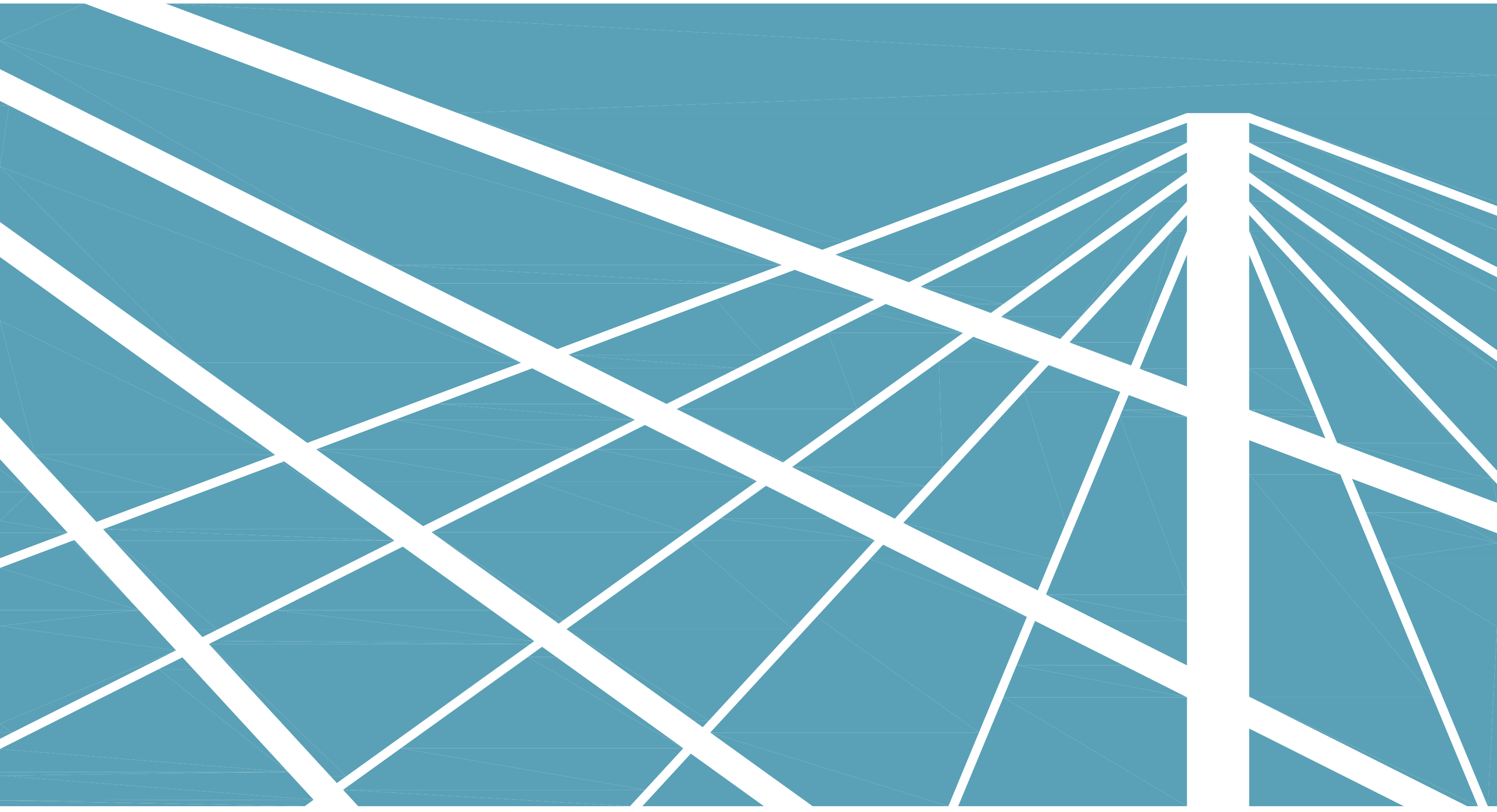
FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 15-1
AESTHETIC GUIDELINES

US 181 Harbor Bridge Project



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Project Overview

The US 181 Harbor Bridge Project includes the design, construction and maintenance of the US 181 Harbor Bridge, and portions of US 181, I 37 and SH 286 in Corpus Christi, Texas. The Project limits extend both north and south along US 181 and SH 286 and east and west along I 37 and includes: US 181 to Beach Avenue on the north; Crosstown Expressway to Morgan Avenue on the south; I 37 to Up River Road on the west; and I 37 to Carancahua Street on the east.

Third party relationships to note are the Port of Corpus Christi Authority (PCCA), the Union Pacific Railroad (UPRR), the United States Coast Guard (USCG), the Federal Aviation Administration (FAA), and the US Army Corps of Engineers (USACE).

This document delineates the treatment criteria that serve as the preliminary aesthetic design of the corridor. It establishes the standards necessary to produce the intended form, function and appearance of each bridge and highway feature and component. This document is not intended to define the design of the project, but rather serve as a set of parameters that will be incorporated into final engineering design. Certain elements may be subject to Design Exception requests, but only by approval from TxDOT. All aesthetic and landscape design shall be in conformance with the pertinent sections of the Project's Techical Provisions (TP). Where conflicts exist between this document and the TP, the TP shall govern.

The Project shall incorporate aesthetics that reflect of the Corpus Christi community and local heritage. The US 181 Harbor Bridge will become a treasured landmark and serve as a jewel of the community. The character of the Project will be unique and have an elegant and sleek appearance.

The architectural and landscape aesthetic guidelines found in this document are based upon community stakeholders' input and visual preferences. In summary, the Project shall receive one, continuous aesthetic theme to be reflected in the corridor. The theme should summon the sense of community of Corpus Christi and complement the historic, industrial and unique areas in the corridor such as North Beach, downtown, the marine port, and the ocean's significance to Corpus Christi.

Examples of such significant components could include ocean waves, ecology of the sea or wetlands, nautical history of the region, industry (shipping/ fishing), and recreation and tourism as they relate to the Gulf of Mexico. Graphic examples of the theme seen throughout this document are guidance for the Developer's Final Design. The Developer's team is expected to create its own thematic design for the Project.

Corrosive salt air, wind and rain shall be considered when selecting materials and types of aesthetic applications. The Developer shall make efforts to minimize the appearance of these environmental effects on the facility to the extent reasonable and practical.

The Developer shall include roosting bird prevention measures where required per *TP Section 13.2.1.19, Maintenance and Inspection*, however they shall not detract from aesthetic treatments.

Figure i – Project Limits Map

1.0 US 181 Harbor Bridge

1.1 Overview

The US 181 Harbor Bridge design must realize the vision of TxDOT and the local community to create a safe and functional new harbor crossing. This highly visible city landmark is intended to be an elegant, unique, and memorable structure.

Design and construction objectives:

- To combine functional requirements and aesthetic objectives in one structural design.
- To recognize the technical aspects of the structure as design features.
- To provide a design for concrete components that allows consistent, smooth surface finish concrete form-work. Textured form-work shall be of consistent high quality. The pattern of form-work will be an important design element.
- To integrate best practices in transportation sustainability by employing a “triple bottom line” (social, environmental, economic) approach to design, as described by the FHWA’s INVEST initiative.

1.2 Tower and Cable Configuration

The towers are a significant visible feature of the bridge, designed for both structural capacity and aesthetic integrity. The Developer shall consider space requirements for the towers’ component parts: stay cable anchorages; diaphragms; and tension ties. Also to be considered are inspection activities; maintenance facilities; lighting for ship channel navigation; aviation and port requirements; and roadway and architectural lighting. The towers shall be a dominant feature of the bridge that define the viewer’s perception of the entire crossing. When illuminated at night, they shall be further enhanced (see subchapter 8.1 Architectural Lighting).

All tower configurations, with the exception of H-shaped towers with a horizontal strut above deck level, are be permitted. An H-shaped tower with a horizontal strut under the deck is permitted. A fan arrangement of cables is required.

1.3 Deck and Superstructure

The deck and superstructure aesthetics shall be governed by constructibility and life-cycle serviceability. Their appearance shall be consistent with the technical and aesthetic aspects of the towers. The deck and superstructure transitions between the approach bridges and the US 181 Harbor Bridge shall be seamless, elegant and well-resolved. The deck layout shall at all times ensure traffic flow while fulfilling safety and maintenance requirements.

Aesthetic treatment on concrete framing Elements is limited to opaque sealer, which shall be applied to the underside of each Element and outer surfaces of fascia members. Steel framing Elements shall receive opaque sealer applications on all exposed surfaces.

Opaque sealer on concrete framing Elements shall meet all criteria in he TxDOT DMS, Section DMS-8110, Coatings for Concrete.

Opaque sealer on steel framing Elements shall meet all criteria in the TxDOT DMS, Section DMS-8100 Structural Steel Paints - Formula and Section DMS-8101 Structural Steel Paints - Performance.

Figure 1.1 – US 181 Harbor Bridge location

1.4 Anchor Piers and Deck Transitions

Anchor piers shall be elegant and sleek and aesthetically consistent with bents of approach bridges.

Aesthetic treatment on anchor piers is limited to opaque sealer, which shall be applied to the all exposed faces. Opaque sealer shall meet all criteria in TxDOT DMS, Section DMS-8110, Coatings for Concrete.

1.5 Mid-Span Belvedere

A cantilevered belvedere shall be provided at mid-span of the Harbor Bridge over the Corpus Christi Ship Channel, gulf side. It shall serve as a scenic overlook for pedestrians and bicycle riders on the shared use path. The belvedere shape and layout shall be designed to provide safe and easy access for path users.

A pedestrian fence shall run continuously from the shared use path and along the outer edge of the belvedere. Refer to Chapter 6.0, Pedestrian Fencing.

1.6 Concrete Traffic Barrier

TxDOT Concrete Traffic Barrier (CTB) railing type T80HT shall be used for the US 181 Harbor Bridge per *TP Section 15.3.6, Traffic Railings*. This railing will allow motorist views off the bridge. Maintaining visibility from the bridge to the vistas below is a high priority. See *Figure 1.2* for required aesthetic surface treatments. Paint on concrete shall meet all criteria in the *TxDOT Departmental Material Specifications (DMS),* Section DMS-8110, Coatings for Concrete. No physical modifications to rail components that change their structural integrity or tested abilities are permitted. Life-cycle maintenance and cleaning shall be a primary factor when selecting aesthetic applications to the T80HT rail surface.

1.7 Utility and Maintenance Structures

Utility components shall be designed and located to have minimal adverse visual impacts on major bridge components. Consolidate minor components and integrate them into the overall architectural composition.

All utilities that are exposed on the bridge structure shall be painted to match the structure.

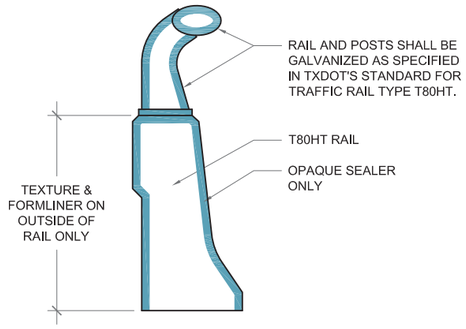


Figure 1.2 – Required aesthetic surface treatments on T80HT rails

2.1 Overview

The transition from the US 181 Harbor Bridge to the approach bridges shall be seamless. Aesthetic treatments and forms of the bridge elements discussed in the subsequent chapters shall not differ between the bridge segments, unless otherwise noted. The location of approach bridges in the Project corridor are illustrated in Figure 2.1.

The Developer shall minimize the number of approach bridge bents to the extent reasonable and practical. The intent of fewer bents is to prevent the appearance of a “forest of columns” as observed from below the bridges.

TxDOT will initiate public involvement activities to help define the uses and aesthetics beneath the Approach Bridge where the right-of-way intersects the Northside Neighborhood. The general location of the neighborhood/Approach Bridge intersection is illustrated in *Figure 2.1*. The Developer shall coordinate with TxDOT to ensure that development in this area is consistent with the outcome of the public involvement activities. Refer to *TP Section 3.2.5, Customer Groups*.

Figure 2.1 – Approach bridge limits

2.1 Overview (continued)

The transition from the approach bridges to the remainder of the corridor facilities shall be seamless. Aesthetic treatments and architectural forms and shapes of the facility elements shall not differ between the approach bridges and corridor facilities. The location of corridor connections in the Project corridor are illustrated in *Figure 2.2*.

At corridor termini, the aesthetics shall blend into the existing roadway facilities. Methods of blending aesthetics include the continuation of aesthetic treatments on CTB rails beyond the project limits. A logical stopping point would be where a CTB terminates at a ramp, ends at a bridge rail, or the rail transitions to a metal beam guard fence. This approach shall be developed in concept and presented to TxDOT for approval prior to the formal Design Submittal.

Figure 2.2 – Corridor connections limits

This section applies to the approach bridges and corridor.

3.1 Rail

The applied aesthetics of the rails at the approach bridges shall be the same or complementary to that of the US 181 Harbor Bridge rail. Required aesthetic surface treatments are illustrated in *Figure 3.1*.

CTB rail types used in the remainder of the corridor shall be per *TP Section 13.2.1.12*. Applied aesthetics shall be complementary to that of the US 181 Harbor Bridge and approach bridge rails. Required aesthetic surface treatments are illustrated in *Figure 3.2.*

Opaque sealer on concrete shall meet all criteria in the *TxDOT DMS,* Section DMS-8110, Coatings for Concrete. No physical modifications to rail components that diminish their structural integrity or crash tested

3.2 Beams and Girders

Aesthetic treatment on concrete beams and girders is limited to opaque sealer, which shall be applied to the underside of each beam and outer surfaces of the outside beams as illustrated in *Figure 3.3*. Steel girders shall receive opaque sealer applications on all surfaces as illustrated in *Figure 3.4*.

Opaque sealer on concrete beams shall meet all criteria in the *TxDOT DMS,* Section DMS-8110, Coatings for Concrete.

Opaque sealer on steel girders shall be compatible with metallizing or galvanizing as outlined per *TP Section 13.3.8*.

Texture applications or other aesthetics modifications shall not diminish the structural integrity of beam.

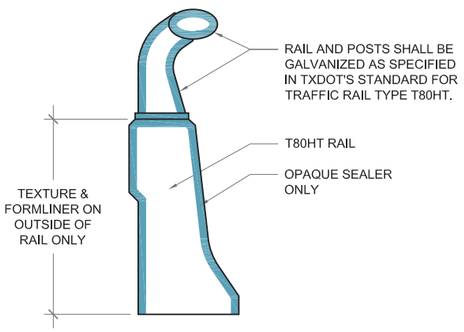


Figure 3.1 – Required aesthetic surface treatments on T80HT rails

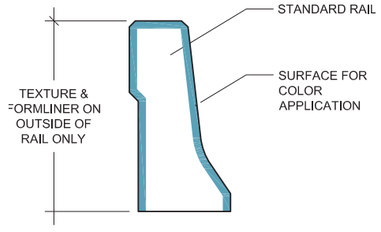


Figure 3.2 – Required aesthetic surface treatments on rails

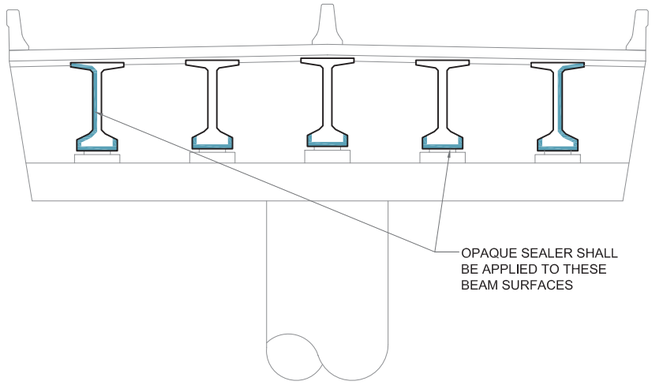


Figure 3.3 – Required surfaces for aesthetic treatment on concrete beams

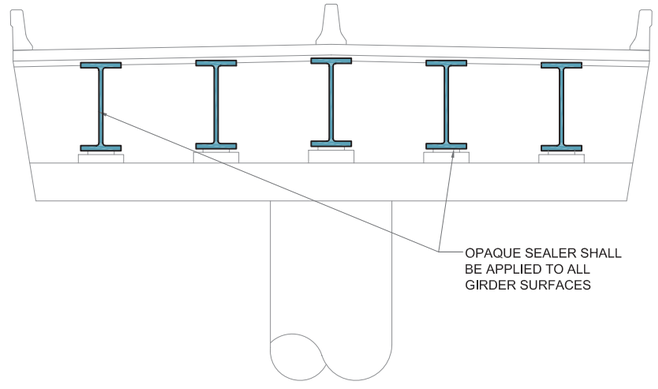


Figure 3.4 – Required surfaces for aesthetic treatment on steel girders

4.0 Bents

This section applies to the approach bridges and corridor.

4.1 Bents

Bent aesthetics shall complement and support the Project's aesthetic theme. The scale and level of detail of applied aesthetics shall be appropriate for the structure's size and location as well as for an observer traveling at the designated speed limit and/or stopped at a traffic signal.

Surfaces that shall receive aesthetic treatment are, but are not limited to, those illustrated in *Figure 4.2*. An opaque sealer shall be applied to all exposed surfaces. Additionally, texture and/or mounted or cast-in-place forms are allowed.

Opaque sealer on concrete shall meet all criteria in the *TxDOT DMS,* Section DMS-8110, Coatings for Concrete.

Single column bents may show a clear distinction in width between a bent cap and the column, or they can be constructed as a unit that transitions in width (flared column). Bents shall be proportioned so that horizontal lines of the superstructure are not interrupted. Bent columns shall not be too slender nor caps too tall so as they convey a feeling of instability.

The column shape shall be rectangular or square. Circular columns are prohibited per the *TP Section 15.3.2, Bridges*. Chamfered and rounded corners are allowable. Rounded corners shall not exceed 1/4 the length of each face; see *Figure 4.1.*

Tapered columns or those with wider bases are allowable. If tapered columns are designed, the base of the column shall not exceed 150% of the width at the top. If columns with a wider base are designed, the wider base shall not offset from the main column width by more than 150% of the column's width, and the height shall not exceed one-third of the height of the shortest column in a bridge span.

Although a variety of shapes and sizes are permissible, the Developer should use restraint when combining/selecting aesthetic preferences. Too much ornamentation or variety is not in keeping with the sleek, elegant vision for the bridge.

Aesthetic applications shall not diminish the structural integrity of the bent.

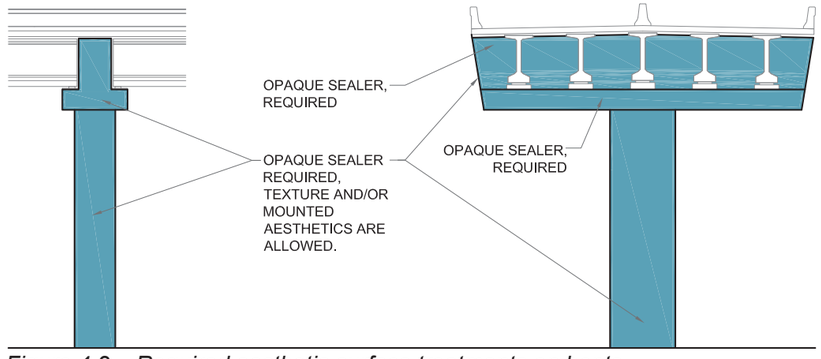


Figure 4.2 – Required aesthetic surface treatments on bents

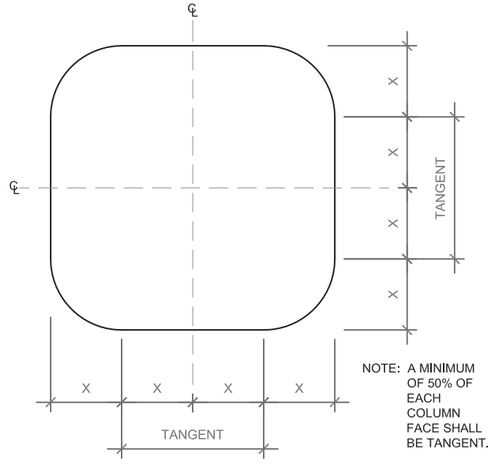


Figure 4.1 – Limits of rounded corners on square columns.

5.1 Retaining Walls

Aesthetic applications on retaining walls shall rely on opaque sealers, form liners and/or applied textures. Retaining walls shall meet all criteria of Item 423 of *Attachment 13-1, Structure Provisions*. Opaque sealer on concrete shall meet all criteria in the *TxDOT DMS*, Section DMS-8110, Coatings for Concrete.

Applied aesthetics not permitted:

- Retaining wall texture type “fractured fin”; refer to *Figure 5.1* for an example.
- Painted murals, large and small

Continuously running horizontal lines, texture, pattern or design alignment are not permitted. Any settling and resulting rotation over time will be more noticeable in a highly linear application. Offsetting and breaking up horizontal lines will draw the eye away from any shifting of retaining wall panels that occurs.

The retaining wall aesthetics shall be developed in a way that supports and complements the Project’s aesthetic theme. This is also defined in *TP Section 15.3.4, Retaining Walls*.

Aesthetics on walls will be seen from a variety of vehicular speeds, elevations and directions. The aesthetics shall employ scale, level of detail, depth of reveal/relief and color to befit those conditions in which the motorist/pedestrian/bicyclist will be viewing them.

Retaining walls shall carry the higher-detailed aesthetic application within the bottom 10 feet of the wall (measured from finished grade). See *Figure 5.2* for the envelope of higher detail and *Figure 5.3* for an applied design example. Surface area outside of the envelope shall have a simpler, repetitive aesthetic application as illustrated in *Figure 5.4*.

Figure 5.1 – Fractured fin texture on retaining walls shall not be accepted

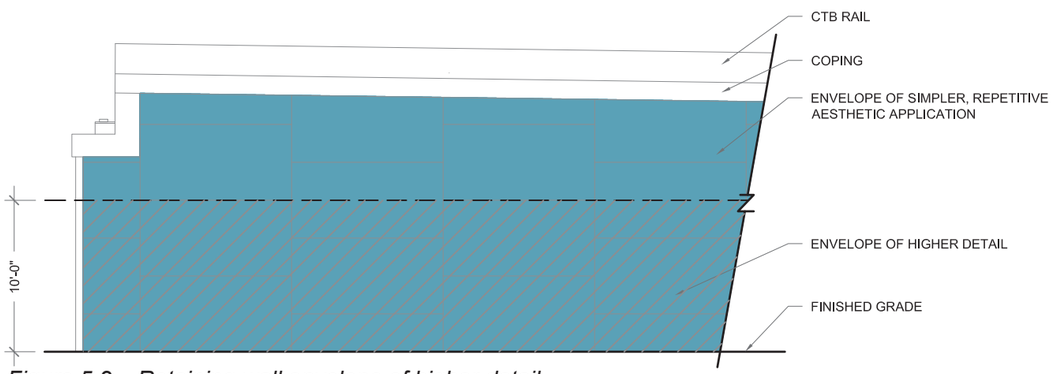


Figure 5.2 – Retaining wall envelope of higher detail

The Developer shall identify and account for the sloping conditions of the superstructure and finished grade as it relates to the layout of the applied aesthetic and the envelope of higher detail.

TxDOT reserves the right to require wall construction where existing land features shall be preserved.

For additional texture samples, refer to Chapter 11.0, Finish Schedule.

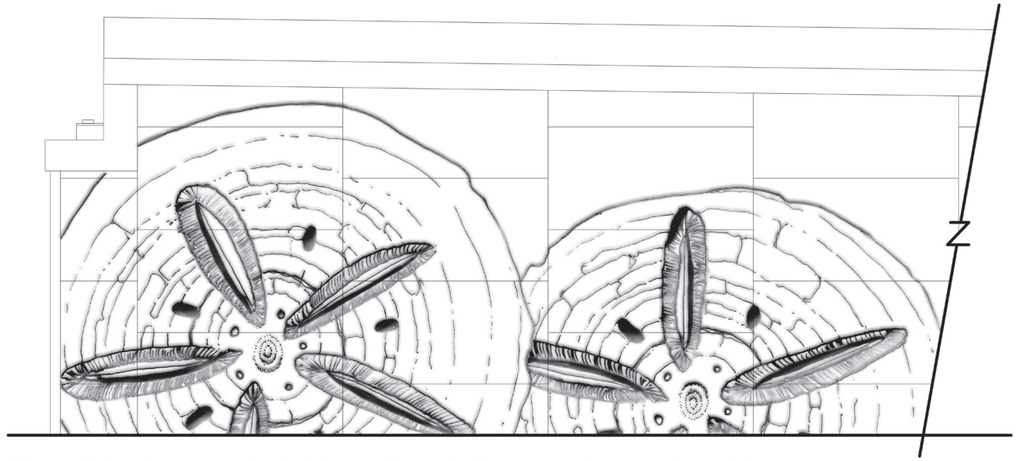


Figure 5.3 – Conceptual retaining wall aesthetics - sample accent graphic

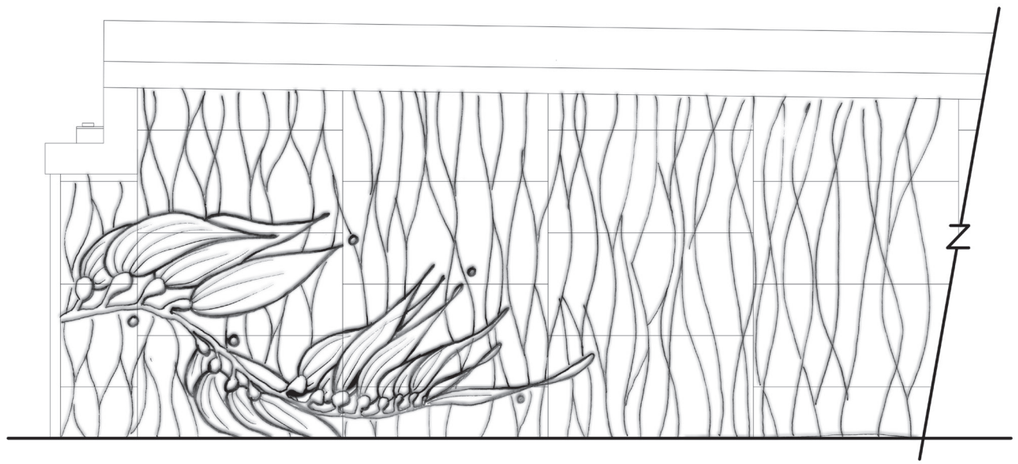


Figure 5.4 – Conceptual retaining wall aesthetics - sample accent graphic with texture background

5.2 Abutments

All proposed abutment walls shall be consistent with or complement the aesthetics of the adjacent retaining walls.

Figure 5.5 demonstrates two abutment walls and the components to which these guidelines apply. Where a vertical endwall is used, the wall shall carry the higher-detailed, dominating aesthetic application within the bottom 10 feet of the wall (measured from finished grade). Surface area outside of the envelope shall exhibit a simpler aesthetic pattern. Acceptable and unacceptable applied aesthetics are the same as those listed in subchapter 5.1, Retaining Walls.

Abutments shall satisfy the requirements of Item 420 in *Attachment 13-1, Structure Provisions*.

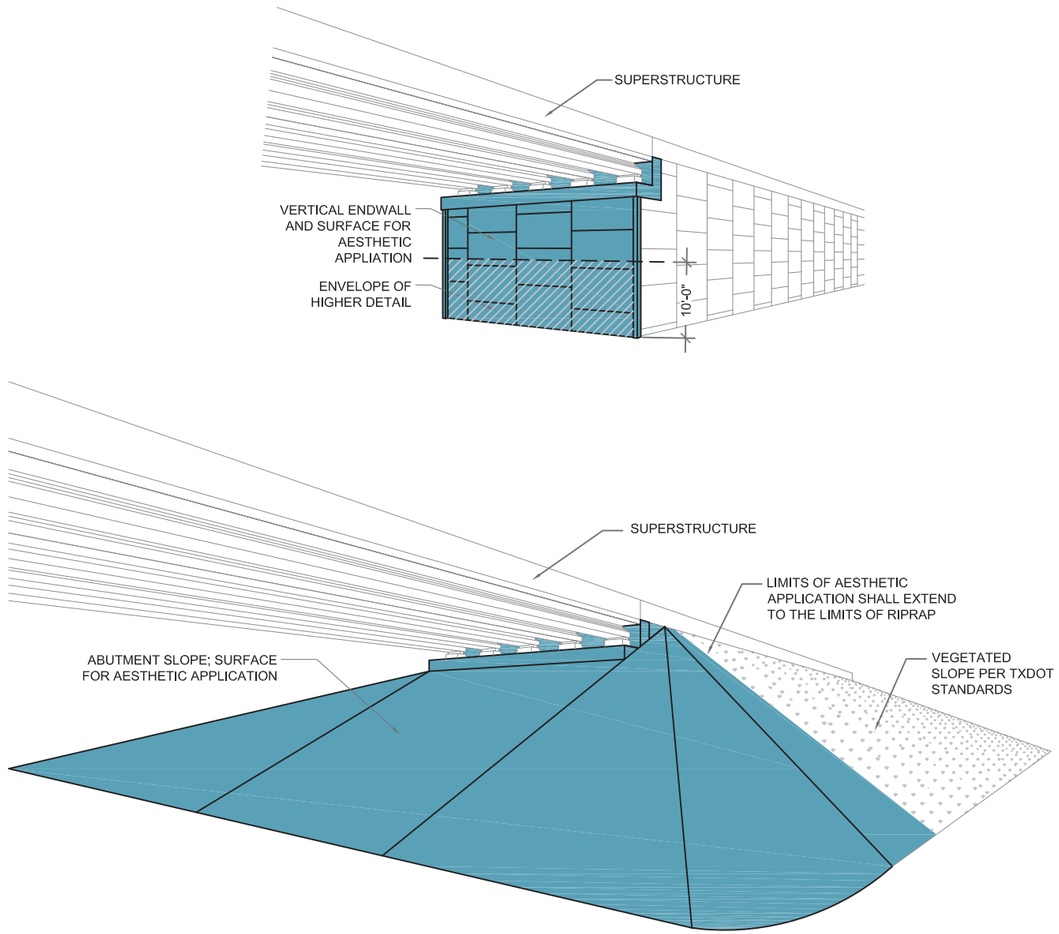


Figure 5.5 – Abutment wall and slope treatment areas

5.3 Riprap

Riprap shall meet all criteria in *TP Section 15.3.14*. Enhanced riprap shall incorporate the Project's aesthetic theme only at highly visible areas, including US 181/SH 286 and I 37 interchange, North Port Avenue, Brownfield Boulevard, Leopard Street, Broadway Street, Broadway Boulevard, and Burleson Street. This treatment includes areas between roadway and structures with a distance or width greater than ten feet or where ramps transition between mainlanes and frontage roads at widths greater than ten feet.

Ease of maintenance shall be the Developer's priority when selecting aesthetically enhanced non-grass riprap materials. Riprap shall, at minimum, meet all criteria in Item 432 of *Attachment 13-1, Structure Provisions*, however use of loose aggregate and pavers is not permitted. Enhanced aesthetics include but are not limited to:

- Colored - integral color, stained or acid-etched (all surfaces shall be non-slip in pavement applications)
- Exposed aggregate - seeded, colored, or hand-cast
- Other textural finishes - stamped, scored, salt, tined/grooved, stippled, stenciled, sponged, grouted cast-in-place forms or form liners

Non-enhanced, non-grass riprap includes concrete with a broom (coarse to fine), smooth troweled, or floated finish.

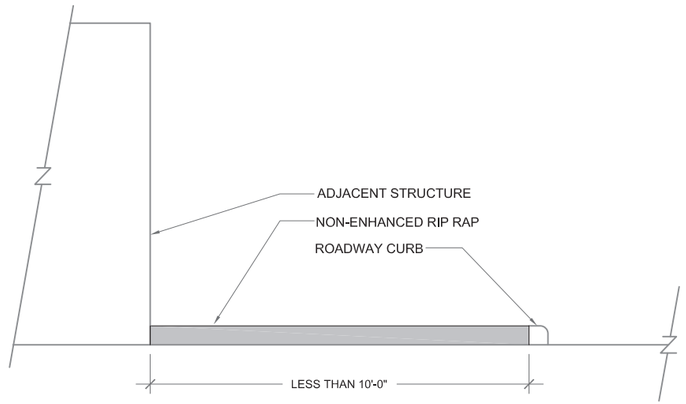


Figure 5.6 – Example delineating where enhanced riprap is not required

Figure 5.7 – Example delineating where enhanced riprap is not required

Instances where riprap doesn't require enhanced aesthetic application include:

- Areas between roadway and structures with a distance or width of less than ten feet, as illustrated in *Figure 5.6*
- Where ramps transition between mainlanes and frontage road (freeway gores) at widths of less than ten feet, as shown in *Figure 5.7*
- Areas between or adjacent to guard fence posts, sign posts, bent columns, retaining walls, paved ditches, flumes, and ditch inlets

6.0 Pedestrian Fencing

6.1 Overview

Pedestrian fence on the Project shall, meet all requirements found in *TP Sections 15.3.11, Fencing; 15.3.12 Color and Surface Palette; 13.2.1 Bridge; TxDOT DMS,* Section DMS-8100 Structural Steel Paints - Formula and Section DMS-8101 Structural Steel Paints - Performance.

6.2 Pedestrian Fencing at the Harbor Bridge and Approach Bridges

Fence design shall be developed in relation to other US 181 Harbor Bridge components and reflect the technical and aesthetic elegance of the towers, cables, and superstructure. Fence panels shall have an open design so as to minimally obstruct views. Height of pedestrian fencing shall be 54 inches; refer to *Figure 6.1*.

The pedestrian fencing on the US 181 Harbor Bridge shall have an arched top and meet the minimum height requirements in accordance with the *Joint BNSF/UPRR Guidelines for Railroad Grade Crossing Separations Projects*, or its most current edition, and be designed to meet shared use path clearances in accordance with AASHTO in the publication *Guide for the Development of Bicycle Facilities, 2012v*, or its most current edition; refer to *Figure 6.2.* The Developer shall consult the UPRR and PCCA regarding locations, if any, that require the protective containment cage per the *TxDOT Bridge Railing Manual*, Section 2, Bridge Railing for Pedestrians. Additionally, any protection structures over railroads shall follow AREMA standards. Refer to *Figure 6.3* for railroad crossing locations.

Fence fabric shall be installed on pedestrian fencing. Fence fabric shall be made of welded wire mesh or metal pickets. Maximum opening of mesh shall be 2 inches. Metal pickets shall be spaced at 4 inches on center, or that a 4 inch orb may not pass between pickets. Fence fabric shall not be climbable. Horizontal members shall be, at minimum, 45 inches apart. Material alternatives include painted and/or treated corrosion-resistant metal fabric.

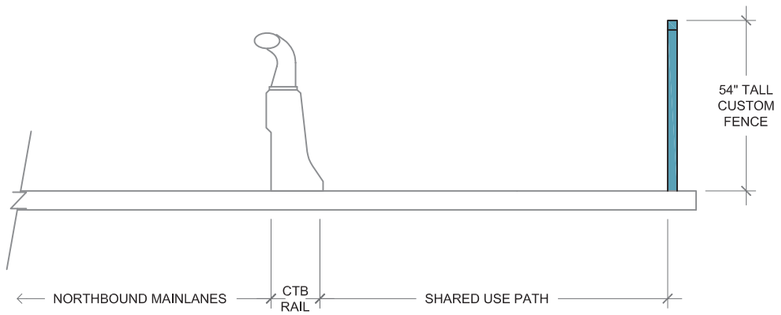


Figure 6.1 – 54" pedestrian fence

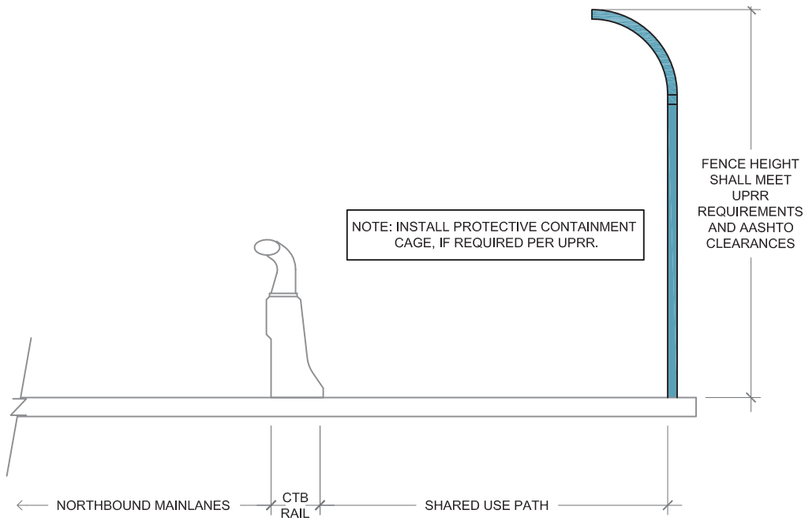


Figure 6.2 – US 181 Harbor Bridge pedestrian fence

Opaque sealer on metal components shall meet all criteria in the *TxDOT DMS*, Section DMS-8100 Structural Steel Paints - Formula and Section DMS-8101 Structural Steel Paints - Performance.

Figure 6.3 – Railroad and port crossing locations

6.3 Pedestrian Fencing in the Corridor

Heights, picket spacing and materials of the pedestrian fencing shall meet all TxDOT standards.

6.4 Staples Bridge Pedestrian Crossing

The pedestrian bridge at North Alameda Street shall be demolished, however, the overhead steel structure shall be removed, transferred and re-installed or rebuilt. The pedestrian crossing shall be rerouted on the new North Staples Street bridge. The travel path currently meets shared use path design requirements. The Developer shall ensure that the design's shared use path clearances are maintained and that the design remains in accordance with AASHTO in the publication *Guide for the Development of Bicycle Facilities, 2012v*, or its most current edition.

The steel structure, including light fixutres, on the pedestrian bridge shall be installed on the new North Staples Street bridge. The Developer shall determine if the steel structure on the pedestrian bridge will be salvaged and reinstalled, or reconstructed. See *Figure 6.5* for the existing structure on N. Alameda Street. See *Figure 6.6* for the installation of the structure on the new N. Staples Street bridge.

Figure 6.4 – Examples of acceptable fence fabric

The Developer shall develop the details for installing the steel structure on the new bridge, complete with light fixtures, traffic barrier rails and pedestrian fence in accordance with TxDOT standards. Construction documents for the original steel structure are available.

The Developer shall plan, design for and install the steel structure and electrical components in a manner identical to the original structure. Re-use of existing materials in originally specified condition or restored to original condition is encouraged. All new introduced components and/or components replacing failed/ unusable original pieces shall be galvanized to match the galvanization of the re-used structure. Visible patches or corrosion on metal will not be accepted. New electrical conduit and wiring shall be used where signs of degredation and failure of existing are aparent. The Developer shall replace any elements of the structure which are damaged during salvage and reinstall operations. If the quality of salvage and reinstall does not meet TxDOT approval, it will be subject to reconstruction.

Figure 6.5 – Existing North Alameda Street bridge with steel pedestrian arch.

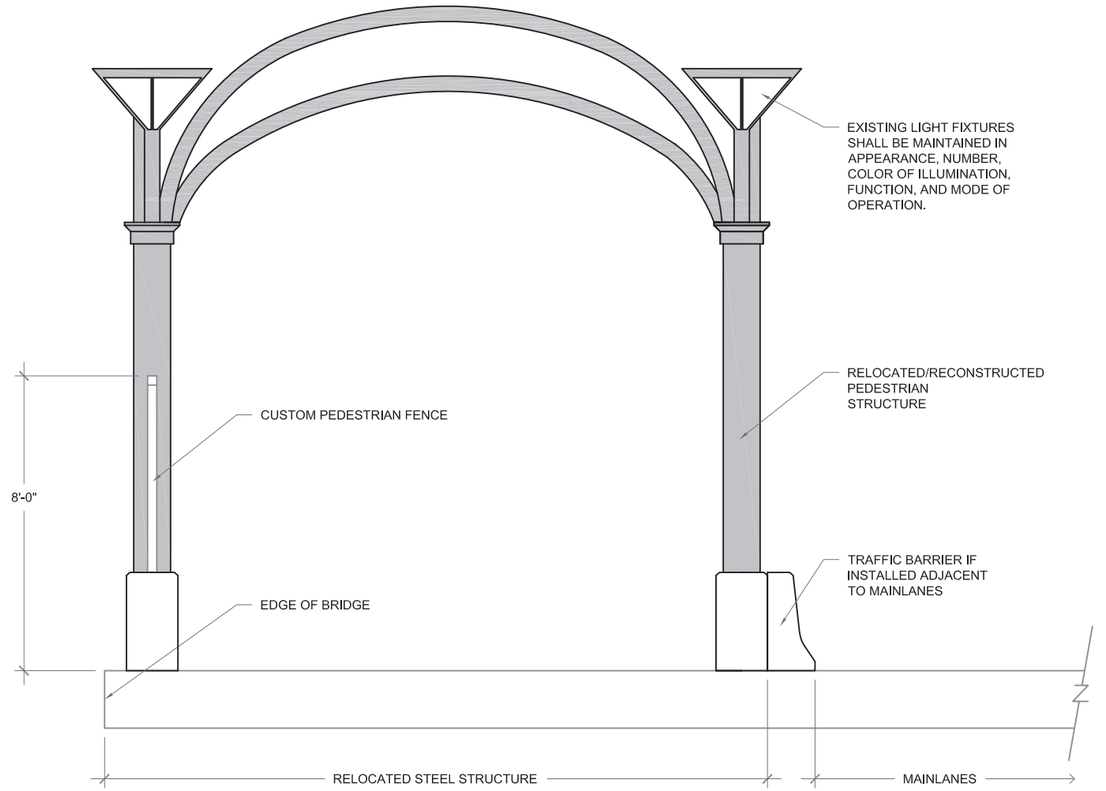


Figure 6.6 – North Staples Street bridge pedestrian crossing with steel pedestrian arch

7.1 Overhead Roadway Signage

Sign columns shall incorporate the Project's aesthetic theme. An open, vertical truss structure, as shown in *Figure 7.1*, is not permitted. Horizontal trusses are permitted. Refer to *Figure 7.2* for an example of acceptable roadway signage.

The color, geometry, texture and scale of the concrete columns shall complement the Project's aesthetic theme and be consistent throughout the Project limits. Acceptable aesthetic treatments include opaque sealer, texture, and/or mounted or cast-in-place forms. Opaque sealer on concrete shall meet all criteria in the *TxDOT DMS, Section DMS-8110, Coatings for Concrete*.

Sign structures used shall meet all *Texas Manual of Uniform Traffic Control and Devices (TMUTCD) for Streets and Highways* and *TP Section 13.1, Structures General Requirements* guidelines.

7.2 Shared Use Path Signage

Shared use path signage size, height, and text shall conform to the most current version of the *TMUTCD*.

Content for the informational/wayfinding signage at shared use path termini shall be submitted to and approved by TxDOT. (Refer to subchapter 9.3 Shared Use Path).

Shared use path signage shall not be placed adjacent to the mainlanes or adjacent roadway and shall not interfere with roadway users' navigation.

It is acceptable to paint poles and mounting pieces of signage in a fashion that is in keeping with the Project aesthetic and per *TP Section 16*. The Developer shall consider the relationship between signage and the two heights of fencing located on the shared use path (refer to subsection 6.2, Pedestrian Fencing).

Figure 7.1 – Overhead roadway signage, visibility of open vertical trusses shall not be accepted

Figure 7.2 – Example of concrete sign columns supporting horizontal trusses

8.0 Lighting

8.1 Architectural Lighting

Architectural lighting shall only be developed and installed on the US 181 Harbor Bridge. Architectural lighting and roadway lighting shall complement each other in order to provide visual and functional efficiency. Maintaining the safety of vehicular and shared use path users shall be the priority of the Developer. Undesirable glare and distractions from the roadway are not permitted. Lighting shall not hinder the visibility of vehicles, pedestrians, bicyclists, nor ship and aviation navigation.

The US 181 Harbor Bridge will be a highly visible structure, especially when viewed from Whataburger Field, US 181 and the beaches of Corpus Christi. The Existing Harbor Bridge has a programmable, architectural lighting system capable of multi-color display; refer to *Figure 8.1*. The US 181 Harbor Bridge shall have an architectural lighting system that meets or exceeds the appearance and performance of the existing bridge's system. Architectural lighting design shall:

- Emphasize the bridge's structural design
- Minimize adverse visual impact - light equipment shall explicitly complement the surrounding architecture
- Light surfaces evenly; avoid hotspots/dark spots
- Select fixtures based on efficient power consumption
- Protect fixtures from vandalism if attached in a location accessible to the public
- Prioritize ease of maintenance shall be of high priority and reviewed by TxDOT
- Arrange fixtures in a manner that does not create glare or distraction to motorists, marine vessels, aviation, pedestrians or bicyclists
- Select fixtures that perform well given the high vibration environment of bridges and harsh characteristics of the coastal environment
- Employ robust and durable mounting armatures
- Propose/supply controller(s) based on architectural lighting objectives

All light fixtures shall be LED RGB. Architectural lighting methods shall include, but are not limited to:

- Up-lighting and down-lighting of the bridge towers
- Up-light washing of cables
- Washing of superstructure fascia

The proposed architectural lighting design shall be coordinated, reviewed and approved by the PCCA, USCG and FAA prior to final review and approval by TxDOT.

8.2 Roadway Lighting

Roadway light fixtures shall be upgraded from the TxDOT standard cobra heads and shall only appear on the US 181 Harbor Bridge. Fixtures shall utilize LED technology. The light pole, arm, metal fixture housing and mounting components shall be painted and/or treated with corrosion-resistant materials.

Figure 8.1 – Existing Harbor Bridge multi-color display

Proposed roadway lighting shall be reviewed and approved by TxDOT. Roadway lighting on the US 181 Harbor Bridge shall be coordinated, reviewed and approved by the PCCA, FAA, and the USCG prior to TxDOT final review and approval. Roadway lighting proposed on the approach bridges shall be coordinated, reviewed and approved by PCCA prior to TxDOT reviews.

Lighting shall, at minimum, meet all criteria in *TP Section 16.3.9, Lighting*.

8.2.1 US 181 Harbor Bridge

Architectural roadway poles and luminaires shall be vandal-resistant. The style of fixtures and poles shall be elegant and coordinate with the theme and appearance of the US 181 Harbor Bridge.

8.2.2 Approach Bridges and Corridor

Roadway poles and luminaires shall be vandal-resistant. Luminaires shall be LED fixtures. Where bridge structures intersect bicycle and pedestrian paths, under-bridge lighting is of the utmost importance for safety. Lighting provided under the bridge structures shall meet all safety regulations, and luminaires shall be LED fixtures.

Prior to selecting under approach bridge lighting, the Developer shall ensure aesthetic and photometric compatibility with Northside Neighborhood park improvements.

8.3 Shared Use Path Lighting

Shared use path light fixtures shall be vandal-resistant. The scale shall be appropriate for pedestrians and bicyclists. The appearance of the selected fixture shall be complement the corridor aesthetic. Shared use path lighting shall conform to the current AASHTO's Guide for the Development of Bicycle Facilities.

Where the proposed shared use path lighting falls within the limits of the US 181 Harbor Bridge, the design shall be reviewed and approved by the PCCA, USCG, and FAA prior to TxDOT final review and approval.

Refer to subsection 6.4 Staples Pedestrian Crossing for lighting on the relocated steel structure.

9.1 Noise Walls

Noise walls shall be designed by the Developer and shall complement the Project's aesthetic theme.

The applied aesthetics of the noise walls within the Project shall complement the aesthetic theme of the corridor.

Noise walls shall not be located on any bridge structures. Noise wall locations will be determined in accordance with NEPA. The Developer, in cooperation with TxDOT, shall engage affected property owners as they vote whether they would like a wall to be built. Walls will be built based on majority rule in each identified location. Refer to *TP Section 3.2.5, Customer Groups*.

Riprap shall be installed under noise wall panels at a width of two inches wider than the columns.

Where noise walls and buildings within the public right-of-way are less than 10 feet apart, the Developer shall place concrete riprap (four inch depth) between the two structures. This treatment shall facilitate access to utilities and greatly reduce maintenance concerns. Noise wall design shall consider accommodations for removable panels where conditions may not allow enough clearance for equipment access between the walls, utilities and other site structures. Any removable panels shall appear identical to permanent panels.

The noise wall design shall address sloping grades.

The distance between the bottom of the wall panels and the finished grade shall be two inches. A variance between zero to four inches is permissible if the average clearance within any single panel is two inches.

If the wall needs to step in height, it shall step in constant intervals of four, eight or 12 inches until a level section of at least three panels is incorporated. For example, if wall panels are 30 feet on center in length and the grade change is two feet over 120 feet, the walls shall incrementally step eight inches. The top edge of the subsequent three or more panels shall be at the same height before the next slope change is addressed in constant intervals.

If a dip in the ground plane occurs, an additional panel shall be added to the bottom of the wall, regardless of the wall height determined by the noise analysis at that location.

9.2 Paving

Paving within the facility for pedestrian use shall be low maintenance and non-skid. Paving enhancements are required. Acceptable paving enhancements include:

- Colored — integral color, stained or acid-etched (all surfaces shall be non-slip in pavement applications)
- Exposed aggregate — seeded, colored, or hand-cast
- Other textural finishes — stamped, scored, broom (coarse to fine), salt, troweled smooth, floated, tined/grooved, stippled, stenciled, or sponged

Use of topical paint/stain on paving is not permitted. Unit pavers are not permitted.

All pedestrian facilities in the Project shall adhere to the American with Disabilities Act (ADA) of 1990 requirements.

9.3 Shared Use Path

The shared use path facilities (its paving materials/ methods, layout and clearances) shall be designed in accordance with AASHTO in the publication *Guide for the Development of Bicycle Facilities, 2012v*, or its most current edition.

Pavement striping, signage, and signals shall be developed in accordance with the most current Texas version of the *TMUTCD*.

The shared use path design shall meet all guidelines set forth by the American with Disabilities Act (ADA) of 1990, as enforced in Texas by the Architectural Barriers Section of the Texas Department of Licensing and Regulation. An allowable exception, from *Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG),* is where the shared use path is aligned and adjacent with the main lanes of the corridor.

Shared use path connections to the hike and bike trail will be developed as trailheads. The community hike and bike trails will develop trailheads at connection points to the shared used path. Developer is responsible for providing connectivity where the corridor meets the planned local hike and bike trails, adjacent to the corridor. The connection at the north shall be made within the ROW to the south side of Beach Avenue; refer to *Figure 9.1*. The connection at the south shall be made within the ROW to the north side of Lake Street; refer to *Figure 9.2*.

The method the Developer chooses for the transition from the mainlanes to the hike and bike trails shall ensure that all grades, railing, switchback/turning radii, vertical clearances, safety lighting, and signage are in accordance with the current version of AASHTO's *Guide for the Development of Bicycle Facilities.*

All shared use path bridge structures and their components shall incorporate the Project's aesthetic theme.

Construction activities associated with the shared use path connections shall take place within the US 181 Harbor Bridge Project NEPA footprint.

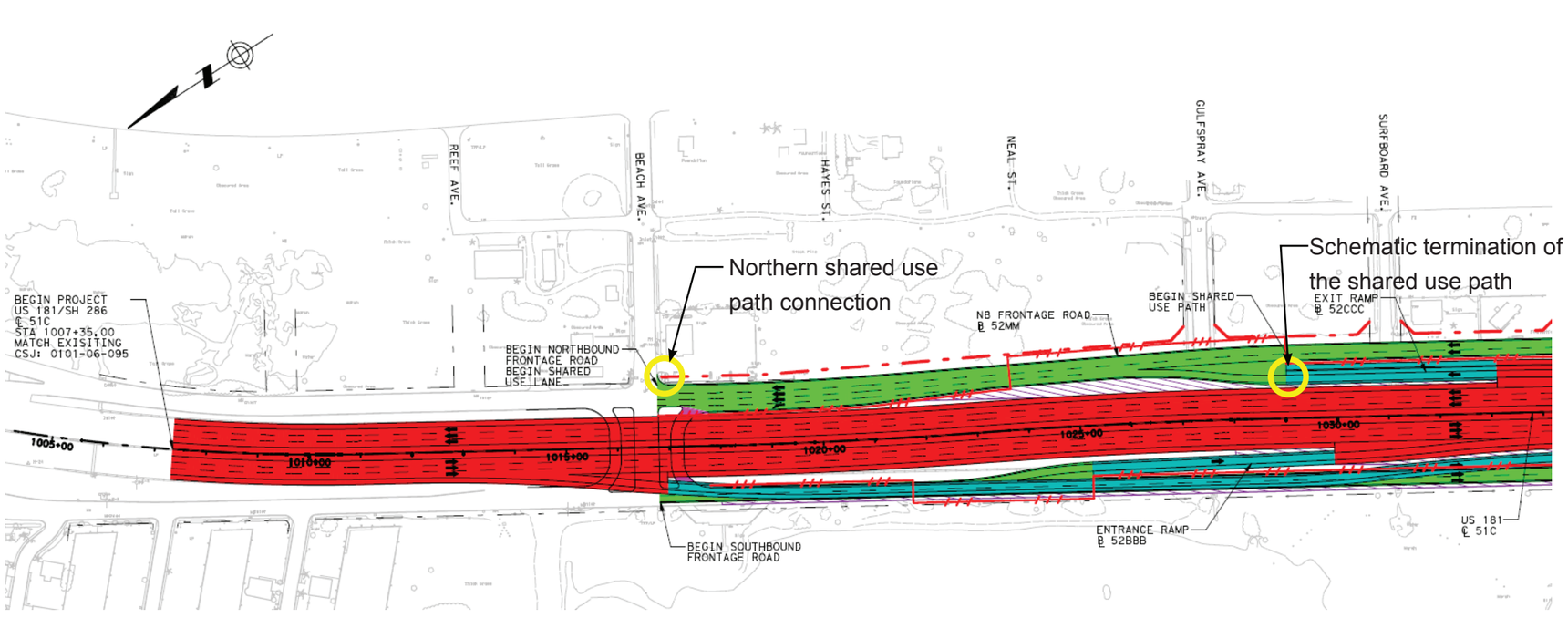


Figure 9.1 – Northern shared use path connection context

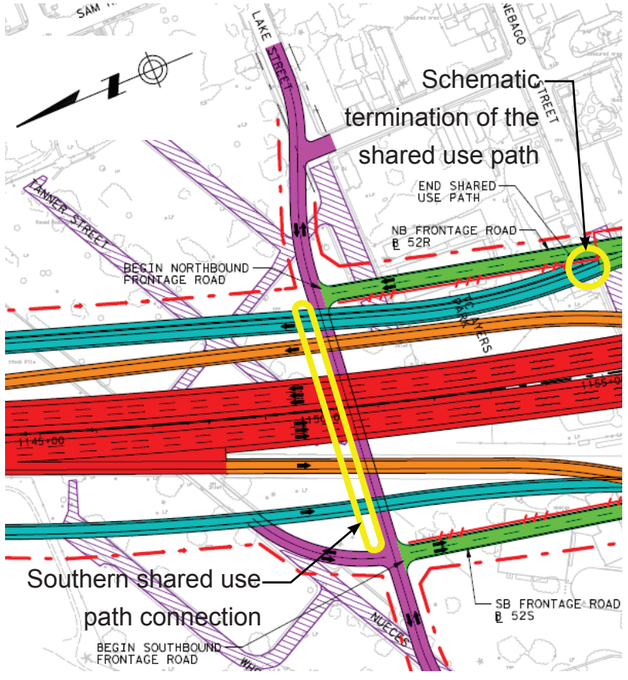


Figure 9.2 – Southern shared use path connection context

10.1 Overview

Landscape design shall prioritize low maintenance and low water use. Xeriscape plants shall be utilized. The work shall meet or exceed all criteria, in *TP Sections 15.3.13, Trees, Shrubs, and Other Plant Materials; 15.3.14 Maintenance and Establishment Period;* and *TxDOT Spec Book Item 193 Landscape Establishment*, and *Item 751 Landscape Maintenance*.

Plant material that creates sight hazards to facility users is prohibited. Vegetation shall meet setback and sight triangle requirements. No vegetation shall be placed where pruning will be required in the future to maintain safe sight-distances. Do not place plants near merging lanes. Refer to the *TxDOT Roadway Design Manual,* Chapter 2, Section 5 for requirements. All trees shall be located a minimum of 30 feet from back of curb. All shrubs and ornamental grasses shall be located a minimum of 15 feet from the back of curb. If there is no curb, measure from edge of pavement.

The Developer shall not plant trees, shrubs, ornamental grasses or groundcover in locations that receive shade from approach or corridor bridges for more than six hours of the day during the growing season.

Landscape planting beds are areas that include plant material such as trees, shrubs, ornamental grasses or groundcovers. Eighteen-inch wide, 6-inch deep mow curbs shall separate planting beds and turf grass. Two or more adjacent trees planted less than 15 feet on center are considered a tree grove and shall be contained by a mow curb as specified above. Turf grass shall not be located within plant beds or tree groves. The use of steel edging is prohibited.

Where mow curbs are used to separate turf grass and plant bed or tree grove, the curb shall facilitate ease of mowing. Angular mow curb are prohibited. Curvilinear mow curbs, as seen in *Figure 10.1*, are preferred.

The Developer is responsible for modifying landscape treatments where utilities will remain.

10.2 Approach Bridges

Landscape installations shall occur outside of the PCCA and UPRR right-of-ways.

The Developer shall coordinate with TxDOT for stakeholder meetings to determine the level of landscape installation where the approach bridges cross through neighborhoods. Refer to *TP Section 3.2.5, Customer Groups*.

10.3 Corridor

The Developer shall prepare a landscape design plan for the overall project area. Trees, shrubs and other plant materials shall be specified from the recommended plant lists as listed in the subchapter 10.5, Plant List and Details.

Trees shall be planted in groves. Groves in this Project shall include 7 to 25 trees and shall be installed within a tree bed. Shrub/ornamental grasses shall be installed in landscape planting beds.

The Developer's landscape plan shall emphasize key intersections as defined by the station points listed below and the minimum landscape planting requirements:

- I 37 between STA 80+00 and STA 91+00, 50 trees, 1000 shrubs/ornamental grasses
- I 37 between STA 106+50 and STA 122+50, 60 trees, 600 shrubs/ornamental grasses
- I 37 between STA 122+50 and STA 126+50, 16 trees, 300 shrubs/ornamental grasses
- I 37 between STA 126+50 and STA 143+50, 50 trees, 1000 shrubs/ornamental grasses
- I 37 between STA 143+50 and STA 155+00, no trees, 1000 shrubs/ornamental grasses
- US 181/SH 286 between STA 1159+00 and STA 1162+50 (see I 37 between STA 122+50 and STA 126+50)
- US 181/SH 286 between STA 1162+50 and STA 1166+50, 100 trees, 1000 shrubs/ornamental grasses.
- US 181/SH 286 between STA 1166+50 and STA 1174+00, 40 trees, 400 shrubs/ornamental grasses
- US 181/SH 286 between STA 1132.00 and STA 1159+00, refer to subchapter 10.2, Approach Bridges, for neighborhood landscape.

In addition to the key intersection plantings, the Developer's landscape plan shall provide landscape plantings that establish continuity along the corridor. The Developer's landscape plan shall address the following segments and minimum requirements:

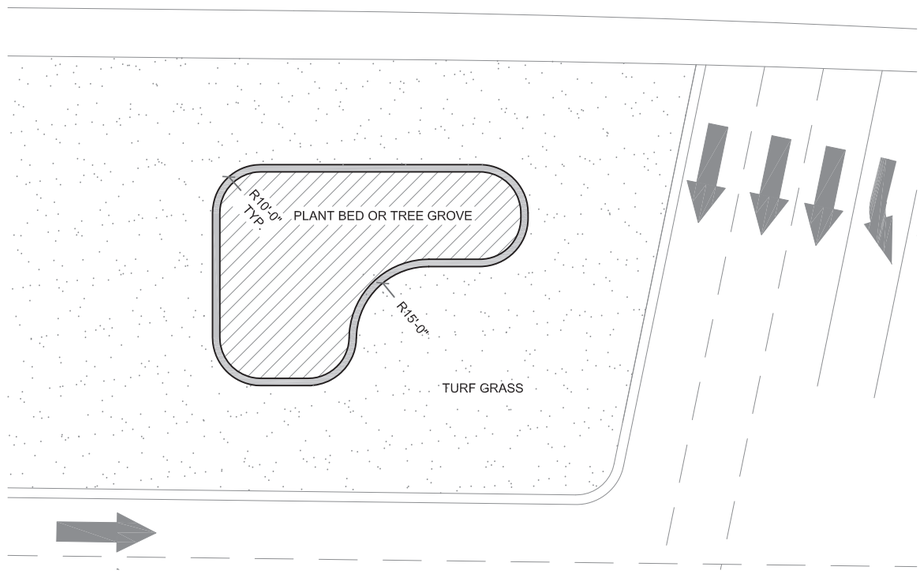


Figure 10.1 – Curved mow curbs preferred

- I 37 between STA 67+64.90 and STA 80+00, no trees, no shrubs/ornamental grasses
- I 37 between STA 91+00 and STA 106+50, 40 trees, 400 shrubs/ornamental grasses
- I 37 between STA 155+00 and STA 165+00, 25 trees, 300 shrubs/ornamental grasses
- I 37 between STA 165+00 and STA 185+00, no trees, 1000 shrubs/ornamental grasses
- US 181/SH 286 between STA 1007+35 and STA 1132.00, no trees, no shrubs/ornamental grasses
- US 181/SH 286 between STA 1174+00 and STA 1181+00, 20 trees, no shrubs/ornamental grasses
- US 181/SH 286 between STA 1181+00 and STA 1196+62.67, 35 trees, no shrubs/ornamental grasses

Trees shall be three-inch caliper or larger. Palm trees shall be a minimum height of 12 feet. All shrubs and ornamental grasses shall be three-gallon or larger. If a three-gallon size is not readily available in the region, the Developer shall request TxDOT approval for an alternate installation of three one-gallon plants in lieu of each proposed three-gallon plant.

Tree and shrub/ornamental grass planting quantities are minimums and are to be equally divided along each side of the roadway. The Developer shall relocate plantings in suitable locations, provided overall plant quantities remain intact, when:

- slopes exceed 4:1,
- the back of curb to ROW width is less than 25 feet, or
- 25-foot or greater clearances are impaired by ancillary structures and/or utility conflicts

Per subchapter 10.6, Irrigation, all plant material shall be irrigated by drip or bubbler underground irrigation system provided by the Developer.

Prior to planting, all landscape planting/tree beds shall be treated with herbicides from TxDOT's approved materials list.

10.4 Shared Use Path

Trees shall be located along the shared used path when located at grade. Proposed tree placement shall meet all TxDOT requirements for tree clearances, tree spacing, avoiding sight hazards, planting on slopes and maintenance.

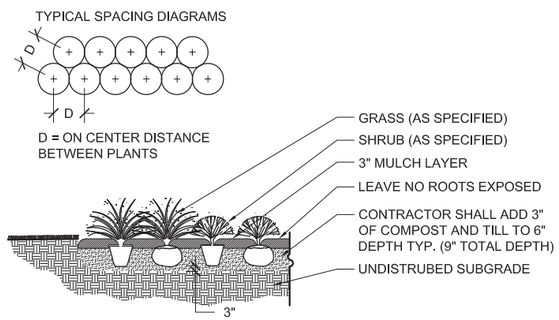


Figure 10.2 – Plant bed preparation and spacing

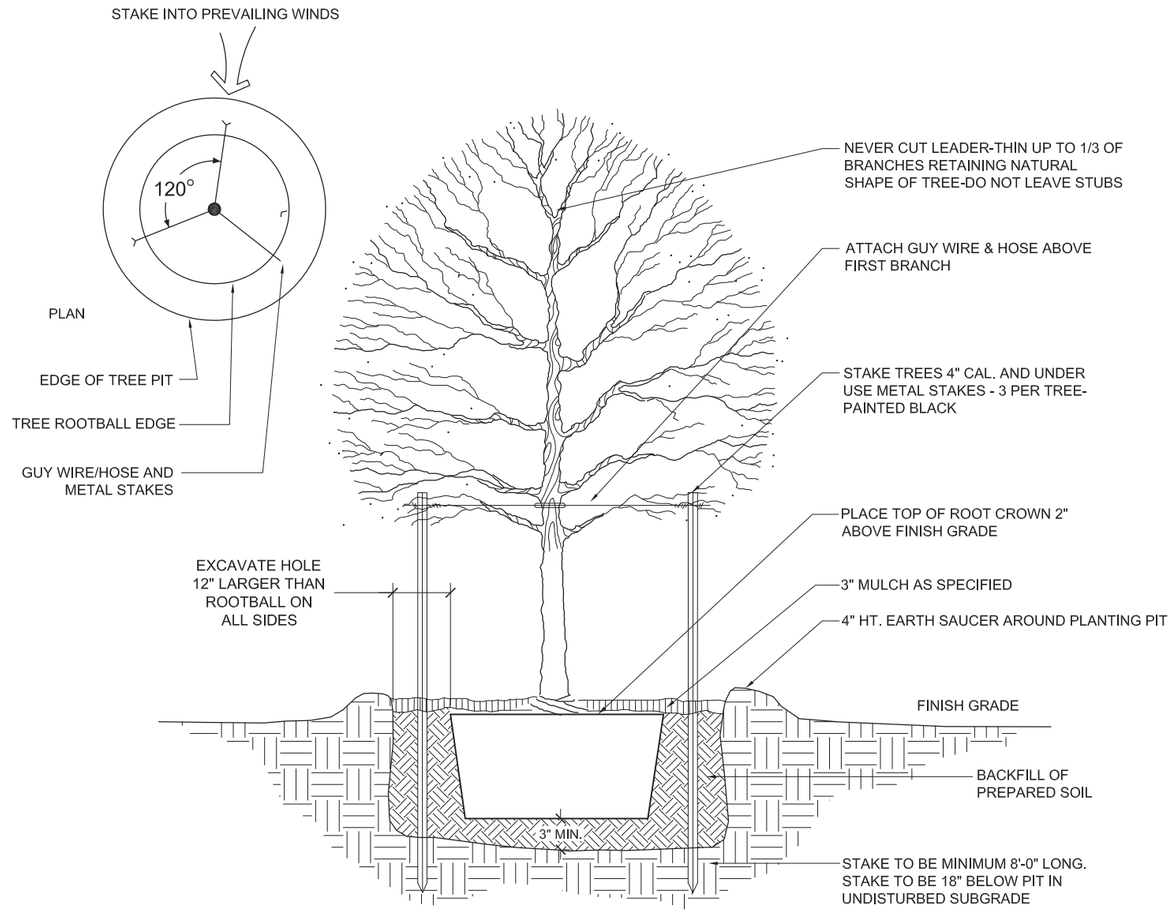


Figure 10.3 – Tree planting detail

Per 200 linear feet of shared use path, the Developer shall plant six shade trees of two different species and two ornamental trees. Minimum on-center spacing for all trees shall be 16 feet. All trees associated with the shared use path shall be located a minimum of 30 feet from back of curb. If there is no curb, measure from edge of pavement.

10.5 Plant List and Details

The plant list shall conform to *Corpus Christi Strategic Parks and Recreation Master Plan (CCSPRMP)* (2012) and/or the *Water Wise Plant List for Coastal Bend (WWPLCB)* developed by the Xeriscape Corpus Christi Program. Tree spacing shall meet the recommendations shown in the *CCSPRMP*. Any palm trees listed on the *WWPLCB* shall be spaced 10 to 15

feet apart on center. Spacing of any trees used from the *WWPLCB* shall be determined by comparing the tree's mature growth to those listed in the *CCSPRMP* and applying the spacing recommended for trees of similar mature height. Tree protection procedures shall conform to *Texas Technical Institute's Recommendations, Procedures, and Guidelines for the Protection of Trees and Sensitive Landforms*. Plant bed preparation shall conform to *Figure 10.1*, tree installation shall conform to *Figure 10.2*.

10.6 Irrigation

All landscape planting beds and trees shall have drip irrigation that is with battery-operated or solar powered. All irrigation improvements shall be of operational quality for a minimum of three years. The system(s) shall utilize a rain sensor(s).

Installation of all irrigation systems shall meet all City of Corpus Christi requirements and shall be safely accessible to maintenance personnel. Components requiring adjustment or maintenance shall be located away from traffic.

Irrigation mainlines shall maintain a distance between trees and structures equal to or greater than the radius of the mature dripline.

The Developer shall provide TxDOT with an irrigation design and submittals for review and approval.

Irrigation controller(s) locations(s) shall be reviewed by TxDOT. All irrigation controller boxes shall be mounted on a concrete footing and located in a safe, accessible location, away from vehicular traffic.

Refer to *Figures 10.4 through 10.7* for irrigation standards.

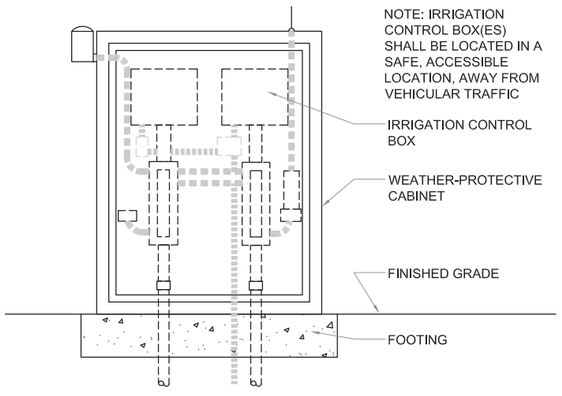


Figure 10.4 – Irrigation control boxes on footing

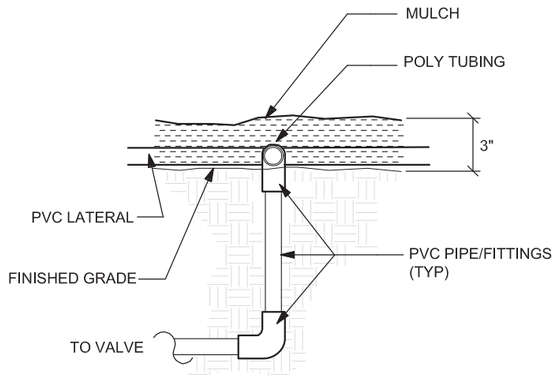


Figure 10.5 – Typical irrigation PVC/header connection

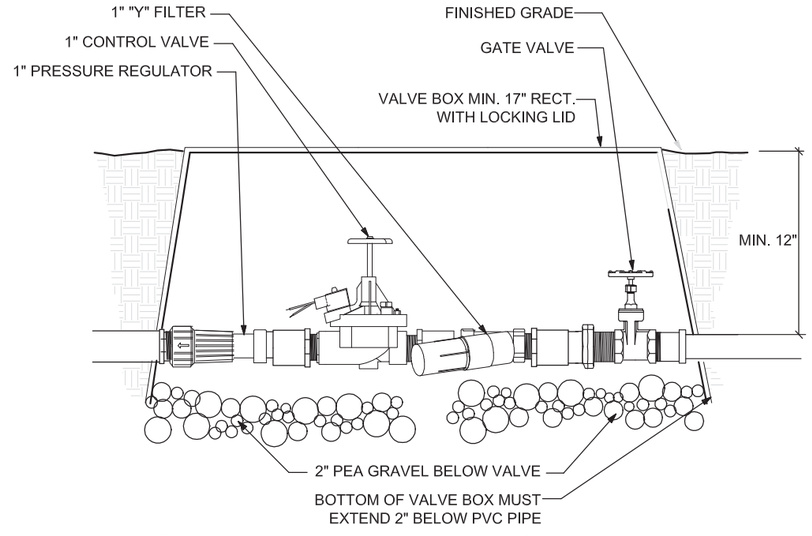


Figure 10.6 – Typical valve assembly for drip irrigation

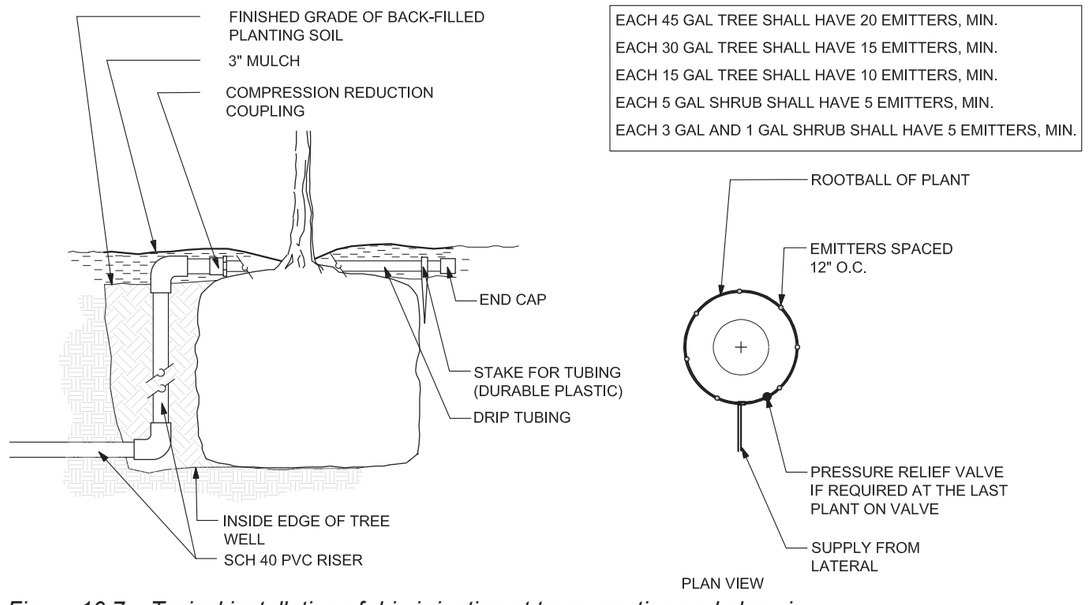


Figure 10.7 – Typical installation of drip irrigation at trees, section and plan view

11.0 Finishes Schedule

11.1 Color Palette

The colors selected for the Project shall be suitable for the intended purpose. The colors should help increase the safety and ease of use of the facility and increase the visual appeal. To make color selections:

- Link elements widely separated by space. Colors used to link elements should be similar in shade and brightness
- Highlight certain elements to attract attention. (Care shall be taken to avoid distracting motorists.)
- Reduce the visual prominence or conspicuous nature of an element. Muted colors that reflect less light than elements near or behind them will attract less attention.
- Contrast one element with another to enable quick identification and wayfinding. High-contrast colors used close to one another will attract attention to that location.

Colors that are intended to be distinguished at long distances should be brighter than those one would normally select for objects intended to be viewed from close range in order to compensate for haze, fog, rain and other atmospheric conditions. Narrow lines of color (only a few inches wide) will be lost when viewed from far distances.

The size of the roadway creates an important relationship between color, texture, pattern, and scale. In order to be appreciated, a color, pattern, or texture must be large enough to be visible. However, too much of a single treatment can become mundane or overpowering. Special treatments should accent rather than dominate a landscape.

Tones of blue and other cool colors shall be used in this Project. See *Figure 11.1* for an example of cool color palettes.

Provide color samples as specified in *TP Section 15.4, Construction Requirements*.

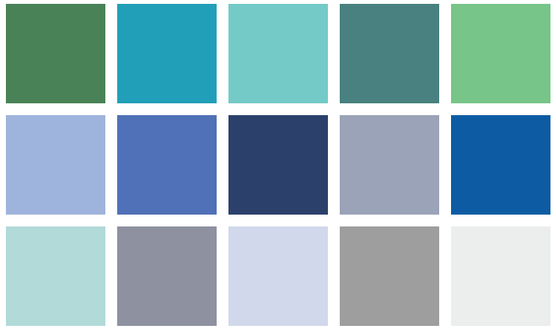


Figure 11.1 – Example of cool color palettes

11.2 Textures

Textures on concrete shall be achieved through the use of form liners, sandblasting, or washing to expose the integral aggregate. If sandblasting or washing is proposed, relief depths shall not diminish the structural integrity of the design component.

Textures are most visually effective where traffic speeds are slower. Rougher textures are more appropriate when viewed from a distance and by higher speed traffic.

The use of an uninterrupted horizontal texture or design alignment is discouraged. Any settling and resulting rotation over time will be more noticeable in a highly linear application. Offsetting and breaking up horizontal lines will draw the eye away from any shifting.

Figure 11.2 – Thematic textures

11.3 Opaque Sealer

Ensure the coating is smooth, even, continuous, and free of drips, runs, sags, holidays, wrinkles, or other coating defects. Ensure the coating has a uniform appearance within all portions of the painted piece and all related pieces and components of the Project.

Texas Department of Transportation

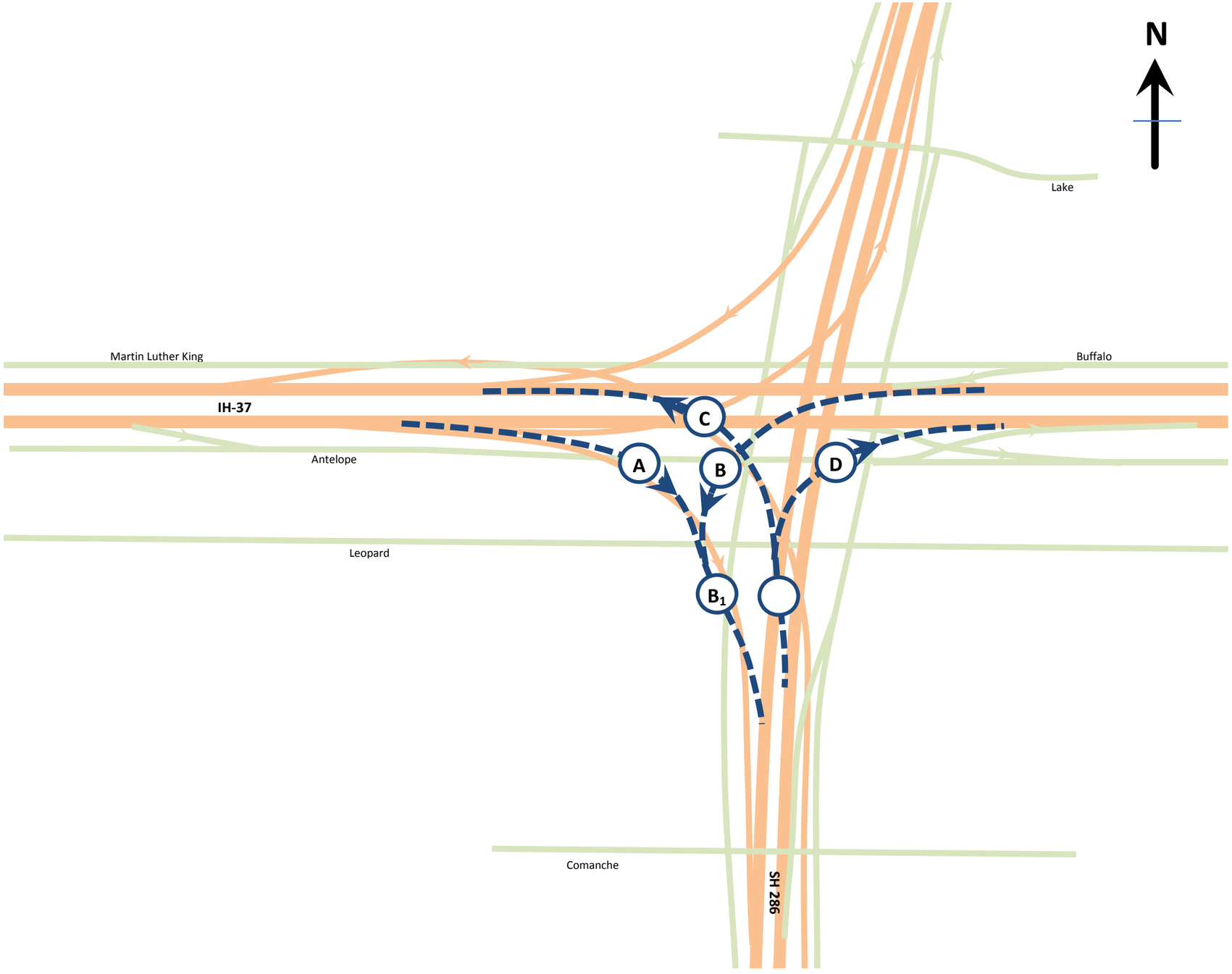
BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 18-1
EXISTING DIRECT CONNECTS AT
SH 286 / IH 37 INTERCHANGE



LEGEND	
	Existing Direct Connect
	Proposed Direct Connect
	IH-37
	SH 286
	Frontage Road / Ramp / Roadway

Notes:

1) Attachment 18-1 is intended to be read in conjunction with Section 18.3 of the Technical Provisions solely to reference the existing Direct Connects for the purpose of specifying Lane Closure restrictions.

Existing DC	Lanes	Shoulder
A	1	1
B	2	0
B_1	3	1
C	1	1
D	1	1
D_1	2	1

Attachment 18.1

Diagram of Existing Direct Connects at SH 286 / IH 37 Interchange

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 19-1
BASELINE PERFORMANCE AND MEASUREMENT TABLE NEW HARBOR BRIDGE

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
1) ROADWAY						*Unless stated otherwise, measurements shall be conducted using procedures, techniques, and measuring equipment consistent with TxDOT's Pavement Management Information System Rater's Manual.*			
1.1	**Obstructions and debris**	Roadway and clear zone free from obstructions and debris	2 hrs	NA	NA	Visual Inspection	1.1.1	Number of obstructions and debris	Nil
1.2	**Pavement**	All roadways have a smooth and quiet surface course (including bridge decks, covers, gratings, frames and boxes) with adequate skid resistance and free from Defects.	24 hrs	28 days	6 months	**a) Ruts – Mainlanes, shoulders & ramps** Depth as measured using an automated device in compliance with TxDOT Standards.		*Percentage of wheel path length with ruts greater than ¼" in depth in each Performance Section*	
							1.2.1	• Mainlanes, shoulders and ramps - 3%	Nil
						10ft straight edge used to measure rut depth for localized areas.	1.2.3	Depth of rut at any location greater than ½"	Nil
						b) Ride quality		*NOT USED*	
						c) Failures Instances of failures exceeding the failure criteria set forth in the TxDOT PMIS Rater's Manual, including potholes, base failures, punchouts and jointed concrete pavement failures	1.2.4	Individual discontinuities greater than 1/4"	Nil
						d) Edge drop-offs Physical measurement of edge drop-off level compared to adjacent surface	1.2.5	Occurrence of any failure	Nil
							1.2.6	Number of instances of edge drop-off greater than 2"	Nil
1.2	**Pavement**	Road users warned of potential skidding hazards	24 hrs	28 days	6 months	**e) Skid resistance** ASTM E 274 Standard Test Method for Skid Resistance Testing of Paved Surfaces at 50 MPH using a full scale smooth tire meeting the requirements of ASTM E 524	1.2.7	• Performance Sections with skid numbers for 0.5-mile section of mainlines, shoulders and ramps exceeding 30 and for which investigations as to potential risk of skidding accidents and appropriate remedial actions have been taken.	100%
							1.2.8	~~• Performance Sections with skid numbers for 0.5-mile section of frontage roads exceeding 30 and for which investigations as to potential risk of skidding accidents and appropriate remedial actions have been taken.~~ NOT USED	
							1.2.9	• When the skid number is below 25 and/or when a site is categorized by TxDOT in accordance with the Wet Weather Accident Reduction Program, as a Wet Weather Accident Site, Developer shall perform a site investigation and perform required corrective action.	100%
							1.2.10	Instances where road users are warned of a potential skidding hazard where corrective action is required following the categorization as a Wet Weather Accident Reduction Site.	100%
1.3	**Crossovers and other paved areas**	Crossovers and other paved areas are free of Defects	24 hrs	28 days	6 months	**a) Potholes**	1.3.1	Number of potholes of low severity or higher	Nil
						b) Base failures	1.3.2	NOT USED	Nil
1.4	**Joints in concrete**	Joints in concrete paving are sealed and watertight Longitudinal joint separation is controlled	24 hrs	28 days	6 months	Visual inspection of joints	1.4.1	Length of unsealed joints greater than ¼"	Nil
						Measurement of joint width and level difference of two sides of joints	1.4.2	Joint width more than 1" or faulting more than ¼"	Nil
1.5	**Curbs**	Curbs are in good alignment and free of Defects	24 hrs	28 days	6 months	Visual inspection	1.5.1	Continuous curb lengths where more than 10% of the length has defects such as cracks and chips	Nil
						Physical measurement	1.5.2	Continuous curb lengths where more than 5% of the length has a separation exceeding 0.25" between curb face and adjacent roadway surface	Nil
						Survey and 10' straight edge	1.5.3	Continuous curb lengths where more than 5% of the length has either the top or face of curbs exceeding 0.5" from intended design alignment	Nil

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
1.6	**Maintenance/Access Roads**	Maintenance / access roads are fee of Defects	24 hrs	28 days	6 months	Crown: Flat A shape or super-elevation with 4% cross slopes maintained to minimize ponding	1.6.1	Cross slope less than 3% or more than 6%	Nil
						Shoulder: Maintain slope away from the travel way and shoulder flush with travel way	1.6.2	Shoulder cross slope less than travel way cross slope; shoulder lower or higher than travel way	Nil
						Ditch: Maintain size and shape of ditch for proper drainage	1.6.3	Sides of ditches slumping or eroding, or obstructed by debris	Nil
						Ruts/potholes: Depth as measured using an automated device in compliance with TxDOT standards	1.6.4	Depth of ruts or potholes at any location greater than 1"	Nil
						Subgrade: Identify and repair any subgrade failures	1.6.5	Locations where subgrade failure is evident	Nil
2) DRAINAGE									
2.1	**Pipes and Channels**	Each element of the drainage system is maintained in its proper function by cleaning, clearing and/or emptying as appropriate from the point at which water drains from the travel way to the outfall or drainage way.	24 hrs	28 days	6 months	Visual inspection supplemented by CCTV where required to inspect buried pipe work.	2.1.1	Length of pipe or channel in feet with less than 90% of cross sectional clear area, calculated as the arithmetic mean of the clear cross-sectional areas of individual 10 feet lengths of pipes and channels in each Performance Section.	Nil
2.2	**Drainage treatment devices**	Drainage treatment and balancing systems, flow and spillage control devices function correctly and their location and means of operation is recorded adequately to permit their correct operation on Emergency.	24 hrs	28 days	6 months	Visual inspection	2.2.1	Number of devices functioning correctly with means of operation displayed.	100%
2.3	**Travel Way**	The travel way is free from water to the extent that such water would represent a hazard by virtue of its position and depth.	24 hrs	28 days	6 months	Visual inspection of water on surface.	2.3.1	Number of instances of hazardous water build-up.	Nil
2.4	**Discharge systems**	Surface water discharge systems perform their proper function and discharge to groundwater and waterways complies with the relevant legislation and permits.	24 hrs	28 days	6 months	Visual inspection and records	2.4.1	Performance Sections with surface water discharge systems performing their proper function and discharging in compliance with the relevant legislation and permits.	100%
2.5	**Protected Species**	Named species and habitats are protected.	24 hrs	28 days	6 months	Visual inspection	2.5.1	Performance Sections with named species and habitats with protection of these named species and habitats.	100%
3) STRUCTURES									
3.1	**Structures having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or springlines of arches or extreme ends of openings or multiple boxes**	Substructures and superstructures are free of: • undesirable vegetation • debris and excessive bird droppings • blocked drains, weep pipes manholes and chambers • blocked drainage holes in structural components	24 hrs	28 days	6 months	Inspection and assessment in accordance with the requirements of federal National Bridge Inspection Standards (NBIS) of the Code of Federal Regulations, 23 Highways – Part 650, the TxDOT Bridge Inspection Manual, and the Federal Administration's Bridge Inspector's Reference Manual.		*Records as required in the TxDOT Bridge Inspection Manual*	
		• defects in joint sealants • defects in pedestrian protection measure • scour damage • corrosion of rebar • paint system failures • impact damage				As above	3.1.1	Occurrence of condition rating, in accordance with the TxDOT Bridge Inspection Manual, below seven for any deck, superstructure or substructure	Nil
						~~As above~~	~~3.1.2~~	~~Performance Sections with structure components with condition states of one, in accordance with the TxDOT Field Inspection Manual~~	~~100%~~

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
3.2	**Structure components**	i) Expansion joints are free of: • dirt debris and vegetation • defects in drainage systems • loose nuts and bolts • defects in gaskets ii) The deck drainage system is free of all debris and operates as intended. iii) Parapets are free of: • loose nuts or bolts • blockages of hollow section drain holes • vegetation • accident damage iv) Bearings and bearing shelves are clean. Bearings allow for translation and rotation as designed. No presence of water exists on bearings and bearing seats. v) Sliding and roller surfaces are clean and greased to ensure satisfactory performance. Additional advice contained in bearing manufacturers' instructions is followed. vi) Special finishes are clean and perform to the appropriate standards. vii) All non-structural items such as hoists and electrical fixings, operate correctly, are clean and lubricated as appropriate, in accordance with the manufacturer's recommendations and certification of lifting devices is maintained.	24 hrs	28 days	6 months	Inspection and assessment in accordance with the requirements of federal National Bridge Inspection Standards (NBIS) of the Code of Federal Regulations, 23 Highways – Part 650, the TxDOT Bridge Inspection Manual, and the Federal Administration's Bridge Inspector's Reference Manual.	3.2.1	Occurrence of condition rating, in accordance with the TxDOT Bridge Inspection Manual, below seven for any deck, superstructure or substructure	Nil
						Visual inspection of Elements listed in (i) through (vii) of the general performance requirement column.	3.2.2	Instances of condition of any element not meeting general performance requirement as determined in accordance with Good Industry Practice.	Nil
3.3	**Integral wearing surface**	Integral wearing surface is in a structurally sound condition in which cracking and concrete cover to reinforcement is controlled to ensure durability	24 hrs	28 days	6 months	Concrete cover measured at ~~[10ft]~~ 10 ft intervals	3.3.1	Occurrence of any instance where integral wearing surface thickness is less than ~~[50%]~~ 50% of design value	Nil
						Cracks measured ~~at [3 ft] intervals~~ within designated 1,500 SF measurement areas on the surface of the deck prior to 3 hours after sunrise at concrete age greater than 28 days	3.3.2	~~Instances of cracks wider than [0.025] inches~~ Instances where more than 150 linear ft of cracks exceeding 0.020 inches in width are present within any 1,500 SF measurement area.	Nil
						De-lamination or spalling	3.3.3	Instances of de-lamination or spalling	Nil
3.4	**Stay Cables**	Stay cable system operates as intended including damping system (if any) and acoustic monitoring system.	24 hrs	28 days	NA	Visual and hands-on inspection	3.4.1	Instances of damage or deterioration of the corrosion protection system including coatings, protective pipes and anchorage units	Nil
							3.4.2	Instances of damaged or broken strand / wire	Nil
							3.4.3	Instances of stay cable damping system not operating as intended including failure to provide the minimum design level of damping	Nil
							3.4.4	Instances of stay cable acoustic monitoring system not operating as intended including failure to transmit measured information.	Nil
3.5	**Inspection and access equipment**	Inspection and access equipment is properly maintained including: • Under-deck inspection systems such as maintenance travelers • Fixed access and inspection platforms • Access stairways and lift systems	24 hrs	28 days	6 months	Visual and hands-on inspection	3.5.1	Instances of loose assemblies or nuts and bolts not fully tightened	Nil
							3.5.2	Instances of defects in surface protection such as failures of coating systems to bare metal or loss of galvanizing	Nil
							3.5.3	Instances of failures to conform with relevant standards for fixed and mobile inspection facilities, hoists and lifts	Nil
							3.5.4	Instances where maintenance traveler fails to operate smoothly under power or braking, has uneven or inconsistent movement of any driven component or exhibits binding or swaying, in each case in a manner that exceeds normal operational parameters.	Nil
3.6	**Ship impact protection system**	The ship impact protection system (if any) including any fenders and exposed foundations shall be maintained such that it is able to perform its intended function	24 hrs	28 days	6 months	Visual inspection	3.6.1	Instances of marine boring (timber systems)	Nil

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
							3.6.2	Instances of corrosion that would reduce the system resistance to below its intended design state	Nil
							3.6.3	Instances of damage from vessel impact that would reduce the system resistance to below its intended design state or would cause a material reduction in the remaining service life	Nil
3.7	**Corrosion protection systems**	Corrosion protection systems are intact and operating in line with design intent including: • Paint systems for steel • Concrete surface protection systems • Sacrificial protection systems Zinc metalizing	24 hrs	28 days	6 months	Visual inspection	3.7.1	Instances of failure of coating system down to bare metal or instances of repair / removal of overcoat that damages underlying metallized coating.	Nil
							3.7.2	Loss of galvanizing	Nil
						Color determined by CIE 1976 L*a*b*utilizing a D65 illuminant and 10 degree observer	3.7.3	Damaged, blistered, cracked, delaminated or peeling material including any painted surface for which a color is specified that has changed color by more than 10 Delta-E CIE LAB units.	Nil
							3.7.4	Noncompliance with manufacturer's recommendations for the maintenance and re-application of coatings	Nil
3.8	**Lightning Protection Systems**	Lightning protection systems are intact and operating in line with design intent.	24 hrs	7 days	NA	Inspection and assessment in accordance with the requirements of Underwriters Laboratories, Inc. (UL) 96 and Lightning Protection Institute (LPI) 175.	3.8.1	Noncompliance with specified standards.	Nil
							3.8.2	Instances of lightning protection system not operating as intended.	Nil
3.11	**Load Ratings**	All structures maintain the design load capacity.	24 hrs	7 days	NA	Load rating calculations in accordance with the Manual for Bridge Evaluation and the TxDOT Bridge Inspection Manual and per the Technical Provisions	3.11.1	Number of structures with load restrictions for Texas legal loads (including legally permitted vehicles) in each Performance Section	Nil
3.12	**Access Points**	All hatches and points of access have fully operational and lockable entryways.	24 hrs	28 days	6 months	Visual Inspection	3.12.1	Number with defects in locks or entryways	Nil
3.14	**Structural Surfaces**	Vertical Surfaces free of graffiti, markings by vandalism.	24 hrs	28 days	6 months	Visual Inspection	3.14.1	Number of areas where graffiti is present	Nil
4) PAVEMENT MARKINGS, OBJECT MARKERS, BARRIER MARKERS AND DELINEATORS									
4.1	**Pavement markings**	Pavement markings are: • clean and visible during the day and at night • whole and complete and of the correct color, type, width and length • placed to meet the TMUTCD and TxDOT's Pavement Marking Standard Sheets	24 hrs	28 days	6 months	**a) Markings - General**			
						Portable retroreflectometer, which uses 30 meter geometry, meeting the requirements described in ASTM E 1710	4.1.1	Percentage of total length of pavement marking in each Performance Section meeting the minimum retroreflectivity 175 med/sqm/lx for white	100%
							4.1.2	Percentage of total length of pavement marking in each Performance Section meeting the minimum retroreflectivity 125 med/sqm/lx for ~~white~~ yellow	100%
						Physical measurement	4.1.3	Length of pavement marking in each Performance Section with more than 5% loss of area of material at any point	Nil
							4.1.4	Length of pavement marking in each Performance Section with spread more than 10% of specified dimensions.	Nil
						b) Profile Markings			
						Visual inspection	4.1.5	Percentage of total length of pavement marking in each Performance Section performing its intended function and compliant with relevant regulations	100%
4.2	**Raised Reflective Markings**	Raised reflective pavement markers are: • clean and clearly visible • of the correct color and type • reflective or retroreflective in accordance with TxDOT standards • correctly located, aligned and at the correct level • are firmly fixed • are in a condition that will ensure that they remain at the correct level.	24 hrs	28 days	6 months	Visual inspection	4.2.1	Number of markers associated with road markings that are ineffective in any 10 consecutive markers. (Ineffective includes missing, damaged, settled or sunk)	Nil
							4.2.2	A minimum of four markers are visible at 80' spacing when viewed under low beam headlights.	100%
							4.2.3	Uniformity (replacement raised reflective pavement markers have equivalent physical and performance characteristics to adjacent markers).	100%

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
4.3	**Delineators and Markers**	Object markers, mail box markers and delineators are: • clean and visible • of the correct color and type • legible and reflective • straight and vertical	24 hrs	28 days	6 months	Visual inspection	4.3.1	Number of object markers or delineators in each Performance Section that is defective or missing	Nil
5) GUARDRAILS, SAFETY BARRIERS AND IMPACT ATTENUATORS									
5.1	**Guardrails and Safety Barriers**	All guardrails, safety barriers, concrete barriers, etc. are maintained free of Defects, , and undesirable vegetation. They are appropriately placed and correctly installed at the correct height and distance from roadway or obstacles. Installation and repairs shall be carried out in accordance with the requirements of NCHRP 350 standards.	24 hrs	28 days	6 months	Visual inspection	5.1.1	Performance Sections with all guard rails and safety barriers appropriately placed and correction installed	100%
							5.1.2	Performance Sections with all guard rails and safety barriers free from defects	100%
							5.1.3	Performance Sections with all guard rails and safety barriers at correct heights	100%
							5.1.4	Performance Sections with all guard rails and safety barriers at correct distances from roadway obstacles	100%
5.2	**Impact Attenuators**	All impact attenuators are appropriately placed and correctly installed	24 hrs	28 days	6 months	Visual inspection	5.2.1	Performance Sections will all impact attenuators appropriately placed and correctly installed.	100%
6) TRAFFIC SIGNS									
6.1	**General - All Gantry-Mounted overhead signs**	i) Signs are clean, correctly located, clearly visible, legible, reflective, at the correct height and free from structural and electrical defects ii) Identification markers are provided, correctly located, visible, clean and legible iii) Visibility distances meet the stated requirements iv) Obsolete and redundant signs are removed or replaced as appropriate v) Sign information is of the correct size, location, type and wording to meet its intended purpose and any statutory requirements vi) All structures and elements of the signing system are kept clean and free from debris and have clear access provided. vii) All replacement and repair materials and equipment are in accordance with the requirements of the TMUTCD viii) Dynamic message signs are in an operational condition	24 hrs	28 days	6 months	**a) Retroreflectivity** Determination of Coefficient of retro-reflectivity	6.1.1	Number of signs with actual reflectivity below the requirements of TxDOT's TMUTCD in each Performance Section	Nil
						b) Face damage Visual inspection	6.1.2	Number of signs in each Performance Section with face damage greater than 5% of area	Nil
						c) Placement Visual inspection	6.1.3	All signs in each Performance Section are placed in accordance with TxDOT's Sign Crew Field Book including not twisted or leaning	100%
						d) Obsolete signs Visual inspection	6.1.4	Number of obsolete signs in each Performance Section	100%
						e) Sign Information Visual inspection	6.1.5	All sign information in each Performance Section is of the correct size, location, type and wording to meet its intended purpose	100%
						f) Dynamic Message Signs Visual inspection	6.1.6	Dynamic message signs are fully functioning	100%
6.2	**Gantries**	Sign and signal mounting structures (including gantries) are structurally sound and free of: • defects in surface protection systems • loose nuts and bolts • graffiti	24 hrs	28 days	6 months	Visual inspection	6.2.1	Number with defects in surface protection system	Nil
							6.2.1	Number with loose nuts and bolts	Nil
							6.2.3	Number with graffiti	Nil
7) TRAFFIC SIGNALS (NOT PART OF MAINTAINED ELEMENTS)									
8) LIGHTING									
8.1	**Roadway Lighting**	i) All lighting is free from defects and provides acceptable uniform lighting quality ii) Lanterns are clean and correctly positioned iii) Lighting units are free from any damage or vandalism iv) Columns are upright, correctly founded, visually acceptable and structurally sound	24 hrs	28 days	6 months	**a) Mainlane lights operable** Night time inspection or automated logs	8.1.1	Performance Sections with less than 90% of lights functioning correctly at all times	Nil

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
						b) Mainlane lights out of action Night time inspection or automated logs	8.1.2	Instances of more than two consecutive lights out of action	Nil
8.2	**Sign Lighting**	Sign lighting is fully operational	24 hrs	28 days	6 months	Night time inspection or automated logs	8.2.1	Number of instances of more than one bulb per sign not working in each Performance Section	Nil
8.3	**Electrical Supply**	Electricity supply, feeder pillars, cabinets, switches and fittings are electrically, mechanically and structurally sound and functioning	24 hrs	7 days	28 days	Testing to meet NEC regulations, visual inspection	8.3.1	Inspection records showing safe installation and maintenance in each Performance Section	Nil
8.4	**Access Panels**	All access panels in place at all times.	24 hrs	7 days	28 days	Visual Inspection	8.4.1	Number of instances of missing or damaged access panels in each Performance Section	Nil
8.5	**High Mast Lighting**	*NOT USED*				*NOT USED*			
8.6	**Navigational Lighting**	Navigational lighting is fully operational	24 hrs	7 days	28 days	Night time inspection or automated logs	8.5.1	Number of instances of more than one bulb per sign not working in each Performance Section	Nil
8.7	**Architectural Lighting**	All architectural lighting is functioning in accordance with the original design requirements and specifications			28 days	Night time inspection or automated logs	8.6.1	Instances of architectural lighing with more than 10% of lamps not functioning	Nil
8.8	**Bridge Inspection Lighting**	All bridge inspection lighting is functioning in accordance with original design requirements and specifications	24 hrs	7 days	28 days	Night time inspection or automated logs	8.7.1	Instances of bridge inspection lighting where failures could adversely impact safety or security of inspections or access	Nil
9) FENCES, WALLS AND SOUND ABATEMENT (NOT USED)									
10) ROADSIDE MANAGEMENT (NOT USED)									
11) REST AREAS AND PICNIC AREAS (NOT USED)									
12) EARTHWORKS, EMBANKMENTS AND CUTTINGS (NOT USED)									
13) ITS EQUIPMENT									
13.1	**ITS Equipment - Maintenance**	All ITS equipment is fully functional and housing is functioning and free of defects. i) All equipment and cabinet identification numbers are visible, sites are well drained and access is clear. ii) Steps, handrails and accesses are kept in a good condition. iii) Access to all communication hubs, ground boxes, cabinets and sites is clear. iv) All drainage is operational and all external fixtures and fittings are in a satisfactory condition. v) All communications cable markers, cable joint markers and duct markers are visible and missing markers are replaced. vi) Backup power supply system is available at all times	24 hrs	14 days	28 days	Visual Inspection	13.1.1	Inspection records showing compliance with requirements for maintenance of ITS equipment in each Performance Section.	100%
13.2	**Dynamic Message Sign Equipment**	Dynamic Message Signs are free from faults such as: i) Any signal displaying a message which is deemed to be a safety hazard. ii) Failure of system to clear sign settings when appropriate. iii) 2 or more contiguous sign failures that prevent control office setting strategic diversions. iv) Signs displaying an incorrect message.	2 hrs	24 hrs	14 days	Defect measurement dependent on equipment	13.2.1	Inspection records showing compliance with requirements for Dynamic Message Signs in each Performance Section	100%

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
13.3	**CCTV Equipment**	CCTV Systems are free from serious faults that significantly limit the availability of the operators to monitor the area network, such as: i) Failure of CCTV Systems to provide control offices with access and control of CCTV images. ii) Failure of a CCTV camera or its video transmission system. iii) Failure of a Pan / Tilt unit or its control system. iv) Moisture ingress onto CCTV camera lens. v) Faults that result in significant degradation of CCTV images.	2 hrs	24 hrs	14 days	Defect measurement dependent on equipment	13.3.1	Inspection records showing compliance with requirements for CCTV equipment in each Performance Section	100%
13.4	**Vehicle Detection Equipment**	All equipment free of defects and operational problems such as: i) Inoperable loops. ii) Malfunctioning camera controllers.	2 hrs	24 hrs	28 days	Defect measurement dependent on equipment	13.4.1	Inspection records showing compliance with requirements for vehicle detection equipment in each Performance Section	100%
							13.4.2	Traffic Detector Loop circuit's inductance to be > 50 and < 1,000 micro henries.	100%
							13.4.3	Insulation resistance to be > 50 meg ohms.	100%
14) TOLLING FACILITIES AND BUILDINGS (NOT USED)									
15) AMENITY (NOT USED)									
16) SNOW AND ICE CONTROL									
16.1	**Travel lanes**	Maintain travel way free from snow and ice.	2 hrs	NA	NA	Maximum 1hr response time to complete manning and loading of spreading vehicles.	16.1.1	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	100%
						Maximum 2hrs from departure from loading point to complete treatment and return to loading point.	16.1.2	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	100%
						Maximum 1hr response time for snow and ice clearance vehicles to depart from base.	16.1.3	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	100%
16.2	**Weather Forecasting**	Weather forecast information is obtained and assessed and appropriate precautionary treatment is carried out to prevent ice forming on the travel way.	2 hrs	NA	NA	Operations plan details the process and procedures in place and followed.	16.2.1	Inspection records showing compliance with requirements for weather forecasting in each Performance Section	100%
16.3	**Operational Plans**	Operate snow and ice clearance plans to maintain traffic flows during and after snowfall and restore the travel way to a clear condition as soon as possible.	2 hrs	NA	NA	Operations plan details the process and procedures in place and followed.	16.3.1	Inspection records showing compliance with snow and ice clearance plans in each Performance Section	100%
16.4	**Operations and Maintenance Manual**	Operations and maintenance instructions for the anti-icing system and items of equipment (if Used)	2 hrs	NA	NA	Operations and maintenance instructions detail the process and procedures in place and followed.	16.4.1	Inspection records showing compliance with operations and maintenance instructions in each Performance Section.	100%
17) INCIDENT RESPONSE									
17.1	**General**	Monitor the Project and respond to Incidents in accordance with the Maintenance Management Plan (MMP).	1 hr	NA	NA	Response times are met for 98% of incidents measured on a 1 year rolling basis.	17.1.1	Inspection records showing compliance with the MMP and requirements regarding incident response times in each Performance Section	100%
						No complaints from Emergency Services.	17.1.2	Inspection records showing compliance with the MMP and requirements regarding incident response times in each Performance Section	100%
17.2	**Hazardous Materials**	Monitor the Project and respond to Incidents involving Hazardous Materials in accordance with the Maintenance Management Plan (MMP).	1 hr	NA	NA	MMP details the process and procedures in place and followed.	17.2.1	Inspection records showing compliance with the MMP details regarding hazardous materials in each Performance Section	100%
17.3	**Structural Assessment**	Evaluate structural damage to structures and liaise with emergency services to ensure safe working environment while clearing the incident	1 hr	NA	NA	Inspections and surveys as required by incident	17.3.1	Inspection records showing compliance with the MMP and requirements for incidents in each Performance Section	100%
17.4	**Temporary and permanent remedy**	Propose and implement temporary measures or permanent repairs to Defects arising from the incident. Ensure the structural safety of any structures affected by the Incident.	24 hrs	28 days	NA	Review and inspection of the incident site	17.4.1	Inspection records showing compliance with requirements for temporary and permanent remedy for incidents in each Performance Section	100%
18) CUSTOMER RESPONSE									
18.1	**Response to inquiries**	Timely and effective response to customer inquiries and complaints.	48 hrs	NA	NA	Contact the customer within 48 hours following initial customer inquiry.	18.1.1	Percentage of responses within specified times in each Performance Section.	100%
						All work resulting from customer requests is scheduled within 48 hours of customer contact.	18.1.2	Demonstrated by O&M Records	100%

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
						Follow-up contact with the customer within 72 hours of initial inquiry.	18.1.3	Demonstrated by O&M Records	100%
						All customer concerns/requests are resolved to TxDOT's satisfaction within 2 weeks of the initial inquiry.	18.1.4	Demonstrated by O&M Records	100%
18.2	**Customer Contact Line**	Telephone line manned during business hours and 24 hour availability of messaging system. Faults to telephone line or message system rectified.	24 hrs	7 days	NA	Instances of line out of action or unmanned	18.2.1	Number of operations records showing non availability of the customer contact line in each Performance Section including complaints from public.	Nil
19) SWEEPING AND CLEANING									
19.1	**Sweeping**	i) Keep all channels, hard shoulders, gore areas, ramps, intersections, islands and frontage roads swept clean with vacuum sweepers, ii) Clear and remove debris from traffic lanes, hard shoulders, verges and central reservations, footways and cycle ways iii) Remove all sweepings without stockpiling in the right of way and dispose of at approved tip.	24 hrs	28 days	3 months	Buildup of dirt, ice, rock, debris, etc. on roadways and bridges not to accumulate greater than 24" wide or 1/2" deep	19.1.1	Inspection records showing compliance with requirements for sweeping in each Performance Section.	100%
19.2	**Litter**	i) Keep the right of way in a neat condition, remove litter regularly. ii) Pick up large litter items before mowing operations. Dispose of all litter and debris collected at an approved solid waste site.	24 hrs	28 days	3 months	No more than 20 pieces of litter per roadside mile shall be visible when traveling at highway speed.	19.2.1	Inspection records showing compliance with requirements regarding litter pick-up in each Performance Section.	100%

NOTES FOR ATTACHMENT 19-1

1 Hazard Mitigation shall be an action taken by Developer to mitigate a hazard to Users or imminent risk of damage or deterioration to property or the environment such that the Category 1 Defect no longer exists.

2 Permanent Remedy shall be an action taken by Developer to restore the condition of an Element following Hazard Mitigation of a Category 1 Defect: (a) to the standard required for new construction / Renewal Work; or (b) to a condition such that the Target is achieved for each Measurement Record.

3 Permanent Repair shall be an action taken by Developer to restore the condition of an Element for which a Category 2 Defect has been recorded: (a) to the standard required for new construction / Renewal Work; or (b) to a condition such that the Target is achieved for each Measurement Record.

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 19-2
BASELINE PERFORMANCE AND MEASUREMENT TABLE ROADWAY SECTION DURING CONSTRUCTION

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Baseline Condition Repair				
1) ROADWAY						*Unless stated otherwise, measurements shall be conducted using procedures, techniques, and measuring equipment consistent with TxDOT's Pavement Management Information System Rater's Manual.*			
1.1	**Obstructions and debris**	Roadway and clear zone free from obstructions and debris	2 hrs	N/A	N/A	Visual Inspection	1.1.1	Number of obstructions and debris	Nil
1.2	**Pavement**	All roadways shall be safe for road users and shall maintain or exceed the applicable reference condition (on a location-specific basis) as identified in the BECR (including shoulders, bridge decks, covers, gratings, frames and boxes).	24 hrs	28 days	28 days	**a) Ruts – Mainlanes, shoulders & ramps** Physical measurement and visual inspection.	1.2.1	Wheel path length with ruts greater than the reference condition in the BECR	Nil
						10ft straight edge used to measure rut depth for localized areas.	1.2.2	Depth of rut greater than the reference condition in the BECR	Nil
						b) Ride quality 10-ft straightedge used to measure discontinuities	1.2.3	Individual discontinuities greater than the reference condition in the BECR	Nil
						d) Failures Instances of failures exceeding the failure criteria set forth in the TxDOT PMIS Rater's Manual, including potholes, base failures, punchouts and jointed concrete pavement failures	1.2.4	Occurrence of any failure exceeding the reference condition in the BECR	Nil
						e) Edge drop-offs Physical measurement of edge drop-off level compared to adjacent surface	1.2.5	Number of instances of edge drop-off greater than the reference condition in the BECR	Nil
						f) Skid resistance ASTM E 274 Standard Test Method for Skid Resistance Testing of Paved Surfaces at 50 MPH using a full scale smooth tire meeting the requirements of ASTM E 524	1.2.6	Not used	
1.2	**Pavement**	Road users warned of potential skidding hazards	24hrs	7 days	N/A		1.2.7	Instances where road users are warned of a potential skidding hazard where remedial action is identified.	100%
1.3	**Crossovers and other paved areas**	Crossovers and other paved areas are free of defects exceeding the reference condition (on a location-specific basis) as identified in the BECR.	24 hrs	28 days	28 days	**a) Potholes**	1.3.1	Number of potholes exceeding the reference condition in the BECR	Nil
						b) Base failures	1.3.2	Number of base failures exceeding the reference condition in the BECR	Nil
1.4	**Joints in concrete**	Joints in concrete paving meet or exceed the reference condition (on a location-specific basis) as identified in the BECR	24 hrs	28 days	28 days	Visual inspection of joints	1.4.1	Length of unsealed joints exceeding the reference condition in the BECR	Nil
		Longitudinal joint separation meets or exceeds the reference condition (on a location-specific basis) as identified in the BECR.				Visual inspection	1.4.2	Joint width exceeding the reference condition in the BECR	Nil
2) DRAINAGE									
2.1	**Pipes and Channels**	Each element of the drainage system is maintained in its proper function by cleaning, clearing and/or emptying as appropriate from the point at which water drains from the travel way to the outfall or drainage way.	24 hrs	28 days	28 days	Visual inspection	2.1.1	Length of pipe or channel subject to accumulation of debris, silt or other blockage exceeding the reference condition in the BECR.	Nil

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Baseline Condition Repair				
2.2	**Drainage treatment devices**	Drainage treatment and balancing systems, flow and spillage control devices function correctly and their location and means of operation is recorded adequately to permit their correct operation on Emergency.	24 hrs	28 days	28 days	Visual inspection	2.2.1	Number of devices functioning correctly with means of operation displayed	100%
2.3	**Travel Way**	The travel way is free from water to the extent that such water would represent a hazard by virtue of its position and depth.	24 hrs	28 days	NA	Visual inspection of water on surface	2.3.1	Number of instances of hazardous water build-up	Nil
2.4	**Discharge systems**	Surface water discharge systems perform their proper function and discharge to groundwater and waterways complies with the relevant legislation and permits.	24 hrs	28 days	6 months	Visual inspection and records	2.4.1	Performance Sections with surface water discharge systems performing their proper function and discharging in compliance with the relevant legislation and permits.	100%
2.5	**Protected Species**	Named species and habitats are protected.	24 hrs	28 days	6 months	Visual inspection	2.5.1	Performance Sections with named species and habitats with protection of these named species and habitats	100%
3) STRUCTURES									
3.1	**Structures having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or springlines of arches or extreme ends of openings or multiple boxes**	Substructures and superstructures shall maintain or exceed the applicable reference condition (on a location-specific basis) as identified in the BECR including: • graffiti • undesirable vegetation • debris and excessive bird droppings • blocked drains, weep pipes manholes and chambers • blocked drainage holes in structural components • defects in joint sealants • defects in pedestrian protection measure • scour damage • corrosion of rebar • paint system failures • impact damage	24 hrs	28 days	28 days	Inspection and assessment in accordance with the requirements of federal National Bridge Inspection Standards (NBIS) of the Code of Federal Regulations, 23 Highways – Part 650, the TxDOT Bridge Inspection Manual, and the Federal Administration's Bridge Inspector's Reference Manual.		Records as required in the TxDOT Bridge Inspection Manual	
							3.1.1	Presence of any defect not recorded in the applicable reference condition (on a location-specific basis) as identified in the BECR	Nil
							3.1.2	All condition states to be at least equal to the condition states recorded on a structure-specific basis in the BECR for all structure components	100%

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Baseline Condition Repair				
3.2	**Structure components**	Except as otherwise recorded as the reference condition on a structure-specific basis in the BECR: i) Expansion joints are free of: • dirt debris and vegetation • defects in drainage systems • loose nuts and bolts • defects in gaskets ii) The deck drainage system is free of debris all and operates as intended. iii) Parapets are free of: • loose nuts or bolts • blockages of hollow section drain holes • graffiti • vegetation • accident damage iv) Bearings and bearing shelves are clean. v) Sliding and roller surfaces are clean and greased to ensure satisfactory performance. Additional advice contained in bearing manufacturers' instructions in the Structure Maintenance Manual is followed. Special finishes are clean and perform to the appropriate standards. vii) All non-structural items such as hoists and electrical fixings, operate correctly, are clean and lubricated as appropriate, in accordance with the manufacturer's recommendations and certification of lifting devices is maintained.	24 hrs	28 days	28 days	Inspection and assessment in accordance with the requirements of federal National Bridge Inspection Standards (NBIS) of the Code of Federal Regulations, 23 Highways – Part 650, the TxDOT Bridge inspection Manual, and the Federal Administration's Bridge Inspector's Reference Manual.		Records as required in the TxDOT Bridge Inspection Manual	
							3.2.1	Presence of any defect not recorded in the applicable reference condition (on a location-specific basis) as identified in the BECR	Nil
							3.2.2	All condition states to be at least equal to the condition states recorded on a structure-specific basis in the BECR for all structure components	100%
3.3	**Non-bridge class culverts**	Except as otherwise recorded as the reference condition on a structure-specific basis in the BECR: Non-bridge-class culverts are free of: • vegetation and debris and silt • defects in sealant to movement joints • scour damage	24 hrs	28 days	28 days	Visual inspection	3.3.1	Presence of any defect not recorded in the applicable reference condition (on a location-specific basis) as identified in the BECR	Nil
							3.3.2	Not used	Nil
							3.3.3	Not used	Nil

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Baseline Condition Repair				
3.4	**Gantries and high masts**	Except as otherwise recorded as the reference condition on a structure-specific basis in the BECR: Sign signal gantries, high masts are structurally sound and free of: • loose nuts and bolts • defects in surface protection systems • graffiti	24 hrs	28 days	6 months	Visual inspection	3.4.1	Number of gantries and high masts with loose assemblies	Nil
							3.4.2	Number of gantries and high masts with defects in surface protection	Nil
3.5	**Load ratings**	All structures maintain the design load capacity.	24 hrs	28 days	6 months	Load rating calculations in accordance with the Manual for Bridge Evaluation and the TxDOT Bridge Inspection Manual Load restriction requirements as per the TxDOT Bridge Inspection Manual	3.5.1	Number of structures with load restrictions for Texas legal loads (including legally permitted vehicles)	Nil
3.6	**Access points**	All hatches and points of access have fully operational and lockable entryways.	24 hrs	28 days	6 months	Visual Inspection	3.6.1	Number with defects in locks or entryways	Nil
3.7	**Mechanically Stabilized Earth and Retaining Walls**	Except as otherwise recorded as the reference condition on a structure-specific basis in the BECR: Mechanically Stabilized Earth and Retaining Walls free of: • blocked weep holes • undesirable vegetation • defects in joint sealants • defects in pedestrian protection • scour damage • corrosion of reinforcing bars • paint system failure • concrete spalling • impact damage Parapets free of: • loose nuts and bolts • blockage of drain holes • undesirable vegetation • impact damage • concrete spalling • graffiti	24 hrs	28 days	28 days	Inspection and assessment in accordance with the requirements of federal Nations Bridge Inspection Standards (NBIS) of the Code of Federal Regulations, 23 Highways - Part 650, the TxDOT Bridge Inspection Manual and the Federal Highway Administration's Bridge Inspector's Reference Manual.	3.7.1	Records as required in the TxDOT Bridge Inspection Manual	100%
4) PAVEMENT MARKINGS, OBJECT MARKERS, BARRIER MARKERS AND DELINEATORS									
4.1	**Pavement markings**	Pavement markings are: • clean and visible during the day and at night • placed to meet the TMUTCD and TxDOT's Pavement Marking Standard Sheets	24 hrs	28 days	28 days	**a)** Markings - General			
						Visual inspection (to include a record of visibility of markings under low beam headlights)	4.1.1	Occurrence of any marking visibility condition on a location-specific basis less than the reference condition in the BECR	Nil

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Baseline Condition Repair				
						Physical measurement	4.1.2	Length of pavement marking where the loss of pavement marking material exceeds the reference condition for loss of pavement marking material recorded on a location-sepcific basis in the BECR	Nil
								Not used	
						b) Profile Markings			
						Visual inspection	4.1.3	Profile marking condition at least equal to the reference condition in the BECR	100%
4.2	**Raised reflective markers**	Raised reflective pavement markers are: • clean and clearly visible • of the correct color and type • reflective or retroreflective in accordance with TxDOT Standards • correctly located, aligned and at the correct level • are firmly fixed • are in a condition that will ensure that they remain at the correct level.	24 hrs	28 days	6 months	Visual inspection	4.2.1	Number of markers associated with road markings that are ineffective in any 10 consecutive markers. (Ineffective includes missing, damaged, settled or sunk)	Nil
							4.2.2	Not Used	
							4.2.3	Not Used	
4.3	**Delineators & Markers**	Object markers, mail box markers and delineators are: • clean and visible • of the correct color and type • legible and reflective • straight and vertical	24 hrs	28 days	28 days	Visual inspection	4.3.1	Delineators and markers condition at least equal to the reference condition in the BECR	100%
5) GUARDRAILS, SAFETY BARRIERS AND IMPACT ATTENUATORS									
5.1	**Guardrails and safety barriers**	All guardrails, safety barriers, concrete barriers, etc. are maintained free of defects, graffiti, and undesirable vegetation. They are appropriately placed and correctly installed at the correct height and distance from roadway or obstacles. Installation and repairs shall be carried out in accordance with the requirements of NCHRP 350 standards.	24 hrs	28 days	28 days	Visual inspection	5.1.1	Guardrail condition at least equal to the reference condition in the BECR	100%
							5.1.2	Not used	100%
							5.1.3	Guardrail correct height and offset at least equal to the reference condition in the BECR	100%
							5.1.4	Not used	100%
5.2	**Impact attenuators**	All impact attenuators are appropriately placed and correctly installed	24 hrs	7 days	6 months	Visual inspection	5.2.1	Impact Attenuator condition at least equal to the reference condition in the BECR	100%
6) TRAFFIC SIGNS									
6.1	**Gantry-mounted overhead signs**	Signs are clean, correctly located, clearly visible, legible, reflective, at the correct height and free from structural and electrical defects	24 hrs	28 days	28 days	Visual inspection	6.1.1	Condition of gantry-mounted signs at least equal to the reference condition in the BECR	100%
7) TRAFFIC SIGNALS (NOT PART OF MAINTAINED ELEMENTS)									

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Baseline Condition Repair				
8) LIGHTING									
8.1	**Roadway Lighting**	i) All lighting is free from defects and provides acceptable uniform lighting quality ii) Lanterns are clean and correctly positioned iii) Lighting units are free from any damage or vandalism iv) Columns are upright, correctly founded, visually acceptable and structurally sound	24 hrs	28 days	28 days	Visual inspection	6.1.1	Condition of roadway lighting at least equal to the reference condition in the BECR	100%
9) FENCES, WALLS AND SOUND ABATEMENT									
9.1	**Construction**	Integrity and structural condition of fences is maintained	24 hrs	28 days	6 months	Structural assessment if visual inspection warrants	9.1.1	Inspection records for fences and walls showing compliance with fence and wall requirements	100%
10) ROADSIDE MANAGEMENT									
10.1	**Vegetated Areas - Except landscaped areas – General**	Vegetation is maintained so that: i) Height of grass and weeds is kept within the limits described for urban and rural areas. Mowing begins before vegetation reaches the maximum height. ii) Spot mowing at intersections, ramps or other areas maintains visibility of appurtenances and sight distance. iii) Grass or vegetation does not encroach into or on paved shoulders, main lanes, sidewalks, islands, riprap, traffic barrier or curbs. iv) A full width mowing cycle is completed after the first frost	24 hrs	7 days	28 days	**a) Urban areas** Physical measurement of height of grass and weeds	10.1.1	Individual measurement to have 95% of grass and weeds between 5" and 18"in height.	100%
						b) Rural areas Physical measurement of height of grass and weeds	10.1.2	Individual measurement to have 95% of height of grass and weeds between 5" and 30" in height.	100%
						c) Encroachment Visual inspection of instances of encroachment of vegetation	10.1.3	Number of occurrences of vegetation encroachment	Nil
						d) Sight lines Visual inspection	10.1.4	Number of instances of impairment of sight lines or sight distance to signs	Nil
10.2	**Landscaped Areas**	i) All landscaped areas are maintained to their originally constructed condition. Landscaped areas are as designated in the plans. ii) Mowing, litter pickup, irrigation system maintenance and operation, plant maintenance, pruning, insect, disease and pest control, fertilization, mulching, bed maintenance, watering is undertaken as per MMP. iii) The height of grass and weeds is kept between 2" and 8". Mowing begins before vegetation reaches 8 in.	24 hrs	7 days	28 days	Visual inspection	10.2.1	Inspection records showing compliance with requirements for landscaping.	100%
10.3	**Fire Hazards**	Fire hazards are controlled	24 hrs	7 days	28 days	Visual inspection	10.3.1	Number of instances of dry brush or vegetation forming fire hazard	Nil

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Baseline Condition Repair				
10.4	**Trees, brush and ornamentals**	i) Trees, brush and ornamentals on the right of way, except in established no mow areas, are trimmed in accordance with TxDOT standards. ii) Trees, brush and ornamentals are trimmed to insure they do not interfere with vehicles or sight distance, or inhibit the visibility of signs. iii) Dead trees, brush, ornamentals and branches are removed. Potentially dangerous trees or limbs are removed. iv) All undesirable trees and vegetation are removed. Diseased trees or limbs are treated or removed by licensed contractors.	24 hrs	7 days	28 days	Visual inspection	10.4.1	Inspection records showing compliance with requirements for trees, brush and ornamentals	100%
10.5	**Wetlands**	Wetlands are managed in accordance with the permit requirements.	24 hrs	7 days	28 days	Visual inspection, assessment of permit issuers	10.5.1	Number of instances of permit requirements not met	Nil
11) REST AREAS AND PICNIC AREAS (Not Used)									
12) EARTHWORKS, EMBANKMENTS AND CUTTINGS									
12.1	**Slope Failure**	All structural or natural failures of the embankment and cut slopes of the Project are repaired	24 hrs	28 days	6 months	Visual inspection by geotechnical specialist and further tests as recommended by the specialist	12.1.1	Number of recorded instances of slope failure	Nil
12.2	**Slopes - General**	Slopes are maintained in general conformance to the original graded cross-sections, the replacement of landscaping materials, reseeding and re-vegetation for erosion control purposes and removal and disposal of all eroded materials from the roadway and shoulders	24 hrs	28 days	6 months	Visual inspection by geotechnical specialist and further tests as recommended by the specialist	12.2.1	Inspection records showing compliance with requirements for slopes	100%
13) ITS EQUIPMENT									
13.1	**ITS Equipment - Maintenance**	All ITS equipment is fully functional and housing is functioning and free of defects. i) All equipment and cabinet identification numbers are visible, sites are well drained and access is clear. ii) Steps, handrails and accesses are kept in a good condition. iii) Access to all communication hubs, ground boxes, cabinets and sites is clear. iv) All drainage is operational and all external fixtures and fittings are in a satisfactory condition. v) All communications cable markers, cable joint markers and duct markers are visible and missing markers are replaced. vi) Backup power supply system is available at all times	24 hrs	14 days	1 month	Visual Inspection	13.1.1	Inspection records showing compliance with requirements for maintenance of ITS equipment	100%

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Baseline Condition Repair				
13.2	**Dynamic Message Sign Equipment**	Dynamic Message Signs are free from faults such as: i) Any signal displaying a message which is deemed to be a safety hazard. ii) Failure of system to clear sign settings when appropriate. iii) 2 or more contiguous sign failures that prevent control office setting strategic diversions. iv) Signs displaying an incorrect message.	2 hrs	24 hrs	14 days	Defect measurement dependent on equipment	13.2.1	Inspection records showing compliance with requirements for Dynamic Message Signs	100%
13.3	**CCTV Equipment**	CCTV Systems are free from serious faults that significantly limit the availability of the operators to monitor the area network, such as: i) Failure of CCTV Systems to provide control offices with access and control of CCTV images. ii) Failure of a CCTV camera or its video transmission system. iii) Failure of a Pan / Tilt unit or its control system. iv) Moisture ingress onto CCTV camera lens. v) Faults that result in significant degradation of CCTV images.	2 hrs	24 hrs	14 days	Defect measurement dependent on equipment	13.3.1	Inspection records showing compliance with requirements for CCTV equipment	100%
13.4	**Vehicle Detection Equipment**	All equipment free of defects and operational problems such as:	2 hrs	24 hrs	1 month	Defect measurement dependent on equipment	13.4.1	Inspection records showing compliance with requirements for vehicle detection equipment in each Performance Section	100%
		i) Inoperable loops.				Traffic Detector Loops:	13.4.2	Traffic Detector Loop circuit's inductance to be > 50 and < 1,000 micro henries.	100%
		ii) Malfunctioning camera controllers.				Loop circuit's inductance to be > 50 and < 1,000 micro henries.	13.4.3	Insulation resistance to be > 50 meg ohms.	100%
14) TOLLING Facilities and Buildings (Not Used)									
15) AMENITY									
16) SNOW AND ICE CONTROL									
16.1	**Travel lanes**	Maintain travel way free from snow and ice	2 hrs	N/A	N/A	Maximum 1hr response time to complete manning and loading of spreading vehicles.	16.1.1	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	100%
						Maximum 2hrs from departure from loading point to complete treatment and return to loading point.	16.1.2	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	100%
						Maximum 1hr response time for snow and ice clearance vehicles to depart from base.	16.1.3	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	100%
16.2	**Weather Forecasting**	Weather forecast information is obtained and assessed and appropriate precautionary treatment is carried out to prevent ice forming on the travel way.	2 hrs	N/A	N/A	Operations plan details the process and procedures in place and followed.	16.2.1	Inspection records showing compliance with requirements for weather forecasting in each Performance Section	100%
16.3	**Operational Plans**	Operate snow and ice clearance plans to maintain traffic flows during and after snowfall and restore the travel way to a clear condition as soon as possible.	2 hrs	N/A	N/A	Operations plan details the process and procedures in place and followed.	16.3.1	Inspection records showing compliance with snow and ice clearance plans in each Performance Section	100%

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Baseline Condition Repair				
17) INCIDENT RESPONSE									
17.1	**General**	Monitor the Project and respond to Incidents in accordance with the Maintenance Management Plan (MMP).	1 hr	N/A	N/A	Maintenance Specifications are met for 98% of incidents measured on a 1 year rolling basis.	17.1.1	Inspection records showing compliance with the MMP and requirements regarding incident response times in each Performance Section	100%
						No complaints from Emergency Services.	17.1.2	Inspection records showing compliance with the MMP and requirements regarding incident response times in each Performance Section	100%
17.2	**Hazardous Materials**	Monitor the Project and respond to Incidents involving Hazardous Materials in accordance with the Maintenance Management Plan (MMP).	1 hr	N/A	N/A	MMP details the process and procedures in place and followed.	17.2.1	Inspection records showing compliance with the MMP details regarding hazardous materials in each Performance Section	100%
17.3	**Structural assessment**	Evaluate structural damage to structures and liaise with emergency services to ensure safe working environment while clearing the incident	1 hr	N/A	N/A	Inspections and surveys as required by incident	17.3.1	Inspection records showing compliance with the MMP and requirements for incidents in each Performance Section	100%
17.4	**Temporary and permanent remedy**	Propose and implement temporary measures or permanent repairs to Defects arising from the incident. Ensure the structural safety of any structures affected by the Incident.	24 hrs	28 days	N/A	Review and inspection of the incident site	17.4.1	Inspection records showing compliance with requirements for temporary and permanent remedy for incidents in each Performance Section	100%
18) CUSTOMER RESPONSE									
18.1	**Response to inquiries**	Timely and effective response to customer inquiries and complaints.	48 hrs	NA	NA	Contact the customer within 48 hours following initial customer inquiry.	18.1.1	Percentage of responses within specified times in each Performance Section.	100%
						All work resulting from customer requests is scheduled within 48 hours of customer contact.	18.1.2	Demonstrated by O&M Records	100%
						Follow-up contact with the customer within 72 hours of initial inquiry.	18.1.3	Demonstrated by O&M Records	100%
						All customer concerns/requests are resolved to TxDOT's satisfaction within 2 weeks of the initial inquiry.	18.1.4	Demonstrated by O&M Records	100%
18.2	**Customer Contact Line**	Telephone line manned during business hours and 24 hour availability of messaging system. Faults to telephone line or message system rectified.	24 hrs	7 days	NA	Instances of line out of action or unmanned	18.2.1	Number of operations records showing non availability of the customer contact line in each Performance Section including complaints from public.	Nil
19) SWEEPING AND CLEANING									
19.1	**Sweeping**	i) Keep all channels, hard shoulders, gore areas, ramps, intersections, islands and frontage roads swept clean with vacuum sweepers, ii) Clear and remove debris from traffic lanes, hard shoulders, verges and central reservations, footways and cycle ways iii) Remove all sweepings without stockpiling in the right of way and dispose of at approved tip.	24 hrs	28 days	3 months	Buildup of dirt, ice, rock, debris, etc. on roadways and bridges not to accumulate greater than 24" wide or 1/2" deep	19.1.1	Inspection records showing compliance with requirements for sweeping in each Performance Section.	100%
19.2	**Litter**	i) Keep the right of way in a neat condition, remove litter regularly. ii) Pick up large litter items before mowing operations. Dispose of all litter and debris collected at an approved solid waste site.	24 hrs	28 days	3 months	No more than 20 pieces of litter per roadside mile shall be visible when traveling at highway speed.	19.2.1	Inspection records showing compliance with requirements regarding litter pick-up in each Performance Section.	100%

ATTACHMENT 19-2: PERFORMANCE AND MEASUREMENT TABLE BASELINE FOR ROADWAY SECTION DURING CONSTRUCTION

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Baseline Condition Repair				

NOTES FOR ATTACHMENT 19-1

1 Hazard Mitigation shall be an action taken by Developer to mitigate a hazard to Users or imminent risk of damage or deterioration to property or the environment such that the Category 1 Defect no longer exists.

2 Permanent Remedy shall be an action taken by Developer to restore the condition of an Element following Hazard Mitigation of a Category 1 Defect: (a) to the standard required for new construction / Renewal Work; or (b) to a condition such that the Target is achieved for each Measurement Record.

3 Baseline Condition Repair shall be an action taken by Developer to restore the condition of an Element for which a Category 2 Defect has been recorded: (a) to the standard required for new construction / Renewal Work; or (b) to a condition such that the Target is achieved for each Measurement Record.

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 19-3
BASELINE PERFORMANCE AND MEASUREMENT TABLE ROADWAY SECTION AFTER SUBSTANTIAL COMPLETION

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1 Hazard Mitigation	Cat 1 Permanent Remedy	Cat 2 Permanent Repair				
1) ROADWAY						*Unless stated otherwise, measurements shall be conducted using procedures, techniques, and measuring equipment consistent with TxDOT's Pavement Management Information System Rater's Manual.* *Renewal Work and new construction are subject to construction quality IRI standards (75 inches per mile for rigid pavements, 65 inches per mile for flexible pavements- refer to Technical Provisions Section 8.3.2)*			
1.1	**Obstructions and debris**	Roadway and clear zone free from obstructions and debris	2 hrs	NA	NA	Visual Inspection	1.1.1	Number of obstructions and debris	Nil
1.2	**Pavement**	All roadways have a smooth and quiet surface course (including bridge decks, covers, gratings, frames and boxes) with adequate skid resistance and free from Defects.	24 hrs	28 days	6 months	**a) Ruts – Mainlanes, shoulders & ramps** Depth as measured using an automated device in compliance with TxDOT Standards.		*Percentage of wheel path length with ruts greater than ¼" in depth in each Performance Section*	
							1.2.1	• Mainlanes, shoulders and ramps - 3%	Nil
							1.2.2	• Frontage roads - 10%	Nil
						10ft straight edge used to measure rut depth for localized areas.	1.2.3	Depth of rut at any location greater than ½"	Nil
						b) Ride quality Measurement of International Roughness Index (IRI) according to TxDOT standard Tex-1001-S, Operating Inertial Profilers and Evaluating Pavement Profiles		*For 80% of all Performance Sections measured, IRI throughout 98% of each Performance Section is less than or equal to:*	
							1.2.4	• Mainlanes, ramps -95" per mile**	100%
						~~** To allow for measurement bias, an adjustment of -10 (minus ten) is made to IRI measurements for concrete pavements before assessing threshold compliance.~~	1.2.5	• Frontage roads - 120" per mile**	100%
								IRI throughout 98% of each Performance Section is less than or equal to:	
							1.2.6	• Mainlanes, ramps - 120" per mile**	100%
							1.2.7	• Frontage roads - 150" per mile**	100%
							1.2.8	Mainlanes, ramps, 0.1 mile average - 150" per mile**	100%
							1.2.9	Frontage roads, 0.1 mile average - 180" per mile**	100%
						10-ft straightedge used to measure discontinuities	1.2.10	IRI measured throughout 98% of each lane containing a bridge deck in any Performance Section, 0.1 mile average - 200" per mile**	100%
						c) Failures Instances of failures exceeding the failure criteria set forth in the TxDOT PMIS Rater's Manual, including potholes, base failures, punchouts and jointed concrete pavement failures	1.2.11	Individual discontinuities greater than 1/4"	Nil
							1.2.12	Occurrence of any failure	Nil
						d) Edge drop-offs Physical measurement of edge drop-off level compared to adjacent surface	1.2.13	Number of instances of edge drop-off greater than 2"	Nil

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
1.2	**Pavement**	Road users warned of potential skidding hazards	24 hrs	28 days	6 months	**e) Skid resistance** ASTM E 274 Standard Test Method for Skid Resistance Testing of Paved Surfaces at 50 MPH using a full scale smooth tire meeting the requirements of ASTM E 524	1.2.14	• Performance Sections with skid numbers for 0.5-mile section of mainlines, shoulders and ramps exceeding 30 and for which investigations as to potential risk of skidding accidents and appropriate remedial actions have been taken.	100%
							1.2.15	• Performance Sections with skid numbers for 0.5-mile section of frontage roads exceeding 30 and for which investigations as to potential risk of skidding accidents and appropriate remedial actions have been taken.	100%
							1.2.16	• When the skid number is below 25 and/or when a site is categorized by TxDOT in accordance with the Wet Weather Accident Reduction Program, as a Wet Weather Accident Site, Developer shall perform a site investigation and perform required corrective action.	100%
							1.2.17	Instances where road users are warned of a potential skidding hazard where corrective action is required following the categorization as a Wet Weather Accident Reduction Site.	100%
1.3	**Crossovers and other paved areas**	Crossovers and other paved areas are free of Defects	24 hrs	28 days	6 months	**a) Potholes**	1.3.1	Number of potholes of low severity or higher	Nil
						b) Base failures	1.3.2	Number of base failures of low severity or higher	Nil
1.4	**Joints in concrete**	Joints in concrete paving are sealed and watertight Longitudinal joint separation is controlled	24 hrs	28 days	6 months	Visual inspection of joints	1.4.1	Length of unsealed joints greater than ¼"	Nil
						Measurement of joint width and level difference of two sides of joints	1.4.2	Joint width more than 1" or faulting more than ¼"	Nil
1.5	**Curbs**	Curbs are in good alignment and free of Defects	24 hrs	28 days	6 months	Visual inspection	1.5.1	Continuous curb lengths where more than 10% of the length has defects such as cracks and chips	Nil
						Physical measurement	1.5.2	Continuous curb lengths where more than 5% of the length has a separation exceeding 0.25" between curb face and adjacent roadway surface	Nil
						Survey and 10' straight edge	1.5.3	Continuous curb lengths where more than 5% of the length has either the top or face of curbs exceeding 0.5" from intended design alignment	Nil
1.6	**Maintenance/Access Roads**	Maintenance / access roads are fee of Defects	24 hrs	28 days	6 months	Crown: Flat A shape or super-elevation with 4% cross slopes maintained to minimize ponding	1.6.1	Cross slope less than 3% or more than 6%	Nil
						Shoulder: Maintain slope away from the travel way and shoulder flush with travel way	1.6.2	Shoulder cross slope less than travel way cross slope; shoulder lower or higher than travel way	Nil
						Ditch: Maintain size and shape of ditch for proper drainage	1.6.3	Sides of ditches slumping or eroding, or obstructed by debris	Nil
						Ruts/potholes: Depth as measured using an automated device in compliance with TxDOT standards	1.6.4	Depth of ruts or potholes at any location greater than 1"	Nil
						Subgrade: Identify and repair any subgrade failures	1.6.5	Locations where subgrade failure is evident	Nil

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
2) DRAINAGE									
2.1	**Pipes and Channels**	Each element of the drainage system is maintained in its proper function by cleaning, clearing and/or emptying as appropriate from the point at which water drains from the travel way to the outfall or drainage way.	24 hrs	28 days	6 months	Visual inspection supplemented by CCTV where required to inspect buried pipe work.	2.1.1	Length of pipe or channel in feet with less than 90% of cross sectional clear area, calculated as the arithmetic mean of the clear cross-sectional areas of individual 10 feet lengths of pipes and channels in each Performance Section.	Nil
2.2	**Drainage treatment devices**	Drainage treatment and balancing systems, flow and spillage control devices function correctly and their location and means of operation is recorded adequately to permit their correct operation on Emergency.	24 hrs	28 days	6 months	Visual inspection	2.2.1	Number of devices functioning correctly with means of operation displayed.	100%
2.3	**Travel Way**	The travel way is free from water to the extent that such water would represent a hazard by virtue of its position and depth.	24 hrs	28 days	6 months	Visual inspection of water on surface.	2.3.1	Number of instances of hazardous water build-up.	Nil
2.4	**Discharge systems**	Surface water discharge systems perform their proper function and discharge to groundwater and waterways complies with the relevant legislation and permits.	24 hrs	28 days	6 months	Visual inspection and records	2.4.1	Performance Sections with surface water discharge systems performing their proper function and discharging in compliance with the relevant legislation and permits.	100%
2.5	**Protected Species**	Named species and habitats are protected.	24 hrs	28 days	6 months	Visual inspection	2.5.1	Performance Sections with named species and habitats with protection of these named species and habitats.	100%
3) STRUCTURES									
3.1	**Structures having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or springlines of arches or extreme ends of openings or multiple boxes**	Substructures and superstructures are free of: • undesirable vegetation • debris and excessive bird droppings • blocked drains, weep pipes manholes and chambers • blocked drainage holes in structural components	24 hrs	28 days	6 months	Inspection and assessment in accordance with the requirements of federal National Bridge Inspection Standards (NBIS) of the Code of Federal Regulations, 23 Highways – Part 650, the TxDOT Bridge Inspection Manual, and the Federal Administration's Bridge Inspector's Reference Manual.		*Records as required in the TxDOT Bridge Inspection Manual*	
		• defects in joint sealants • defects in pedestrian protection measure • scour damage • corrosion of rebar • paint system failures • impact damage				As above	3.1.1	Occurrence of condition rating, in accordance with the TxDOT Bridge Inspection Manual, below seven for any deck, superstructure or substructure	Nil
						~~As above~~	~~3.1.2~~	~~Performance Sections with structure components with condition states of one, in accordance with the TxDOT Field Inspection Manual~~	~~100%~~

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
3.2	**Structure components**	i) Expansion joints are free of: • dirt debris and vegetation • defects in drainage systems • loose nuts and bolts • defects in gaskets ii) The deck drainage system is free of all debris and operates as intended. iii) Parapets are free of: • loose nuts or bolts • blockages of hollow section drain holes • vegetation • accident damage iv) Bearings and bearing shelves are clean. Bearings allow for translation and rotation as designed. No presence of water exists on bearings and bearing seats. v) Sliding and roller surfaces are clean and greased to ensure satisfactory performance. Additional advice contained in bearing manufacturers' instructions is followed. vi) Special finishes are clean and perform to the appropriate standards. vii) All non-structural items such as hoists and electrical fixings, operate correctly, are clean and lubricated as appropriate, in accordance with the manufacturer's recommendations and certification of lifting devices is maintained.	24 hrs	28 days	6 months	Inspection and assessment in accordance with the requirements of federal National Bridge Inspection Standards (NBIS) of the Code of Federal Regulations, 23 Highways – Part 650, the TxDOT Bridge Inspection Manual, and the Federal Administration's Bridge Inspector's Reference Manual.	3.2.1	Occurrence of condition rating, in accordance with the TxDOT Bridge Inspection Manual, below **seven (7)** for any deck, superstructure or substructure	Nil
						Visual inspection of Elements listed in (i) through (vii) of the general performance requirement column.	3.2.2	Instances of condition of any element not meeting general performance requirement as determined in accordance with Good Industry Practice.	Nil
3.9	**Non-bridge class culverts**	Non-bridge-class culverts are free of: • vegetation and debris and silt • defects in sealant to movement joints • scour damage	24 hrs	28 days	NA	Visual inspection	3.9.1	Number of non-bridge class culverts with vegetation, debris and silt in each Performance Section	Nil
							3.9.2	Number of non-bridge class culverts with defects in sealant and movement joints in each Performance Section	Nil
							3.9.3	Number of non-bridge class culverts with scour damage in each Performance Section	Nil
3.10	**Gantries and High-masts**	Overhead sign bridges, high masts are structurally sound and free of: • loose nuts and bolts • defects in surface protection systems	24 hrs	28 days	NA	Visual and up close inspection	3.10.1	Number of gantries and high masts with loose assemblies in each Performance Section	Nil
							3.10.2	Number of gantries and high masts with defects in surface protection in each Performance Section	Nil
3.11	**Load Ratings**	All structures maintain the design load capacity.	24 hrs	7 days	NA	Load rating calculations in accordance with the Manual for Bridge Evaluation and the TxDOT Bridge Inspection Manual and per the Technical Provisions	3.11.1	Number of structures with load restrictions for Texas legal loads (including legally permitted vehicles) in each Performance Section	Nil
3.12	**Access Points**	All hatches and points of access have fully operational and lockable entryways.	24 hrs	28 days	6 months	Visual Inspection	3.12.1	Number with defects in locks or entryways	Nil

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
3.13	**Mechanically Stabilized Earth and Retaining Walls**	Mechanically Stabilized Earth and Retaining Walls free of: • blocked weep holes • undesirable vegetation • defects in joint sealants • defects in pedestrian protection • scour damage • corrosion of reinforcing bars • paint system failure • concrete spalling • impact damage	24 hrs	28 days	6 months	Inspection and assessment in accordance with the requirements of federal Nations Bridge Inspection Standards (NBIS) of the Code of Federal Regulations, 23 Highways - Part 650, the TxDOT Bridge Inspection Manual and the Federal Highway Administration's Bridge Inspector's Reference Manual.	3.13.1	Records as required in the TxDOT Bridge Inspection Manual	100%
		Parapets free of: • loose nuts and bolts • blockage of drain holes • undesirable vegetation • impact damage • concrete spalling				Visual Inspection	3.13.2	Number of parapet areas with loose nuts & bolts, blockage, undesirable vegetation, impact damage or concrete spalling in the Performance Section.	Nil
3.14	**Structural Surfaces**	Vertical Surfaces free of graffiti, markings by vandalism.	24 hrs	28 days	6 months	Visual Inspection	3.14.1	Number of areas where graffiti is present	Nil
4) PAVEMENT MARKINGS, OBJECT MARKERS, BARRIER MARKERS AND DELINEATORS									
4.1	**Pavement markings**	Pavement markings are: • clean and visible during the day and at night • whole and complete and of the correct color, type, width and length • placed to meet the TMUTCD and TxDOT's Pavement Marking Standard Sheets	24 hrs	28 days	6 months	**a) Markings - General**			
						Portable retroreflectometer, which uses 30 meter geometry, meeting the requirements described in ASTM E 1710	4.1.1	Percentage of total length of pavement marking in each Performance Section meeting the minimum retroreflectivity 175 med/sqm/lx for white	100%
							4.1.2	Percentage of total length of pavement marking in each Performance Section meeting the minimum retroreflectivity 125 med/sqm/lx for ~~white~~ yellow	100%
						Physical measurement	4.1.3	Length of pavement marking in each Performance Section with more than 5% loss of area of material at any point	Nil
							4.1.4	Length of pavement marking in each Performance Section with spread more than 10% of specified dimensions.	Nil
						b) Profile Markings			
						Visual inspection	4.1.5	Percentage of total length of pavement marking in each Performance Section performing its intended function and compliant with relevant regulations	100%
4.2	**Raised Reflective Markings**	Raised reflective pavement markers are: • clean and clearly visible • of the correct color and type • reflective or retroreflective in accordance with TxDOT standards • correctly located, aligned and at the correct level • are firmly fixed • are in a condition that will ensure that they remain at the correct level.	24 hrs	28 days	6 months	Visual inspection	4.2.1	Number of markers associated with road markings that are ineffective in any 10 consecutive markers. (Ineffective includes missing, damaged, settled or sunk)	Nil
							4.2.2	A minimum of four markers are visible at 80' spacing when viewed under low beam headlights.	100%
							4.2.3	Uniformity (replacement raised reflective pavement markers have equivalent physical and performance characteristics to adjacent markers).	100%

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
4.3	**Delineators and Markers**	Object markers, mail box markers and delineators are: • clean and visible • of the correct color and type • legible and reflective • straight and vertical	24 hrs	28 days	6 months	Visual inspection	4.3.1	Number of object markers or delineators in each Performance Section that is defective or missing	Nil
5) GUARDRAILS, SAFETY BARRIERS AND IMPACT ATTENUATORS									
5.1	**Guardrails and Safety Barriers**	All guardrails, safety barriers, concrete barriers, etc. are maintained free of Defects, , and undesirable vegetation. They are appropriately placed and correctly installed at the correct height and distance from roadway or obstacles. Installation and repairs shall be carried out in accordance with the requirements of NCHRP 350 standards.	24 hrs	28 days	6 months	Visual inspection	5.1.1	Performance Sections with all guard rails and safety barriers appropriately placed and correction installed	100%
							5.1.2	Performance Sections with all guard rails and safety barriers free from defects	100%
							5.1.3	Performance Sections with all guard rails and safety barriers at correct heights	100%
							5.1.4	Performance Sections with all guard rails and safety barriers at correct distances from roadway obstacles	100%
5.2	**Impact Attenuators**	All impact attenuators are appropriately placed and correctly installed	24 hrs	28 days	6 months	Visual inspection	5.2.1	Performance Sections will all impact attenuators appropriately placed and correctly installed.	100%
6) TRAFFIC SIGNS									
6.1	**General - All Gantry-Mounted overhead signs**	i) Signs are clean, correctly located, clearly visible, legible, reflective, at the correct height and free from structural and electrical defects	24 hrs	28 days	6 months	**a) Retroreflectivity** Determination of Coefficient of retro-reflectivity	6.1.1	Number of signs with actual reflectivity below the requirements of TxDOT's TMUTCD in each Performance Section	Nil
		ii) Identification markers are provided, correctly located, visible, clean and legible				**b) Face damage** Visual inspection	6.1.2	Number of signs in each Performance Section with face damage greater than 5% of area	Nil
		iii) Visibility distances meet the stated requirements				**c) Placement** Visual inspection	6.1.3	All signs in each Performance Section are placed in accordance with TxDOT's Sign Crew Field Book including not twisted or leaning	100%
		iv) Obsolete and redundant signs are removed or replaced as appropriate				**d) Obsolete signs** Visual inspection	6.1.4	Number of obsolete signs in each Performance Section	100%
		v) Sign information is of the correct size, location, type and wording to meet its intended purpose and any statutory requirements vi) All structures and elements of the signing system are kept clean and free from debris and have clear access provided. vii) All replacement and repair materials and equipment are in accordance with the requirements of the TMUTCD				**e) Sign Information** Visual inspection	6.1.5	All sign information in each Performance Section is of the correct size, location, type and wording to meet its intended purpose	100%
		viii) Dynamic message signs are in an operational condition				**f) Dynamic Message Signs** Visual inspection	6.1.6	Dynamic message signs are fully functioning	100%

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
6.2	**Gantries**	Sign and signal mounting structures (including gantries) are structurally sound and free of: • defects in surface protection systems	24 hrs	28 days	6 months	Visual inspection	6.2.1	Number with defects in surface protection system	Nil
		• loose nuts and bolts					6.2.1	Number with loose nuts and bolts	Nil
		• graffiti					6.2.3	Number with graffiti	Nil
7) TRAFFIC SIGNALS (NOT PART OF MAINTAINED ELEMENTS)									
8) LIGHTING									
8.1	**Roadway Lighting**	i) All lighting is free from defects and provides acceptable uniform lighting quality ii) Lanterns are clean and correctly positioned iii) Lighting units are free from any damage or vandalism iv) Columns are upright, correctly founded, visually acceptable and structurally sound	24 hrs	28 days	6 months	**a) Mainlane lights operable** Night time inspection or automated logs	8.1.1	Performance Sections with less than 90% of lights functioning correctly at all times	Nil
						b) Mainlane lights out of action Night time inspection or automated logs	8.1.2	Instances of more than two consecutive lights out of action	Nil
8.2	**Sign Lighting**	Sign lighting is fully operational	24 hrs	28 days	6 months	Night time inspection or automated logs	8.2.1	Number of instances of more than one bulb per sign not working in each Performance Section	Nil
8.3	**Electrical Supply**	Electricity supply, feeder pillars, cabinets, switches and fittings are electrically, mechanically and structurally sound and functioning	24 hrs	7 days	28 days	Testing to meet NEC regulations, visual inspection	8.3.1	Inspection records showing safe installation and maintenance in each Performance Section	Nil
8.4	**Access Panels**	All access panels in place at all times.	24 hrs	7 days	28 days	Visual Inspection	8.4.1	Number of instances of missing or damaged access panels in each Performance Section	Nil
8.5	**High Mast Lighting**	i) All high mast luminaries functioning on each pole ii) All obstruction lights are present and working (if required) iii) Compartment door is secure with all bolts in place iv) All winch and safety equipment is correctly functioning and maintained without rusting or corrosion	24 hrs	28 days	6 months	Night-time inspections or automated logs	8.5.1	Instances of two or more lamps not working per high mast pole	Nil
							8.5.2	Any other defects per the "general Performance Requirements" column	Nil

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
9) FENCES, WALLS AND SOUND ABATEMENT									
9.1	**Design and Location**	Fences and walls act as designed and serve the purpose for which they were intended	24 hrs	28 days	6 months	Visual Inspection	9.1.1	Inspection records for fences and walls showing compliance with fence and wall requirements in each Performance Section	100%
9.2	**Construction**	Integrity and structural condition of the fence is maintained	24 hrs	28 days	6 months	Structural assessment if visual inspection warrants	9.2.2	Inspection records for fences and walls showing compliance with fence and wall requirements in each Performance Section	100%
9.3	**Operation**	Fences, Walls, and Sound Abatement elements free of: • blocked weep holes • undesirable vegetation • defects in joint sealants • defects in pedestrian protection • scour damage • corrosion of reinforcing bars • paint system failure • concrete spalling • impact damage • graffiti	24 hrs	28 days	6 months	Structural assessment if visual inspection warrants	9.3.1	Inspection records for fences and walls showing compliance with fence and wall requirements in each Performance Section	100%
10) ROADSIDE MANAGEMENT									
10.1	**Vegetated Areas - Except landscaped areas - General**	Vegetation is maintained so that: i) Height of grass and weeds is kept within the limits described for urban and rural areas. Mowing begins before vegetation reaches the maximum height. ii) Spot mowing at intersections, ramps or other areas maintains visibility of appurtenances and sight distance. iii) Grass or vegetation does not encroach into or on paved shoulders, main lanes, sidewalks, islands, riprap, traffic barrier or curbs. iv) A herbicide program is undertaken in accordance with the TxDOT Herbicide Manual to control noxious weeds and to eliminate grass in pavement or concrete. v) A full width mowing cycle is completed after the first frost.	24 hrs	7 days	28 days	**a) Urban areas** Physical measurement of height of grass and weeds	10.1.1	Individual measurement areas in each Performance Section to have 95% of grass and weeds between 5" and 18" in height.	100%
						b) Encroachment Visual inspection of instances of encroachment of vegetation	10.1.2	Number of occurrences of vegetation encroachment in each Performance Section	Nil
						c) Wildflowers Visual Inspection with audit of process.	10.1.3	Adherence to vegetation management manuals	100%
						d) Sight lines Visual inspection	10.1.4	Number of instances of impairment of sight lines or sight distance to signs in each Performance Section	Nil
10.2	**Landscaped Areas**	i) All landscaped areas are maintained to their originally constructed condition. Landscaped areas are as designated in the plans. ii) Mowing, litter pickup, irrigation system maintenance and operation, plant maintenance, pruning, insect, disease and pest control, fertilization, mulching, bed maintenance, watering is undertaken as per MMP. iii) The height of grass and weeds is kept between 2" and 8". Mowing begins before vegetation reaches 8 in. iv) Damaged or dead vegetation is replaced. v) Areas under approach structures are kept free of weeds and undesirable vegetation, and under-bridge gravel or rip-rap is maintained in its originally constructed condition.	24 hrs	7 days	28 days	Visual inspection	10.2.1	Inspection records showing compliance with requirements for landscaping in each Performance Section.	100%

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
10.3	**Fire Hazards**	Fire hazards are controlled	24 hrs	7 days	28 days	Visual inspection	10.3.1	Number of instances of dry brush or vegetation forming fire hazard in each Performance Section.	Nil
10.4	**Trees, Bushes and Ornamentals**	i) Trees, brush and ornamentals on the right of way, except in established no mow areas, are trimmed in accordance with TxDOT standards. ii) Trees, brush and ornamentals are trimmed to insure they do not interfere with vehicles or sight distance, or inhibit the visibility of signs. iii) Dead trees, brush, ornamentals and branches are removed. Potentially dangerous trees or limbs are removed. iv) All undesirable trees and vegetation are removed. Diseased trees or limbs are treated or removed by licensed contractors.	24 hrs	7 days	28 days	Visual inspection	10.4.1	Inspection records showing compliance with requirements for trees, brush and ornamentals in each Performance Section.	100%
10.5	**Wetlands**	Wetlands are managed in accordance with the permit requirements.	24 hrs	7 days	28 days	Visual inspection, assessment of permit issuers	10.5.1	Number of instances of permit requirements not met in each Performance Section	Nil
11) REST AREAS AND PICNIC AREAS (Not Used)									
12) EARTHWORKS, EMBANKMENTS AND CUTTINGS									
12.1	**Slope Failure**	All structural or natural failures of the embankment and cut slopes of the Project are repaired	24 hrs	28 days	6 months	Visual inspection by geotechnical specialist and further tests as recommended by the specialist	12.1.1	Number of recorded instances of slope failure in each Performance Section	Nil
12.2	**Slopes - General**	Slopes are maintained in general conformance to the original graded cross-sections, the replacement of landscaping materials, reseeding and re-vegetation for erosion control purposes and removal and disposal of all eroded materials from the roadway and shoulders	24 hrs	28 days	6 months	Visual inspection by geotechnical specialist and further tests as recommended by the specialist	12.2.1	Inspection records showing compliance with requirements for slopes in each Performance Section.	100%

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
13) ITS EQUIPMENT									
13.1	**ITS Equipment - Maintenance**	All ITS equipment is fully functional and housing is functioning and free of defects. i) All equipment and cabinet identification numbers are visible, sites are well drained and access is clear. ii) Steps, handrails and accesses are kept in a good condition. iii) Access to all communication hubs, ground boxes, cabinets and sites is clear. iv) All drainage is operational and all external fixtures and fittings are in a satisfactory condition. v) All communications cable markers, cable joint markers and duct markers are visible and missing markers are replaced. vi) Backup power supply system is available at all times	24 hrs	14 days	28 days	Visual Inspection	13.1.1	Inspection records showing compliance with requirements for maintenance of ITS equipment in each Performance Section.	100%
13.2	**Dynamic Message Sign Equipment**	Dynamic Message Signs are free from faults such as: i) Any signal displaying a message which is deemed to be a safety hazard. ii) Failure of system to clear sign settings when appropriate. iii) 2 or more contiguous sign failures that prevent control office setting strategic diversions. iv) Signs displaying an incorrect message.	2 hrs	24 hrs	14 days	Defect measurement dependent on equipment	13.2.1	Inspection records showing compliance with requirements for Dynamic Message Signs in each Performance Section	100%
13.3	**CCTV Equipment**	CCTV Systems are free from serious faults that significantly limit the availability of the operators to monitor the area network, such as: i) Failure of CCTV Systems to provide control offices with access and control of CCTV images. ii) Failure of a CCTV camera or its video transmission system. iii) Failure of a Pan / Tilt unit or its control system. iv) Moisture ingress onto CCTV camera lens. v) Faults that result in significant degradation of CCTV images.	2 hrs	24 hrs	14 days	Defect measurement dependent on equipment	13.3.1	Inspection records showing compliance with requirements for CCTV equipment in each Performance Section	100%
13.4	**Vehicle Detection Equipment**	All equipment free of defects and operational problems such as: i) Inoperable loops. ii) Malfunctioning camera controllers.	2 hrs	24 hrs	28 days	Defect measurement dependent on equipment	13.4.1	Inspection records showing compliance with requirements for vehicle detection equipment in each Performance Section	100%
							13.4.2	Traffic Detector Loop circuit's inductance to be > 50 and < 1,000 micro henries.	100%
							13.4.3	Insulation resistance to be > 50 meg ohms.	100%

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
14) TOLLING FACITLITIES AND BUILDINGS (NOT USED)									
15) AMENITY (NOT USED)									
16) SNOW AND ICE CONTROL									
16.1	**Travel lanes**	Maintain travel way free from snow and ice.	2 hrs	NA	NA	Maximum 1hr response time to complete manning and loading of spreading vehicles.	16.1.1	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	100%
						Maximum 2hrs from departure from loading point to complete treatment and return to loading point.	16.1.2	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	100%
						Maximum 1hr response time for snow and ice clearance vehicles to depart from base.	16.1.3	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	100%
16.2	**Weather Forecasting**	Weather forecast information is obtained and assessed and appropriate precautionary treatment is carried out to prevent ice forming on the travel way.	2 hrs	NA	NA	Operations plan details the process and procedures in place and followed.	16.2.1	Inspection records showing compliance with requirements for weather forecasting in each Performance Section	100%
16.3	**Operational Plans**	Operate snow and ice clearance plans to maintain traffic flows during and after snowfall and restore the travel way to a clear condition as soon as possible.	2 hrs	NA	NA	Operations plan details the process and procedures in place and followed.	16.3.1	Inspection records showing compliance with snow and ice clearance plans in each Performance Section	100%
16.4	**Operations and Maintenance Manual**	Operations and maintenance instructions for the anti-icing system and items of equipment (if Used)	2 hrs	NA	NA	Operations and maintenance instructions detail the process and procedures in place and followed.	16.4.1	Inspection records showing compliance with operations and maintenance instructions in each Performance Section.	100%
17) INCIDENT RESPONSE									
17.1	**General**	Monitor the Project and respond to Incidents in accordance with the Maintenance Management Plan (MMP).	1 hr	NA	NA	Response times are met for 98% of incidents measured on a 1 year rolling basis.	17.1.1	Inspection records showing compliance with the MMP and requirements regarding incident response times in each Performance Section	100%
						No complaints from Emergency Services.	17.1.2	Inspection records showing compliance with the MMP and requirements regarding incident response times in each Performance Section	100%
17.2	**Hazardous Materials**	Monitor the Project and respond to Incidents involving Hazardous Materials in accordance with the Maintenance Management Plan (MMP).	1 hr	NA	NA	MMP details the process and procedures in place and followed.	17.2.1	Inspection records showing compliance with the MMP details regarding hazardous materials in each Performance Section	100%
17.3	**Structural Assessment**	Evaluate structural damage to structures and liaise with emergency services to ensure safe working environment while clearing the incident	1 hr	NA	NA	Inspections and surveys as required by incident	17.3.1	Inspection records showing compliance with the MMP and requirements for incidents in each Performance Section	100%
17.4	**Temporary and permanent remedy**	Propose and implement temporary measures or permanent repairs to Defects arising from the incident. Ensure the structural safety of any structures affected by the Incident.	24 hrs	28 days	NA	Review and inspection of the incident site	17.4.1	Inspection records showing compliance with requirements for temporary and permanent remedy for incidents in each Performance Section	100%

ELEMENT CATEGORY	ELEMENT	PERFORMANCE REQUIREMENT	DEFECT REMEDY PERIOD			INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	TARGET
			Cat 1	Cat 1	Cat 2				
			Hazard Mitigation	Permanent Remedy	Permanent Repair				
18) CUSTOMER RESPONSE									
18.1	**Response to inquiries**	Timely and effective response to customer inquiries and complaints.	48 hrs	NA	NA	Contact the customer within 48 hours following initial customer inquiry.	18.1.1	Percentage of responses within specified times in each Performance Section.	100%
						All work resulting from customer requests is scheduled within 48 hours of customer contact.	18.1.2	Demonstrated by O&M Records	100%
						Follow-up contact with the customer within 72 hours of initial inquiry.	18.1.3	Demonstrated by O&M Records	100%
						All customer concerns/requests are resolved to TxDOT's satisfaction within 2 weeks of the initial inquiry.	18.1.4	Demonstrated by O&M Records	100%
18.2	**Customer Contact Line**	Telephone line manned during business hours and 24 hour availability of messaging system. Faults to telephone line or message system rectified.	24 hrs	7 days	NA	Instances of line out of action or unmanned	18.2.1	Number of operations records showing non availability of the customer contact line in each Performance Section including complaints from public.	Nil
19) SWEEPING AND CLEANING									
19.1	**Sweeping**	i) Keep all channels, hard shoulders, gore areas, ramps, intersections, islands and frontage roads swept clean with vacuum sweepers, ii) Clear and remove debris from traffic lanes, hard shoulders, verges and central reservations, footways and cycle ways iii) Remove all sweepings without stockpiling in the right of way and dispose of at approved tip.	24 hrs	28 days	3 months	Buildup of dirt, ice, rock, debris, etc. on roadways and bridges not to accumulate greater than 24" wide or 1/2" deep	19.1.1	Inspection records showing compliance with requirements for sweeping in each Performance Section.	100%
19.2	**Litter**	i) Keep the right of way in a neat condition, remove litter regularly. ii) Pick up large litter items before mowing operations. Dispose of all litter and debris collected at an approved solid waste site.	24 hrs	28 days	3 months	No more than 20 pieces of litter per roadside mile shall be visible when traveling at highway speed.	19.2.1	Inspection records showing compliance with requirements regarding litter pick-up in each Performance Section.	100%

NOTES FOR ATTACHMENT 19-3

1 Hazard Mitigation shall be an action taken by Developer to mitigate a hazard to Users or imminent risk of damage or deterioration to property or the environment such that the Category 1 Defect no longer exists.

2 Permanent Remedy shall be an action taken by Developer to restore the condition of an Element following Hazard Mitigation of a Category 1 Defect: (a) to the standard required for new construction / Renewal Work; or (b) to a condition such that the Target is achieved for each Measurement Record.

3 Permanent Repair shall be an action taken by Developer to restore the condition of an Element for which a Category 2 Defect has been recorded: (a) to the standard required for new construction / Renewal Work; or (b) to a condition such that the Target is achieved for each Measurement Record.

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

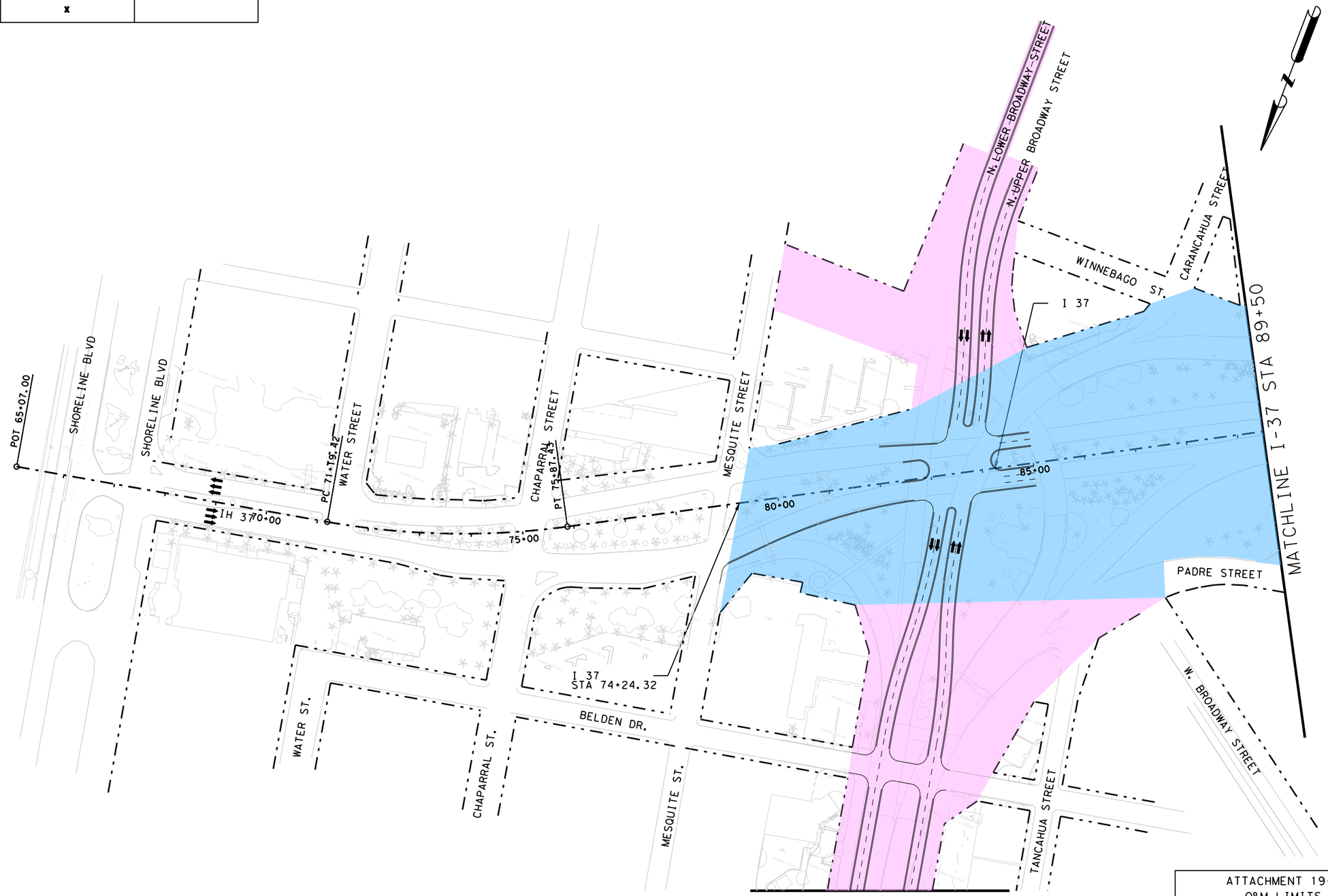
DESIGN-BUILD PROJECT

ATTACHMENT 19-4
OPERATIONS AND MAINTENANCE LIMITS

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW

PROPOSED ROW



MATCHLINE C-C
SEE SHEET 15 OF 15

ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

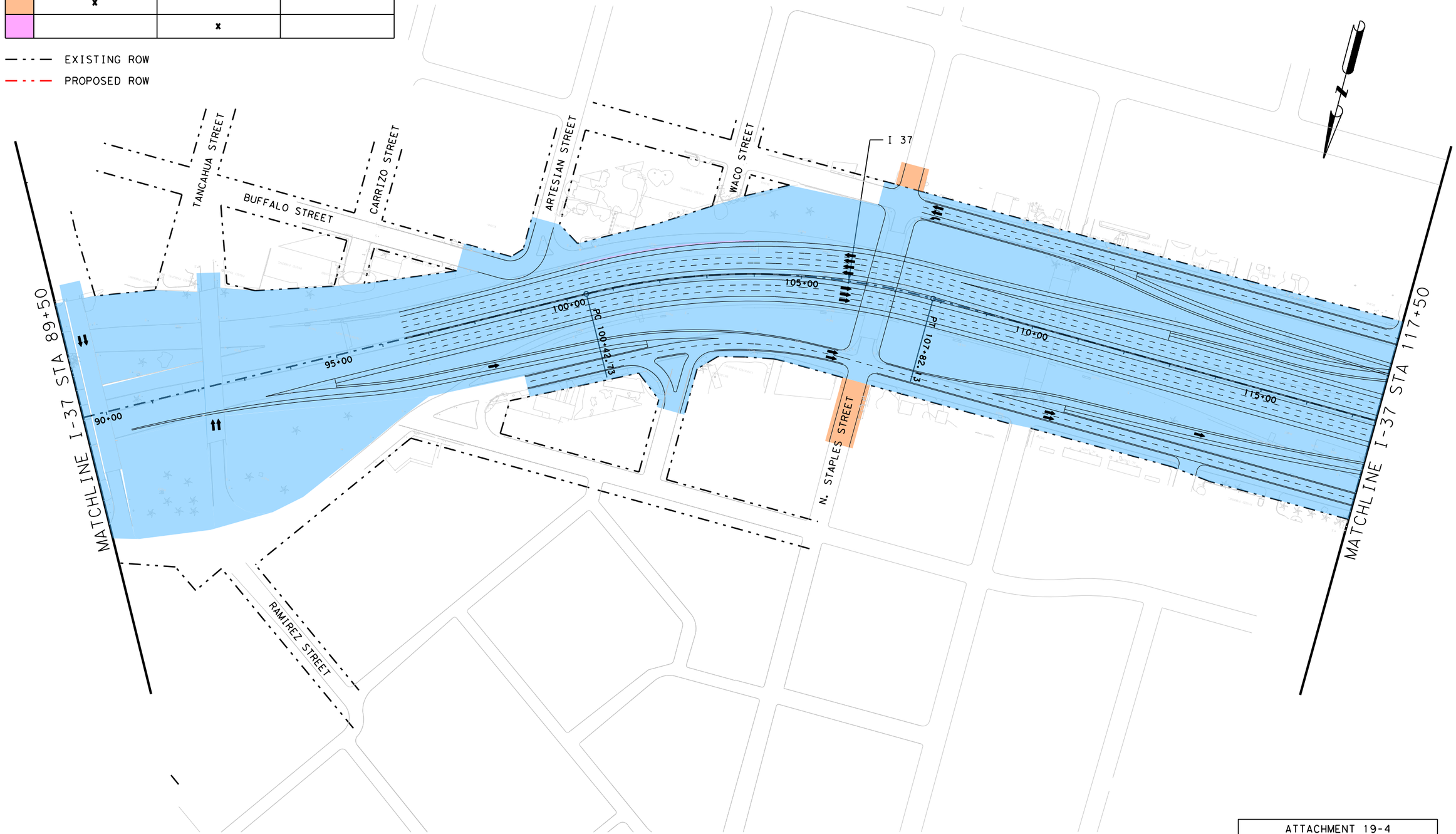
SHEET 1 OF 15

Scale: 1:200
Plotted on: 1/27/2015
Model Name: PLN031
Pen Table:TexasTwoStep*pentable*co.tbl
Design Filename:US181HB-E-RD-PLN00.dgn

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW

PROPOSED ROW



Scale: 1:200
Plotted on: 1/27/2015

Model Name: PLN032

Pen Table:TexasTwoStep+pentable+co.tbl
Design Filename: US181HB-E-RD-PLN00.dgn

ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

SHEET 2 OF 15

MATCHLINE US-181/SH-286 STA 1169+90.6
SEE SHEET 12 OF 15

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW
PROPOSED ROW

MESTINA STREET
MESTINA STREET
US 181/SH 286
LEOPARD STREET
I 37
1165+00
CLEVELAND STREET
DOSS STREET
LESTER STREET
I 37
MATCHLINE I-37 STA 117+50
MATCHLINE I-37 STA 145+50
120+00
125+00
130+00
135+00
140+00
145+00
1160+00
1155+00
WINNEBAGO STREET
US 181
TC AYERS PARK
COKE STREET
NORTH PORT AVENUE

MATCHLINE US-181 STA 1151+58.1
SEE SHEET 11 OF 15

ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

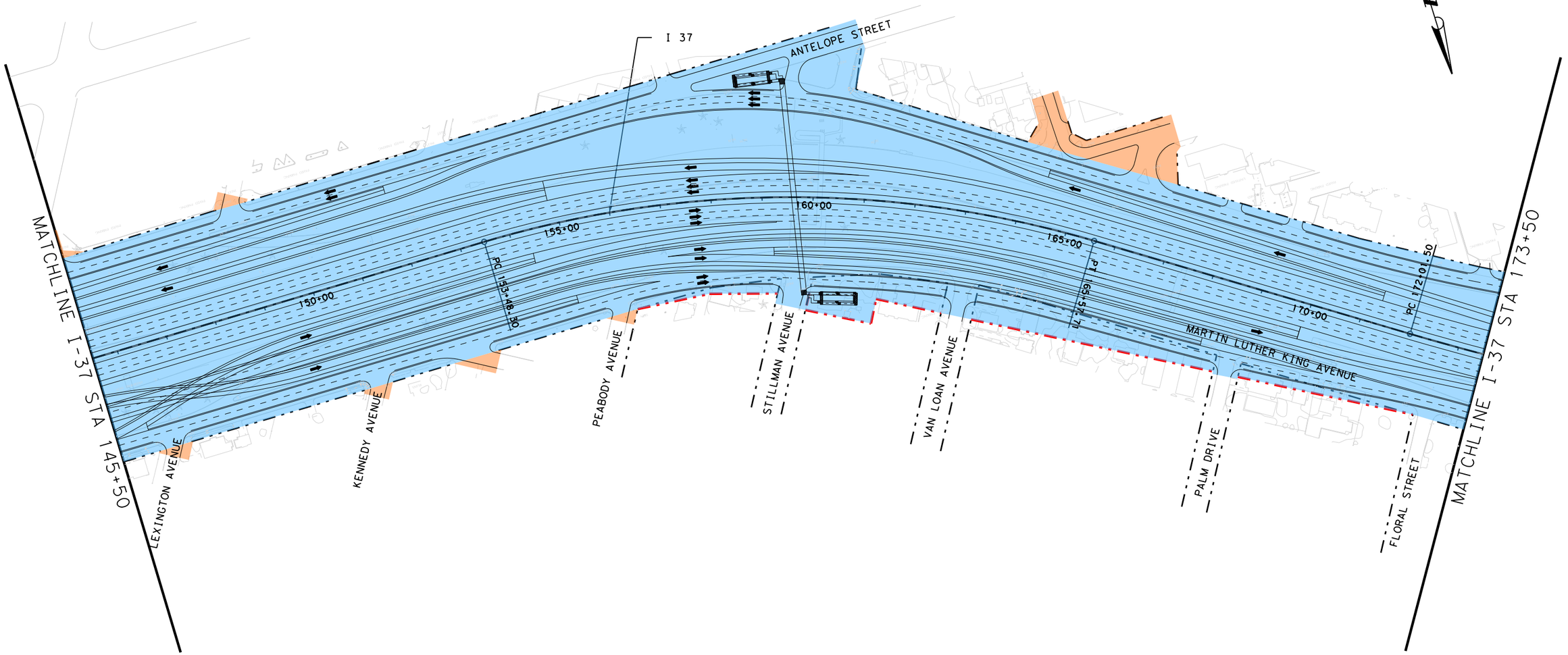
SHEET 3 OF 15

Scale: 1:200
Plotted on: 1/27/2015
Model Name: PLN033
Pen Table:TexasTwoStep.pentable.co.tbl
Design Filename: US181HB-E-RD-PLN00.dgn

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW

PROPOSED ROW



ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

SHEET 4 OF 15

Scale: 1:200
Plotted on: 1/27/2015

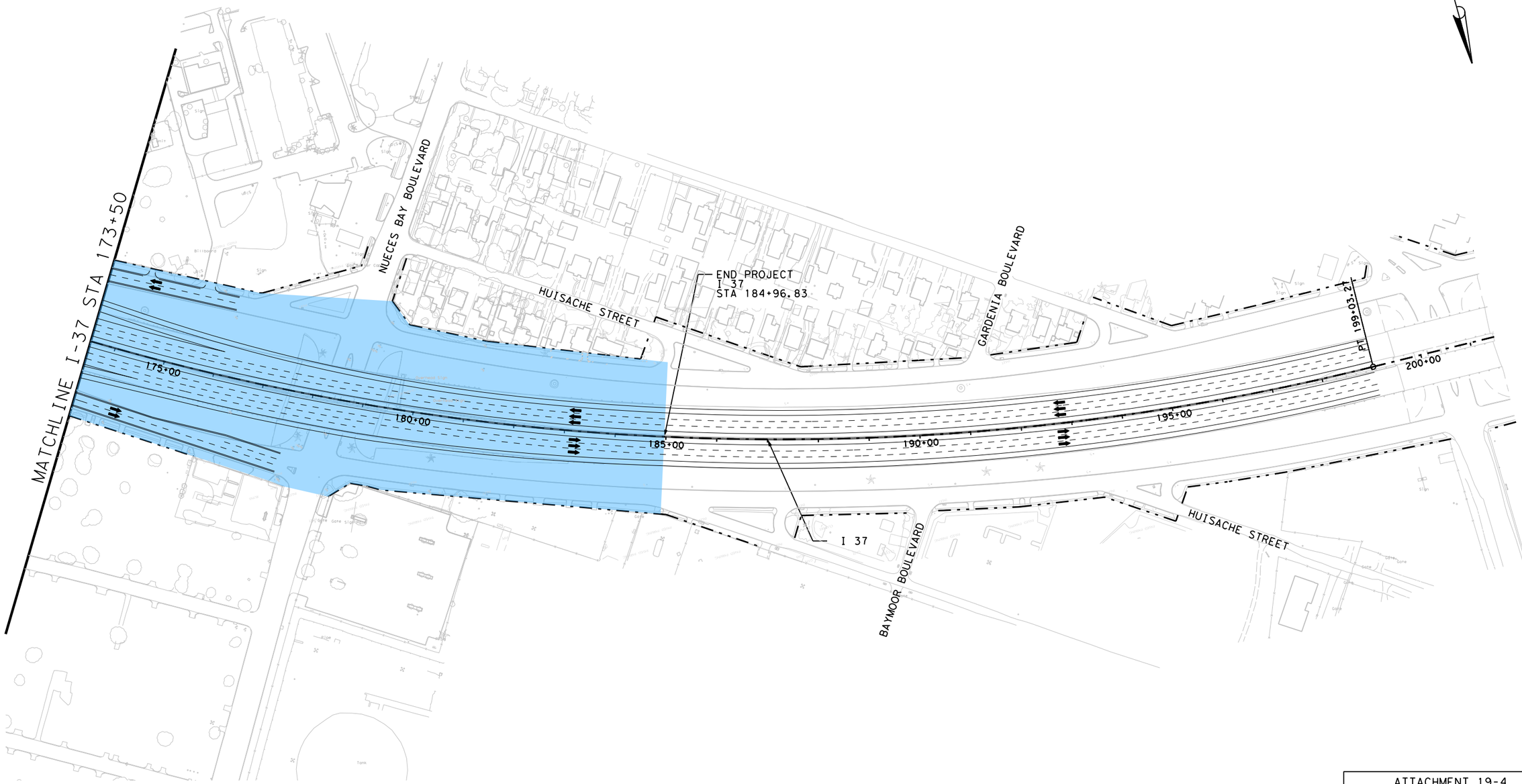
Model Name: PLN034

Pen Table:TexasTwoStep*pentable*co.tbl
Design Filename: US181HB-E-RD-PLN00.dgn

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW

PROPOSED ROW



ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

SHEET 5 OF 15

Scale: 1:200
Plotted on: 1/27/2015

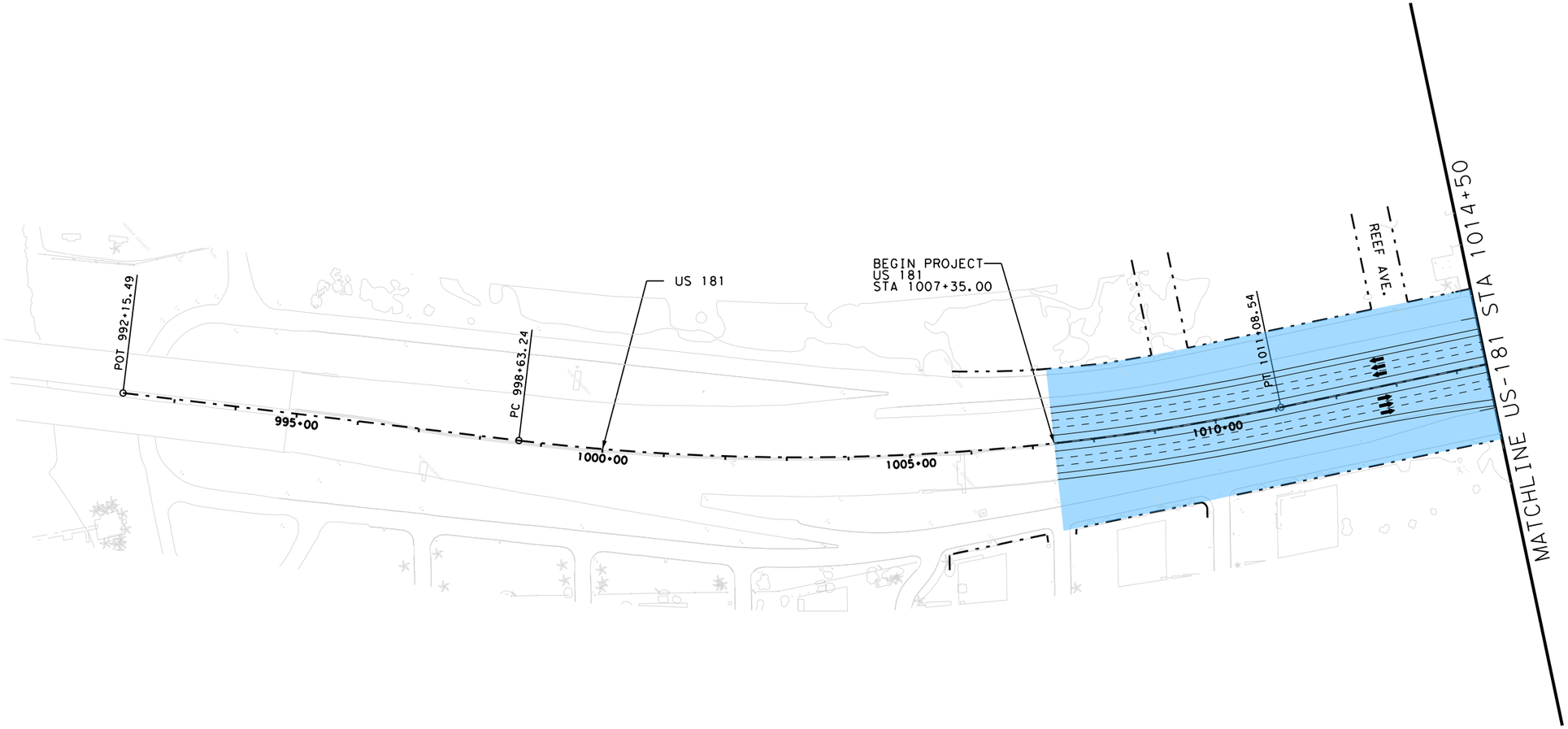
Model Name: PLN035

Pen Table:TexasTwoStep*pentable*co.tbl
Design Filename:US181HB-E-RD-PLN00.dgn

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

— - - — EXISTING ROW

— · - — PROPOSED ROW



ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

SHEET 6 OF 15

Scale: 1:200
Plotted on: 1/27/2015

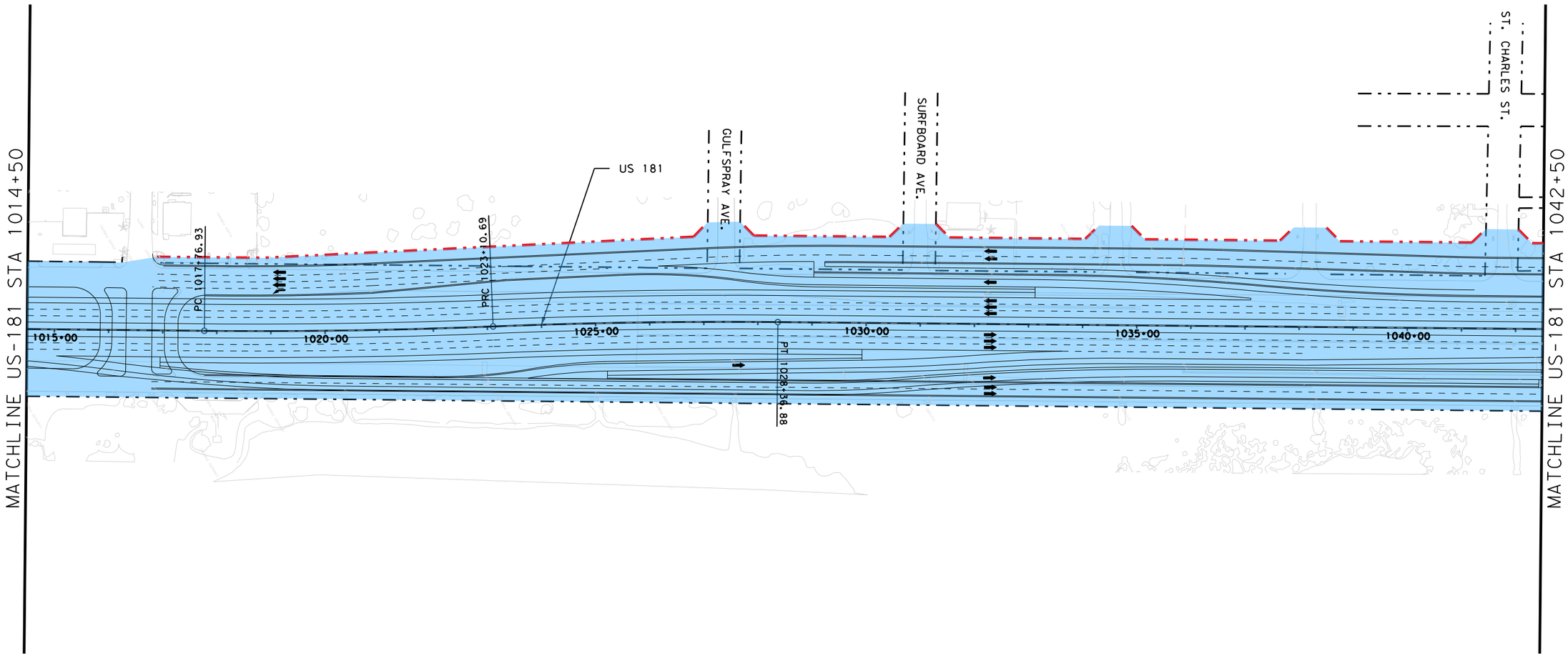
Model Name: PLN036

Pen Table:TexasTwoStep*pentable*co.tbl
Design Filename:US181HB-E-RD-PLN00.dgn

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW

PROPOSED ROW



ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

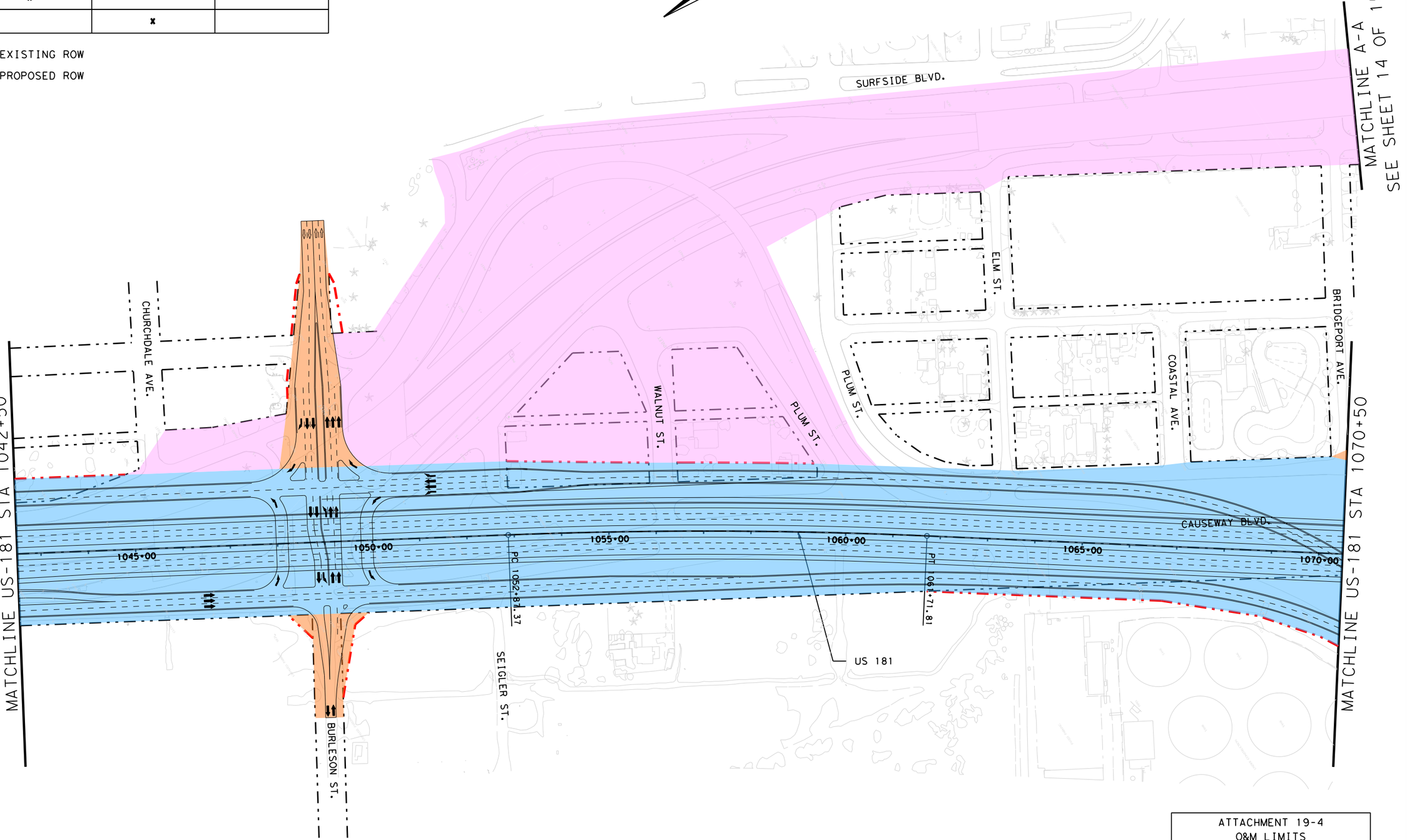
SHEET 7 OF 15

Scale: 1:200
Plotted on: 1/27/2015
Model Name: PLN037
Pen Table:TexasTwoStep*pentable*co.tbl
Design Filename: US181HB-E-RD-PLN00.dgn

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW

PROPOSED ROW



ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

SHEET 8 OF 15

Scale: 1:200
Plotted on: 1/27/2015

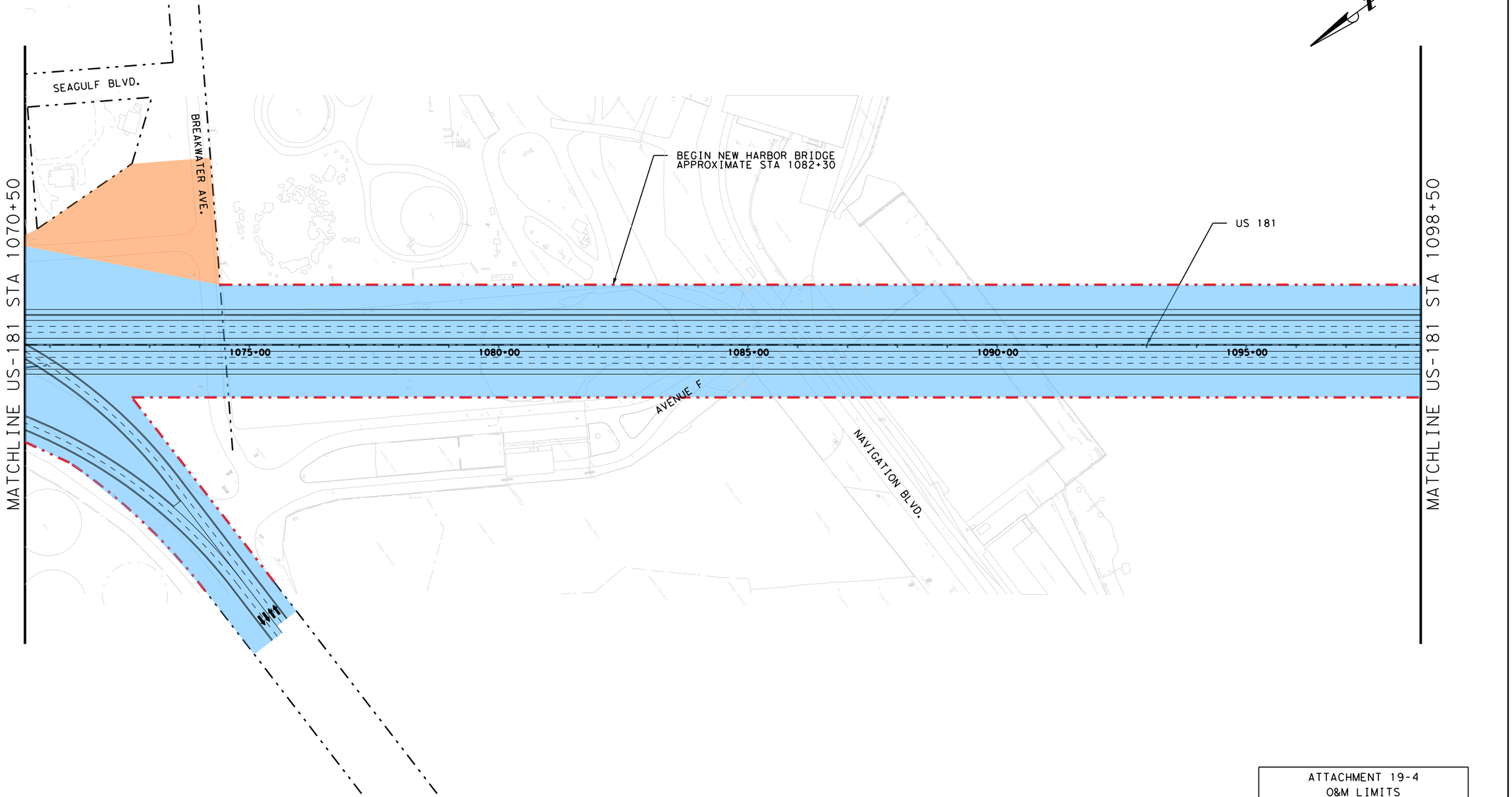
Model Name: PLN038

Pen Table:TexasTwoStep.pentable.tbl
Design Filename: US181HB-E-RD-PLN00.dgn

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW

PROPOSED ROW



ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

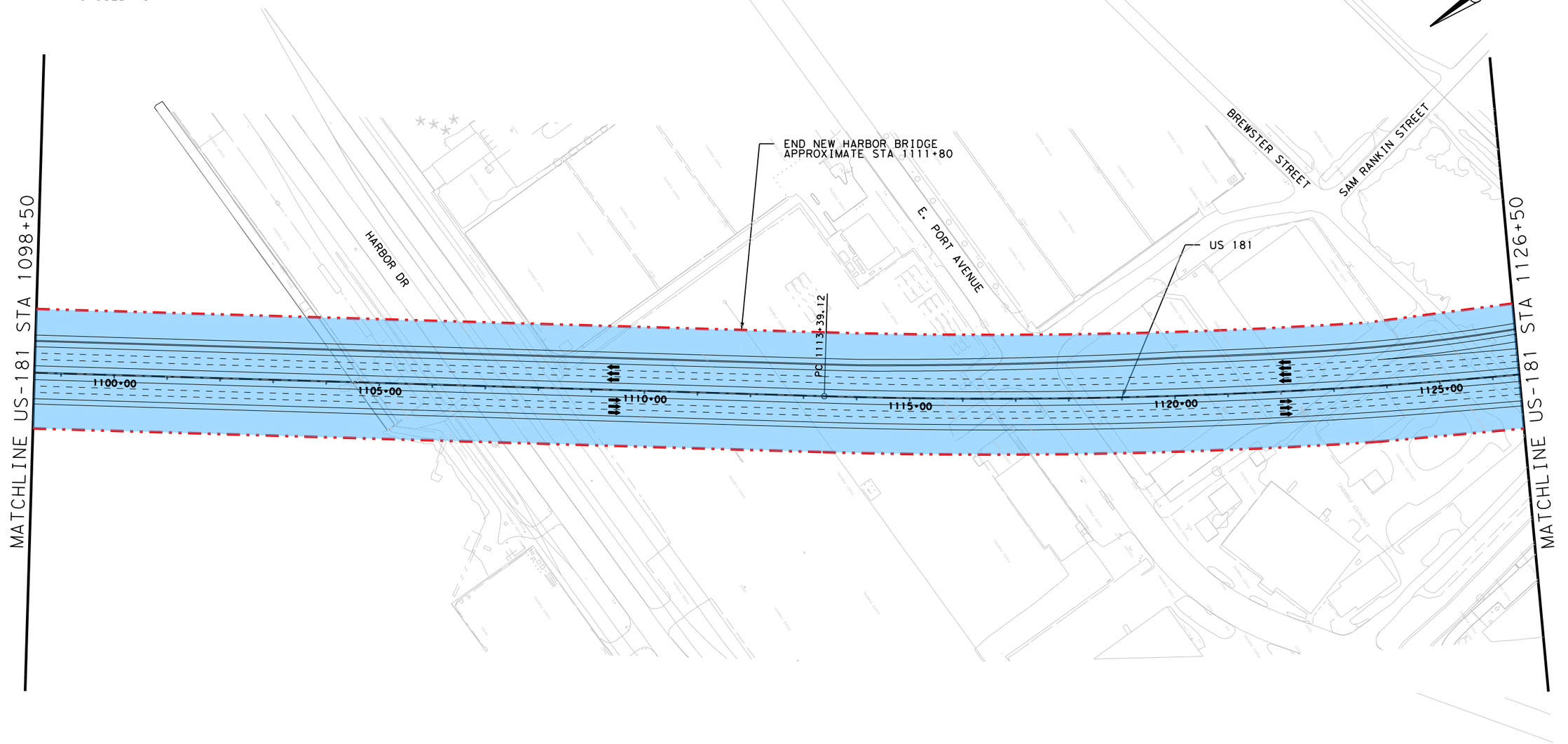
SHEET 9 OF 15

Scale: 1:200
Plotted on: 1/27/2015
Model Name: PLN039
Pen Table:TexasTwoStep*pentable*co.tbl
Design Filename: US181HB-E-RD-PLN00.dgn

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW

PROPOSED ROW



ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

SHEET 10 OF 15

Scale: 1:200
Plotted on: 1/27/2015

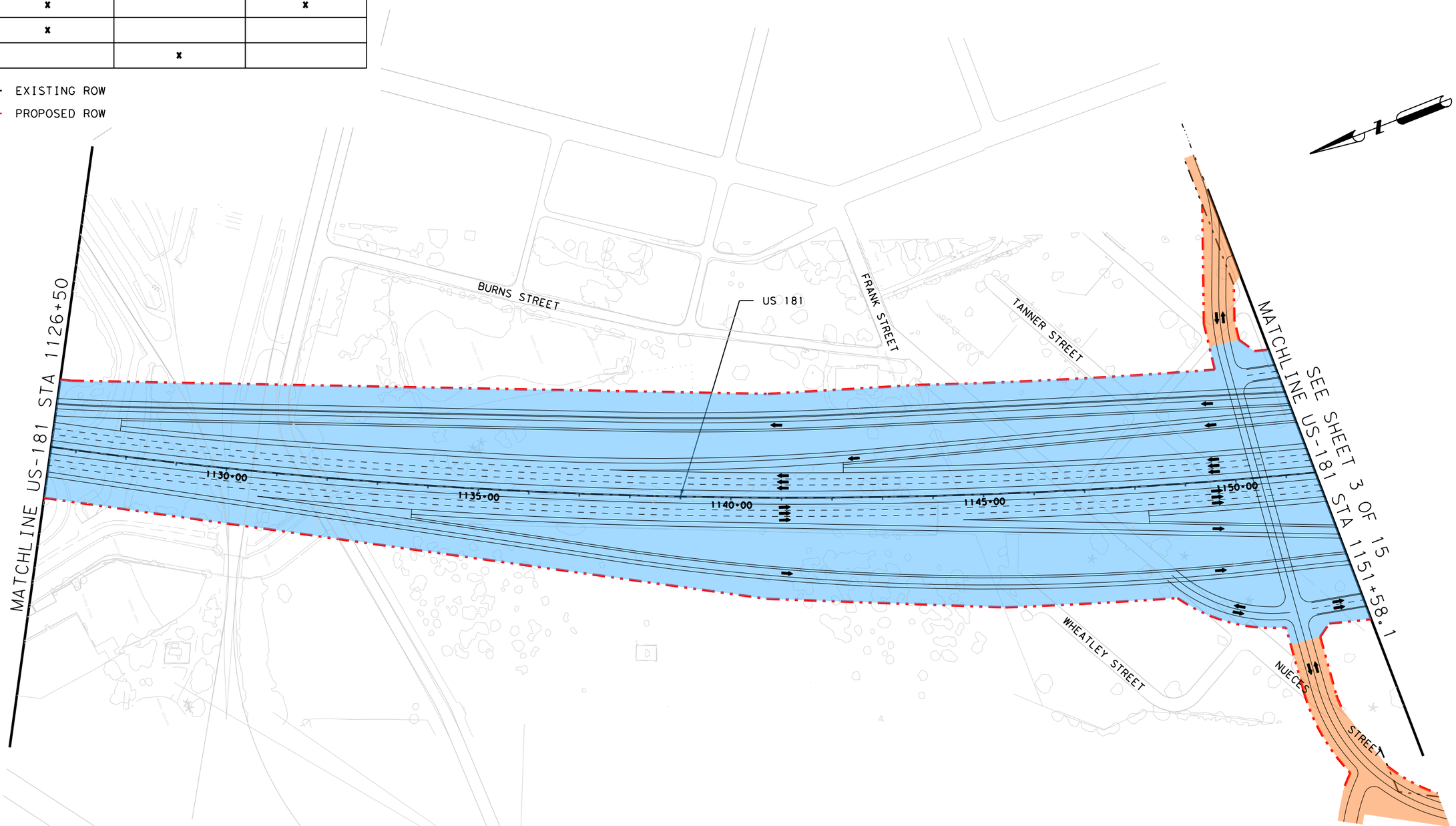
Model Name: PLN040

Pen Table:TexasTwoStep*pentable*co.tbl
Design Filename: US181HB-E-RD-PLN00.dgn

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW

PROPOSED ROW



ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

SHEET 11 OF 15

Scale: 1:200
Plotted on: 1/27/2015

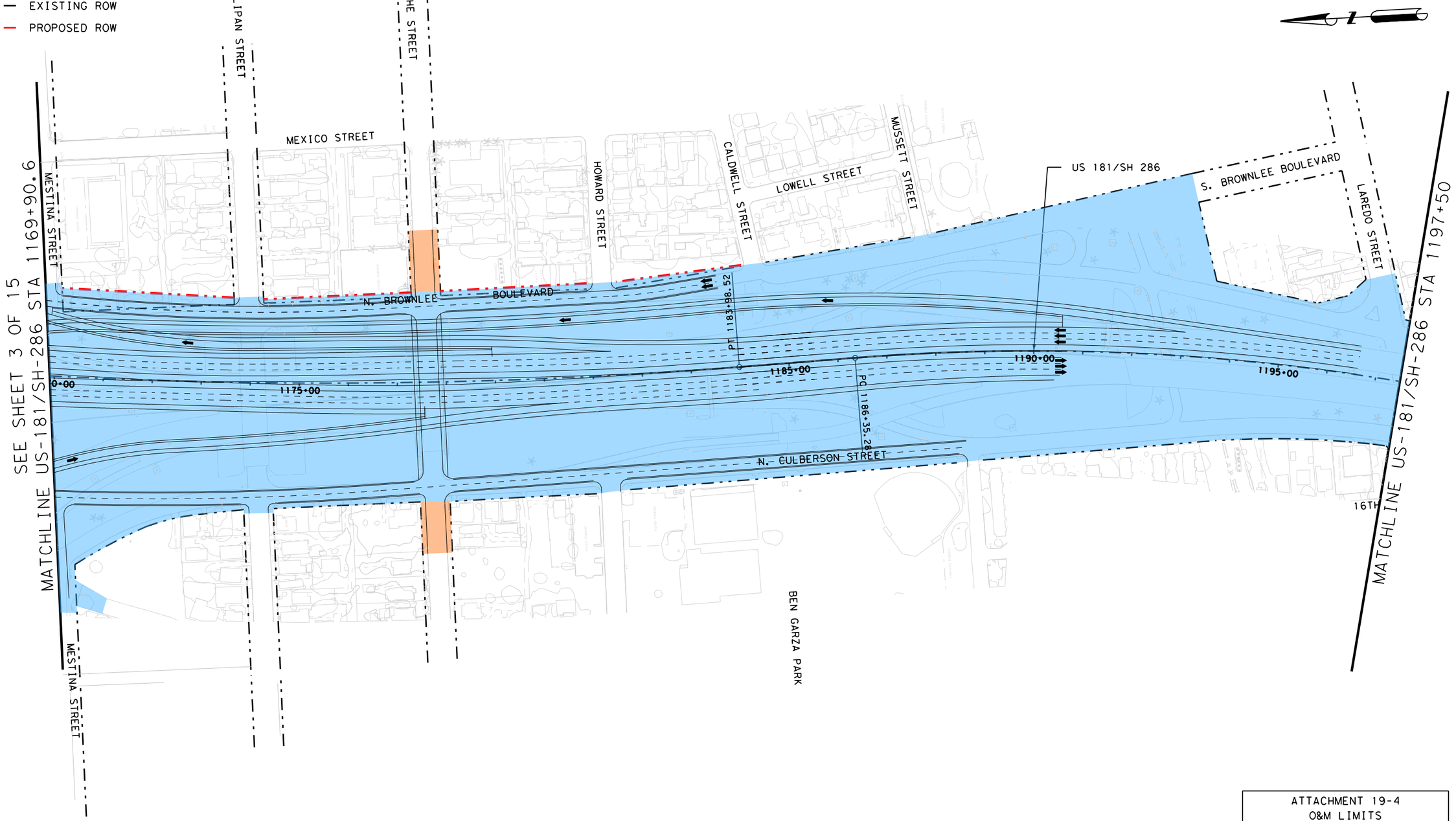
Model Name: PLN041

Pen Table:TexasTwoStep*pentable*co.tbl
Design Filename: US181HB-E-RD-PLN00.dgn

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW

PROPOSED ROW



ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

SHEET 12 OF 15

Scale: 1:200
Plotted on: 1/27/2015
Model Name: PLN042
Pen Table: TexasTwoStep*pentable*co.tbl
Design Filename: US181HB-E-RD-PLN00.dgn

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW

PROPOSED ROW

ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

SHEET 13 OF 15

Scale: 1:200
Plotted on: 1/27/2015

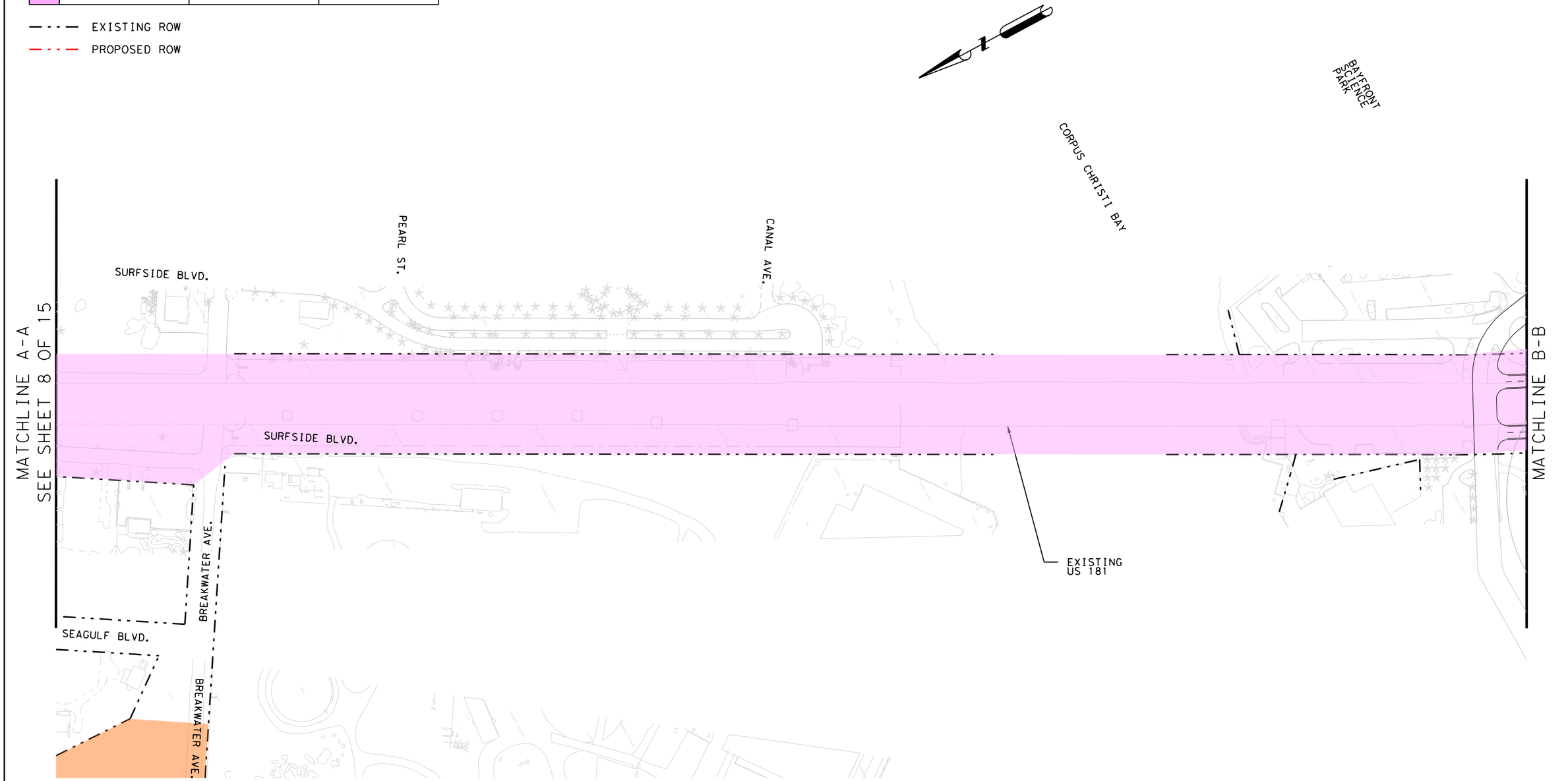
Model Name: PLN043

Pen Table: TexasTwoStep*pentable*co.tbl
Design Filename: US181HB-E-RD-PLN00.dgn

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW

PROPOSED ROW



ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

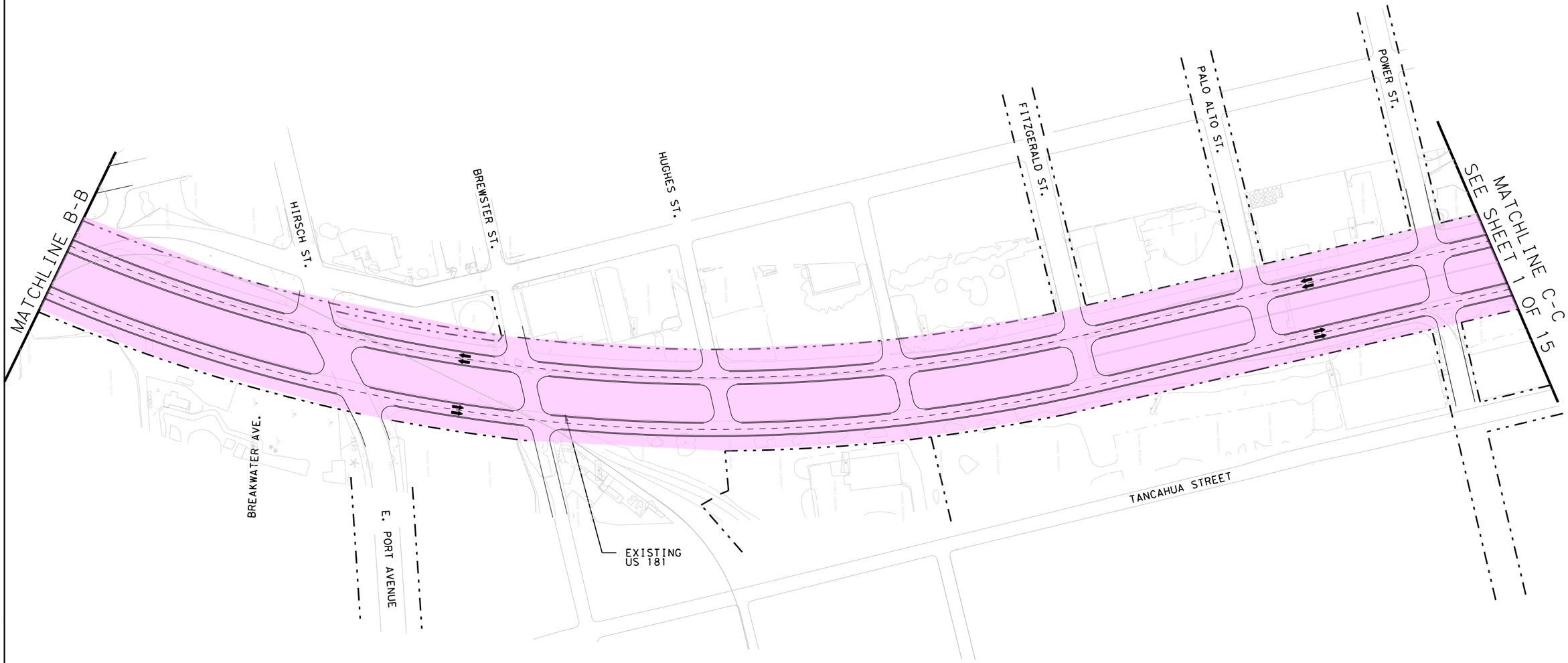
SHEET 14 OF 15

Scale: 1:200
Plotted on: 1/27/2015
Model Name: PLN044
Pen Table:TexasTwoStep*pentable*co.tbl
Design Filename: US181HB-E-RD-PLN00.dgn

	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 1)	O&M LIMITS FOR O&M DURING CONSTRUCTION (PHASE 2)	O&M LIMITS AFTER SUBSTANTIAL COMPLETION
	x		x
	x		
		x	

EXISTING ROW

PROPOSED ROW



ATTACHMENT 19-4
O&M LIMITS

SCALE: 1" = 200'

SHEET 15 OF 15

Scale: 1:200
Plotted on: 1/27/2015

Model Name: PLN045

Pen Table:TexasTwoStep*pentable*co.tbl
Design Filename:US181HB-E-RD-PLN00.dgn

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 19-5
ASSET CONDITION SCORE CALCULATION METHOD NEW HARBOR BRIDGE

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [1]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
1) ROADWAY									3.5
1.1	**Obstructions and debris**	Visual Inspection	1.1.1	Number of obstructions and debris	25	2.4%	3	0.07	
1.2	**Pavement**	**a) Ruts – Mainlanes, shoulders & ramps** Depth as measured using an automated device in compliance with TxDOT Standards.		*Percentage of wheel path length with ruts greater than ¼" in depth in each Performance Section*					
			1.2.1	• Mainlanes, shoulders and ramps - 3%	10	1.0%	4	0.04	
		10ft straight edge used to measure rut depth for localized areas.	1.2.3	Depth of rut at any location greater than ½"	10	1.0%	4	0.04	
		b) Ride quality		*NOT USED*					
		c) Failures Instances of failures exceeding the failure criteria set forth in the TxDOT PMIS Rater's Manual, including potholes, base failures, punchouts and jointed concrete pavement failures	1.2.4	Individual discontinuities greater than 1/4"	10	1.0%	4	0.04	
		d) Edge drop-offs Physical measurement of edge drop-off level compared to adjacent surface	1.2.5	Occurrence of any failure	5	0.5%	5	0.02	
			1.2.6	Number of instances of edge drop-off greater than 2"	5	0.5%	5	0.02	
1.2	**Pavement**	**e) Skid resistance** ASTM E 274 Standard Test Method for Skid Resistance Testing of Paved Surfaces at 50 MPH using a full scale smooth tire meeting the requirements of ASTM E 524	1.2.7	• Performance Sections with skid numbers for 0.5-mile section of mainlines, shoulders and ramps exceeding 30 and for which investigations as to potential risk of skidding accidents and appropriate remedial actions have been taken.	10	1.0%	5	0.05	
			1.2.8	~~• Performance Sections with skid numbers for 0.5-mile section of frontage roads exceeding 30 and for which investigations as to potential risk of skidding accidents and appropriate remedial actions have been taken.~~ NOT USED	0	0.0%		0.00	
			1.2.9	• When the skid number is below 25 and/or when required by the Wet Weather Accident Reduction Program, areas categorized as high risk, Developer shall perform a site investigation and perform required corrective action.	10	1.0%	2	0.02	
			1.2.10	Instances where road users are warned of a potential skidding hazard where remedial action is identified.	10	1.0%	2	0.02	
1.3	**Crossovers and other paved areas**	**a) Potholes**	1.3.1	Number of potholes of low severity or higher	5	0.5%	4	0.02	
		b) Base failures	1.3.2	NOT USED	0	0.0%	0	0.00	
1.4	**Joints in concrete**	Visual inspection of joints	1.4.1	Length of unsealed joints greater than ¼"	10	1.0%	3	0.03	
		Measurement of joint width and level difference of two sides of joints	1.4.2	Joint width more than 1" or faulting more than ¼"	10	1.0%	3	0.03	
1.5	**Curbs**	Visual inspection	1.5.1	Continuous curb lengths where more than 10% of the length has defects such as cracks and chips	5	0.5%	3	0.01	
		Physical measurement	1.5.2	Continuous curb lengths where more than 5% of the length has a separation exceeding 0.25" between curb face and adjacent roadway surface	5	0.5%	3	0.01	
		Survey and 10' straight edge	1.5.3	Continuous curb lengths where more than 5% of the length has either the top or face of curbs exceeding 0.5" from intended design alignment	5	0.5%	3	0.01	

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [1]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
1.6	**Maintenance/Access Roads**	Crown: Flat A shape or super-elevation with 4% cross slopes maintained to minimize ponding	1.6.1	Cross slope less than 3% or more than 6%	2	0.2%	4	0.01	
		Shoulder: Maintain slope away from the travel way and shoulder flush with travel way	1.6.2	Shoulder cross slope less than travel way cross slope; shoulder lower or higher than travel way	2	0.2%	4	0.01	
		Ditch: Maintain size and shape of ditch for proper drainage	1.6.3	Sides of ditches slumping or eroding, or obstructed by debris	2	0.2%	5	0.01	
		Ruts/potholes: Depth as measured using an automated device in compliance with TxDOT standards	1.6.4	Depth of ruts or potholes at any location greater than 1”	2	0.2%	5	0.01	
		Subgrade: Identify and repair any subgrade failures	1.6.5	Locations where subgrade failure is evident	2	0.2%	5	0.01	
2) DRAINAGE									3.1
2.1	**Pipes and Channels**	Visual inspection supplemented by CCTV where required to inspect buried pipe work.	2.1.1	Length of pipe or channel in feet with less than 90% of cross sectional clear area, calculated as the arithmetic mean of the clear cross-sectional areas of individual 10 feet lengths of pipes and channels in each Performance Section.	5	0.5%	5	0.02	
2.2	**Drainage treatment devices**	Visual inspection	2.2.1	Number of devices functioning correctly with means of operation displayed.	5	0.5%	2	0.01	
2.3	**Travel Way**	Visual inspection of water on surface.	2.3.1	Number of instances of hazardous water build-up.	20	2.0%	2	0.04	
2.4	**Discharge systems**	Visual inspection and records	2.4.1	Performance Sections with surface water discharge systems performing their proper function and discharging in compliance with the relevant legislation and permits.	10	1.0%	3	0.03	
2.5	**Protected Species**	Visual inspection	2.5.1	Performance Sections with named species and habitats with protection of these named species and habitats.	20	2.0%	4	0.08	
3) STRUCTURES									3.8
3.1	**Structures having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or springlines of arches or extreme ends of openings or multiple boxes**	Inspection and assessment in accordance with the requirements of federal National Bridge Inspection Standards (NBIS) of the Code of Federal Regulations, 23 Highways – Part 650, the TxDOT Bridge Inspection Manual, and the Federal Administration's Bridge Inspector's Reference Manual.		*Records as required in the TxDOT Bridge Inspection Manual*					
		As above	3.1.1	Occurrence of condition rating, in accordance with the TxDOT Bridge Inspection Manual, below**seven** for any deck, superstructure or substructure	50	4.9%	5	0.24	
		As above	3.1.2	Not Used					

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [1]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
3.2	**Structure components**	Inspection and assessment in accordance with the requirements of federal National Bridge Inspection Standards (NBIS) of the Code of Federal Regulations, 23 Highways – Part 650, the TxDOT Bridge Inspection Manual, and the Federal Administration's Bridge Inspector's Reference Manual.	3.2.1	Occurrence of condition rating, in accordance with the TxDOT Bridge Inspection Manual, below**seven** for any deck, superstructure or substructure	50	4.9%	3	0.15	
		Visual inspection of Elements listed in (i) through (vii) of the general performance requirement column in the Performance and Measurement Table.	3.2.2	Instances of condition of any element not meeting general performance requirement as determined in accordance with Good Industry Practice.	50	4.9%	4	0.20	
3.3	**Integral wearing surface**	Concrete cover measured at ~~[10ft]~~ 10 ft intervals.	3.3.1	Occurrence of any instance where integral wearing surface thickness is less than ~~[50%]~~ 50% of design value	25	2.4%	4	0.10	
		Cracks measured ~~at [3 ft] intervals~~ within designated 1,500 SF measurement areas on the surface of the deck prior to 3 hours after sunrise at concrete age greater than 28 days	3.3.2	~~Instances of cracks wider than [0.025] inches~~ Instances where more than 150 linear ft of cracks exceeding 0.020 inches in width are present within any 1,500 SF measurement area.	25	2.4%	2	0.05	
		De-lamination or spalling	3.3.3	Instances of de-lamination or spalling	10	1.0%	2	0.02	
3.4	**Stay Cables**	Visual and hands-on inspection	3.4.1	Instances of damage or deterioration of the corrosion protection system including coatings, protective pipes and anchorage units	20	2.0%	3	0.06	
			3.4.2	Instances of damaged or broken strand / wire	50	4.9%	5	0.24	
			3.4.3	Instances of stay cable damping system not operating as intended including failure to provide the minimum design level of damping	20	2.0%	5	0.10	
			3.4.4	Instances of stay cable acoustic monitoring system not operating as intended including failure to transmit measured information.	20	2.0%	5	0.10	
3.5	**Inspection and access equipment**	Visual and hands-on inspection	3.5.1	Instances of loose assemblies or nuts and bolts not fully tightened	10	1.0%	2	0.02	
			3.5.2	Instances of defects in surface protection such as failures of coating systems to bare metal or loss of galvanizing	10	1.0%	1	0.01	
			3.5.3	Instances of failures to conform with relevant standards for fixed and mobile inspection facilities, hoists and lifts	10	1.0%	2	0.02	
			3.5.4	Instances where maintenance traveler fails to operate smoothly under power or braking, has uneven or inconsistent movement of any driven component or exhibits binding or swaying, in each case in a manner that exceeds normal operational parameters.	10	1.0%	3	0.03	
3.6	**Ship impact protection system**	Visual inspection	3.6.1	Instances of marine boring (timber systems)	10	1.0%	5	0.05	
			3.6.2	Instances of corrosion that would reduce the system resistance to below its intended design state	10	1.0%	5	0.05	
			3.6.3	Instances of damage from vessel impact that would reduce the system resistance to below its intended design state or would cause a material reduction in the remaining service life	10	1.0%	4	0.04	

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [1]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
3.7	**Corrosion protection systems**	Visual inspection	3.7.1	Instances of failure of coating system down to bare metal	15	1.5%	3	0.04	
			3.7.2	Loss of galvanizing	10	1.0%	2	0.02	
		Color determined by CIE 1976 L*a*b*utilizing a D65 illuminant and 10 degree observer	3.7.3	Damaged, blistered, cracked, delaminated or peeling material including any painted surface for which a color is specified that has changed color by more than 10 Delta-E CIE LAB units.	10	1.0%	3	0.03	
			3.7.4	Noncompliance with manufacturer's recommendations for the maintenance and re-application of coatings	10	1.0%	4	0.04	
3.8	**Lightning Protection Systems**	Inspection and assessment in accordance with the requirements of Underwriters Laboratories, Inc. (UL) 96 and Lightning Protection Institute (LPI) 175.	3.8.1	Noncompliance with specified standards.	5	0.5%	5	0.02	
			3.8.2	Instances of lightning protection system not operating as intended.	5	0.5%	5	0.02	
3.11	**Load Ratings**	Load rating calculations in accordance with the Manual for Bridge Evaluation and the TxDOT Bridge Inspection Manual and per the Technical Provisions	3.11.1	Number of structures with load restrictions for Texas legal loads (including legally permitted vehicles) in each Performance Section	10	1.0%	5	0.05	
3.12	**Access Points**	Visual Inspection	3.12.1	Number with defects in locks or entryways	5	0.5%	3	0.01	
3.14	**Structural Surfaces**	Visual Inspection	3.14.1	Number of areas where graffiti is present	5	0.5%	3	0.01	
4) PAVEMENT MARKINGS, OBJECT MARKERS, BARRIER MARKERS AND DELINEATORS									3.9
4.1	**Pavement markings**	**a) Markings - General**							
		Portable retroreflectometer, which uses 30 meter geometry, meeting the requirements described in ASTM E 1710	4.1.1	Percentage of total length of pavement marking in each Performance Section meeting the minimum retroreflectivity 175 med/sqm/lx for white	5	0.5%	3	0.01	
			4.1.2	Percentage of total length of pavement marking in each Performance Section meeting the minimum retroreflectivity 125 med/sqm/lx for ~~white~~ yellow	5	0.5%	4	0.02	
		Physical measurement	4.1.3	Length of pavement marking in each Performance Section with more than 5% loss of area of material at any point	5	0.5%	4	0.02	
			4.1.4	Length of pavement marking in each Performance Section with spread more than 10% of specified dimensions.	5	0.5%	4	0.02	
		b) Profile Markings							
		Visual inspection	4.1.5	Percentage of total length of pavement marking in each Performance Section performing its intended function and compliant with relevant regulations	5	0.5%	3	0.01	
4.2	**Raised Reflective Markings**	Visual inspection	4.2.1	Number of markers associated with road markings that are ineffective in any 10 consecutive markers. (Ineffective includes missing, damaged, settled or sunk)	2	0.2%	5	0.01	
			4.2.2	A minimum of four markers are visible at 80' spacing when viewed under low beam headlights.	2	0.2%	5	0.01	
			4.2.3	Uniformity (replacement raised reflective pavement markers have equivalent physical and performance characteristics to adjacent markers).	2	0.2%	5	0.01	
4.3	**Delineators and Markers**	Visual inspection	4.3.1	Number of object markers or delineators in each Performance Section that is defective or missing	2	0.2%	4	0.01	

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [1]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
5) GUARDRAILS, SAFETY BARRIERS AND IMPACT ATTENUATORS									3.8
5.1	**Guardrails and Safety Barriers**	Visual inspection	5.1.1	Performance Sections with all guard rails and safety barriers appropriately placed and correction installed	20	2.0%	3	0.06	
			5.1.2	Performance Sections with all guard rails and safety barriers free from defects	20	2.0%	5	0.10	
			5.1.3	Performance Sections with all guard rails and safety barriers at correct heights	5	0.5%	5	0.02	
			5.1.4	Performance Sections with all guard rails and safety barriers at correct distances from roadway obstacles	5	0.5%	3	0.01	
5.2	**Impact Attenuators**	Visual inspection	5.2.1	Performance Sections will all impact attenuators appropriately placed and correctly installed.	5	0.5%	2	0.01	
6) TRAFFIC SIGNS									3.9
6.1	**General - All Signs**	**a) Retroreflectivity** Determination of Coefficient of retro-reflectivity	6.1.1	Number of signs with actual reflectivity below the requirements of TxDOT's TMUTCD in each Performance Section	20	2.0%	3	0.06	
		b) Face damage Visual inspection	6.1.2	Number of signs in each Performance Section with face damage greater than 5% of area	10	1.0%	4	0.04	
		c) Placement Visual inspection	6.1.3	All signs in each Performance Section are placed in accordance with TxDOT's Sign Crew Field Book including not twisted or leaning	5	0.5%	4	0.02	
		d) Obsolete signs Visual inspection	6.1.4	Number of obsolete signs in each Performance Section	5	0.5%	5	0.02	
		e) Sign Information Visual inspection	6.1.5	All sign information in each Performance Section is of the correct size, location, type and wording to meet its intended purpose	5	0.5%	5	0.02	
		f) Dynamic Message Signs Visual inspection	6.1.6	Dynamic message signs are fully functioning	5	0.5%	3	0.01	
6.2	**Gantries**	Visual inspection	6.2.1	Number with defects in surface protection system	10	1.0%	5	0.05	
			6.2.1	Number with loose nuts and bolts	10	1.0%	4	0.04	
			6.2.3	Number with graffiti	10	1.0%	4	0.04	
7) TRAFFIC SIGNALS (NOT PART OF MAINTAINED ELEMENTS)									

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [1]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
8) LIGHTING									4.3
8.1	**Roadway Lighting**	**a) Mainlane lights operable** Night time inspection or automated logs	8.1.1	Performance Sections with less than 90% of lights functioning correctly at all times	25	2.4%	4	0.10	
		b) Mainlane lights out of action Night time inspection or automated logs	8.1.2	Instances of more than two consecutive lights out of action	25	2.4%	5	0.12	
8.2	**Sign Lighting**	Night time inspection or automated logs	8.2.1	Number of instances of more than one bulb per sign not working in each Performance Section	10	1.0%	5	0.05	
8.3	**Electrical Supply**	Testing to meet NEC regulations, visual inspection	8.3.1	Inspection records showing safe installation and maintenance in each Performance Section	10	1.0%	4	0.04	
8.4	**Access Panels**	Visual Inspection	8.4.1	Number of instances of missing or damaged access panels in each Performance Section	5	0.5%	4	0.02	
8.5	**High Mast Lighting**			*NOT USED*					
8.6	**Navigational Lighting**	Night time inspection or automated logs	8.5.1	Number of instances of more than one bulb per sign not working in each Performance Section	15	1.5%	4	0.06	
8.7	**Architectural Lighting**	Night time inspection or automated logs	8.6.1	Instances of architectural lighting with more than 10% of lamps not functioning	25	2.4%	4	0.10	
8.8	**Bridge Inspection Lighting**	Night time inspection or automated logs	8.7.1	Instances of bridge inspection lighting where failures could adversely impact safety or security of inspections or access	10	1.0%	4	0.04	
9) FENCES, WALLS AND SOUND ABATEMENT									
9.1	**Design and Location**	Visual Inspection		*NOT USED*					
9.2	**Construction**	Structural assessment if visual inspection warrants		*NOT USED*					
9.3	**Operation**	Structural assessment if visual inspection warrants		*NOT USED*					
10) ROADSIDE MANAGEMENT (NOT USED)									
11) REST AREAS AND PICNIC AREAS (NOT USED)									
12) EARTHWORKS, EMBANKMENTS AND CUTTINGS (NOT USED)									
13) ITS EQUIPMENT									4.3
13.1	**ITS Equipment - Maintenance**	Visual Inspection	13.1.1	Inspection records showing compliance with requirements for maintenance of ITS equipment in each Performance Section.	5	0.5%	4	0.02	
13.2	**Dynamic Message Sign Equipment**	Defect measurement dependent on equipment	13.2.1	Inspection records showing compliance with requirements for Dynamic Message Signs in each Performance Section	5	0.5%	4	0.02	
13.3	**CCTV Equipment**	Defect measurement dependent on equipment	13.3.1	Inspection records showing compliance with requirements for CCTV equipment in each Performance Section	5	0.5%	4	0.02	
13.4	**Vehicle Detection Equipment**	Defect measurement dependent on equipment	13.4.1	Inspection records showing compliance with requirements for vehicle detection equipment in each Performance Section	5	0.5%	4	0.02	
			13.4.2	Traffic Detector Loop circuit's inductance to be > 50 and < 1,000 micro henries.	5	0.5%	5	0.02	
			13.4.3	Insulation resistance to be > 50 meg ohms.	5	0.5%	5	0.02	
14) TOLLING FACILITIES AND BUILDINGS (NOT USED)									
15) AMENITY (NOT USED)									

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [1]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
16) SNOW AND ICE CONTROL (NOT PART OF ASSET CONDITION SCORE)									
16.1	**Travel lanes**	Maximum 1hr response time to complete manning and loading of spreading vehicles.	16.1.1	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	0	0.0%			
		Maximum 2hrs from departure from loading point to complete treatment and return to loading point.	16.1.2	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	0	0.0%			
		Maximum 1hr response time for snow and ice clearance vehicles to depart from base.	16.1.3	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	0	0.0%			
16.2	**Weather Forecasting**	Operations plan details the process and procedures in place and followed.	16.2.1	Inspection records showing compliance with requirements for weather forecasting in each Performance Section	0	0.0%			
16.3	**Operational Plans**	Operations plan details the process and procedures in place and followed.	16.3.1	Inspection records showing compliance with snow and ice clearance plans in each Performance Section	0	0.0%			
16.4	**Operations and Maintenance Manual**	Operations and maintenance instructions detail the process and procedures in place and followed.	16.4.1	Inspection records showing compliance with operations and maintenance instructions in each Performance Section.	0	0.0%			
17) INCIDENT RESPONSE (NOT PART OF ASSET CONDITION SCORE)									
17.1	**General**	Response times are met for 98% of incidents measured on a 1 year rolling basis.	17.1.1	Inspection records showing compliance with the MMP and requirements regarding incident response times in each Performance Section	0	0.0%			
		No complaints from Emergency Services.	17.1.2	Inspection records showing compliance with the MMP and requirements regarding incident response times in each Performance Section	0	0.0%			
17.2	**Hazardous Materials**	MMP details the process and procedures in place and followed.	17.2.1	Inspection records showing compliance with the MMP details regarding hazardous materials in each Performance Section	0	0.0%			
17.3	**Structural Assessment**	Inspections and surveys as required by incident	17.3.1	Inspection records showing compliance with the MMP and requirements for incidents in each Performance Section	0	0.0%			
17.4	**Temporary and permanent remedy**	Review and inspection of the incident site	17.4.1	Inspection records showing compliance with requirements for temporary and permanent remedy for incidents in each Performance Section	0	0.0%			
18) CUSTOMER RESPONSE (NOT PART OF ASSET CONDITION SCRE)									
18.1	**Response to inquiries**	Contact the customer within 48 hours following initial customer inquiry.	18.1.1	Percentage of responses within specified times in each Performance Section.	0	0.0%			
		All work resulting from customer requests is scheduled within 48 hours of customer contact.	18.1.2	Demonstrated by O&M Records	0	0.0%			
		Follow-up contact with the customer within 72 hours of initial inquiry.	18.1.3	Demonstrated by O&M Records	0	0.0%			
		All customer concerns/requests are resolved to TxDOT's satisfaction within 2 weeks of the initial inquiry.	18.1.4	Demonstrated by O&M Records	0	0.0%			
18.2	**Customer Contact Line**	Instances of line out of action or unmanned	18.2.1	Number of operations records showing non availability of the customer contact line in each Performance Section including complaints from public.	0	0.0%			

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [1]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
19) SWEEPING AND CLEANING									4.5
19.1	**Sweeping**	Buildup of dirt, ice, rock, debris, etc. on roadways and bridges not to accumulate greater than 24" wide or 1/2" deep	19.1.1	Inspection records showing compliance with requirements for sweeping in each Performance Section.	15	1.5%	4	0.06	
19.2	**Litter**	No more than 20 pieces of litter per roadside mile shall be visible when traveling at highway speed.	19.2.1	Inspection records showing compliance with requirements regarding litter pick-up in each Performance Section.	15	1.5%	5	0.07	
						100.0%			
AGGREGATED ASSET CONDITION SCORE FOR NEW HARBOR BRIDGE AFTER SUBSTANTIAL COMPLETION [6]								**3.82**	

NOTES FOR ASSET CONDITION SCORE CALCULATION

1 Weighting is the assigned weighting for each Measurement Record on a scale of 1-50 for purpose of Asset Condition Score

2 Weighting Factor is the Weighting expressed as a percentage for each Measurement Record and totaling 100%

3 Example Raw Asset Condition Score = Asset Condition Score for each Measurement Record across all inspected Performance Sections

4 Weighted Score = Raw Asset Condition Score x Weighting Factor

5 Element Category Asset Condition Score = Sum of Weighted Score / Sum of Weighting Factors for each Element Category

6 Aggregated Asset Condition Score = Sum of Weighted Scores for each Measurement Record for all Element Categories

90	Number of non-zero Weightings
1023	Total of Weightings
11.37	Average Weighting

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 19-6
ASSET CONDITION SCORE CALCULATION METHOD ROADWAY SECTION AFTER SUBSTANTIAL COMPLETION

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [2]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
1) ROADWAY									
1.1	**Obstructions and debris**	Visual Inspection	1.1.1	Number of obstructions and debris	50	4.0%	3	0.12	3.2
1.2	**Pavement**	**a) Ruts – Mainlanes, shoulders & ramps** Depth as measured using an automated device in compliance with TxDOT Standards.		*Percentage of wheel path length with ruts greater than ¼" in depth in each Performance Section*					
			1.2.1	• Mainlanes, shoulders and ramps - 3%	15	1.2%	4	0.05	
			1.2.2	• Frontage roads - 10%	10	0.8%	4	0.03	
		10ft straight edge used to measure rut depth for localized areas.	1.2.3	Depth of rut at any location greater than ½"	10	0.8%	4	0.03	
		b) Ride quality Measurement of International Roughness Index (IRI) according to TxDOT standard Tex-1001-S, Operating Inertial Profilers and Evaluating Pavement Profiles		*For 80% of all Performance Sections measured, IRI throughout 98% of each Performance Section is less than or equal to:*					
			1.2.4	• Mainlanes, ramps - 95" per mile**	10	0.8%	3	0.02	
		~~** To allow for measurement bias, an adjustment of -10 (minus ten) is made to IRI measurements for concrete pavements before assessing threshold compliance.~~	1.2.5	• Frontage roads - 120" per mile**	10	0.8%	3	0.02	
				IRI throughout 98% of each Performance Section is less than or equal to:					
			1.2.6	• Mainlanes, ramps - 120" per mile**	10	0.8%	4	0.03	
			1.2.7	• Frontage roads - 150" per mile**	10	0.8%	4	0.03	
			1.2.8	Mainlanes, ramps, 0.1 mile average - 150" per mile**	10	0.8%	4	0.03	
			1.2.9	Frontage roads, 0.1 mile average - 180" per mile**	10	0.8%	4	0.03	
		10-ft straightedge used to measure discontinuities	1.2.10	IRI measured throughout 98% of each lane containing a bridge deck in any Performance Section, 0.1 mile average - 200" per mile**	10	0.8%	4	0.03	
		c) Failures Instances of failures exceeding the failure criteria set forth in the TxDOT PMIS Rater's Manual, including potholes, base failures, punchouts and jointed concrete pavement failures	1.2.11	Individual discontinuities greater than 1/4"	20	1.6%	3	0.05	
		d) Edge drop-offs Physical measurement of edge drop-off level compared to adjacent surface	1.2.12	Occurrence of any failure	20	1.6%	5	0.08	
			1.2.13	Number of instances of edge drop-off greater than 2"	20	1.6%	2	0.03	

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [2]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
1.2	**Pavement**	**e) Skid resistance** ASTM E 274 Standard Test Method for Skid Resistance Testing of Paved Surfaces at 50 MPH using a full scale smooth tire meeting the requirements of ASTM E 524	1.2.14	• Performance Sections with skid numbers for 0.5-mile section of mainlines, shoulders and ramps exceeding 30 and for which investigations as to potential risk of skidding accidents and appropriate remedial actions have been taken.	15	1.2%	3	0.04	
			1.2.15	• Performance Sections with skid numbers for 0.5-mile section of frontage roads exceeding 30 and for which investigations as to potential risk of skidding accidents and appropriate remedial actions have been taken.	10	0.8%	5	0.04	
			1.2.16	• When the skid number is below 25 and/or when a site is categorized by TxDOT in accordance with the Wet Weather Accident Reduction Program, as a Wet Weather Accident Site, Developer shall perform a site investigation and perform required corrective action.	15	1.2%	3	0.04	
			1.2.17	Instances where road users are warned of a potential skidding hazard where corrective action is required following the categorization as a Wet Weather Accident Reduction Site.	15	1.2%	1	0.01	
1.3	**Crossovers and other paved areas**	**a) Potholes**	1.3.1	Number of potholes of low severity or higher	50	4.0%	3	0.12	
		b) Base failures	1.3.2	Number of base failures of low severity or higher	50	4.0%	3	0.12	
1.4	**Joints in concrete**	Visual inspection of joints	1.4.1	Length of unsealed joints greater than ¼"	5	0.4%	2	0.01	
		Measurement of joint width and level difference of two sides of joints	1.4.2	Joint width more than 1" or faulting more than ¼"	10	0.8%	3	0.02	
1.5	**Curbs**	Visual inspection	1.5.1	Continuous curb lengths where more than 10% of the length has defects such as cracks and chips	5	0.4%	2	0.01	
		Physical measurement	1.5.2	Continuous curb lengths where more than 5% of the length has a separation exceeding 0.25" between curb face and adjacent roadway surface	5	0.4%	2	0.01	
		Survey and 10' straight edge	1.5.3	Continuous curb lengths where more than 5% of the length has either the top or face of curbs exceeding 0.5" from intended design alignment	5	0.4%	2	0.01	
1.6	**Maintenance/Access Roads**	Crown: Flat A shape or super-elevation with 4% cross slopes maintained to minimize ponding	1.6.1	Cross slope less than 3% or more than 6%	2	0.2%	4	0.01	
		Shoulder: Maintain slope away from the travel way and shoulder flush with travel way	1.6.2	Shoulder cross slope less than travel way cross slope; shoulder lower or higher than travel way	2	0.2%	3	0.00	
		Ditch: Maintain size and shape of ditch for proper drainage	1.6.3	Sides of ditches slumping or eroding, or obstructed by debris	2	0.2%	3	0.00	
		Ruts/potholes: Depth as measured using an automated device in compliance with TxDOT standards	1.6.4	Depth of ruts or potholes at any location greater than 1"	2	0.2%	3	0.00	
		Subgrade: Identify and repair any subgrade failures	1.6.5	Locations where subgrade failure is evident	2	0.2%	3	0.00	

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [2]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
2) DRAINAGE									2.8
2.1	**Pipes and Channels**	Visual inspection supplemented by CCTV where required to inspect buried pipe work.	2.1.1	Length of pipe or channel in feet with less than 90% of cross sectional clear area, calculated as the arithmetic mean of the clear cross-sectional areas of individual 10 feet lengths of pipes and channels in each Performance Section.	10	0.8%	2	0.02	
2.2	**Drainage treatment devices**	Visual inspection	2.2.1	Number of devices functioning correctly with means of operation displayed.	10	0.8%	3	0.02	
2.3	**Travel Way**	Visual inspection of water on surface.	2.3.1	Number of instances of hazardous water build-up.	10	0.8%	4	0.03	
2.4	**Discharge systems**	Visual inspection and records	2.4.1	Performance Sections with surface water discharge systems performing their proper function and discharging in compliance with the relevant legislation and permits.	10	0.8%	3	0.02	
2.5	**Protected Species**	Visual inspection	2.5.1	Performance Sections with named species and habitats with protection of these named species and habitats.	10	0.8%	2	0.02	
3) STRUCTURES									3.3
3.1	**Structures having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or springlines of arches or extreme ends of openings or multiple boxes**	Inspection and assessment in accordance with the requirements of federal National Bridge Inspection Standards (NBIS) of the Code of Federal Regulations, 23 Highways – Part 650, the TxDOT Bridge Inspection Manual, and the Federal Administration's Bridge Inspector's Reference Manual.		*Records as required in the TxDOT Bridge Inspection Manual*					
		As above	3.1.1	Occurrence of condition rating, in accordance with the TxDOT Bridge Inspection Manual, below seven for any deck, superstructure or substructure	50	4.0%	2	0.08	
			3.1.2	Not Used					
3.2	**Structure components**	Inspection and assessment in accordance with the requirements of federal National Bridge Inspection Standards (NBIS) of the Code of Federal Regulations, 23 Highways – Part 650, the TxDOT Bridge Inspection Manual, and the Federal Administration's Bridge Inspector's Reference Manual.	3.2.1	Occurrence of condition rating, in accordance with the TxDOT Bridge Inspection Manual, below **seven (7)** for any deck, superstructure or substructure	50	4.0%	3	0.12	
		Visual inspection of Elements listed in (i) through (vii) of the general performance requirement column in the Performance and Measurement Table.	3.2.2	Instances of condition of any element not meeting general performance requirement as determined in accordance with Good Industry Practice.	50	4.0%	3	0.12	

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [2]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
3.9	**Non-bridge class culverts**	Visual inspection	3.9.1	Number of non-bridge class culverts with vegetation, debris and silt in each Performance Section	10	0.8%	4	0.03	
			3.9.2	Number of non-bridge class culverts with defects in sealant and movement joints in each Performance Section	10	0.8%	4	0.03	
			3.9.3	Number of non-bridge class culverts with scour damage in each Performance Section	10	0.8%	4	0.03	
3.10	**Gantries and High-masts**	Visual and up close inspection	3.10.1	Number of gantries and high masts with loose assemblies in each Performance Section	10	0.8%	4	0.03	
			3.10.2	Number of gantries and high masts with defects in surface protection in each Performance Section	10	0.8%	4	0.03	
3.11	**Load Ratings**	Load rating calculations in accordance with the Manual for Bridge Evaluation and the TxDOT Bridge Inspection Manual and per the Technical Provisions	3.11.1	Number of structures with load restrictions for Texas legal loads (including legally permitted vehicles) in each Performance Section	20	1.6%	5	0.08	
3.12	**Access Points**	Visual Inspection	3.12.1	Number with defects in locks or entryways	5	0.4%	3	0.01	
3.13	**Mechanically Stabilized Earth and Retaining Walls**	Inspection and assessment in accordance with the requirements of federal Nations Bridge Inspection Standards (NBIS) of the Code of Federal Regulations, 23 Highways - Part 650, the TxDOT Bridge Inspection Manual and the Federal Highway Administration's Bridge Inspector's Reference Manual.	3.13.1	Records as required in the TxDOT Bridge Inspection Manual	10	0.8%	5	0.04	
		Visual Inspection	3.13.2	Number of parapet areas with loose nuts & bolts, blockage, undesirable vegetation, impact damage or concrete spalling in the Performance Section.	10	0.8%	4	0.03	
3.14	**Structural Surfaces**	Visual Inspection	3.14.1	Number of areas where graffiti is present	10	0.8%	4	0.03	
4) PAVEMENT MARKINGS, OBJECT MARKERS, BARRIER MARKERS AND DELINEATORS									3.8
4.1	**Pavement markings**	**a) Markings - General**							
		Portable retroreflectometer, which uses 30 meter geometry, meeting the requirements described in ASTM E 1710	4.1.1	Percentage of total length of pavement marking in each Performance Section meeting the minimum retroreflectivity 175 med/sqm/lx for white	15	1.2%	3	0.04	
			4.1.2	Percentage of total length of pavement marking in each Performance Section meeting the minimum retroreflectivity 125 med/sqm/lx for ~~white~~ yellow	15	1.2%	3	0.04	
		Physical measurement	4.1.3	Length of pavement marking in each Performance Section with more than 5% loss of area of material at any point	15	1.2%	3	0.04	
			4.1.4	Length of pavement marking in each Performance Section with spread more than 10% of specified dimensions.	15	1.2%	4	0.05	
		b) Profile Markings							
		Visual inspection	4.1.5	Percentage of total length of pavement marking in each Performance Section performing its intended function and compliant with relevant regulations	5	0.4%	3	0.01	

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [2]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
4.2	**Raised Reflective Markings**	Visual inspection	4.2.1	Number of markers associated with road markings that are ineffective in any 10 consecutive markers. (Ineffective includes missing, damaged, settled or sunk)	10	0.8%	5	0.04	
			4.2.2	A minimum of four markers are visible at 80' spacing when viewed under low beam headlights.	10	0.8%	5	0.04	
			4.2.3	Uniformity (replacement raised reflective pavement markers have equivalent physical and performance characteristics to adjacent markers).	10	0.8%	5	0.04	
4.3	**Delineators and Markers**	Visual inspection	4.3.1	Number of object markers or delineators in each Performance Section that is defective or missing	10	0.8%	4	0.03	
5) GUARDRAILS, SAFETY BARRIERS AND IMPACT ATTENUATORS									3.0
5.1	**Guardrails and Safety Barriers**	Visual inspection	5.1.1	Performance Sections with all guard rails and safety barriers appropriately placed and correction installed	25	2.0%	3	0.06	
			5.1.2	Performance Sections with all guard rails and safety barriers free from defects	20	1.6%	3	0.05	
			5.1.3	Performance Sections with all guard rails and safety barriers at correct heights	20	1.6%	2	0.03	
			5.1.4	Performance Sections with all guard rails and safety barriers at correct distances from roadway obstacles	20	1.6%	4	0.06	
5.2	**Impact Attenuators**	Visual inspection	5.2.1	Performance Sections will all impact attenuators appropriately placed and correctly installed.	20	1.6%	3	0.05	
6) TRAFFIC SIGNS									3.3
6.1	**General - All Gantry-Mounted overhead signs**	**a) Retroreflectivity** Determination of Coefficient of retro-reflectivity	6.1.1	Number of signs with actual reflectivity below the requirements of TxDOT's TMUTCD in each Performance Section	20	1.6%	3	0.05	
		b) Face damage Visual inspection	6.1.2	Number of signs in each Performance Section with face damage greater than 5% of area	10	0.8%	4	0.03	
		c) Placement Visual inspection	6.1.3	All signs in each Performance Section are placed in accordance with TxDOT's Sign Crew Field Book including not twisted or leaning	5	0.4%	4	0.02	
		d) Obsolete signs Visual inspection	6.1.4	Number of obsolete signs in each Performance Section	5	0.4%	3	0.01	
		e) Sign Information Visual inspection	6.1.5	All sign information in each Performance Section is of the correct size, location, type and wording to meet its intended purpose	5	0.4%	3	0.01	
		f) Dynamic Message Signs Visual inspection	6.1.6	All dynamic message signs in each Performance Section are fully functioning	10	0.8%	3	0.02	
7) TRAFFIC SIGNALS (NOT USED)									

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [2]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
8) LIGHTING									3.7
8.1	**Roadway and aesthetic Lighting – General**	**a) Mainline lights operable** Night time inspection or automated logs	8.1.1	Performance Sections with less than 90% of lights functioning correctly at all times	25	2.0%	3	0.06	
		b) Mainline lights out of action Night time inspection or automated logs	8.1.2	Instances of more than two consecutive lights out of action	25	2.0%	4	0.08	
8.2	**Sign Lighting**	Night time inspection or automated logs	8.2.1	Number of instances of more than one bulb per sign not working in each Performance Section	10	0.8%	4	0.03	
8.3	**Electrical Supply**	Testing to meet NEC regulations, visual inspection	8.3.1	Inspection records showing safe installation and maintenance in each Performance Section	10	0.8%	5	0.04	
8.4	**Access Panels**	Visual Inspection	8.4.1	Number of instances of missing or damaged access panels in each Performance Section	5	0.4%	5	0.02	
8.5	**High Mast Lighting**	Yearly inspection and night time inspections or automated logs	8.5.1	Instances of two or more lamps not working per high mast pole	15	1.2%	3	0.04	
			8.5.2	Any other defects per the "general Performance Requirements" column	10	0.8%	3	0.02	
9) FENCES, WALLS AND SOUND ABATEMENT									4.0
9.1	**Design and Location**								
9.2	**Construction**					0.0%			
9.3	**Operation**	Structural assessment if visual inspection warrants	9.3.1	Inspection records for fences and walls showing compliance with fence and wall requirements in each Performance Section	20	1.6%	4	0.06	
10) ROADSIDE MANAGEMENT									4.0
10.1	**Vegetated Areas - Except landscaped areas - General**	**a) Urban areas** Physical measurement of height of grass and weeds	10.1.1	Individual measurement areas in each Performance Section to have 95% of grass and weeds between 5” and 18” in height.	10	0.8%	3	0.02	
		b) Encroachment Visual inspection of instances of encroachment of vegetation	10.1.2	Number of occurrences of vegetation encroachment in each Performance Section	10	0.8%	5	0.04	
		c) Wildflowers Visual Inspection with audit of process.	10.1.3	Adherence to vegetation management manuals	10	0.8%	3	0.02	
		d) Sight lines Visual inspection	10.1.4	Number of instances of impairment of sight lines or sight distance to signs in each Performance Section	10	0.8%	4	0.03	
10.2	**Landscaped Areas**	Visual inspection	10.2.1	Inspection records showing compliance with requirements for landscaping in each Performance Section.	10	0.8%	4	0.03	
10.3	**Fire Hazards**	Visual inspection	10.3.1	Number of instances of dry brush or vegetation forming fire hazard in each Performance Section.	10	0.8%	5	0.04	
10.4	**Trees, Bushes and Ornamentals**	Visual inspection	10.4.1	Inspection records showing compliance with requirements for trees, brush and ornamentals in each Performance Section.	10	0.8%	5	0.04	
10.5	**Wetlands**	Visual inspection, assessment of permit issuers	10.5.1	Number of instances of permit requirements not met in each Performance Section	10	0.8%	3	0.02	

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [2]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
11) REST AREAS AND PICNIC AREAS (NOT USED)									
12) EARTHWORKS, EMBANKMENTS AND CUTTINGS									5.0
12.1	**Slope Failure**	Visual inspection by geotechnical specialist and further tests as recommended by the specialist	12.1.1	Number of recorded instances of slope failure in each Performance Section	12	0.9%	5	0.05	
12.2	**Slopes - General**	Visual inspection by geotechnical specialist and further tests as recommended by the specialist	12.2.1	Inspection records showing compliance with requirements for slopes in each Performance Section.	12	0.9%	5	0.05	
13) ITS EQUIPMENT									3.7
13.1	**ITS Equipment - Maintenance**	Visual Inspection	13.1.1	Inspection records showing compliance with requirements for maintenance of ITS equipment in each Performance Section.	5	0.4%	4	0.02	
13.2	**Dynamic Message Sign Equipment**	Defect measurement dependent on equipment	13.2.1	Inspection records showing compliance with requirements for Dynamic Message Signs in each Performance Section	5	0.4%	3	0.01	
13.3	**CCTV Equipment**	Defect measurement dependent on equipment	13.3.1	Inspection records showing compliance with requirements for CCTV equipment in each Performance Section	5	0.4%	4	0.02	
13.4	**Vehicle Detection Equipment**	Defect measurement dependent on equipment	13.4.1	Inspection records showing compliance with requirements for vehicle detection equipment in each Performance Section	5	0.4%	5	0.02	
			13.4.2	Traffic Detector Loop circuit's inductance to be > 50 and < 1,000 micro henries.	5	0.4%	3	0.01	
			13.4.3	Insulation resistance to be > 50 meg ohms.	5	0.4%	3	0.01	
14) TOLLING FACILITIES AND BUILDINGS (NOT USED)									
15) AMENITY (NOT USED)									
16) SNOW AND ICE CONTROL (NOT PART OF ASSET CONDITION SCORE)									
16.1	**Travel lanes**	Maximum 1hr response time to complete manning and loading of spreading vehicles.	16.1.1	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	0	0.0%			
		Maximum 2hrs from departure from loading point to complete treatment and return to loading point.	16.1.2	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	0	0.0%			
		Maximum 1hr response time for snow and ice clearance vehicles to depart from base.	16.1.3	Inspection records showing compliance with requirements for snow and ice control in each Performance Section	0	0.0%			
16.2	**Weather Forecasting**	Operations plan details the process and procedures in place and followed.	16.2.1	Inspection records showing compliance with requirements for weather forecasting in each Performance Section	0	0.0%			
16.3	**Operational Plans**	Operations plan details the process and procedures in place and followed.	16.3.1	Inspection records showing compliance with snow and ice clearance plans in each Performance Section	0	0.0%			
16.4	**Operations and Maintenance Manual**	Operations and maintenance instructions detail the process and procedures in place and followed.	16.4.1	Inspection records showing compliance with operations and maintenance instructions in each Performance Section.	0	0.0%			

ELEMENT CATEGORY	ELEMENT	INSPECTION AND MEASUREMENT METHOD	MEASURE-MENT REF	MEASUREMENT RECORD	WEIGHTING (1 TO 50) [1]	WEIGHTING FACTOR [2]	EXAMPLE RAW ASSET CONDITION SCORE [3]	WEIGHTED SCORE [4]	ELEMENT CATEGORY ASSET CONDITION SCORE [5]
17) INCIDENT RESPONSE (NOT PART OF ASSET CONDITION SCORE)									
17.1	**General**	Response times are met for 98% of incidents measured on a 1 year rolling basis.	17.1.1	Inspection records showing compliance with the MMP and requirements regarding incident response times in each Performance Section	0	0.0%			
		No complaints from Emergency Services.	17.1.2	Inspection records showing compliance with the MMP and requirements regarding incident response times in each Performance Section	0	0.0%			
17.2	**Hazardous Materials**	MMP details the process and procedures in place and followed.	17.2.1	Inspection records showing compliance with the MMP details regarding hazardous materials in each Performance Section	0	0.0%			
17.3	**Structural Assessment**	Inspections and surveys as required by incident	17.3.1	Inspection records showing compliance with the MMP and requirements for incidents in each Performance Section	0	0.0%			
17.4	**Temporary and permanent remedy**	Review and inspection of the incident site	17.4.1	Inspection records showing compliance with requirements for temporary and permanent remedy for incidents in each Performance Section	0	0.0%			
18) CUSTOMER RESPONSE (NOT PART OF ASSET CONDITION SCORE)									
18.1	**Response to inquiries**	Contact the customer within 48 hours following initial customer inquiry.	18.1.1	Percentage of responses within specified times in each Performance Section.	0	0.0%			
		All work resulting from customer requests is scheduled within 48 hours of customer contact.	18.1.2	Demonstrated by O&M Records	0	0.0%			
		Follow-up contact with the customer within 72 hours of initial inquiry.	18.1.3	Demonstrated by O&M Records	0	0.0%			
		All customer concerns/requests are resolved to TxDOT's satisfaction within 2 weeks of the initial inquiry.	18.1.4	Demonstrated by O&M Records	0	0.0%			
18.2	**Customer Contact Line**				0	0.0%			
19) SWEEPING AND CLEANING									4.5
19.1	**Sweeping**	Buildup of dirt, ice, rock, debris, etc. on roadways and bridges not to accumulate greater than 24" wide or 1/2" deep	19.1.1	Inspection records showing compliance with requirements for sweeping in each Performance Section.	15	1.2%	5	0.06	
19.2	**Litter**	No more than 20 pieces of litter per roadside mile shall be visible when traveling at highway speed.	19.2.1	Inspection records showing compliance with requirements regarding litter pick-up in each Performance Section.	15	1.2%	4	0.05	
						100.0%			
AGGREGATED ASSET CONDITION SCORE FOR ROADWAY SECTION AFTER SUBSTANTIAL COMPLETION [6]								**3.4**	

NOTES FOR ASSET CONDITION SCORE CALCULATION

1 Weighting is the assigned weighting for each Measurement Record on a scale of 1-50 for purpose of Asset Condition Score

2 Weighting Factor is the Weighting expressed as a percentage for each Measurement Record and totaling 100%

3 Example Raw Asset Condition Score = Asset Condition Score for each Measurement Record across all inspected Performance Sections

4 Weighted Score = Raw Asset Condition Score x Weighting Factor

5 Element Category Asset Condition Score = Sum of Weighted Score / Sum of Weighting Factors for each Element Category

6 Aggregated Asset Condition Score = Sum of Weighted Scores for each Measurement Record for all Element Categories

94	Number of non-zero Weightings
1264	Total of Weightings
13.45	Average Weighting

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

Design-Build Project

ATTACHMENT 19-7
TxDOT FUNCTION CODES FOR MMS

ATTACHMENT 19-7 : MAINTENANCE PLANNING ACTIVITIES & ASSOCIATED FUNC. CODES

DISTRICT CROSS REFERENCE CODE CHART 12 (FIMS SEGMENT 78, AND PORTIONS OF 70, 71 AND 72)

All segment 78 functions are trackable

Effective September, 2012 (Rev Date: July, 2011)

110	P03	CY	Removal and Replacement Removal of base and/or subgrade materials from distressed or failed areas and replacement with suitable materials. (Includes resurfacing.)	522	R0	MI	Street Sweeping Routine street sweeping. Units are the actual miles swept regardless of centerline miles.	593	T04	LF	Cable Median Barrier Installation and maintenance of high tension cable median barrier systems, including the cable, posts and end treatments.	733	T03	EA	Vandalized Signs Replacement or repair of signs damaged by vandalism.
120	P03	CY	In Place Repair In place repair base and/or subgrade material. (Includes resurfacing, and may or may not include additional stabilizing material.)	523	R1	MI	Debris Routine **patrolling** to remove and dispose of debris, including dead animals.	594	T04	LF	Concrete Barrier Installation, removal and maintenance of concrete barriers, including attached headlight barrier fence.	738	T11	EA	Installation and Maintenance of Flashing Beacons Installation and maintenance of overhead flashing beacons, pedestal or sign mounted flashing beacons, etc.
135	R05	EA ~~LF~~	Install and/or Maintain Underdrains Installation, repair and maintenance of all types of underdrains.	524	R0	AC	Spot Litter Spot removal and disposal of litter, including dead animals, from the right of way.	595	T04	LF	Guard Fence Installation and maintenance of guard fence, MBGF, turn down ends, headlights	742	T07	EA	Illumination Installation, maintenance and operation of illumination systems, including
145	S06	SY	Unpaved Road Maintenance Repair of gravel or dirt roads, including blading, addition of base, etc.	525	R0	HRS	Adopt-A-Highway Installation of posts and signs, materials furnished to groups, and the personnel and equipment used to assist in removal and disposal of collected litter.				barrier fence, including posts, metal beams, etc. (End treatment other than turn down ends, see function 596.)	743	T06	EA	continuous lighting, safety lighting and sign illumination. Installation and Maintenance of Isolated Traffic Signals Maintenance and operation of isolated traffic signals, diamond interchange signals, etc.
				526			Deleted replaced by 522	596	T05	EA	Guardrail End Treatment Systems	~~744~~			Replaced by Function Code 743
211	P01	SY	Leveling or Overlay with Laydown Machine The application of asphaltic tack coat and placing of asphaltic concrete materials to improve the ride qualities or level up low spots.	527	R0	SY	Hand Sweeping Hand sweeping of riprap, islands, medians, curb & gutter, bullpens, driveways, etc.				Installation and maintenance of guardrail end treatment systems. (For attenuators other than GETS, see function 725).	745	T08	CL M	Traffic Management System Maintenance and operation of traffic management systems on freeways or non-freeways, entrance/exit ramps, motorist information (e.g. changeable message
212	P01	SY	Leveling or Overlay with a Maintainer The application of asphaltic tack coat and placing layers of asphaltic concrete material.	530	S10	SF	Removal of Graffiti Removal of graffiti from fixtures, wing walls, bridge structures, etc. Not to be used in lieu of function 733 (Vandalized Signs), 731 or 732 (Sign Installation).	597	T03	EA	Mailboxes, Installation and Maintenance				signs, highway advisory radio, etc.) surveillance and related communications equipment. (ITS Control Center personnel should charge to segment 70, detail 0570.)
				531	S06	HRS	Picnic Area Maintenance (Without Restrooms) Refer to function 532 for description.	598	S06	HRS	Boat Ramp Maintenance Work performed in maintaining boat ramps, including mowing, litter removal, emptying litter barrels, maintenance of paved and unpaved areas, etc.	750	T09	EA	Installation and Removal of Pavement Markers Installation and/or removal of traffic buttons or reflective pavement markers.
213	P01	SY	Leveling by Hand The application of asphaltic tack coat and placing layers of asphaltic concrete material by hand. This includes repair of pavement areas greater than one square	532	S06	HRS	Rest Area Maintenance (With Restrooms) Work performed in janitorial and grounds maintenance, including mowing, litter pickup, emptying litter barrels, maintenance of plantings, cleaning restroom, cleaning arbors,	610	S04	HRS	Bridge, Movable Span Operation, routine maintenance and inspection of movable span bridges (swing barge, lift or turn). Restricted use: Beaumont, Houston, Pharr and Yoakum Districts only.	790	S07	HR	Miscellaneous Traffic Services All traffic surveys (including all motor vehicle and pedestrian counts at intersections and directly related locations) and other traffic services not covered elsewhere.
214	P01	SY	Leveling or Overlay with Drag Box The application of asphaltic tack coat and placing layers of asphaltic concrete material.				graffiti removal, minor paintings, etc. This item shall also include special maintenance required to repair/replace arbors, picnic tables, fixtures, litter barrels, paved areas, etc. (including maintenance of treatment plants and dump stations).	611	S04	HRS	Bridge, Portable Installation, removal, maintenance and inspection of portable bridges.				**Note**: Traffic control performed during the pavement evaluation process should be charged to segment 71, detail 3214 and the appropriate function (600 thru 690).
225	P06	LM	Sealing Cracks Cleaning, filling and sealing cracks in the pavement using asphaltic rubber or other sealants.	533	S06	HRS	Rest Area Facility Maintenance through Regional Contracts (Maintenance Division Use Only)	620	S05	CY	Bridge Channel Maintenance Removal of silt and drift, filling eroded areas, channel maintenance (including easements) and maintenance and repair of jetties and dikes.	799	S07	HR	Traffic Control The placement, maintenance and removal of barricades, signs, cones, lights and other such devices needed to handle traffic during emergencies or special events.
				535	S0	HRS	Maintenance of Specialty Facilities	628	S02	LF	Bridge Rail				This includes flaggers.
231	P05	SY	Seal Coat Application of a single layer of asphaltic material followed by the application of a single layer of aggregate over the full width of the lane or a shoulder (greater than 6' in width) for a minimum of 1000 continuous feet.				All maintenance costs to specialty facilities including border safety inspection facilities (BSIFs), toll booths, service plazas, fencing and associated appurtenances. This includes both temp and perm facilities. The highway class code will determine the type of facility.	645	S02	LF	Maintenance of bridge rail, posts & post connections to deck, including painting. Bridge Joint Maintenance Repair of bridge joints, including cleaning and sealing	~~806~~ ~~807~~ ~~809~~			Replaced by Function Code 799 Replaced by Function Code 799 Accident Flag selected Replaced by Function Code 799 Disaster Project;Task number
				646	S02	LF	Bridge Joint Replacement					~~810~~			Replaced by Function Code 523 Disaster Project;Task number
232	P04	SY	Strip or Spot Seal Coat Application of a single layer of asphaltic material followed by the application of a single layer of aggregate over areas less than the full width of the lane or shoulder (6' or less in width), or the full width of the lane or shoulder but less than 1000 feet in length.	538	R0	AC	Pest Control Activities related to use of predatory animal and insect control whether in turf and ornamental sites or on the ROW.	650	S01	SF	Replacement of bridge joints Bridge Deck Repair to bridge decks.	811	S07	HR	Snow and Ice Response Emergency response to clear roads during or after a snow/ice event. Includes sanding, deicing, clearing and removal, etc.
				540	R0	HRS	Hand Vegetation Control Hand cleaning vegetation out of islands, medians, riprap, drainage channels, etc. by chemical, manual or mechanical means.	660	S01	SF	Bridge Superstructure, Concrete Routine maintenance of the concrete components of the bridge superstructure, including bearings, concrete diaphragms, and beams.	~~813~~ ~~814~~ ~~820~~			Replaced by Function Code 799, 523 Disaster Project;Task number Replaced by Function Code 563 Disaster Project;Task number Deleted
233	P04	SY	Fog Seal Retain aggregate, enliven surface and/or seal hairline cracks by the application of a thin layer of asphaltic material.	541	R0	AC	Chemical Vegetation Control, Edges Complete control of vegetation encroaching in pavement edges, shoulders, medians, islands and curbs with herbicides.	665	S01	SF	Bridge Superstructure, Steel Routine maintenance of the steel components of the bridge superstructure, including stell diaphragms and beams.	~~821~~ ~~822~~ ~~823~~			Replaced by Function Code 110, 120 Disaster Project;Task number Replaced by Function Code 360 Disaster Project;Task number Replaced by Function Code 360 Disaster Project;Task number
235	P04	SY	Microsurfacing The application of a polymer modified high performance emulsion coupled with fine graded aggregate, mineral fillers and special additives in a slurry, to full ruts or to a new wearing surface. (Caution: Should not be used to seal cracked pavements.)	542	R0	AC	Chemical Vegetation Control, Overspray Control of undesirable vegetation growth by overspraying wide areas of the right of including fixtures (i.e. signs, delineators, guardrails, culverts, etc.) with herbicides.	670	S03	SF	Bridge Substructure, Concrete Routine maintenance of the concrete components of the bridge substructure, including caps, columns, abutments, wingwalls, pilings, etc.	~~824~~ ~~825~~			Replaced by Function Code 211, 212, 213, 214 Replaced by Function Code 231, 232 Disaster Project;Task number Replaced by Function Code 560,561,562,563
241	P09	EA	Pothole Repair The repair of holes with an area of less than or equal to one square yard. Charge to Function 213 if greater than one square yard.	544	R0	AC	Chemical Vegetation Control, Rope-wick Control of tall vegetation (i.e. Johnsongrass) in the right of way with a wick application.	675	S03	SF	Bridge Substructure, Steel and Timber Routine maintenance of the steel or timber components of the bridge substructure, including caps, abutments, pile extensions, etc.	~~826~~ ~~827~~			Appropriate Bridge, Disaster Project;Task number Replaced by whatever Function Code; Disaster or Damage Claim Project;Task number Replaced by Function Code 743; Disaster or Damage Claim Project;Task number
242			Replaced by Function 241	545	R0	HRS	Chemical Vegetation Control, Basal Application	680	S03	SF	Bridge Painting	~~828~~			Replaced by Function Code 721,731,732; Disaster or Damage Claim Project;Task number
245	P10	SY	Adding or Widening Pavement Widening travel lanes up to 2 feet, adding shoulders up to 4 feet **to correct a maintenance problem** (includes sub-grade, base & surfacing), or adding turn lanes to improve safety.	548	R0	SY	Control of undesirable brush species in the right of way with a low volumne basal bark application. Seeding, Sodding, Hydromulching and Blanketing Seeding, sodding, hydromulching and/or placing soil retention blankets.	690	S04	HRS	Cleaning and painting of superstructure or substructure. Bridge, Mechanical and Electrical Maintenance and repair of the electrical & mechanical components of a bridge.	~~829~~ 830	R1	HR	Replaced by Function Code 742; Disaster or Damage Claim Project;Task number Hazardous Material Clean up, Spills or Leaking Storage Tanks Investigations, testing, clean up, removal, disposal and restoration work associated with a spill or leaking storage tanks.
252	P02	SY	Milling and Planing The removal of pavement surface by milling or planing.	551	R0	AC	Landscaping The installation or maintenance of landscape plantings and their facilities including planter walls, borders, sprinkler systems, etc. (excluding picnic and rest areas).	695	S04	HRS	Fender Systems Installation and maintenance of fender systems.	831	R1	HR	Hazardous Material Clean up, Abandoned Materials Investigations, testing, clean up, removal, disposal and restoration work associated with abandoned hazardous materials of unknown ownership.
253	P02	SY	Spot Milling The removal of pavement surface by milling using a small milling machine (4 feet or less drum width).	552	R0	CL	Tree and Brush Control The trimming, pruning and disposal of shrubs, vines, and trees (excluding picnic and rest areas).	711	T01	LF	Paint and Bead Striping Striping or re-striping lane lines, centerlines and edge lines using paint and beads.	**Segment 70**			**Maintenance Section Overhead Costs** Detail 08XX (XX = Office No.); not reasonably identifiable to a roadway
265	P04	SY	Treat Bleeding Pavement Treatment of excess asphalt on the pavement surface.	558	R0	LF	Storm Water Pollution Protection Maintenance or installation of storm water pollution protection plan (SW3P) in accordance with EPA regulations on projects designated by area engineers.	712	T02	LF	High Performance Striping Striping or re-striping lane lines, centerlines and edge lines using thermoplastic or other high performance materials.	400 401 402			Training (informal or on-the-job training) Meetings (non-coded meetings; Safety Banquets) Yard Maintenance and Inspections (maintenance/inspections to facilities or yard)
270	P07	LF	Edge Repair Repair of raveled, low or damaged pavement edges with asphaltic materials.	560	R06	SY	Riprap Installation and Maintenance Installation and maintenance of ditch liners, retards, down drains, riprap, flumes, concrete mowing strips, gabions, retaining walls and other erosion protection.	713	T02	EA	Specialty Markings Medians, islands and other pavement markings not covered under function 711 or 712. (Including make-ready operations for all stripe alignment, such spotting, tabs, temporary tape, etc.)	403 404 405 406 407			Office/Section Administration (pick up/purchase supplies, HR admin., office tech duties) Section Support (customer support, contractor support, damage claims) Section Management (checking on crews, supervisor admin, meeting with local govts.) Material Management (inventory mgmt, material deliveries from WH to yard, hauling) Standby Time (weekend and weekday)
315	P08	SY	Slab Stabilization / Jacking Leveling concrete pavement through the use of hydraulically placed material.												
325	P06	LF	Cleaning and Sealing Joints and Cracks Cleaning, filling and sealing joints and cracks in concrete pavement.	561	R04	CY	Ditch Maintenance Removal and hauling of silt, drift, and/or filling eroded areas. Not to be used for work at culverts or bridges (see functions 570 or 620).	715	T02	LF	Removal of Pavement Striping Use when striping is not going to be replaced.	408			General Overhead **District Contract Management - Roadway Maintenance**
330	P08	SY	Blowouts and Stress Relief Repair of blowouts and cutting pavement for stress relief.												**(not reasonably identifiable to a roadway)**
345	P08	SY	Repair Spalling Clean and repair spalled areas (not full depth of concrete slab).	562	R04	LF	Reshaping Ditches Reshaping ditches using maintainer and/or gradall, etc. Not to be used for work at culverts or bridges (see functions 570 or 620).	716	S11	LM	Performance Based Contract Distribution (Contract Payments ONLY) These contracts are set up to pay the contractor a fixed price on a periodic basis of type of work performed and/or amount of work performed				Detail 0585 All district costs of roadway maintenance contract development and management not reasonably identifiable to a specific roadway or other accounts.
360	P08	SY	Full Depth Removal and Replacement The removal and replacement of failed areas for the full depth of the concrete slab.	563	R06	SY	Slope Repair/Stabilization Slope repair and/or stabilization. Not to be used for work at culverts or bridges (see functions 570 or 620).	721	T03	EA	Delineators Installation, maintenance and/or replacement of damaged or missing reflectors and/or posts. This function shall include straightening of posts. Measured by each post and each reflector replaced.	**Segment 71**			**Direct District Charges (No specified road location)** Detail 1305, function 020; field inspections not identifiable to a roadway, including damage assessments, night inspections, permit inspections, bridge inspections
455	P07	LF ~~SY~~	Reshaping Unpaved Shoulders Restore sod or flexible base shoulders to original sections. Includes reshaping front slope to eliminate low pavement edges along a paved shoulder.	570	R0	EA	Culvert and Storm Drain Maintenance The installation, repair and maintenance of culverts up to bridge classification	724	T04	LF	Roadway Access Control Installation and maintenance of barriers (other than those covered by functions 594 or 595) designed to control access on highways, including post and cable				Detail 1310, function 020; special services not identifiable to a roadway, including cleaning stockpile locations, collecting ditch grade data, and counting loads of RAP for county assistance.
480	S08	SY	Side Road Approaches, Crossovers and Turnouts The installation or maintenance of side road approaches, crossovers, historical markers, mailbox and litter barrel turnouts, etc.	571	R0	EA	Storm Water Pump Station Maintenance Repair and maintenance of motors, pumps, generators, wet wells, dry wells, debris screening baskets, buildings, etc., including costs of utility services.	725	T05	EA	Vehicle Attenuators Installation and maintenance of vehicle attenuators, crash cushions, etc. (**Excludes** the end treatment devices on guard fence.)				fences, ROW fences and cattle guards. Detail 1315, function 020; Courtesy Patrol **Roadway Evaluation** Detail 3214, function codes 600 thru 690; functions related to Pavement Management, including traffic control while performing pavement evaluation
488	S08	SY	Concrete Appurtenance Installation and Maintenance The maintenance, installation, or removal of concrete appurtenances which include curbs and/or gutters, raised medians, sidewalks and sound barriers.												
495	S06	SY	Parking Area Maintenance Repair of sub-grade, base or surface of areas including parking lots, park and ride lots and camping pads.	580	T03	EA	Removal of Illegal Signs on ROW, TEMP (Temporary, no special handling required.) Removal of illegal signs on right of way, including disposal and written notice to owners.	731	T03	EA	Installation/Maintenance of Small Signs The installation and maintenance of signs (less than 4 ft. X 4 ft.). Includes the	**Segment 72**			**Off-System Disaster Cleanup** Detail 000470001; off-system assistance that has been approved by the Disaster District Chairman
511	R02	AC	Mowing Mowing of the right of way.	581	T03	EA	Removal of Illegal Signs on ROW, PERM (Permanent, special handling required.) Removal of illegal signs on right of way, including disposal and to written notice to owners.				installation of an old sign on a new post, the installation of a new sign on an existing post, removing or straightening of signs and posts. Not to be used in lieu of function 732 (Installation of Large Signs), function 733 (Vandalized Signs), or function 525 (Adopt-A-Highway). Measured by each post and each sign maintained.	500 501 505			Debris Removal Fire Control Evacuee Assistance
513	R02	HRS	Spot Mowing Spot mowing of the right of way.	582	S10	HRS	Removal of Encroachments, Other than Signs Removal of illegal encroachments (other than signs) on the ROW, including disposal and written notice to owners.	732	T10	EA	Installation/Maintenance of Large Signs The installation or maintenance of signs (equal to or greater than 4 ft. X 4 ft.) Includes the installation of an old sign on a new post, the installation of a new sign on an existing post, removing or straightening of signs and posts. Not to be used in lieu of function 731 (Installation of Small Signs), function 733 (Vandalized Signs), or function 525 (Adopt-A-Highway)	510 515 520			Traffic Control for Disasters Sign and Signal Repair for Disasters Repairs to Roads for Disasters
520	R10	CY	Illegal Dumpsite Removal and Disposal Removal and disposal of debris discarded or deposited in an unauthorized area in the right of way such as under a bridge, overpass, culvert, etc.	585	S08	SY	Driveway Installation/Removal and Maintenance See access management policy.								
521	R03	AC	Litter Removal and disposal of litter from the entire right of way, excluding paved areas, picnic and rest areas.	591	S09	HRS	Utilities and Driveway Inspection								

P01	Pavement Leveling	R01	Sweeping	S01 Bridge Superstructure Maintenance
P02	Milling	R02	Mowing	S02 Bridge Rial and Joints
P03	Base Repair	R03	Litter Control	S03 Bridge Substructure Maintenance
P04	Spot Seal Coat	R04	Drainage Maintenance	S04 Specialty Bridge Maintenance
P05	Full Width Seal Coat	R05	Drainage Structures	S05 Bridge Channel Maintenance
P06	Cracl Sea:	R06	Erosion Control	S06 Specialty Maintenance
P07	Edge Maintenance	R07	Vegetation and Pest Control	S07 Traffic Control Services
P08	Concrete Pavement Maintenance	R08	Tree and Brush Control	S08 County Road Approaches, Crossovers, & Turnouts
P09	Pothole Repair	R09	Landscape Maintennace	S09 Utility & Driveway Inspection
P10	Adding or Widening Pavement	R10	Debris and Cleanup	S10 Graffiti & Encroachment Removal

T01	Paint and Bead Striping	T07	Illumination Maintenance
T02	High Performance Striping	T08	Traffic Management Systems
T03	Sign Maintenance	T09	Raised Pavement Markings
T04	Safety Barrier Maintenance	T10	large Sign Maintenance
T05	Crash Attenuators	T11	Beacon Maintenanee
T06	Traffic Signal Maintenance		

Texas Department of Transportation

BOOK 2 – TECHNICAL PROVISIONS

FOR

US 181 HARBOR BRIDGE PROJECT

DESIGN-BUILD PROJECT

ATTACHMENT 19-8
BASELINE INSPECTION REQUIREMENTS

ATTACHMENT 19-8: BASELINE ELEMENT CONDITION SURVEY REQUIREMENTS

Provide photographic records and physical measurements referenced by location to establish an agreed reference condition for each Performance Section as follows:				
ELEMENT CATEGORY	**ELEMENT**		**MEASURE-MENT REF**	**BASELINE INSPECTION REQUIREMENT**
1) ROADWAY				
1.2	**Pavement**	**a) Ruts – Mainlanes, shoulders & ramps**	1.2.1	Wheel path length with given rut depth
			1.2.2	Depth of rut at any location
		b) Ride quality	1.2.3	Individual discontinuity (e.g. bumps and depressions)
		d) Failures	1.2.4	Failure conditions per TxDOT PMIS Rater's Manual, including potholes, base failures, punchouts and jointed concrete pavement failures
		e) Edge drop-offs	1.2.5	Edge drop-offs
1.3	**Crossovers and other paved areas**	**a) Potholes**	1.3.1	Size and number of potholes
		b) Base failures	1.3.2	Size and frequency of base failures
1.4	**Joints in concrete**		1.4.1	Length and width of unsealed joints
2) DRAINAGE				
2.1	**Pipes and Channels**		2.1.1	Length of pipe or channel subject to accumulation of debris, silt or other blockage
2.2	**Drainage treatment devices**		2.2.1	General condition
2.3	**Travel Way**		2.3.1	General condition
2.4	**Discharge systems**		2.4.1	General condition and permit compliance
3) STRUCTURES				
3.1	**Structures**		3.1.1	Condition and defects as noted in each structure
			3.1.2	Condition States applicable to each Structure
3.2	**Structure components**		3.2.1	Condition and defects as noted in each structure
			3.2.2	Condition States applicable to each Structure
3.3	**Non-bridge class culverts**		3.3.1	Condition and defects as noted in each structure
3.4	**Gantries and high masts**		3.4.1	Condition and defects as noted in each structure
3.7	**Mechanically Stabilized Earth and Retaining Walls**		3.7.1	Condition and defects as noted in each structure

ATTACHMENT 19-8: BASELINE ELEMENT CONDITION SURVEY REQUIREMENTS

ELEMENT CATEGORY	ELEMENT		MEASURE-MENT REF	BASELINE INSPECTION REQUIREMENT
4) PAVEMENT MARKINGS, OBJECT MARKERS, BARRIER MARKERS AND DELINEATORS				
4.1	**Pavement markings**	**a) Markings - General**		
			4.1.1	Marking visibility under low-beam headlight
			4.1.2	Length of pavement marking where there is loss of material
		b) Profile Markings	4.1.3	General condition
4.2	**Raised reflective markers**		4.2.1	Number ineffective, missing, damaged, settled or sunk
4.3	**Delineators & Markers**		4.3.1	General condition
5) GUARDRAILS, SAFETY BARRIERS AND IMPACT ATTENUATORS				
5.1	**Guardrails and safety barriers**		5.1.1	General condition
			5.1.3	Height and offset compliance
5.2	**Impact attenuators**		5.2.1	General condition
6) TRAFFIC SIGNS				
6.1	**Gantry-mounted overhead signs**		6.1.1	General condition
7) TRAFFIC SIGNALS (NOT PART OF MAINTAINED ELEMENTS)				
8) LIGHTING				
8.1	**Roadway Lighting**		8.1.1	General condition
9) FENCES, WALLS AND SOUND ABATEMENT				
9.1	**Construction**		9.1.1	General condition
10) ROADSIDE MANAGEMENT				
10.1	**Vegetated Areas -**		10.1.1	Height of grass and weeds
10.2	**Landscaped Areas**		10.2.1	General condition
11) REST AREAS AND PICNIC AREAS (Not Used)				
12) EARTHWORKS, EMBANKMENTS AND CUTTINGS				
12.1	**Slope Failure**		12.1.1	General condition including any failures
13) ITS EQUIPMENT				
13.1	**ITS Equipment-Maintenance**		13.1.1	General condition
13.2	**Dynamic Message Sign Equipment**		13.2.1	General condition
13.3	**CCTV Equipment**		13.3.1	General condition
13.4	**Vehicle Detection Equipment**		13.4.1	General condition