

- d. An integral keyswitch shall provide for activation of an authorized bypass timer, which shall allow the door to be opened for up to 15 seconds without initiating an alarm condition. The key cylinder shall be provided by the door hardware supplier and shall be keyed to the Owner's master key system. Coordinate with the Architect as required to ensure proper keying of all units.
- e. Provide remote bypass keyswitches as indicated on the Security Drawings (as applicable) for activation of the authorized bypass timer from the side of the door opposite the unit. The remote keyswitch shall provide the same functions as the integral keyswitch. The key cylinder shall be provided by the door hardware supplier and shall be keyed to the Owner's master key system.
- f. The LA shall have a user selectable automatic reset that shall reset the horn and alarm output contact up to one minute after activation of the alarm.
- g. Provide for remote reset and deactivation the unit through control output contacts activated manually by the ACS File Server / system workstation keyboard and ACS time schedule.
- h. The unit shall have a tamper switch that shall immediately activate the output alarm contact upon removal of the unit from the wall.

J. Access Control Cabling

- 1. The Contractor shall furnish and install the following as indicated on the technology drawings and associated equipment schedules and diagrams.
- 2. The Contractor shall install an 8-foot service loop to be coiled, mounted, and stored at the access control panel.
- 3. The Contractor shall install a 20-foot service loop to be coiled, mounted, and stored on the wall above the ladder rack in Equipment Room/Telecommunications Rooms.
- 4. Wires shall be routed utilizing the pathways as indicated in the technology drawings.

3.6 Pathway Cable Support

- A. All cables shall be installed and supported in conduit systems, cable trays, cores, sleeves, etc. as indicated in the technology drawings.
- B. When cables leave the main pathway systems as indicated on the technology drawings, they shall be installed and supported in Contractor furnished and installed j-hooks or saddle straps.
- C. No cable pathway shall exceed 40% fill ratio.
- D. The contractor shall furnish a separate j-hook or saddle strap pathway for each wiretype.
- E. J-hooks and saddle straps shall be installed no more than five-feet (5') apart on center, using only manufacturer-approved installation methods and hardware.
- F. J-hooks shall be furnished with closure clips.
- G. Maximum sag between supports shall not exceed twelve-inches (12").
- H. Contractor shall establish j-hook and saddle strap pathways and shall coordinate pathways with all other disciplines. Under no-circumstances shall these pathways be used to support other low-voltage applications not included in this specification.

I. Cable Dressing

1. No nylon cable ties shall be used at any time during the installation of the wire.
2. Above Ceiling
  - a. Contractor shall furnish and install plenum-rated hook & loop straps in plenum-rated airspaces.
    - 1) The Contractor shall install no more than (1) hook & loop strap between each j-hook or saddle strap or at service loop locations.
3. Security Controller Locations
  - a. The Contractor shall bundle all visible wires with Contractor furnished and installed hook & loop straps.
  - b. Hook & loop straps shall be installed twenty-four (24) inches apart on center.

3.7 Labeling

- A. Contractor shall verify room numbers and confirm the final room numbering scheme prior to generating any labels.
- B. Cables shall be labeled within (12) inches from the termination point inside the Equipment Room/Telecommunications/Security Control Location Rooms.
- C. Cables shall be labeled within (6) inches from the termination point at the device end.
- D. Cables shall be labeled identically at both ends.
- E. Label all controls as necessary to agree with their function.

3.8 Fire Stop

- A. Provide fire stop as required.

3.9 System Programming and Data Entry

- A. Provide all initial system programming and setup of the ACS including, but not limited to the following:
  1. Coordinate ACS integration into existing Open Options system with Owner.

3.10 Wiring Techniques

- A. Furnish and install all ACS wire and cable with the exception of traveling cable for elevator control and monitoring.
- B. Provide code compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where the penetrations are made by or used for installation of the ACS.
- C. Coordinate the routing of wire and cable requiring isolation from power, radio frequency (RF), electromagnetic interference (EMI), telephone, etc. with the Architect.
- D. Run all wire and cable continuous from device location to the final point of termination. No mid-run cable splices shall be allowed.
- E. Where splicing and/or patching of coaxial cable is deemed necessary, it shall be accomplished through equalization and/or distribution amplifiers. Provide power for the

amplifiers as required. The exact location of all equalization/distribution amplifiers (as applicable) shall be indicated on the Record Drawings.

- F. Furnish and install all coaxial cable such that ample slack is supplied at the device terminating end of the cable to compensate for any final field modifications in camera location. The extra cable (approximately three meters) shall be bundled and wrapped.
- G. At no time shall any coaxial cable be subjected to a bend less than a 150 mm radius.
- H. Wire and cable within DGPs, power distribution cabinets and other security enclosures shall be neatly installed, completely terminated, pulled tight with slack removed and routed in such a way as to allow direct, unimpeded access to the equipment within the enclosure. All wire and cable shall be bundled and tied. Ties shall be similar to T&B TyRap cable ties.
- I. Provide heat-shrink to insulate all wire splices and connections. The use of electrical tape for splices and connections shall not be acceptable.
- J. Visually inspect all wire and cable for faulty insulation prior to installation.
- K. Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on Wire and Cable.
- L. Make connections with solderless devices, mechanically and electrically secured in accordance with the manufacturers' recommendations. Wire nuts shall not be an acceptable means of connecting wire and cable.
- M. Neatly bundle and wrap all horizontally run (above accessible ceilings and not within conduit) wire and cable at three meter intervals. Provide supports as required. All supports shall be UL listed for the application.
- N. All system wiring within vertical riser shafts (as required) shall be bundled, wrapped and tied to the structure at three meter intervals in order to isolate it from other wire and cable within the shaft. Additionally, all wire and cable within the shaft shall be supported at least every two floors using Greenlee Slack Grips (Split Mesh Lace Closing) or approved equal. Provide all personnel and equipment necessary to install and support the cable. All equipment shall be UL listed for the application.

### 3.11 Conduit, Boxes and Raceways

- A. Install all conduit necessary for a complete installation, but not provided for in the Security Conduit Drawings, in finished areas concealed in chases, furrings, concrete slabs and/or above suspended ceilings. No exposed conduit shall be installed within public areas.
- B. Conduit shall be carefully installed, properly and adequately supported as required to comply with the requirements outlined herein and as required by the NEC to provide a neat, workmanlike installation. Horizontal conduit runs shall be supported by clamps, pipe straps, special brackets or heavy iron tie, tied to the black iron structural members supporting the ceiling. Fastening of conduit to masonry walls, floor or partitions require malleable pipe clips with screws and suitable expansion sleeves.
- C. All conduit shall be cut accurately to measurements established at the building and shall be installed without springing or forcing.
- D. All required inserts shall be drilled-in and all openings required through concrete or masonry shall be saw cut or core drilled with tools specifically designed for this purpose.
- E. Swab out and remove all burrs from conduit before any wires are pulled.

- F. Lay out and install conduit runs as to avoid proximity to hot pipes. In no case shall a conduit be run within 75 mm of such pipes, except where crossings are unavoidable and then the conduit shall be kept at least 25 mm from the covering of the pipe crossed.
- G. Provide fire stops where conduits penetrate fire rated walls and/or floors.
- H. All conduit installation, whether run exposed or concealed, shall be approved prior to installation by the Architect.

### 3.12 Power Requirements

- A. 120VAC AC power dedicated to security shall be provided by the electrical contractor for the Security System as indicated on drawings. Coordinate with the Architect to establish locations of security dedicated 120VAC AC circuits.
- B. Connect to the AC power (provided by electrical contractor) and provide UL listed power supplies and transformers to distribute low voltage power to the system components as required.
- C. Provide hinged cover terminal cabinets with tamper switches for all power supplies, transformers and power distribution terminal strips. Provide all conduit and wiring from the AC power facilities to the terminal cabinets.
- D. Surge Protection
  - 1. Provide protection against spikes, surges, noise, and other line problems for all system equipment and components.
  - 2. Protect all exterior video, control, power, signal cables and conductors against power surges. Each surge protector shall be UL Listed.

### 3.13 Labeled Doors and Frames

- A. In no instance shall any UL labeled door or frame be drilled, cut, penetrated, or modified in any way.
- B. The Contractor shall be responsible for replacing any labeled door or frame that is modified without written approval from the Architect.

### 3.14 Demonstration and Training

- A. Demonstration:
  - 1. Demonstrate that integrated security and communication system functions properly.
  - 2. Perform demonstration at final system inspection by qualified representative of manufacturer.
- B. Instruction and Training:
  - 1. Provide instruction and training of Owner's personnel as required for operation of integrated security and communication system.
  - 2. Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.
  - 3. Provide instruction and training by qualified representative of manufacturer.

- C. Record, label, and catalog all training on DVD. Provide the DVD to the Owner for future in-house training sessions and / or reviews. Furnish all temporary equipment necessary for recording all training sessions. Maintain accurate and up-to-date time sheets of all training sessions.
- D. The Contractor shall be on call during the Warranty to answer any questions the Owner might have. The Owner reserves the right to use any excess training hours, not used by the time of system completion, for future training as requested by the Owner until the total number of training hours has been completed.

### 3.15 System Start-Up

- A. The Work shall be complete and ready to operate prior to final acceptance.
- B. Load all of the initial user database into all programmable systems up to the inaugural day of beneficial use of the Security System. The Architect shall assist in establishing procedural guidelines and in defining terminology and conditions unique to the Owner's operation.

### 3.16 Substantial Completion

- A. In order to qualify for the Architect's consideration of Substantial Completion, the Work must, at a minimum, meet the following requirements:
  - 1. The initial card holder database must be fully loaded into the ACS.
  - 2. All sub-system interfaces must be complete and operational.
  - 3. All required operator training must have been provided to the Owner and/or its representatives.
- B. Substantial Completion shall not be construed as final acceptance of the Work.

### 3.17 System Acceptance

- A. Final acceptance testing of the Work will be conducted by the Architect.
- B. Prior to any final acceptance testing, the Contractor shall submit two sets of preliminary (draft) Record Drawings to the Architect. The preliminary Record Drawings are to be used by the Architect to conduct the system final test.
- C. Submit a paragraph by paragraph completion matrix indicating completion or delinquency for each item included in the Specification and all subsequent addenda and bulletins as part of the Work. Indicate completion of the requirement by the word "Completed" following each paragraph number. Indicate delinquency for the requirement by the words "To Be Completed" following the applicable paragraph number. Should work on any item be under way, but not yet fully complete, indicate the extent (or lack thereof) of completion to date, and the proposed date of completion.
- D. Conduct a complete test of the entire Security System and provide the Architect with a written report on the results of that test. During the course of this test, place the integrated Security System in service, and calibrate and test all equipment.
- E. Following completion of the initial testing and correction of any noted deficiencies, conduct a five day burn-in test. The intent of the burn-in test shall be to prove the Security System by placing it in near real operating conditions. During this period the Security System shall be fully functional and programmed such that all points, interfaces, controls, reports, messages, prompts, etc. can be exercised and validated. Record and correct any system

anomaly, deficiency, or failure noted during this period. Scheduling of the final acceptance test shall be based on a review of the results of this burn-in test.

- F. Deliver a report describing the results of functional tests, burn-in tests, diagnostics, calibrations, corrections, and repairs including written certification to the Architect that the installed complete Security System has been calibrated, tested, and is fully functional as specified herein.
- G. Prior to the final acceptance test, coordinate with the Architect for security related construction clean-up and patch work requirements. Security equipment closets and similar areas should be free of accumulation of waste materials or rubbish caused by operations under the Contract. At completion of the Work, remove all waste materials, rubbish, the Contractor's and its subcontractors' tools, construction equipment, machinery and all surplus materials.
- H. Upon written notification from the Contractor that the Security System is completely installed, integrated and operational, and the burn-in testing completed, the Architect will conduct a final acceptance test of the entire system.
- I. During the course of the final acceptance test by the Architect, the Contractor shall be responsible for demonstrating that, without exception, the completed and integrated system complies with the contract requirements. All physical and functional requirements of the project shall be demonstrated and shown. This demonstration will begin by comparing "as built" conditions of the Security System to requirements outlined in the Specification, item by item. Following the Specification compliance review, all Security System head-end equipment will be evaluated.
- J. The functionality of the various interfaces between systems will be tested.
- K. Following the Security System head-end equipment and console review, the installation of all field devices will be inspected. This field inspection will weigh heavily on the general neatness and quality of installations, complete functionality of each individual device, and mounting, backbox and conduit requirements compliance.
- L. All equipment shall be on and fully operational during any and all testing procedures. Provide all personnel, equipment, and supplies necessary to perform all site testing. Provide a minimum of two employees familiar with the system for the final acceptance test. One employee shall be responsible for monitoring and verifying alarms while the other will be required to demonstrate the function of each device. Supply at least two two-way radios for use during the test. A manufacturer's representative may be present on site to answer any questions that may be beyond the technical capability of the Contractor's employees, if the Contractor so elects or by specific request of the Architect or Owner, at no charge to the Architect or Owner.
- M. Upon successful completion of the final acceptance test (or subsequent punch list retest) the Architect will issue a letter of final acceptance.
- N. The Architect retains the right to suspend and/or terminate testing at any time when the system fails to perform as specified. In the event that it becomes necessary to suspend the test, all of the Owner's/Architect's fees and expenses related to the suspended test will be deducted from the Contractor's retainage. Furthermore, in the event it becomes necessary to suspend the test, the Contractor shall work diligently to complete/repair all outstanding items to the condition specified in the Specification and as indicated on the Drawings. The Contractor shall supply the Architect with a detailed completion schedule outlining phase by phase completion dates and a tentative date for a subsequent punch list retest. During the

final acceptance test, no adjustments, repairs or modifications to the system will be conducted without the permission of the Architect.

### 3.18 Project Closeout Documentation

#### A. As-Built Drawings

1. Drawings shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until drawings are received and approved by the Architect/Engineer.
2. Three (3) sets of drawings depicting the condition of the access control system as installed.
3. As-Built drawings shall be produced in AutoCAD 2010 or higher and provided in hardcopy and electronically in .dwg and PDF format.
4. Hardcopy drawings shall be provided in the original size as issued by the Architect/Engineer.
5. Drawings shall retain the formatting and title block of the original drawings as issued by the Architect/Engineer.
6. Drawings shall be provided utilizing the original scale and shall include the exact dimensions and locations of all equipment room/telecommunication room layouts, wall elevations, equipment rack elevations, ladder racks, cable tray, sleeves, pathways, card reader locations and labeling scheme.

#### B. Contactor's Statement of Warranty

1. Statement of warranty shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until statement of warranty is received and approved by the Architect/Engineer.
2. Contractor shall furnish a minimum of a one (1) year warranty on all materials, labor and workmanship starting at final system acceptance.
3. One original and two copies of Contractor's warranty terms and conditions to include contact information (i.e. Contractor name, Point of Contact, address, phone number and email address) and start and end date for warranty call outs.

**END OF SECTION**

## SECTION 28 23 00 - ELECTRONIC SURVEILLANCE SYSTEM

### PART 1 - GENERAL

- 1.01 This section identifies the requirements, technical design, and specifications for the electronic surveillance system at the San Antonio Water Systems – East Side and Northwest Operations Center in San Antonio, Texas (“Owner”). The electronic surveillance system as specified is an industry-standard and includes interior and exterior surveillance cameras, network video recorder, and electronic surveillance cabling as specified.
- 1.02 The Contractor shall provide a Manufacturer’s Performance Certification for the installed electronic surveillance system. The entire security system shall be designed, coordinated, supplied, and integrated by a single approved licensed security Contractor approved by SAWS and who is certified by United Technologies as a FCW NX Global installer. All system integration and testing shall be performed by SAWS agent of record with UTC, currently Alterman Data Comm. There are to be no substitutions.
- 1.03 Contractor shall include materials, equipment, and labor necessary to provide a complete and functional electronic surveillance system regardless of any items not listed or described in this specification or associated drawings.
- 1.04 Requirements
- A. Contractor Experience Requirements
  - B. Submittal Requirements
  - C. Acceptable Manufacturers
  - D. Codes, Standards and Regulations
  - E. General Requirements
  - F. System Requirements
  - G. Testing Requirements
  - H. Training Requirements
  - I. Project Closeout Documentation
  - J. Attachments
- 1.05 Related Requirements
- A. The Drawings, Specifications, General Conditions, Supplementary General Conditions, and other requirements of Division 1 apply to the work specified in Division 28, and shall be complied with in every respect. The Contractor shall examine all of the items which make up the Contract Documents, and shall coordinate them with the work on the project.
  - B. Qualified Contractor
    - 1. The entire system shall be designed, coordinated, supplied, and integrated by single approved licensed security Contractor from the list below. The contractor shall be



certified by United Technologies as a FCWNX Global installer. All system integration and testing shall be performed by SAWS agent of record with UTC, currently Alterman Data Comm. There are to be no substitutions.

- a. Alterman Data Comm
- b. Or pre-approved by SAWS Security prior to the Bid Opening

C. Contractor Experience Requirements

1. The Contractor shall possess all relevant Manufacturer Certifications (i.e. hardware installation, software installation and programming, etc.) for both the company and individual technicians prior to submitting a bid for the work.
2. The Contractor shall have been in business for a minimum of five (5) years.
3. The Contractor shall have a local office with local technicians and an adequate workforce to complete this project within a 75-mile radius of the project site.
4. The Contractor shall have completed a minimum of five (5) projects similar in size and scope to the Owner's installation, where the systems have been in continuous satisfactory operation for at least one (1) year.

- C. Subcontractors shall be identified at the time of bid and comply with the requirements and intentions of these specifications, associated drawings, and related contract documents.

1.06 Submittal Requirements

A. Pre-Installation Submittal

1. Contractor shall not order, purchase, or install any equipment until pre-installation submittals have been accepted in writing by the Architect/Engineer.
2. Manufacturer product data sheets for each proposed system component.
  1. For product data sheets containing more than one (1) part number or product, the Contractor shall clearly identify the specific part number or product being submitted.
3. Shop drawings of the proposed system installation.
  1. Shop drawings shall include surveillance camera locations, rack elevations, installation typical details, preliminary cable numbers, proposed cable pathways, system schematics, and riser diagrams. Shop drawings shall be submitted on 30" X 42" bond paper.
  2. Contractor shall maintain a set of shop drawings on site at all times and shall update the shop drawings on a weekly basis. Shop drawings shall be made available for inspection at the request of the Architect/Engineer.
4. Itemized list of all equipment, materials and labor required for the installation of the electronic surveillance system as specified herein.

1. This list shall be provided in printed and electronic format (Microsoft Excel) and shall contain: Part Number, Description, Unit of Measure, Unit Cost, Quantity, Labor Cost and Extended Cost to provide a complete and functional electronic surveillance system. Attachment "A" attached to these specifications shall be used for this purpose.
5. Estimated cable count required for the electronic surveillance system listed per Equipment Room and or Telecommunications Room.
  1. This listing shall be provided in printed form and electronic format (Microsoft Excel). Attachment "B" attached to these specifications shall be used for this purpose.
6. Manufacturer Product Certifications for Company.
7. Manufacturer Product Certifications for Installers.
8. Manufacturer Warranty letter.
9. Documentation indicating that Contractor has been in business for (5) years.
10. Address of Contractor's local office within a 75-mile radius of the project site.
11. Quantity of full time local technicians within a 75-mile radius of the project site.
12. List of five (5) contractor-installed projects of a similar size and scope in operation for at least (1) year. The Contractor shall provide the following information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, Brief Description of Project, Client Point of Contact Name and Phone Number.
13. List of completed and ongoing projects with the Owner. The Contractor shall provide the following information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, and Brief Description of Project.

## **PART 2 - PRODUCTS**

### **2.01 General Requirements**

- A. The following sections specifically list the acceptable equipment types and items for this project.
- B. Architect/Engineer will have final determination of acceptability of all proposed equipment and must approve submitted equipment prior to purchase or installation.
- C. Provide IP fixed dome and PTZ cameras, SAWS Security will help with locations during the design phase.
- D. Proposed equivalent items must be approved in writing by the Architect/Engineer prior to submitting a bid. Proposed equivalent items must meet or exceed these specifications and the specifications of the specified item.
- E. In the event a manufacturer's specified product or part number has changed or is no longer available, Contractor shall substitute the appropriate equivalent manufacturer's part number.

- F. In the event of a discrepancy between the specifications and the drawings, the greater quantity and/or better quality will be furnished.
  - G. For listed products with no part number specified, Contractor shall provide a product that meets the performance requirements of these specifications, industry standard practices, and intended application.
  - A. All wiring, equipment, and installation materials shall be new and of the highest quality.
  - B. Labels on all wiring, materials, and equipment must indicate a nationally recognized testing laboratory.
  - C. Original Equipment Manufacturer (OEM) documentation must be provided to the Architect/Engineer which certifies performance characteristics and compliance with industry standards.
- 2.02 Acceptable Manufacturers
- A. Electronic Surveillance System Software/Hardware
    - 1. Electronic Surveillance System Server
      - 1. Network Video Recorder
        - 1) UTC TVN-2016-16T
        - 2) or approved equal
  - B. Surveillance Cameras
    - 1. Interior Camera
      - 1. Fixed Dome IP Camera
        - 1) Axis P3367-V
        - 2) Or approved equal
      - 2. Exterior Camera
        - 1. Fixed Dome IP Camera
          - 1) Vandal Resistant P3367-VE
        - 2. Pan Tilt Zoom Dome IP Camera
          - 1) Vandal Resistant Axis Q6045-E
          - 2) Or approved equal
    - C. Power Equipment
      - 1. Surge Protection
        - 1) Ditek - DTK-RM12POE 12-Channel
        - 2) Ditek - DTK-PVPIP Camera Surge Protection

2. Uninterruptable Power Supply
    - 1) APC Smart-UPS
  - D. Video Displays
    1. 32" Flat Panel: Samsung UN32F5000 with Tilting Wall Mount: Chief MTMU
  - E. Pullout Keyboard Video and Mouse Console
    1. TRIPP LITE B020-008-17 8-Port NetDirector 1U Rackmount Console KVM Switch w/17" LCD
  - F. Electronic Surveillance System Cabling – Provided by Division 27
  - G. Pathway Cable Support
    1. Panduit J-Mod Cable Support System
    2. Erico – CADDY CAT LINKS J-Hook Series
    3. Panduit Plenum Rated Hook & Loop (Black)
  - H. Labeling
    1. Permanent Labels for Fiber Optic Cables
      1. Panduit Self-Laminating Labels
      2. Brady
  - I. Fire Stop
    1. STI Spec Seal
    2. 3M Products
- 2.03 Cameras
- A. Camera type, location, enclosure and mounting requirements shall be as indicated on the drawings.
  - B. All interior cameras are to be mounted as indicated on drawings.
  - C. Connect to data cable provided under Division 27 as indicated on technology and security drawings.
  - D. Contractor shall provide necessary Category 6 patch cable to connect the camera to the provided data connection as indicated on the technology and security drawings.
  - E. Camera will receive power via Ethernet from POE Switch.
  - F. Provide, terminate and test ESS data cabling, patch cord and patch panel.
  - G. Provide surge suppressor for all exterior mounted cameras.

- H. Surge suppression shall be configured to protect video, power, and data wiring for exterior cameras.
- I. Provide lightning protection for power, control and video cables for all exterior cameras. Seal and make watertight at all exterior cameras.
- J. Provide and install an Uninterruptable Power Supply in the MDF room for server protection.

#### 2.04 Basis of Design for Server and Storage

- A. Program all cameras initially to provide for recording and live viewing, 25 FPS, H.264 compression, 1.3 MB. , 50% motion to be archived locally for minimum of 30 days.

#### 2.05 Network Communications

- A. Contractor to provide and install PoE network switches. Coordinate locations with Owner.
- B. Category 6 structured cable system to be provided under separate sections and provided by others.

### **PART 3 EXECUTION**

#### 3.01 Codes, Standards, Regulations

- A. American National Standards Institute (ANSI)
- B. American Society for Testing and Materials (ASTM)
  1. ASTM B 1 (2001; R 2007) Standard Specification for Hard-Drawn Copper Wire
  2. ASTM B 8 (2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
  3. ASTM D 1557 (2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>) (2700 kN-m/m<sup>3</sup>)
  4. ASTM D 709 (2001; R 2007) Laminated Thermosetting Materials
- C. Alliance for Telecommunications Industry Solutions (ATIS)
- D. Building Industry Consulting Service International (BICSI)
  1. Telecommunications Distribution Methods Manual 13<sup>th</sup> Edition
  2. Outside Plant Design Reference Manual 5<sup>th</sup> Edition
  3. ANSI/BICSI 002-2011, Data Center Design and Implementation Best Practices
  4. NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling

5. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
- E. Electronics Industry Alliance (EIA)
- F. Federal Communications Commission (FCC)
1. FCC Part 15, Radiated Emissions Limits, revised 1998
  2. FCC Part 68, Connection of Terminal Equipment to the Telephone Network, revised 1998
  3. FCC Part 76, Cable Television Service, revised 1998
- G. Insulated Cable Engineers Association (ICEA)
1. ICEA S-87-640 (2006) Fiber Optic Outside Plant Communications Cable
  2. ICEA S-98-688 (2006) Broadband Twisted Pair, Telecommunications Cable Aircore, Polyolefin Insulated Copper Conductors
  3. ICEA S-99-689 (2006) Broadband Twisted Pair Telecommunications Cable Filled, Polyolefin Insulated Copper Conductors
- H. International Electrotechnical Commission (IEC)
- I. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
1. IEEE Standard 81-1983, IEEE Guide for Measuring Earth Resistance, Ground Impedance, and Earth Surface Potential of a Ground System
  2. IEEE Standard 1100-1999, Recommended for practice for Powering and Grounding Sensitive
  3. Electronic Equipment in Industrial and Commercial Power Systems (IEEE Emerald Book)
  4. IEEE C2 (2007; Errata 2007; INT 2008) National Electrical Safety Code
  5. IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms
- J. International Organization for Standardization (ISO)
1. International Organization of Standardization/International Electrotechnical Commission (ISO/IEC)
  2. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises, 1995
  3. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration, 1999
  4. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises, 1995
  5. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration, 1999

- K. National Cable Television Association (NCTA)
- L. National Electrical Manufacturers Association (NEMA)
  - 1. NEMA C62.61 (1993) Gas Tube Surge Arresters on Wire Line Telephone Circuits
- M. National Fire Protection Association (NFPA)
  - 1. NFPA-70, National Electrical Code
  - 2. NFPA-75, Protection of Electronic Computer Data Processing Equipment.
  - 3. NFPA-101, Life Safety Code
  - 4. NFPA-297, Guide on Principles and Practices for Telecommunications Systems
  - 5. NFPA-780, Standard for the Installation of Lightning Protection Systems.
- N. National Institute Standards and Technology (NIST)
- O. Occupational Safety and Health Administration (OSHA)
- P. Telecommunications Industry Association (TIA)
  - 1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009
  - 2. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009
  - 3. ANSI/TIA -568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard, 2009
  - 4. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, 2008
  - 5. ANSI/TIA/EIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces, 2005
  - 6. ANSI/TIA-569-B Amendment 1, Commercial Building Standard for Telecommunications Pathways and Spaces, 2009
  - 7. ANSI/TIA/EIA-606-B, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2012
  - 8. ANSI/TIA/EIA-607-B, Commercial Building Grounding and Bonding Requirements for Telecommunications, 2011
  - 9. ANSI/TIA-758, Customer-Owned Outside Plant Telecommunications Infrastructure Standard, 2004
- Q. Underwriters Laboratories, Inc. (UL)
  - 1. UL 510 (2005; Rev thru Aug 2005) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape

## 2. UL 910 (NFPA 262 1990) Applicable Flame Test

3.02 In the event of any conflicts between documents referenced herein and the contents of this specification, the Contractor shall notify the Architect/Engineer in writing of any such occurrences before purchasing or installing any equipment or materials. The Architect/Engineer will notify the Contractor of any actions required to resolve these conflicts. Such actions may include but are not limited to: design changes, equipment, materials and/or installation changes. In any event Contractor shall not supersede specifications and standards from the latest NFPA and NEC publications.

## 3.03 General Requirements

- A. Contractor shall comply with the requirements of local Authority Having Jurisdiction (AHJ), State of Texas, the National Fire Protection Association (NFPA), and the National Electrical Code (NEC). If the Contractor identifies any item in the plans or specifications that will not strictly comply with the aforementioned laws, ordinances, and rules, the matter shall be referred to the Architect/Engineer for direction before proceeding with that part of the work.
- B. The Contractor shall install the materials in accordance with these specifications and the manufacturer's installation guidelines.
- C. No deviations from the plans or specifications shall be made without full consent in writing of the Architect/Engineer. The Contractor shall have written approval from the Architect/Engineer for any additional work beyond the Contract Documents prior to beginning such work. If the Contractor does not obtain written approval from the Architect/Engineer prior to proceeding with the work, the contractor shall not be reimbursed for the work.
- D. The Contractor shall obtain written permission from the Architect/Engineer before proceeding with any work that would necessitate cutting into or through any part of the building structure such as, but not limited to girders, beams, floors, walls, roofs, or ceilings.
- E. Contractor shall notify the Architect/Engineer a minimum of (2) weeks prior to beginning work and will participate in a pre-construction meeting with the Architect/Engineer to perform a walkthrough, review the scope of work, schedule, and escalation procedures.
- F. The Contractor shall maintain a work area free of debris, trash, empty wire reels, scrap wire, etc., and dispose of such items on a daily basis and return the site to the original state of cleanliness. The Contractor shall not use Owner's facilities for the disposal of excess or scrap materials.
- G. Equipment and materials installed by the Contractor shall be free of defects and damage.
- H. Contractor shall be responsible for the repair of any damage caused by the contractor during the installation.
- I. Contractor shall test all wires prior to installation. By failing to perform this testing operation, the Contractor shall accept the wire as compliant and assume all liability for the replacement of the wire at no cost to the Owner should it be found defective at a later date.



- J. Contractor shall maintain a set of working specifications, design drawings, and shop drawings to be kept on site at all times and shall update the shop drawings on a weekly basis. Shop drawings shall be made available for inspection at the request of the Architect/Engineer.
  - K. Equipment and materials shall be consistent throughout the installation. Where multiple units of the same type of equipment and materials are required, these units shall be a standard product with the same manufacturer and model number.
  - L. Equipment and materials shall be delivered and stored in accordance with the manufacturer's guidelines at the Contractor's expense.
  - M. Contractor shall make all stored equipment and materials available for inspection at the request of the Architect/Engineer.
  - N. All equipment and material used in the installation shall be approved by the manufacturer for the environment in which it is being installed.
  - O. Wires shall be properly supported in accordance with industry standards at all times. Improperly supported wires shall be corrected by the Contractor at no cost to the Owner.
  - P. Contractor shall be responsible to properly protect wiring from damage by other trades during construction.
  - Q. Cables shall be routed at 90-degree angles to the building structure. At no time shall a diagonal pull be installed.
  - R. The Contractor shall not install wires in conduits or sleeves without nylon bushings. Wires installed through conduits or sleeves without nylon bushings shall be removed and replaced at no cost to the Owner.
  - S. The Contractor shall provide any lifts necessary to perform work.
- 3.04 System Requirements
- A. Quantities listed are for reference only, contractor is responsible for furnishing materials as required to provide a complete and functioning system. Where quantities are not noted, they may be obtained from the drawings. In the event of a discrepancy between the specifications and the drawings, the greater quantity shall be furnished.
  - B. Electronic Surveillance System Software/Hardware
    - 1. Electronic Surveillance Management System
      - 1) The Contractor shall furnish and install.
        - a) Axis Camera Management Software
      - 2) The Contractor shall configure all associated electronic surveillance system software to include video viewing clients. Number and location of video viewing clients to be determined by Owner.

- 3) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.
- 4) The Contractor shall ensure communication is established between the electronic surveillance management system and installed surveillance cameras:

## 2. Electronic Surveillance System Licensing

- 1) The Contractor shall furnish and install.
  - a) One (1) Each camera as required.
- 2) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.

## 2. Electronic Surveillance System Server

### 1. Network Video Recorder

- 1) The Contractor shall furnish and install the following as indicated on the technology drawings and associated equipment schedules and diagrams.
  - a) UTC TVN-2016-16T
- 2) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.
- 3) The Contractor shall coordinate exact server location prior to installation.
- 4) The Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines.
- 5) The Contractor shall program all network address information for the network video recorder and ensure the server can communicate with other devices on the Owner's network

## C. Surveillance Cameras

### 1. Interior Camera

#### 1. Fixed Dome IP Camera

- 1) The Contractor shall furnish and install the following as indicated on the technology drawings and associated equipment schedules and diagrams.
  - a) Axis P3354
- 2) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.
- 3) The Contractor shall coordinate exact camera location prior to installation.

- 4) The Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines.
- 5) The Contractor shall program all network address information for the camera and ensure the camera can communicate with the electronic surveillance system server.

## 2. Exterior Camera

### 1. Fixed Dome IP Camera

- 1) The Contractor shall furnish and install the following as indicated on the technology drawings and associated equipment schedules and diagrams.
  - a) Axis P3364-VE
- 1) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.
- 2) The Contractor shall coordinate exact camera location prior to installation.
- 3) The Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines.
- 4) The Contractor shall program all network address information for the camera and ensure the camera can communicate with the electronic surveillance system server.

### b. Pan Tilt Zoom

- 1) The Contractor shall furnish and install the following as indicated on the technology drawings and associated equipment schedules and diagrams.
  - a) Exterior Vandal Resistant IP Q6035-E
- 2) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.
- 3) The Contractor shall coordinate exact camera location prior to installation.
- 4) The Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines.
- 5) The Contractor shall program all network address information for the camera and ensure the camera can communicate with the electronics surveillance system server.

## 2. Power Equipment – All Cameras are PoE from Owner provided switches

### a. Surge Protection

- 1) The Contractor shall furnish and install the following.

- a)
    - a) Ditek - DTK-RM12POE 12-Channel
    - b) Ditek - DTK-PVPIP Camera Surge Protection
  - 2) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.
  - 3) The Contractor shall coordinate exact location prior to installation.
- b. Uninterruptible Power Supply
- 1) The Contractor shall furnish and install the following as indicated on the technology drawings and associated equipment schedules and diagrams.
    - a) APC Smart-UPS
  - 2) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.
  - 3) The Contractor shall coordinate exact uninterruptible power supply location prior to installation.
  - 4) The Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines.
3. Video Display
- a. Flat Panel Display
- 1) Contractor shall furnish and install the following:
    - a) 32" Flat Panel: Samsung UN32F5000 with Tilting Wall Mount: Chief MTMU
  - 2) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.
  - 3) The Contractor shall coordinate exact Flat Panel Display location prior to installation.
  - 4) The Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines.
- b. Pullout Keyboard Video and Mouse Console
- a) TRIPP LITE B020-008-17 8-Port NetDirector 1U Rackmount Console KVM Switch w/17" LCD
- 1) Contractor shall furnish and install the following:
  - 2) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.
  - 3) The Contractor shall coordinate exact pullout keyboard video mouse console location prior to installation.

- 4) The Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines.

D. Electronic Surveillance System Cabling

1. Provided in Division 27

E. Pathway Cable Support

1. Communication room equipment racks/cabinets and Category 6 structured cable system are to be provided by others and this section is for information only.
  - a. All cables shall be installed and supported in conduit systems, cable trays, cores, sleeves, etc. as indicated in the technology drawings.
  - b. When cables leave the main pathway systems as indicated on the technology drawings, they shall be installed and supported in Contractor furnished and installed j-hooks or saddle straps.
  - c. No cable pathway shall exceed 40% fill ratio.
  - d. The contractor shall furnish a separate j-hook or saddle strap pathway for each wire type.
  - e. J-hooks and saddle straps shall be installed no more than five-feet (5') apart on center, using only manufacturer-approved installation methods and hardware.
  - f. J-hooks shall be furnished with closure clips.
  - g. Maximum sag between supports shall not exceed twelve-inches (12").
  - h. Contractor shall establish j-hook and saddle strap pathways and shall coordinate pathways with all other disciplines. Under no-circumstances shall these pathways be used to support other low-voltage applications not included in this specification.
  - i. Cable Dressing
    - 1) No nylon cable ties shall be used at any time during the installation of the wire.
    - 2) Above Ceiling
    - 3) Contractor shall furnish and install plenum-rated hook & loop straps in plenum-rated airspaces.
      - a) The Contractor shall install no more than (1) hook & loop strap between each j-hook or saddle strap or at service loop locations.
  - j. Equipment Rooms / Telecommunications Rooms
    - 1) The Contractor shall bundle all visible wires with Contractor furnished and installed hook & loop straps.

- a) Hook & loop straps shall be installed twenty-four (24) inches apart on center.

F. Grounding and Bonding

1. General

- a. The Contractor shall ensure metal-to-metal contact for all terminations.
- b. All materials shall be UL Listed.
- c. All connections shall be made with UL Listed compression 2-hole lugs.
- d. Contractor shall use an anti-oxidation compound on all connections.
- e. In a metal frame (structural steel) building, where the steel framework is readily accessible within or external to the room; each TMGB and TGB shall be bonded to the vertical steel metal frame using a minimum # 6 AWG plenum rated green insulated conductor.
- f. A Grounding Equalizer conductor shall be installed when required by ANSI/TIA/EIA-607-B (Interconnects multiple TBBs on the top floor and every 3rd floor in between).
- g. The connection to building steel does not eliminate the requirement for the TBB or EBC to the service ground.

G. System Labeling

1. Contractor shall verify room numbers and confirm the final room numbering scheme prior to generating any labels.
2. Cables shall be labeled within (12) inches from the termination point inside the Equipment Room/Telecommunications Rooms.
3. Cables shall be labeled within (6) inches from the termination point at the device end.
4. Cables shall be labeled identically at both ends.
5. Equipment Room/Telecommunications Rooms
  - a. Contractor shall use the following room designations for wire labeling:
    - 1) MDF/IDF
6. Cable
  - a. Electronic Surveillance System Cable
    - 1) Electronic Surveillance System cable labels shall contain the device number as indicated in the technology drawings, wire origin room number, wire destination room number, and wire type (i.e. C01/122-210/CAT6). In instances where no origin room number exists, utilize

the device number as indicated in the technology drawings, wire destination room number, and wire type (i.e. C01/210/CAT6).

## 7. Equipment

### a. Electronic Surveillance System Devices

- 1) Equipment to be labeled shall include but not be limited to cameras, network video recorders, video encoders, and media converters. Coordinate name, font style, and devices to be labeled with Owner or Owner's representative before labeling. Provide computer generated labels, handwritten labels will not be accepted.

## 3.05 Testing Requirements

### A. Electronic Surveillance System

1. The Contractor shall test and commission each component per the specifications and manufacture's installation instructions.
2. Coordinate final network (ports, IP addresses, programming, etc.) requirements with Architect and Owner.
3. Test the Electronic Surveillance System devices, communication, and programming to ensure system components are functioning as intended.
4. A test report for each piece of equipment shall be prepared by the Contractor and submitted to the Owner. This report shall include a complete listing of every device, the date it was tested, and the results. The final test reports shall indicate that every device tested successfully. Failure to completely test and document the testing will result in a delay of final testing and acceptance.
5. In the absence of a test by the manufacturer, use the operator's manual and demonstrates the ability to complete each of the functions listed.
6. Coordinate with the Owner to resolve any programming and communication problems that occurred during the test.
7. The Security Consultant will prepare a punch list of items identified during the test that require correction before final acceptance.
8. Upon completion of testing and coordination, the Owner and the Security Consultant will conduct a final acceptance test.

### B. Grounding and Bonding

1. Main Building Ground
  1. Coordinate with electrical contractor and provide a copy of their test results for the main building ground. The results shall be below 25 Ohms.
2. Two-Point Ground/Continuity Testing

1. Prior to the two-point ground testing, a visual inspection shall be performed to verify that the bonding and grounding system is installed according to the drawings and specifications and in compliance with the TIA-607-B Standard.
2. All testing shall be conducted prior to any active equipment is installed.
3. The Contractor shall use an earth ground resistance tester that is configured for a continuity test. This is also known as a two-point tester or a "dead earth" test.
4. Prior to the two-point continuity test conduct a voltage test to ensure there is no stray voltage in the system.
5. The testing shall include but is not limited to the following points.
  - 1) Building electrical grounding electrode and the TMGB.
  - 2) TMGB/TGB to electrical ground in ER/TR.
  - 3) TMGB/TGB to the building steel (if present).
  - 4) TMGB to each TGB.
  - 5) Building steel (if present) to the electrical ground.
6. Per the TIA-607-B, the maximum value for resistance between any point in the telecommunications bonding and grounding system and the building's electrical grounding electrode system is 100 milliohms. In the case of long TBB and Grounding Equalizer conductor runs, the resistance of the conductor must be factored into the total resistance. For example 1 km of a No. 3/0 conductor has a resistance of 0.2028 ohms. (0.06180 ohms per 1000 ft.)

The Contractor shall notify the Architect/Engineer a minimum of five (5) days in advance to observe field testing

### 3.06 Project Closeout Documentation

#### A. As-Built Drawings

1. Drawings shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until drawings are received and approved by the Architect/Engineer.
2. Three (3) sets of drawings depicting the condition of the electronic surveillance system as installed.
3. As-Built drawings shall be produced in AutoCAD 2010 or higher and provided in hardcopy and electronically in .dwg and PDF format.
4. Hardcopy drawings shall be provided in the original size as issued by the Architect/Engineer.
5. Drawings shall retain the formatting and title block of the original drawings as issued by the Architect/Engineer.



6. Drawings shall be provided utilizing the original scale and shall include the exact dimensions and locations of all equipment room/telecommunication room layouts, wall elevations, equipment rack elevations, ladder racks, cable tray, sleeves, pathways, card reader locations and labeling scheme.

B. Test Documentation

1. Test documentation shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until these test results are received and approved by the Architect/Engineer.
2. Three (3) sets of test documentation for the electronic surveillance system as installed.
3. Test results shall be provided in hard copy and electronic format (i.e., manufacturer's proprietary testing software along with Contractor's test records).
4. Test documentation shall be bound, sectioned, and tabbed in the following sequence as applicable:
  1. Electronic Surveillance System
  2. Electronic Surveillance System Wiring

C. Contactor's Statement of Warranty

1. Statement of warranty shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until statement of warranty is received and approved by the Architect/Engineer.
2. Contractor shall furnish a minimum of a one (1) year warranty on all materials, labor and workmanship starting at final system acceptance.
3. One original and two copies of Contractor's warranty terms and conditions to include contact information (i.e. Contractor name, Point of Contact, address, phone number and email address) and start and end date for warranty call outs.

**Attachment "A"**

Provide an itemized listing of all equipment and material required to meet the specifications for the Electronic Surveillance System. This listing shall include Part Number, Description, Unit of Measure, Unit Cost, Quantity, Labor Cost, and Extended Cost.

Part Number	Description	Unit of Measure	Unit Cost	Quantity	Labor Cost	Extended Cost
<b>Total Equipment and Materials</b>					\$	-
<b>Total Labor and Installation</b>					\$	-
<b>Grand Total</b>					\$	-

**Attachment “B”**

Provide an estimated drop count for each Equipment Room/Telecommunications Room indicating the quantity of wires served from each applicable Equipment Room/Telecommunications Room.

Equipment Room/Telecommunications Room	Category 6 4-Pair UTP	Multi-Conductor Data Cable	Multi-Conductor Power Cable
<b>Total</b>			

**END OF SECTION 28 23 00**

**SECTION 28 31 00  
FIRE ALARM SYSTEMS**

**PART 1. GENERAL**

1.01 CONDITIONS:

- A. The Contractor, Subcontractors, Trade Contractors, and Suppliers are responsible for understanding the requirements of the General Conditions, the Supplementary General Conditions, all Specification Sections, all Drawings, and all Bid Documents that govern or may otherwise impact their Work.
- B. The Contractor, Subcontractors, Trade Contractors, and Suppliers shall compare the requirements of the Specifications to the requirements of the Drawings as part of the bidding process and report any discrepancies to the Architect prior to bidding.
- C. The Contractor, Subcontractors, Trade Contractors, and Suppliers shall bid fully operational systems that represent, to the best of their understanding, the intent of the system installation and operation for the system being proposed and installed.
- D. Additionally, all Work performed under this Section of the Specifications shall be in strict accordance with the provisions found in the Basic Materials and Methods Sections of Divisions 21, 22, 23 & 26.

1.02 SUMMARY

- A. The overall scope of work will include the installation of new fire alarm equipment in the referenced buildings as indicated on the contract drawings.
- B. The system design has been performed by the FPE. The Contractor is responsible for all permitting, labor, materials, and equipment for the following:
  - 1. The system shall be an analog addressable Fire Alarm Control Unit located in the Administration Building and will herein after referred to as the FACU. Approved manufacturers are listed in Part 2 - Products section. The system shall include the following:
    - a. Smoke detectors, waterflow devices, supervisory devices and other initiating devices, control relays and monitoring relays.
    - b. Duct detectors as required on air handling systems over 2,000 CFM.
    - c. Twenty percent (20%) expansion of the listed capacity of the fire alarm panel, transponder panels and on each circuit to allow for future expansion by the Owner.
    - d. User controls to silence waterflow bells and auxiliary functions to allow for maintenance and testing to minimize disruption of normal activities, i.e. walk test or service group functions.
    - e. System must be listed and approved as a smoke detector sensitivity test set and be capable of providing drift compensation.
    - f. All systems must be field programmable for all changes, modifications, additions, deletions and hardware and software upgrades.
    - g. System must be capable of generating comprehensive reports for sensitivity, verification counts and address registers.
    - h. Surge protection for each data circuit or circuit powering addressable equipment shall be provided on each end where the circuit pathway travels underground.
  - 2. It is the responsibility of Division 26 to provide operating power for the Fire Alarm System as outlined on the Project Drawings. All wiring shall be support by J-hooks. See Electrical specification for details.
  - 3. Wire and cable shall be UL-listed for fire alarm use and shall be as required by the manufacturer. Raceways containing conductor identified as "Fire Alarm" conductors shall not contain any other conductors. Each wire or cable, including those in pull boxes, shall be individually labeled per Specification Section 26 05 53 Electrical Identification.
  - 4. Provide new addressable initiating devices and waterflow bells as indicated.
  - 5. Provide a dedicated 120 VAC power circuit for the FACU complete with a lock-on device at the circuit breaker of the electrical panel.
  - 6. Provide supervision of all waterflow and valve supervisory switches.
  - 7. Fire caulk and patch penetrations of all rated assemblies.
  - 8. Provide control/release of electromagnetic security door locks.
  - 9. Conduit, wiring and system installation.

10. Core drilling.
11. Cutting, painting and patching.

#### 1.03 REFERENCES

- A. National Fire Protection Association (NFPA):
  1. NFPA 13, Installation of Sprinkler Systems, current edition.
  2. NFPA 70, National Electrical Code, current edition.
  3. NFPA 72, National Fire Alarm Code, 2010 edition.
  4. NFPA 90A, Installation of Air-Conditioning and Ventilating Systems, current edition.
- B. International Code Council (ICC):
  1. International Building Code (IBC), 2012 with San Antonio amendments.
  2. International Fire Code (IFC), 2012 with San Antonio amendments.
- C. State Licensing Regulations:
  1. Texas Insurance Code, Chapter 6002 (formerly Article 5.43-2), Fire Detection and Alarm Device Installation & 28 TAC § 34.600 the Fire Alarm Rules, current edition.
- D. Equipment Listings:
  1. Underwriters Laboratories (UL) Fire Protection Equipment Directory, 2010 edition.
  2. Other Nationally Recognized Testing Laboratory (NRTL).
- E. Code Conflicts:
  1. Any conflicts between the referenced codes and this specification shall be brought to the attention of the FPE for interpretation.
- F. Other Referenced Standards
  1. UL Standard 268, Smoke Detectors for Fire Protective Signaling Systems, latest edition.
  2. UL Standard 268A, Smoke Detectors for Duct Application, latest edition.
  3. UL Standard 346, Waterflow Indicators for Fire Protective Signaling Systems, latest edition.
  4. UL Standard 864, Control Units for Fire Protective Signaling Systems, latest edition.
  5. UL Standard 1424, Cables for Power-Limited Fire Protective Signaling Systems, latest edition.
  6. UL Standard 2196, Standard for Tests for Fire Protective Signaling Systems, latest edition.
  7. NECA 1, Standard Practice for Good Workmanship in Electrical Contracting, 2000 edition.
  8. NECA 305-2001, Standard for Fire Alarm System Job Practices, latest edition.

#### 1.04 DEFINITIONS

- A. Owner shall mean the SAWS.
- B. Contractor is a licensed fire alarm contractor in the State of Texas qualified to design, install, and test fire alarm systems.
- C. Fire Protection Engineer of Record or FPE shall mean Protection Development, Incorporated, or PDI.
- D. NICET shall mean National Institute for Certification in Engineering Technologies.
- E. CAD based drawings (where requested) shall be provided in ".dwg" format and shall be compatible with AutoCAD release 2010.
- F. Authority Having Jurisdiction, or AHJ shall mean:
  1. The City of San Antonio Fire Department,
  2. Property Insurance Carrier, and
  3. Owner.

#### 1.05 GENERAL AND SPECIAL CONDITIONS

- A. The General Provisions of the Contract, including the Uniform General Conditions of the Contract, the Supplementary General Conditions, Special Conditions and Division 1 - General Requirements, apply to work specified in this Section.
- B. The Contractor shall furnish all equipment, materials, tools, labor, etc. necessary for a complete fire alarm system, with said systems being made ready for operation in accordance with the requirements of these specifications, drawings and the AHJ.

- C. The Contractor shall visit the site before submitting their bid and shall examine all existing physical conditions that may be material to the performance of their work. No extra payments will be allowed to the Contractor because of extra work made necessary by their failure to do so.
- D. Any case of error, omission, discrepancy or lack of clarity shall be promptly identified to the Owner and Engineer for clarification prior to the bid due date.
- E. Project specifications and drawings are issued as a combined bid package. In the event of a conflict between the drawings and the specifications, the specifications shall be brought to the attention of the FPE for further clarification.
- F. The Contractor shall provide all devices and equipment required by the specifications and drawings. Under no circumstances shall the Contractor delete any equipment or devices without the written directive of the FPE and Owner.
- G. The Contractor shall furnish and install additional devices for the fire alarm system to meet the requirements of the standards and guides referenced in Section 1.3. The Contractor shall commence changes to the Scope of Work only upon written directive of the Owner.

#### 1.06 SYSTEM DESCRIPTION

- A. The new fire alarm system shall be installed throughout the referenced building as indicated on the contract drawings. Work shall be in accordance with the codes and standards and their annexes / appendices referenced in Section 1.03 of this specification and as indicated.
  - 1. The addressable fire alarm system shall provide initiation, detection, supervision, alarm, and control. The system status shall be displayed at the FACU panel. The FACU shall be monitored by an approved monitoring station. System programming shall meet the performance objectives of the Fire Alarm System I/O Matrix shown on the Fire Alarm drawings and perform in accordance with the codes and standards (and their annexes/appendices) referenced in Paragraph 1.3.
  - 2. Duct smoke detection shall be provided as indicated on the contract drawings.
  - 3. New power-limited cable, UL listed for use in fire alarm system, shall be used for all circuits. Signal Line Circuits (SLC), Initiating Device Circuits (IDC) wiring shall be solid copper, two conductor, 16 AWG minimum. Waterflow bell Circuit (NAC) wiring, and 24 VDC power wiring shall be solid copper, two conductor, 14 AWG minimum or as indicated in permit documents.
  - 4. All new devices and appliances shall be installed within new metallic back boxes as required per NFPA 70, Section 300.4. Recessed ceiling mounted back boxes shall be installed with approved support tile bridge brackets.
  - 5. System wiring shall be installed in raceway assemblies as indicated on the fire alarm drawings and as approved by the wiring manufacturer for such use. Hangers shall have factory coated materials to prevent breaks in the wire jacket and conductors. Electrical Metallic Tubing (EMT) or Rigid Metallic Conduit (RMC) shall be installed where required by the codes and standards referenced in Part 1, 1.3, of this specification. Flexible metallic conduit may be used as permitted by NFPA 70, but shall never exceed six feet in length. Conduit or conduit sleeves shall be provided for all circuits above hard ceilings and where penetrating walls.
  - 6. Performance of SLC's shall be Class B, in accordance with NFPA 72 Section 12.3.2.
  - 7. Performance of 24 VDC power and waterflow bell circuits shall be Class B, in accordance with NFPA 72 Section 12.3.2.
  - 8. All data transmission circuits shall be Class B in accordance with NFPA 72 Section 12.3.2.
  - 9. All wiring shall be in the above ceiling raceway and coordinated with the technology and electrical contractors.
  - 10. Alarm signals arriving at the FACU shall not be lost following a primary power failure (or outage) before the alarm signal is processed and recorded.
  - 11. All fire alarm cables attached to terminals shall be identified with legibly printed heat-shrink ID labels and shall be WHITE in color with black letters.
  - 12. Wire and cable shall be UL-listed for fire alarm use and shall be as required by the manufacturer. Raceways containing conductor identified as "Fire Alarm" conductors shall not contain any other conductors. Conduit shall be sized per NFPA 70 based upon the number of conductors per run.

#### 1.07 SUBMITTALS

- A. All submittals must be reviewed and approved by the Owner and FPE. Submission to, and permitting by, the City of San Antonio Fire Department is required for this facility and will be the responsibility of the FPE. Should product substitutions by the Contractor require re-design or re-submittal to the City, said information will be provided to the FPE by the Contractor for review, approval, incorporation into the design and submittal to the City of San Antonio. Contractor shall not commence installation work without explicit authorization by the FPE and CITY OF SAN ANTONIO.
1. When applicable, submittals shall include the following documentation:
    - a. Equipment Books: A clearly annotated manufacturer's product data document that includes complete manufacturer's information on every component proposed to be utilized. A complete system bill of material is required.
    - b. Shop Drawings: Shop drawings shall be drawn in AutoCAD format to an indicated scale and plotted on sheets of uniform size with a plan of each floor. Drawings shall include an input / output matrix of sequence of operations. Matrix shall include/list all individual input device types and indicate all output functions that shall occur upon activation of the individual input devices. Drawings shall show the location of the fire alarm control panels, initiating devices and waterflow bells. Drawings must also show the end-of-line resistors, and other field terminations which may be necessary for auxiliary control and supervisory functions. The submittal shall include complete floor plan drawings locating all system devices and appliances including wire routing, line size, conduit size and routing. Provide a "to scale" detail of the FACU wiring and circuit connections at the panel. Control units and equipment must be shown on the floor plan drawings (Contractor shall follow NFPA 72 Section A.10.18.1.1 list of information).
    - c. Battery Calculations: Battery Calculations for Fire Alarm Control Panels, and all remote panels. Submit back-up battery calculations (identifying both the non-alarm and alarm load associated with each) verifying the batteries exceed supervisory and alarm requirements when manufacturer-suggested factors such as aging are included. Batteries must be a minimum 120% of this calculated capacity. The secondary power supply from batteries shall have sufficient capacity to power the fire alarm system under non-alarm condition for a minimum of 24 hours and then shall be capable of operating the system during alarm condition for a period of 5 minutes at maximum connected load in accordance with NFPA 72 Section 10.5.6.3.1(2).
    - d. Normal 120 VAC fire alarm panel(s) circuit loading.
  2. The appropriate number of copies of all documentation shall be submitted to the FPE for distribution as follows:
    - a. One complete set of documents in .dwg format, AutoCAD release 2010 for review by Owner.
    - b. Two complete hard copy sets for Owner use.
    - c. Two complete hard copies shall be provided to FPE for review and comment. One complete copy of the submittal will be retained by the Fire Protection Engineer of Record. One copy of the submittal shall be returned for the use by the Contractor.
  3. Submittal packages shall be signed by State of Texas Alarm Planning Superintendent (Certified NICET III minimum in Fire Alarm Systems) or signed and sealed by a Professional Engineer (P.E.) registered in the State of Texas.
  4. Prior to start of construction; submit the information outlined above for review. Note: PARTIAL SUBMITTALS ARE UNACCEPTABLE.
  5. The submittals will be reviewed for conformance with the construction documents. If submittals are found not to conform to the requirements of the construction documents, the Contractor shall be required to resubmit with modifications. The Contractor shall be responsible for extra expenses or time delays for the subsequent review(s) of the rejected submittals. Approval of the submittals shall in no case relieve the Contractor of the responsibility to meet the requirements of the construction documents and the requirements of the AHJ.
  6. Costs incurred by the Owner for the FPE to review additional submittals resulting from an initial rejection shall be the responsibility of the submitting Contractor.
- B. CLOSE OUT DOCUMENTATION
1. The Owner and FPE shall each be provided with the following documents:
    - a. One complete electronic set of as-built drawings in ".dwg" format, AutoCAD release 2010, on CD-ROM for Owner use.

- b. Two hard copies of the as-built drawing sets shall be provided for Owner records.
- c. One hard copy of the as-built drawing set shall be provided for FPE records.
- d. One complete electronic set of as-built drawings in “.dwg” format, AutoCAD release 2010, on CD-ROM for FPE use.
- e. Operation and maintenance manuals: Two copies shall be provided to Owner. The data shall include a plain language description of the system and operating sequence, manufacturer’s technical data, and data sheets for all installed equipment.
- f. Original test certificates and approvals by the AHJ (one hard copy and one electronic copy in pdf format) shall be provided to Owner. One hard copy of said documents shall be provided to FPE for project record. The documents shall include at a minimum but not be limited to the following:
  - (i) NFPA 72 Fire Alarm System Record of Completion
  - (ii) NFPA 72 Installation and Testing Form
  - (iii) Texas Department of Insurance Fire Alarm Installation Certificate (form FM-009A)
  - (iv) Texas Department of Insurance Fire Alarm System Installation Inspection Form
- g. Original test certificates and approvals by the AHJ shall be provided to Owner. One hard copy of said documents shall be provided to FPE for project record.
- h. Programmer’s disk on a CD-ROM disk(s) compatible with Microsoft Windows operating system shall be provided to Owner. This disk(s) must contain the complete and final database and all other programming data for the fire alarm system. Programmer must provide all panel passwords including those that allow access for program changes.
- i. One hard copy set of plans and pertinent data for first-responders shall be provided for the locked document box at the FACU location.

#### 1.08 QUALITY CONTROL

##### A. QUALIFICATIONS

1. Contractor shall hold a current license issued by the State of Texas Department of Insurance to plan, install, service, inspect, test, certify and maintain fire alarm or fire detection devices.
2. The fire alarm system manufacturer must have trained factory personnel and multiple authorized dealers within the San Antonio area.
3. The Contractor shall provide direct supervision of the fire alarm system installation and testing.
4. All electrical installation of the fire alarm system, including wire installation and terminations, if performed by electricians shall be under the supervision of the Contractor. Installation personnel shall be supervised persons who are qualified and experienced in the installation, inspection and testing of fire alarm systems. The Contractor assumes full responsibility of the installation and shall certify the installation upon completion.
5. Any subcontractors used to install portions of the system shall be approved by the Owner and the Engineer prior to commencement of the installation.
6. Design shall be performed by one of the following: a Fire Protection Engineer licensed in the State of Texas or a NICET Level III or IV fire alarm engineering technician also licensed as a Fire Alarm Planning Superintendent with the Texas Department of Insurance.
7. The Contractor shall be fully responsible to ensure that all designs meet the construction specifications and documents, applicable codes and standards, and shall adhere to those codes and standards mandated by the Texas Department of Insurance for a fully licensed fire alarm systems Contractor.

##### B. PRE-INSTALLATION CONFERENCE

1. Prior to installation, the Contractor shall arrange a pre-installation conference with the Owner to identify installation issues and potential conflicts.

#### 1.09 DELIVERY, STORAGE, AND HANDLING

##### A. ACCEPTANCE AT SITE



1. Contractor shall inspect all material upon arrival at the site. Any defective or damaged material shall be immediately removed from site and replaced with properly operating and serviceable equipment.
2. Handle fire alarm equipment carefully to prevent damage, breaking, and scoring. Do not install damaged equipment or components; replace with new.
3. Store fire alarm equipment in clean, dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
4. Store, handle and protect all equipment and materials in accord with Division 01, Section 01 60 10 – Treatment, Handling and Protecting material and equipment.
5. Electronics and electronic controllers (when separate or as part of as a component of equipment shall be provided with a heating device (such as electric heat) for such stored items to prevent moisture accumulation.

**B. STORAGE AND PROTECTION**

1. Contractor will deliver materials to an area designated by the Owner. Vehicles shall not block fire lanes or fire doors during delivery of materials. If the Owner cannot provide storage, the Contractor shall provide for secure storage on the site at a location approved by the Owner.
2. At the end of each working day, all materials shall be returned to the designated storage area. Material, equipment, tools, etc. will not be left outside the storage area without the consent of the Owner.
3. The cost of all material handling, delivery and freight is the Contractor's responsibility. The Owner will not be responsible for materials delivered to the site.
4. The Contractor is responsible for providing adequate protection for all equipment during construction.
5. Contractor shall maintain the premises free from accumulation of waste materials or rubbish caused by this work. At the completion of the work, remove all surplus materials, tools, etc., and leave the premises clean to the Owner's satisfaction.

**1.10 SCHEDULING AND SEQUENCING**

- A. All sequencing and scheduling of installation, inspections, testing, and placing system in full operation shall be coordinated by the Contractor. Submit a schedule for completion of all work to the Owner for approval.

**1.11 WARRANTY**

- A. All workmanship, materials, and equipment furnished under this contract shall be free from defects in workmanship and materials under normal use and service for a period of one (1) year from the date of acceptance of the entire replacement fire alarm system by the AHJ. Any equipment or materials shown to be defective shall be repaired or replaced during working hours allowed in this specification or at a time convenient to the owner and at no cost to the Owner.
- B. The equipment manufacturer shall be represented by a local service company, and the name shall be furnished to the Owner.
- C. The warranty shall include all necessary material, travel, labor and parts to replace defective components or materials at the job site. The Contractor shall commence repair of any "in warranty" defects within 8 hours of notification of such defects.
- D. The warranty shall include all necessary factory and field software required to perform the specified tasks. This item does not include software installed after system acceptance unless the defective software was installed at the direction of the system manufacturer.
- E. If the Owner experiences more than two spurious or unexplained false alarms or troubles in any 48 hours period while the system is under warranty, the Contractor shall provide the necessary labor, materials and technical expertise to promptly correct the problem(s) without additional cost.
- F. The Contractor shall include, as part of the warranty, a test and inspection of the entire fire alarm system within one month prior to the expiration of the construction warranty. The Contractor shall provide a written report of any deficiencies and repair all the deficiencies. The test and report shall conform to the certification described in NFPA 72.

**1.12 COMMISSIONING**

- A. System acceptance testing and commissioning, performance verification and acceptance testing shall be in accordance with requirements of Chapter 14 in NFPA 72.
- B. Contractor shall employ factory-trained technicians on-site to conduct the final system check and to ensure the system's integrity.

#### 1.13 OFF-SITE MONITORING

- A. The FACU shall be programmed to transmit status to a UL listed central monitoring station.

#### 1.14 QUALIFICATIONS OF BIDDER:

- A. The Owner may make such investigations as he deems necessary to determine the ability of the bidder to perform the Work, and the bidder shall furnish to the Owner all such information and data for this purpose as the Owner may request. The Owner reserves the right to reject any bid if the evidence submitted by, or investigation of, such bidder fails to satisfy the Owner that such bidder is properly qualified to carry out the obligations of the contract and to complete the Work contemplated therein. Conditional bids will not be accepted.
- B. Before using the bid of a Subcontractor as part of his bid, the General Contractor shall satisfy himself that the proposed Subcontractor can satisfy all the requirements expressed above. The Owner reserves the right to reject any bid if the evidence submitted by, or investigation of, such bidder fails to satisfy the Owner that the bidder and/or any Subcontractor he proposes can properly qualify to carry out the obligation of any part of the Contract, and to complete the Work contemplated therein.
- C. The ability of any bidder to obtain plans and provide a performance bond shall not be regarded as the sole qualification of such bidder's competency and responsibility to meet the requirements and obligations of the contract.
- D. The bidder shall be fully experience in the design and installation of the Fire Alarm System herein specified, and shall furnish with the bid an itemized list of the installations of the type specified herein. The list shall include the name of this Project, date of completion, the amount of the contract, and the name of the person to contact for reference. This list must contain at least two (2) projects within a 50-mile radius of the facility to allow the Owner to visit the job site for review of the system installation and service.

## PART 2. PRODUCTS

### 2.01 MATERIALS

- A. Material and equipment shall be standard products listed and approved for use with the FACU. Products for this project shall be of the latest design. Obsolete or discontinued models are not acceptable. All fire alarm equipment shall be a product of one manufacturer. All materials and equipment shall be stock items and readily available in the San Antonio metroplex area.
- B. All component parts of the system shall be listed or labeled by UL for use as part of a protective signaling system meeting NFPA 72. Contractor shall submit proof of such conformance. Field modification of components shall be prohibited.
- C. All equipment and components shall be installed in strict compliance with manufacturers' instructions and recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, approved back boxes, approved installation methods, etc., before beginning system installation.

### 2.02 ADJUSTING

- A. Should discrepancies or installation deficiencies be uncovered by field quality control measures, the Contractor shall modify the work as necessary to meet all project requirements as originally scheduled unless otherwise modified by the Owner.
- B. An authorized manufacturer's representative shall provide training and instruction for operation of the fire alarm system as follows:
  1. Provide training of operating personnel in proper system operation and required user maintenance procedures.
  2. Two separate 2-hour training sessions for operating personnel. The sessions are to cover proper operating and response procedures. The instructions shall be sufficient to enable a previously untrained person to properly operate the system.
  3. The operation and maintenance manuals may serve as the training aids.

**PART 3. EXECUTION****3.01 EXAMINATION**

- A. Examine areas and conditions under which fire alarm systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer. Any inquiries or discrepancies shall be addressed to the Architect.
- B. Contractor shall employ factory-trained technicians on-site to conduct a "pre-test" fire alarm system check of the existing system to which the new fire alarm system is to be connected to ensure the system's integrity prior to calling for AHJ inspections. Pre-test shall be witnessed by the FPE or Owner, and shall be given a minimum of 48 hours' notice before said test is performed.

**3.02 INSTALLATION****A. PRACTICE AND PROCEDURES**

1. Install electrical identification in accordance with Division 26 Basic Electrical Materials and Methods Section "Electrical Identification."
2. The Contractor shall comply with all applicable practices and procedures as required per the referenced codes, standards, and the AHJ to ensure the proper installation of a fully operational, compliant system. All work shall be coordinated with representatives of the Owner at least ten (10) days prior to the scheduled start.
3. Prior to commencing any work, the Contractor shall inspect all areas where work is to be performed. The Contractor shall comply with all appropriate safety guidelines and precautions to accomplish the work without injury to personnel or damage to any building components or contents.
4. All equipment shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings) with approved fastening systems or methods.
5. Control panels shall be installed in non-public areas and may be surface mounted.
6. Smoke detectors shall not be installed until the area of installation is free of debris and construction dust or all detectors in said area shall be replaced. Cleaning of said detectors will not be sufficient to meet the intent of this section.

**B. PRIMARY POWER**

1. The primary power for all control units shall be connected to a dedicated 120 VAC power circuit breaker which can only be accessed by authorized personnel or provided with a "lock-on" device which must be removed before the circuit can be de-energized. The circuit breaker must be clearly and indelibly labeled in color red, "FIRE ALARM CIRCUIT CONTROL". Primary electrical power modifications shall be performed by an electrical contractor under the scope of work of the Contractor.

**C. WIRING AND TERMINATION METHODS**

1. Install wiring, raceways, and electrical boxes and fittings in accordance with DIVISION - 26 – Sections - "Raceways," "Wires and Cables," and "Electrical Boxes and Fittings" for wiring of non-power limited circuits.
2. Install wiring above accessible ceilings utilizing J-hooks and cable management system (where available). Install wiring in metallic raceway within walls, when passing thru areas without ceilings (areas with exposed structure) and in areas without accessible ceilings (including hard Gyp type ceilings). Provide conduit sleeves (quantity, sizes and locations as required) dedicated to fire alarm wiring thru walls above accessible ceilings
3. Install wires and cables without splices. Make connections at terminal strips in cabinets or at equipment terminals. Make soldered splices in electronic circuits in control cabinets
4. Identify junction boxes prominently with red paint
5. All wiring associated with the fire alarm system including power, SLC, IDC, NAC, and auxiliary functions shall be installed in accordance with the respective articles of the National Electric Code, NFPA 70 and the manufacturer's requirements.
6. Fire alarm conductor terminations in the control panel are to be made on terminal strips with separate points for each conductor. All strips and cable shall be numbered or identified with WHITE heat shrink labels and BLACK lettering. Set up termination of cabling and wire racks so that the system may be easily serviced. Ensure that all electrical cable terminations are suitable for the wire gauge being used. All conductors must be splice free. Wire nuts and crimp

connectors are prohibited. All in/out wiring connections for all components of the fire alarm system shall be through the use of screw terminals.

7. Wire which penetrates fire rated wall assemblies shall be properly sealed with a UL approved fire-stop material as specified by the manufacturer for use with the specific wire and construction material. Verify the location of all vertical fire partitions from finished floor to deck with Architect.
8. Wire shall be properly supported in accordance with NFPA 70 and the manufacturer's guidelines. Wiring shall not be supported by suspended ceilings or other similar fixtures and shall be provided with dedicated support wires, straps, guides, etc.

#### D. DEVICE AND APPLIANCE INSTALLATION

1. Install fire alarm system as indicated, in accordance with equipment manufacturer's written instructions and complying with applicable portions of NEC and NECA's "Standard of Installation." All wiring shall be installed in raceways concealed in building
2. Install all initiating and supervisory devices where shown on the fire protection drawings and as specified herein.
3. Provide supervision of all tamper and waterflow switches in accordance with NFPA 72, paragraphs 17.12 and 17.16.1.
4. Duct detectors shall be installed in the return ducts. Duct smoke detectors shall be provided and installed by the Contractor. Duct smoke detection shall be installed in accordance with NFPA 72, paragraphs 17.7.5.4.2 and 17.7.5.5.
5. Spot type smoke detection is required at the FACU.

#### E. SEALING AND PATCHING

1. Penetrations through fire rated walls shall be sealed with approved fire resistive materials and/or assemblies. Material and assemblies shall be suitable for the hourly rating of the penetrated construction element.

### 3.03 FIELD QUALITY CONTROL

- A. The Contractor shall be completely responsible for the fire alarm systems described in this specification meeting the requirements found in NFPA 72 Chapter 14, Installation, Testing, and Maintenance, and herein described.
- B. The Architect and FPE shall be notified of all inspection and test dates in advance and shall be present at such testing. Contractor shall be responsible for coordinating pretesting and final inspection and testing with the FPE and the Owner. As-built drawings, testing and inspection certificates shall be furnished during this event and no later than fourteen (14) days after this event. Acceptance tests will be ruled invalid if not witnessed by the FPE or otherwise waived by the Owner.
- C. All testing that will cause interruption of the normal business operations of the facility must be performed at times other than normal business hours unless approved by the Owner. This testing includes, but is not limited to, audible and visual appliance testing, elevator shunt and recall testing, HVAC system shutdown, security system interface. Coordination with the Owner and building management shall be the responsibility of the Contractor.

### 3.04 CONTRACTOR PRE-TESTING

- A. The Contractor shall perform a system pre-test before the FPE will witness system functional testing. The Contractor Pre-Testing results shall be submitted in a written report with supporting documentation to the FPE for review and approval prior to scheduling FPE Pre-Testing. Deficiencies shall be highlighted in the Contractor Pre-Test report and shall be corrected prior to FPE Pre-Testing. The Contractor Pre-Test shall include:
  1. Ensure the FACU is under the "normal operation" mode as detailed in the manufacturer's operation and maintenance manual.
  2. Verifying no unwanted voltages exist between circuit conductors and ground.
  3. Conduct insulation testing (using a Volt / Ohm Meter) to assess insulation performance. Contractor shall provide a report of testing on each circuit.
  4. Record the short circuit resistance of each circuit pair as well as the end of line (EOL) resistance of circuits where applicable.
  5. Test all circuits for proper signal transmission under open-circuit, ground-fault, and short-circuit conditions.

6. Test each initiating device. Test smoke detectors with approved test agents or actual byproducts of combustion. Testing using magnets is not acceptable for smoke sensing devices. Where devices would be destroyed upon functional testing, consult the FPE on how such equipment is to be tested.
7. Verify that the sequence of operations indicated on the approved I/O Matrix matches the system programming. Verify all auxiliary functions including but not limited to AHU shutdown, security system interface, etc. Systematically verify the performance of the FACU to ensure the indicating lights, displays, signal tones, and annunciators are functioning properly.
8. Test the secondary power source as required by NFPA 72. Testing shall include removal of normal power for the required standby duration, immediately followed by initiation of an alarm event for the required alarm duration. Battery voltage shall be measured and recorded prior, and immediately following the test. Upon test completion, the Contractor shall restore normal power and record the battery voltage at the 48 hour mark.
9. Include with the Contractor Pre-Test report, a letter certifying the pretesting has been completed. Indicate in the letter any corrective actions that were found / corrected during the pre-testing phase.

### 3.05 FPE PRE-TESTING

- A. Following review and acceptance of the Contractor Pre-Test Report by the FPE, the FPE shall witness, at their discretion, any or all tests identified as part of the Contractor Pre-Testing. The Contractor shall notify the Architect and FPE a minimum of five business days prior to the requested FPE Pre-Testing date.

### 3.06 FINAL TESTING

- A. Advance notice of final testing; 48 hour advance notice must be given to FPE and the AHJ.
- B. The final testing sequence will be at the discretion of FPE, the AHJ, and Owner and will include the items listed under the pre-testing section.
- C. All testing that will cause interruption of the normal business operations of the facility must be performed at times other than normal business hours unless approved by the Owner.
- D. System Certification: The Contractor shall provide the following certificate, properly notarized, and signed by the Fire Alarm equipment supplier at the completion of the Project: "The undersigned, having been engaged as the Fire Alarm equipment supplier on the new Lee High School for the North East Independent School District confirms that the Fire Alarm equipment was installed in accordance with the Specifications and in accordance with State of Texas Rule 5.43-2 and all applicable federal, state and local codes, rules and regulations."
- E. The FASC shall be ultimately responsible for safe and complete operation of the system. Any issues affecting proper operation of the system relating to the Electrical, Mechanical, Fire Protection, Fire Suppression or other Contractors shall be resolved by the FASC at no additional cost to and without requesting intervention by the Owner

### 3.07 FOLLOW-UP INSPECTION AND TESTING:

- A. Follow-up test and inspection shall be completed within twelve (12) months of the date of substantial completion and prior to the end of the central station-monitoring period included in this contract
  1. Test and Inspection shall be performed by the installing Contractor of the Fire Alarm System and shall include the following:
    - a. Inspect for any changes or modifications to the fire alarm, initiating and notification systems.
    - b. Test and inspect all associated dedicated power breakers; verify proper operation and that associated panel labels and circuit breaker locking device are in place.
    - c. Check the general condition of the fire alarm panel and related equipment.
    - d. Test all smoke detectors as per manufacturer's requirements.
    - e. Perform detector sensitivity test and reports where applicable.
    - f. Inspect all fire alarm control panels including remote panels and remote annunciator panels.
    - g. Inspect and test all output relay activations.
    - h. Inspect and exercise all flow and tamper switches.

- i. Inspect and verify that all proper signals are received by the central station that is monitoring the system and provide a report prepared by the central monitoring station of all received transmissions.
  - j. Visually or electronically inspect smoke detectors for cleanliness. Cleaning of detectors shall be completed in accordance with manufacturer's requirements.
  - k. Inquire as to the changes in general occupancy environment; operations and conditions related to the fire alarm and detection system in accordance with NFPA standards.
  - l. During testing of the fire alarm detection system, operate outputs for the purpose or testing equipment shutdown, door release, start-up and shutdown of HVAC/smoke control systems, etc.
  - m. Verify and ensure central station information (Central Station telephone #, Account code #) is clearly posted on a label located on the inside door of the FACU.
  - n. Verify receipt of signal at the remote/central station.
2. Inspections shall be performed in accordance with NFPA 72 and meet all state and local government codes and amendments.
  3. Contractor shall submit to NEISD a detailed electronic fire alarm inspection report within ten (10) working days of inspection completion. A sample report format can be obtained from the NEISD Maintenance Electronics Department.
  4. Scheduling of all inspection shall be made to minimize any disruption of facility operations. All scheduling shall be coordinated in advance with the plant manager.
  5. When testing and inspection of the fire alarm system reveals defective components or functions that are covered under the warranty included in this Contract, the Contractor shall replace devices or correct deficiencies as applicable and prepare a written report to be delivered to the Foreman or Operations Manager of the Maintenance Department. The Contractor shall also include this information in his follow-up testing and inspection report.

### 3.08 DOCUMENTATION

- A. System documentation shall be furnished to the Owner at Project close-out and shall include, but not be limited to the following:
  1. Provide completed Testing and Inspection Report as required by NFPA 72 and State of Texas, State Fire Marshal's Office as part of Project closeout.
  2. Provide As-Built Drawings and wiring schematics on reproducible media and on compact disc (CD Rom) in the current version of AutoCAD.
  3. System operation, installation and maintenance manuals.
  4. Written documentation for all logic modules as programmed for system operation-with a matrix showing interaction of all input signals with output commands.
  5. Provide a CD with the final program database to the Owner.

### 3.09 DRAWINGS, MANUALS, AND TRAINING:

- A. Upon completion of the installation and prior to final inspection, this Contractor shall furnish three (3) copies of As-Built Drawings. Ensure that all fire alarm junction boxes and pull boxes are properly and accurately noted on the Record (As-Built) Drawings. In addition, this Contractor shall furnish four (3) copies of a manual giving complete instruction of the operation, inspection, testing, maintenance, and programming of the system including wiring diagrams.  
**NOTE:** Contractor shall indicate all Fire Alarm System junction box locations on the As Built Drawings.
- B. A formal on-site training session shall be provided by this Contractor to the Owner's Representative/Maintenance personnel and shall include instruction in the location, inspection, maintenance, testing and operation of all fire alarm system components. Provide a minimum of eight (8) hours of documented general instruction. Operators Manuals and Closeout Documents with Users Guides shall be provided at the time of this training.
- C. Schedule training with Owner through the Architect/Engineer, with at least seven days, advance notice.

END OF SECTION

**SECTION 31 6329  
DRILLED FOOTINGS**

**PART 1 - GENERAL**

**1.01 REQUIREMENTS INCLUDED**

The extent of drilled footings is shown on the drawings, including locations, diameter of piers and bells, and details of construction.

**1.02 RELATED REQUIREMENTS**

- |    |                 |                         |
|----|-----------------|-------------------------|
| A. | Division 02     | Subsurface Conditions.  |
| B. | Section 03 1100 | Concrete Forming.       |
| C. | Section 03 2000 | Concrete Reinforcing.   |
| D. | Section 03 3000 | Cast-In-Place Concrete. |

**1.03 QUALITY ASSURANCE**

- A. Supervision: The General Contractor shall supervise all footing operations and must be present on the job at all times when the foundation subcontractor is working. He shall assist in inspection of footings and measure footing depths in the presence of the Geotechnical Engineer of record.
- B. Codes and Standards: Perform drilled footing work in compliance with the applicable requirements of governing authorities having jurisdiction, including provisions for adequate protection to persons and property.

**1.04 SITE CONDITIONS**

- A. Subsurface Conditions: Are defined under Division 02 of these Specifications. The data indicated therein is not intended as representations or warranties of the continuity of such conditions. It is expressly understood that the Owner will not be responsible for interpretations or conclusions drawn there from by the Contractor and are not guaranteed to represent all conditions that may be encountered.
- B. Additional Test Boring: Additional test borings and other exploratory operations may be made by the Contractor at no additional cost to the Owner, provided such operations are acceptable to the Architect/Engineer.

**1.05 BASE BID AND ADJUSTMENTS**

- A. Contract Price: Contract price shall be based on base bid depth of piers shown on the drawings. Include the cost of casings in the base price for piers.
- B. Unit Price: Unit prices shall be as follows.
1. Unit prices per linear foot for piers greater or lesser than base bid depth.
  2. Unit prices per linear foot for casing.
  3. Unit prices shall include all labor and materials including overhead and fees for drilled concrete piers. Adjustments to the Contract shall be based on total linear feet greater than or less than the sum of the base depths of each pier size. Additional penetration in the bearing stratum greater than the specified penetration shall not be included in determination of increases or decreases of pier lengths related to adjustments in the Contract unless specified by Geotechnical Engineer.

PART 2 - PRODUCTS

## 2.01 MATERIALS

- A. Concrete: Specified under Section 03 3000.
- B. Concrete Formwork: Specified under Section 03 1100.
- C. Reinforcing Steel: Specified under Section 03 2000.
- D. Formwork: Thin wall fiber forms equal to Sonotube.

PART 3 - EXECUTION

## 3.01 GENERAL

- A. Drilling Equipment: The Contractor shall employ suitable drilling equipment to penetrate to the depth and stratum selected for bearing. This may necessitate the use of heavy crawler rig or power kelly. Note: High torque, high down-load drilling equipment should be anticipated for drilled pier construction at this site.
- B. Open Holes: No open holes shall be allowed. Cover during non-working hours. Keep unauthorized persons, especially minors, at a safe distance during working hours.
- C. Footing Depths: Footing depths shown on drawings are for estimating purposes only. Actual depth for each footing shall be approved by the Geotechnical Engineer of record.
- D. Footing Inspection: The owner shall employ and pay for the services of the Geotechnical Engineer of record to perform the designated duties described herein. The footing as referred to herein shall include concrete / reinforcing from bearing surface to bottom of floor beams; footing cutoff.
- E. Footing Log: The Geotechnical Engineer of record shall keep accurate log of all footing depths, shaft diameter and bell diameter. Cost adjustment will be made on difference in actual depth vs. basic bid depth with each footing considered individually. Unit prices for greater or lesser depth shall be as stated in Contractor's proposal. Include in log confirmation of reinforcing, including lap lengths if required. Record is from bearing surface to bottom of floor beams; footing cutoff.

## 3.02 EXCAVATION

- A. Excavate Accurately: Excavate accurately on designated centers. Drill plumb within 2" variation for every ten feet of depth. Transfer center of shaft at ground surface accurately to bottom of footing with plumb-bob and mark location.
- B. Shafts: Drill accurately to scheduled diameter. "Mushrooming" or enlargement of shaft near the surface due to "in-out" auger action shall be carefully monitored and held to a minimum. Appreciable enlargement of shaft will necessitate the installation of round fiberform for the entire depth of such enlargement and the cost of material and labor for this operation shall be borne by the Contractor. Further, at the time such enlargement is first noticed, corrective measures shall be taken to determine the reason, and no additional footings may be drilled until it is clearly established that the cause is known and will be corrected on all remaining footings. Where the nature of soil strata is such as to cause excessive fall-out or pockets in the shaft wall, the Geotechnical Engineer of record may direct the Contractor to install thin wall fiber forms in those areas and the expense shall be borne by the Owner.
- C. Water at Bearing Level: Provide pumps as required to remove bulk of the water, then hand bail to permit placement of concrete in the dry.
- D. Forms: Form upper part of shafts with thin wall fiber forms, Sonotube or equal, to depths below and above working grade as indicated on plans. Refer to "Excavation" for additional forming requirements.
- E. Footing Construction Joint: See Structural Drawings.



- F. Casing: If water-bearing stratum is encountered, set steel casing in shaft to seal off water so that base may be excavated, reinforcing placed, and concrete poured entirely in the dry. Casing may be pulled after placing concrete, but only in manner and sequence approved by Geotechnical Engineer of record. Allowance for casing is as stated in Contractor's proposal.
- G. Placing Concrete:
1. Placing of concrete shall not begin until the excavation and reinforcing placement has been completed, inspected and approved. Concrete shall be placed within the shaft excavation as soon as practical after drilling and cleaning out has been completed. In no case shall the time lapse exceed eight hours before placement of concrete. No pier shall be started that cannot be completed before the end of that work day. No holes shall be left open overnight.
  2. Provide adequate chutes, tremies and other means of conveying concrete into place. Use chutes, tremies or bottom discharge hoppers for placing concrete.
  3. Place concrete immediately after mixing, and in no case more than 60 minutes after water has been added. Continue depositing of concrete until the completion of the pier to the top of shaft and in no case suspend the placement of concrete, once started, for more than 30 minutes.
  4. The top three feet of the concrete in the shaft shall be thoroughly vibrated in 12" layers and excess water removed.

### 3.03 REINFORCEMENT PLACEMENT

- A. Length of Footing Reinforcement: Extend from bottom of footing to top of plinth or to beams or wall soffit. Never raise above bottom of footing. Forty diameter splices required where steel has been cut too short. Secure Engineer's approval prior to making any splice. Provide side and bottom spacer blocks to accurately maintain proper concrete cover as shown on drawings. The contractor shall determine proper depth to bearing stratum by selectively constructing a few representative footings before fabrication continues.
- B. Inspection and Approval:
1. The Contractor shall provide the Architect/Engineer a schedule for pier drilling operations. It shall be the Contractor's responsibility to insure that the pier excavation has been inspected and approved by the Geotechnical Engineer or record prior to concreting.
  2. The Geotechnical Engineer of record shall determine when the footing excavation has reached the proper stratum and the bearing surface as constructed is capable of supporting the load specified in the Soils Report and/or shown on the footing schedule.
  3. The Contractor shall provide complete inspection facilities including a 100 watt lamp and electrical extension cord of sufficient length to allow lowering to bottom of each footing hole.
- C. Bearing Surface: The footing bearing surface at the bottom of bell shall be undisturbed virgin earth free of all loose soil cuttings, compacted reamed earth, or mud. Compliance with this provision must be visually, or otherwise verifiable from the surface. The contractor shall employ whatever methods, procedures or equipment is necessary to perform these requirements to the satisfaction of the Geotechnical Engineer of record.
- D. Clean-Up: Per Division 01, General Requirements.

END OF SECTION 31 6329

**SECTION 32 84 00  
IRRIGATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Provide an underground irrigation system as shown and specified. The work includes:
  - 1. Automatic irrigation system including piping, fittings, sprinkle heads, controller, and accessories.
  - 2. Valves, backflow preventer, and fittings.
  - 3. Testing.
  - 4. Excavating and backfilling irrigation system work.
  - 5. Associated exterior plumbing, and accessories to complete the system
  - 6. Pipe sleeves.
  
- B. Related Work:
  - 1. Turf Grasses - Section 32 9200
  - 2. Plants – Section 32 9300

**1.2 QUALITY ASSURANCE**

- A. Installer's qualifications: Minimum of 3 years experience installing irrigation systems of comparable size. Contractor shall be a licensed and bonded Irrigator.
  
- B. Materials, equipment, and methods of installation shall comply with the following codes and standards:
  - 1. Texas Commission On Environmental Quality (TCEQ) Chapter 34, Texas Water Code; Chapter 344 Rules for Irrigators.
  - 2. National Fire Protection Association, (NFPA): National Electrical Code.
  - 3. American Society for Testing and Materials, (ASTM).
  - 4. National Sanitation Foundation, (NSF).
  - 5. City of Houston Applicable Plumbing Code
  - 6. City of Houston Uniform Development Code
  
- C. Excavating, backfilling, and compacting operations: Comply with requirements and as specified.
  
- D. Obtain Owner's acceptance of installed and tested irrigation system prior to installing backfill materials.

**1.3 SUBMITTAL**

- A. Submit for approval, manufacturer's product data for all equipment and materials specified herein or proposed for use on this project. Provide information for, but not limited to:
  - 1. Sprinklers, spray and rotary.
  - 2. Nozzles
  - 3. Check Valves for all sprinklers. (Check valves are required for all sprinklers).
  - 4. Piping
  - 5. Pipe Fittings
  - 6. Swing Joints

7. Pipe Cement
  8. Controller
  9. Wire
  10. Wire Splice Kits
  11. Remote Control Valves
  12. Gate or Manual Valves
  13. Quick Coupler Valves
  14. Backflow Prevention Devices
  15. Valve Boxes (Remote control valves, backflow prevention devices, quick coupler, wire splice location, gate/manual valves, etc.
  16. And any other equipment or product necessary to properly complete the work as shown on the drawings and specified herein.
- B. On each copy of the submittal, circle in red or highlight in yellow, each specific product proposed for use. COPIES NOT SO MARKED WILL BE REJECTED.
- C. Upon irrigation system acceptance, submit written operating and maintenance instructions. Provide format and contents as directed by the Landscape Architect.
- D. Provide irrigation system record “as-built” drawings:
1. During the course of installation, legibly mark all changes on drawings to record actual construction.
  2. Upon completion of the installation, transfer the record data to a clean professional quality base drawing and submit to the Landscape Architect for approval. Provide CAD files if required by Owner.
    - a. Indicate horizontal and vertical locations referenced to permanent surface improvements.
    - b. Identify field changes of dimension and detail and changes made by Change Order.
- E. Sustainable Design Submittals
1. Materials Reuse
  2. Recycled Content Materials
  3. Regional Materials
  4. Low Emitting Materials

#### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver irrigation system components in manufacturer’s original undamaged and unopened containers with labels intact and legible.
- B. Deliver plastic piping in bundles, packaged to provide adequate protection of pipe ends, both threaded or plain.
- C. Store and handle materials to prevent damage and deterioration. Do not store PVC pipe in direct sunlight for more than 48 hours.
- D. To prevent installation delays provide secure locked storage for valves, sprinkler heads, and similar components that can not be immediately replaced.

#### **1.5 PROJECT CONDITIONS**

- A. Known underground and surface utility lines are indicated on the utility survey. Verify locations of all known underground and surface utilities by contacting the appropriate utility companies.
- B. Protect existing trees, plants, lawns, and other features designated to remain as part of the final landscape work.
- C. Promptly repair damage to adjacent facilities caused by irrigation system work operations. Cost of repairs at contractor's expense.
- D. Promptly notify the Owner of unexpected sub-surface conditions.
- E. Irrigation system layout is diagrammatic. Exact locations of piping, sprinkler heads, valves, and other components shall be established by contractor in the field at time of installation. Proposed piping layout within tree drip lines will be reviewed by Architect prior to installation. Obtain Architect's approval prior to installation.
  - 1. Space sprinkler components as designed, not to exceed manufacturer recommendations.
  - 2. Minor adjustments in system layout will be permitted to clear existing fixed obstructions. Final system layout shall be acceptable to the Architect and Owner.
- F. Cutting and patching: (if necessary)
  - 1. Cut through concrete and masonry with core drills. Jack hammers not permitted.
  - 2. Material and finishes for patching shall match existing cut surface materials and finish. Exercise special care to provide patching at openings in exterior walls watertight.
  - 3. Methods and materials used for cutting and patching shall be acceptable to the Owner.

## **1.6 WARRANTY AND GUARANTEE**

- A. Materials and workmanship shall be fully guaranteed for one (1) year after substantial completion.
- B. Backfilling of all excavation shall be guaranteed for the one (1) year guarantee period. Repair trenches which have settled.
- C. Raise or lower heads to compensate for settling of lawn areas.
- D. Provide a one (1) year warranty against material, installation and operation defects. Repairs, adjustments and replacement of defective irrigation system materials, including materials which have been installed on the work during the warranty period shall be at Contractor's expense.

## **PART 2 PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Manufacturer
  - 1. Hunter
  - 2. Toro (tree bubblers)
  - 3. Conbraco
  - 4. Armor
  - 5. Lasco
  - 6. Netafim
  - 7. Spears
  - 8. Weathermatic

- B. If contractor chooses to install alternate equipment he shall submit to Architect for acceptance the following:
  - 1. Equipment specifications and product literature
  - 2. Pressure loss calculations including all lateral sections

## 2.2 MATERIALS

### A. General:

- 1. Provide only new materials, without flaws or defects and of the highest quality of their specified class and kind and normally used in recycled water systems.
- 2. Comply with pipe sizes indicated. No substitution of smaller pipes will be permitted. Larger sizes may be used subject to acceptance of the Architect. Remove damaged and defective pipe.
- 3. Provide pipe continuously and permanently marked with manufacturer's name or trademark, size schedule and type of pipe, working pressure at 73 □ F. and Nat  
Foundation (NSF) approval.

### B. Plastic pipe, fittings, and connections:

- 1. Polyvinyl chloride pipe: ASTM D2241, rigid, un-plasticized PVC, extruded from virgin parent material. Provide pipe homogenous throughout and free from visible cracks, holes, foreign materials, blisters, wrinkles, and dents.
  - a. All lateral pipes shall be Class 315 for 1/2", Class 200 for other sizes.
  - b. All mainline piping shall be SCH40.

### C. PVC pipe fittings: ASTM D2241 schedule 40 PVC molded fittings suitable for solvent weld or slip joint ring tight seal. For any threaded connections use only Sch 80 PVC. Fittings made of other materials are not permitted.

- 1. Size slip fitting socket taper to permit a dry un-softened pipe end to be inserted no more than halfway into the socket. Saddle and cross fittings are not permitted.
- 2. Schedule 80 PVC pipe may be threaded.
- 3. Use PVC male adapters for plastic to metal connections. Hand-tighten male adapters plus one turn with a strap wrench.

### D. Sprinkler heads, valves, and associated equipment.

- 1. Refer to drawings for materials.
  - a. Lawn spray type sprinkler heads: HUNTER PRO SPRAY SERIES PROS-PRS40-04-CV, use MP Rotator nozzles where indicated on plan.
  - b. Shrub type sprinkler heads: HUNTER PRO SPRAY, PROS-06-CV
  - c. Quick Coupler Valves: RAINBIRD AS SHOWN ON PLAN
  - d. Underground Splices. Wade WC 014 series.
  - e. Backflow Preventer required
  - f. Valve access box: Armor

### E. Controls: Refer to drawing list.

### F. Electric control wire:

- 1. Control wire shall be 14 AWG, UF Classification, UL approved for direct burial. 2-Wire wiring must be jacketed.
- 2. For runs longer than 2000 feet, larger cable may be used provided it conforms to controller manufacturer's specifications for both material specification and installation.
- 3. All wire splices shall be protected by a valve box. All wire splices shall be shown on "as-built" drawings. No splices will be allowed on runs of less than 500 feet.

## **2.3 ACCESSORIES**

- A. Drainage fill: No. 4 to 1/2-inch washed pea gravel.
- B. Fill: Clean soil free of stones larger than 3/4-inch diameter, foreign matter, organic material, and debris.
  - 1. Provide imported fill material as required to complete the work. Obtain rights and pay all costs for imported materials.
  - 2. Suitable excavated materials removed to accommodate the irrigation system work may be used as fill material subject to the Landscape Architect's review and acceptance.
- C. Clamps; Stainless steel, worm gear hose clamps with stainless steel screws or ear type clamps.
- D. Low Voltage wire connectors: WC 014 splice by Wade Enterprises.
- E. Valve access boxes: Tapered enclosure of rigid plastic material comprised of fibrous components chemically inert and unaffected by moisture corrosion and temperature changes. Provide lid of same material, black or green in color. Provide 10-inch Round Valve Box for remote control valves. Use valve box extensions as necessary to maintain proper level relative to grade. Provide 10-inch Valve Box for wire splices.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. Examine final grades and installation conditions. Do not start irrigation system work until unsatisfactory conditions are corrected.
- B. This contractor to verify existing and proposed locations of all site utilities (i.e., gas, water, electric, telephone, sanitary and storm sewers, etc.) prior to any trenching and laying of pipe. In addition, this contractor shall coordinate all irrigation work with that of all other site work trades and contractors, as applicable.

### **3.2 PREPARATION**

- A. Layout and stake the location of each sprinkler head and sprinkler valve. Obtain Architects acceptance of layout prior to excavating.
- B. Remove existing paving for sleeve installation if required. Saw cut existing paving to provide uniform straight transition at new to existing paving.

### **3.3 INSTALLATION**

- A. Excavating and backfilling:
  - 1. Excavation shall include all materials encountered, except materials that cannot be excavated by normal mechanical means.
  - 2. Excavate trenches of sufficient depth and width to permit proper handling and installation of pipe and fittings as shown on Details.
  - 3. Pulling method will not be allowed on this project. .

4. Excavate to depths required to provide earth fill or sand bedding for piping as shown on plans.
5. Fill to match adjacent grade elevations with approved earth fill material. Place and compact fill in layers not greater than 4-inch depth.
  - a. Provide approved earth fill or sand to a point 4-inches above the top of pipe.
  - b. Provide clean top soil fill free of rocks and debris for top 5-inches of fill.
6. Except as indicated, install irrigation mains with a minimum cover of 10 inches based on finished grades. Install irrigation laterals with a minimum cover of 8-inches based on finished grades.
7. Excavate trenches and install piping and fill during the same working day. Do not leave open trenches or partially filled trenches open overnight.
8. Replace paving of same materials, using joints and patterns to match existing adjoining paving surfaces. Removal of paving or wall material and replacement thereof shall only occur when it is determined by the Landscape Architect that the sleeves installed cannot be located and other methods (i.e., jacking under the construction or re-routing piping) are not able to be executed.

B. Plastic Pipe

1. Install plastic pipe in accordance with manufacturer's installation instructions. Provide for thermal expansion and contraction.
2. Saw cut plastic pipe larger than 2". Use a square-in sawing vice to insure a square cut. Remove burrs and shavings at cut ends prior to installation.
3. Make plastic to plastic joints with solvent weld joints or slip seal joints. Use only solvent recommended by the pipe manufacturer. Install plastic pipe fittings in accordance with pipe manufacturer's instructions. Contractor shall make arrangements with pipe manufacturer or distributor for all necessary field assistance.
4. Make plastic to metal joints with plastic male adapters.
5. Make solvent weld joints in accordance with manufacturer's recommendations.
6. Allow joints to set at least 24 hours before pressure is applied to the system.
7. Maintain pipe interiors free of dirt and debris. Close open ends of pipe by acceptable methods when pipe installation is not in progress.

C. Sprinkler, fittings, valves, and accessories:

1. Install fittings, valves, sprinkler heads, risers, and accessories in accordance with manufacturer's instructions, except as otherwise indicated.
2. Set sprinkler heads perpendicular to finished grades, except as otherwise indicated.
3. Provide pop-up spray heads (with internal check valve) with an adjustable swing joint riser assembled as shown on details.
  - a. Pre-fabricated swing joint risers shall be schedule 80 rated.
4. Obtain Architect's review and acceptance of height for proposed sprinkler heads and valves prior to installation.
5. Locate sprinkler heads to assure proper coverage of indicated areas. Do not exceed sprinkler head spacing distances indicated.
6. Install backflow prevention valve, fittings, and accessories as shown or required to complete the system. Engineer to provide layout and details.
7. Install the specified controller in the location shown on the drawing, with lockable weatherproof controller housing. Controllers shall be pedestal mounted as directed by the owner. Install per manufacturer's recommendations.
  - a. Provide rigid conduit from controller down into grade to accommodate valve wires (see details).
  - b. This contractor shall pull valve wires, program controller by labeling station position for zones, and put controller in operation.

8. Install in-ground control valves in a valve access box as indicated.
9. Install valve access boxes on a suitable base of gravel to provide a level foundation at proper grade and to provide drainage of the access box. Factory valve box extensions shall be required to be used if necessary.
10. Seal threaded connections on pressure side of control valves with Teflon tape. Do not use pipe joint compound.

D. Control wiring

1. Install electric control cable in the mainline piping trenches wherever possible. Place wire in trench adjacent to pipe. Install wire with slack to allow for thermal expansion and contraction. Provide expansion joints at 100 foot intervals by making 5-6 turns around a piece of 1/2-inch pipe. Where necessary to run wire in a separate trench, provide a minimum cover of 12-inches. When more than one wire is placed in a trench the wire shall be taped together at intervals of 50 feet.
2. Provide sufficient slack (expansion coil consisting of 5-6 turns around a 1/2" piece of pipe) at remote control valves in control boxes, and at all wire splices to allow raising the valve bonnet or splice to the surface without disconnecting the wires when repair is required.
3. Connect remote control valve to one station of a controller only.
4. Make wire connections to remote control electric valves and splices of wire in the field, using wire connectors and in accordance with manufacturer's recommendations.

E. Sleeves:

1. Utilize existing sleeves if available for installation of the irrigation system.
2. Provide new sleeves for all locations where existing sleeves are not indicated. Install new sleeves prior to paving installation wherever possible.
3. Install pipe sleeves under existing concrete or asphalt surfaces where cutting is necessary. Obtain Owner's permission before cutting existing concrete and asphalt surfaces. Where piping is shown under paved areas which are adjacent to turf areas, install the piping in the turf areas.

F. Flushing, testing, and adjustment:

1. In the presence of the Landscape Architect or his Representative, hydrostatically test the mainline piping system in place, before backfilling. Test period shall be not less than four hours at 130 PSI. Test is acceptable if no leakage occurs during test period.
2. After sprinkler piping and risers are installed and before sprinkler heads are installed, open control valves and flush out the system with full head of water.
3. Perform system testing upon completion of each section. Make necessary repairs and retest repaired sections as required.
4. Adjust sprinklers after installation for proper and adequate distribution of water over the coverage pattern. Adjust for the proper arc of coverage.
5. Tighten nozzles on spray type sprinklers after installation. Adjust nozzle-adjusting screw on sprinklers as required for proper radius. Interchange nozzle patterns as directed by the Architect, to give best arc of coverage.
6. Adjust all electric remote control valve flow control stems for system balance and optimum performance.
7. Test and demonstrate the controller by operating appropriate day, hour, and station selection features as required to automatically start and shut down irrigation cycles to accommodate plant requirements and weather conditions.
8. Backflow device shall be tested and certified before substantial completion will be issued.

### 3.4 SPARE PARTS

- A. Provide the Owner additional parts as noted.



1. 2 extra sprinkler head(s) of each size and type.
2. 1 extra valve(s) of each size.
3. 2 extra valve access boxes of each size.
4. 2 C100 quick coupling keys and 2 #10 hose swivels.

### **3.5 DISPOSAL OF WASTE MATERIAL**

- A. Stockpile, haul from site, and legally dispose of waste materials, including unsuitable excavated materials, rock, and debris.
- B. Maintain disposal route clear, clean, and free of debris.

### **3.6 SUBSTANTIAL COMPLETION**

- A. An inspection of the irrigation system will be made by the Landscape Architect upon request for Application of Substantial Completion by the Contractor. The irrigation system must be sufficiently complete so that all plant material can be sustained by the system.
- B. Contractor will be required to train maintenance personnel on the use and basic upkeep of this system. If this responsibility is not fulfilled, the cost of obtaining this training by the Owner shall be shown as a deduction in the final payment.
- C. The Contractor shall attach a reduced scale of the area controlled by the controller on the inside of the controller door identifying the location of the valves and the station assigned to each.

### **3.7 FINAL COMPLETION**

- A. An inspection of the irrigation system will be made by the landscape architect upon request for Final Completion by the Contractor. Provide notification of at least ten (10) working days before requested inspection date.

### **3.8 CLEANING**

- A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, soil, debris, and equipment. Repair damage resulting from irrigation system installation.

**END OF SECTION**

**SECTION 329113  
SOIL PREPARATION**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section includes planting soils specified by composition of the mixes.
- B. Related Requirements specified elsewhere:
  - 1. Section 015639 "Temporary Tree and Plant Protection" and associated drawings for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
  - 2. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
  - 3. Section 329300 "Plants" for placing planting soil for plantings.

**1.3 DEFINITIONS**

- A. AAPFCO: Association of American Plant Food Control Officials.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- C. CEC: Cation exchange capacity.
- D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- E. Imported Soil: Soil that is transported to Project site for use.
- F. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through inter-laboratory sample exchanges and statistical evaluation of analytical data.
- G. Organic Matter: The total of organic materials in soil exclusive of un-decayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
- H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- I. Planting Soil: Imported soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

- J. SSSA: Soil Science Society of America.
- K. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- L. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- M. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- N. USCC: U.S. Composting Council.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Pre-installation Conference: Conduct conference at Project site.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include recommendations for application and use.
  - 2. Include test data substantiating that products comply with requirements.
  - 3. Include sieve analyses for aggregate materials.
  - 4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:
    - a. Manufacturer's qualified testing agency's certified analysis of standard products.
    - b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
    - c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
- B. Samples: For each bulk-supplied material, 1-gallon volume, unless otherwise specified, of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture. Samples will be reviewed for physical appearance only.

#### **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For each testing agency.

#### **1.7 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory experienced in soil science, soil testing, and plant nutrition, and that specializes in USDA agricultural soil testing, planting soil mixes, and the types of tests to be performed.

## 1.8 IMPORTED SOIL-SAMPLING REQUIREMENTS

- A. General: Extract soil samples according to requirements in this article. All planting soil for the project shall be imported soil.
- B. Sample Collection and Labeling: Have samples taken and labeled by Contractor.
  - 1. Number and Location of Samples: Minimum of three representative soil samples from each soil source to be imported for landscaping purposes.
  - 2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
  - 3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner's Representative for its records.
  - 4. Labeling: Label each sample with the date, location, supplier, and visible soil condition.

## 1.9 IMPORTED SOIL TESTING REQUIREMENTS

- A. General: Perform tests on all imported soil samples according to requirements in this article. Submit testing results at least 8 weeks prior to scheduled installation of planting soil. Submit planting soil testing results no more than 2 weeks after topsoil, compost, and course sand have been approved. All testing required in this section shall be at the expense of the Contractor.
- B. Testing:
  - 1. Physical Testing:
    - a. Soil Texture: Soil-particle, size-distribution analysis by the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
      - 1) Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
      - 2) Hydrometer Method: Report percentages of sand, silt, and clay.
    - b. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
    - c. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
    - d. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D 698 (Standard Proctor).
  - 2. Chemical Testing:
    - a. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
    - b. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
  - 3. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT SERA-6, including the following:
    - a. Percentage of organic matter by oven-dried weight.
    - b. CEC, calcium percent of CEC, and magnesium percent of CEC.
    - c. Soil reaction (acidity/alkalinity pH value).
    - d. Buffered acidity or alkalinity.

- e. Nutrient levels by parts per million including: nitrogen, phosphorus, potassium, magnesium, manganese, iron, zinc, calcium, and copper. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the soil for optimum growth of the plantings specified.
  - f. Sodium ppm and sodium absorption ratio.
  - g. Soluble-salts ppm.
  - h. Other deleterious materials, including their characteristics and content of each.
4. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
- C. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated into imported soil to produce satisfactory planting soil suitable for healthy, viable plants and turf indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.
- 1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inch depth of soil.
  - 2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inch depth of soil.

## **1.10 DELIVERY, STORAGE, AND HANDLING**

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Bulk Materials:
- 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  - 3. Do not move or handle materials when they are wet or frozen.
  - 4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

## **PART 2 - PRODUCTS**

### **2.1 PLANTING SOIL**

- A. Planting-Soil: Refer to Drawings for various types of mixes. Imported, naturally formed soil from off-site sources and consisting of loam, sandy clay loam, or sandy loam soil according to USDA textures; and modified as specified in this section to produce viable planting soil. Manufactured soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil to meet requirements of this section shall not be used unless imported soil meeting these requirements is not available within 100 miles of the project site.
- 1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from agricultural land, bogs, or

marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, bromegrass, and other commonly known obnoxious weeds and invasive plants.

2. Additional Properties of Imported Soil before Amending:
  - a. Soil Reaction: pH 5.5 to 7.0.
  - b. Organic Matter Content: Minimum of 2 to 5 percent organic-matter content by weight, friable, and with sufficient structure to give good tilth and aeration.
  - c. Soluble Salt Level: Less than 2 mmho/cm.
  - d. Soil Chemistry: Suitable for growing plants specified.
3. Unacceptable Properties (to be controlled by source selection, not by screening the soil):
  - a. Unacceptable Materials: Refuse, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
  - b. Unsuitable Materials: Subsoil, stones, roots larger than 1-inch diameter, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the imported soil.
  - c. Large Materials: Stones, clods, clay lumps, and pockets of coarse sand exceeding 2 inches in any dimension.
4. Amended Soil Composition:
  - a. Blend imported, unamended soil with inorganic and organic soil amendments specified in this article in amounts recommended in soil reports from a qualified testing agency to produce satisfactory planting soil suitable for healthy, viable plants and turf indicated. Blending can occur off-site or on-site.
  - b. Mix inorganic and organic amendments together first and then add to the imported soil. Mix with a loader bucket to loosely incorporate the imported soil into the amendment mix. Do not over mix, mix with a soil blending machine, or screen the soil. At time of final grading, add fertilizer if required to the planting soil in amounts recommended by the testing agency for specified plants and turf.
  - c. Provide a sample with testing data that includes recommendations for chemical additives for the types of plants to be grown. Samples and testing data shall be submitted at the same time.

## **2.2 INORGANIC SOIL AMENDMENTS**

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
  1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
  2. Form: Provide lime in form of ground dolomitic limestone if magnesium is already present in the soil. Otherwise use calcitic limestone.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

- D. Perlite: Horticultural perlite, soil amendment grade.
- E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.
- F. Course Sand: Clean, washed, natural, free of toxic materials, and according to ASTM C 33/C 33M. Course sands shall be clean, sharp, natural coarse sands free of limestone, shale and slate particles. Manufactured coarse sand shall not be permitted. Provide a sample with manufacturer's literature and material certification that the product meets the requirements.
  - 1. Reaction: pH less than 7.0.
  - 2. Particle Size Distribution:

Sieve	% Passing
3/8 inch	100
No 4	95-100
No 8	80-100
No 1	50-85
No 3	25-60
No 5	10-30
No 100	2-10
No 200	2-5

### 2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance (STA)" or as modified in this section for "Planting Bed Establishment with Compost". Before using the compost, Provide a sample with a copy of the lab analysis, performed by a STA Program certified lab, certifying that the compost meets the product requirements listed below. The lab analysis should not be more than 90 days old.
  - 1. Reaction: pH of 6.0 to 8.5.
  - 2. Soluble-Salt Concentration: Less than 2.5 dS/m.
  - 3. Moisture Content: 30 to 60 percent by weight.
  - 4. Organic-Matter Content: 30 to 65 percent of dry weight.
  - 5. Particle Size: Minimum of 98 percent passing through a 3/4 sieve.
  - 6. Stability Carbon Dioxide Evolution Rate: Less than 8 mg CO<sub>2</sub>-C per g OM per day.
  - 7. Maturity (Bioassa) Seed Emergence and Seedling Vigor: At least 80 percent, relative to positive control.
  - 8. Physical Contaminants: Less than 1 percent of dry weight.
  - 9. Chemical Contaminants: Meet or exceed US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels in mg/kg (ppm).
  - 10. Biological Contaminants: Meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) levels for fecal coliform bacteria or salmonella in MPN per gram per dry weight.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of maximum 5 dS/m.
- C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 6 to 7.5, a soluble-salt content measured by electrical conductivity of maximum 5 dS/m, having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

- D. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
- E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

## **2.4 FERTILIZERS**

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium.
  - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency to produce satisfactory planting soil suitable for healthy, viable plants and turf indicated.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.
- C. Proceed with placement only after unsatisfactory conditions have been corrected.

### **3.2 PLACING PLANTING SOIL OVER EXPOSED SUBGRADE**

- A. General: Apply planting soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Equipment: All equipment utilized to install or grade planting soils shall be wide track or balloon tire machines rated with a ground pressure of 4 psi or less. All grading and soil delivery equipment shall have buckets equipped with 6 inch long teeth to scarify any soil that becomes compacted. The use of mulch blowers or soil slingers shall not be permitted due to over mixing and soil breakdown caused by this type of equipment.
- C. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
  - 1. The Owner's Representative shall approve the condition of the subgrade prior to planting soil installation. Do not allow the loosened subgrade to become compacted. In the event that loosened subgrade becomes compacted, loosen again prior to installing planting soil.
  - 2. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top 3 inches of subgrade. Spread remainder of planting soil.



- D. Application: Spread planting soil to total depth indicated on Drawings, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
1. Apply planting soil in lifts not exceeding 12 inches in loose depth for material compacted by compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.
  2. Apply compacting forces to each lift as required to attain the required compaction. Scarify the top of each lift prior to adding more planting soil by dragging the teeth of a loader bucket or backhoe across the soil surface to roughen the surface.
- E. Compaction: Compact each lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698.
1. Maintain moisture conditions within the planting soil during installation or modification to allow for satisfactory compaction. Suspend operations if planting soil becomes wet. Apply water if the soil is overly dry.
  2. Provide adequate equipment to achieve consistent and uniform compaction of planting soils. Use the smallest equipment that can reasonably perform the task of spreading and compaction.
- F. Fertilizers: After installation of planting soils and prior to finish grading, apply fertilizers as recommended by the soil test, and appropriate to the soil and specific plants to be installed. Types, application rates, and methods of application shall be approved by the Owner's Representative prior to any applications.
- G. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades. The depths and grades shown on the Drawings are final grades after settlement and shrinkage of the planting soil.
1. The Owner's Representative shall approve all rough grading prior to finish grading, planting, and mulching.
  2. The Contractor shall install the planting soil at slightly higher elevations to anticipate planting soil settlement and shrinkage. All grade increases are assumed to be as measured prior to addition of mulch or sod. Final grades shall not vary more than 1/10 of a foot from finish elevations.
  3. Utilize hand equipment, small garden tractors with rakes, or small garden tractors with buckets with teeth for fine grading to keep soil surface rough without further compaction. Do not use the flat bottom of a loader bucket to fine grade, as it will cause the finished grade to become overly smooth and or slightly compressed.
  4. Provide for positive drainage from all areas toward existing inlets, drainage structures and or the edges of planting beds. Adjust grades as directed to reflect actual constructed field conditions of paving, wall, and inlet elevations. Notify the Owner's Representative if existing conditions make it impossible to achieve positive drainage.
  5. Provide smooth, rounded transitions between slopes of different gradients and direction. Modify the grade so that finish grades after settlement are 1.5 inches below all adjacent curbs, sidewalks, paving surfaces, or edging after mulching, or as directed by the drawings.
  6. Fill all dips and remove any bumps in the overall plane of the slope. The tolerance for dips and bumps in planting areas shall be a 2-inch deviation from the plane in 10 feet. The tolerance for dips and bumps in lawn areas shall be a 1-inch deviation from the plane in 10 feet.

### **3.3 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
  - 1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 1000 sq. ft. of in-place soil or part thereof.
- C. Planting soil will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken and sampling depth.

### **3.4 PROTECTION**

- A. Tree Protection: Identify protection zones according to the "Tree Protection Plan".
- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Vehicle and foot traffic.
  - 4. Erection of sheds or structures.
  - 5. Impoundment of water.
  - 6. Excavation or other digging, unless otherwise indicated.
- C. If planting soil or subgrade is over-compacted to levels greater than the above requirements, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Owner's Representative and replace contaminated planting soil with new planting soil at no additional cost to the Owner. Surface rototilling shall not be considered adequate to reduce over compaction at levels 6 inches or greater below finished grade.

### **3.5 CLEANING**

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

### **3.6 MAINTENANCE SERVICE**

- A. At the end of the plant Maintenance Period (see Section 329300 – “Plants”), the Owner’s Representative shall observe the soil installation work and establish that all provisions of the contract are complete and the work is satisfactory.
- B. Contractor shall restore any soil settlement and or erosion areas to the finish grades shown on the drawings. When restoring soil grades remove plants and mulch and add soil before restoring the planting. Do not add soil over the root balls of plants or on top of mulch.

END OF SECTION 329113

**SECTION 329200  
TURF AND GRASSES**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Sodding.
- B. Related Requirements:
  - 1. Section 015639 "Temporary Tree and Plant Protection" and associated drawings for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
  - 2. Section 329113 "Soil Preparation" for planting soil.
  - 3. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

**1.3 DEFINITIONS**

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Imported soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for planting soils.
- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

**1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

## **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For landscape Installer.
- B. Certification of Turfgrass Sod: From sod supplier for each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.
- C. Product Certificates: For fertilizers, from manufacturer.
- D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

## **1.6 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

## **1.7 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
  - 1. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
  - 2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 3. Pesticide Applicator: State licensed, commercial.

## **1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.
- B. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  - 3. Accompany each delivery of bulk materials with appropriate certificates.

## **1.9 FIELD CONDITIONS**

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of [planting completion] [Substantial Completion] <Insert starting time>.
  - 1. Spring Planting: Before April 1st.

2. Fall Planting: After November 1st.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

## **PART 2 - PRODUCTS**

### **2.1 TURFGRASS SOD**

- A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Bermudagrass (*Cynodon dactylon*) Tifway 419.

### **2.2 FERTILIZERS**

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency to produce satisfactory planting soil suitable for healthy, viable plants and turf indicated.

### **2.3 PESTICIDES**

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Owner's Representative and replace with new planting soil.

### **3.2 PREPARATION**

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
1. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

### **3.3 TURF AREA PREPARATION**

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Placing Planting Soil: Place planting soil according to Section 329113 "Soil Preparation."
1. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Owner's Representative's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### **3.4 SODDING**

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

### **3.5 TURF MAINTENANCE**

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
  - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
  - 2. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Program irrigation system to automatically control watering of turf at a minimum rate of 1/2 inch per week unless rainfall precipitation is adequate. Adjust watering rates based on any regulatory-enforced drought restrictions in effect. Prevent wilting, puddling, and erosion.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
  - 1. Mow Bermuda grass to a height of 1/2 to 1 inch.
- D. Turf Post fertilization: Apply commercial fertilizer after initial mowing and when grass is dry.
  - 1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

### **3.6 SATISFACTORY TURF**

- A. Turf installations shall meet the following criteria as determined by Owner's Representative:
  - 1. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

### **3.7 PESTICIDE APPLICATION**

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.



### **3.8 CLEANUP AND PROTECTION**

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

### **3.9 MAINTENANCE SERVICE**

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
  - 1. Sodded Turf: 60 days from date of Substantial Completion of planting installation.

END OF SECTION 329200

**SECTION 329300  
PLANTS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Plants.
  - 2. Tree stabilization.
  - 3. Tree-watering devices.
  - 4. Landscape edgings.
- B. Related Requirements:
  - 1. Section 015639 "Temporary Tree and Plant Protection" and associated drawings for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
  - 2. Section 329113 "Soil Preparation" for planting soil.
  - 3. Section 329200 "Turf and Grasses" for turf (lawn).

**1.3 DEFINITIONS**

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.
- D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- E. Finish Grade: Elevation of finished surface of planting soil.
- F. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and

molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

- G. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- H. Planting Area: Areas to be planted.
- I. Planting Soil: Imported soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for planting soils.
- J. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- K. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- L. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- M. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

#### **1.4 COORDINATION**

- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
  - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

#### **1.5 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.6 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
  - 2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
  - 3. Proprietary Staking-and-Guying Devices: Product cut-sheets in digital format.
  - 4. Root Barrier: Product cut-sheets in digital format.

- B. Samples for Verification: For each of the following:
1. Trees and Shrubs: Three samples of each variety and size delivered to site for review. Maintain approved Samples on-site as a standard for comparison.
  2. Organic Mulch: 1-pint volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
  3. Mineral Mulch: 2 lb of each mineral mulch required, in sealed plastic bags labeled with source of mulch. Sample shall be typical of the lot of material to be delivered and installed on-site; provide an accurate indication of color, texture, and makeup of the material.
  4. Edging Materials and Accessories: Representative length indicating manufacturer's standard size, to verify material, color, and accessories selected.

## **1.7 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
1. Manufacturer's certified analysis of standard products.
  2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
- D. Sample Warranty: For special warranty.

## **1.8 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

## **1.9 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
1. Experience: Five years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
  2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  3. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
  - 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
  - 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- D. Plant Material Observation: Owner's Representative may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Owner's Representative may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
  - 1. Notify Owner's Representative of sources of planting materials seven days in advance of delivery to site.

#### **1.10 DELIVERY, STORAGE, AND HANDLING**

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- B. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  - 3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- D. Handle planting stock by root ball.
- E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.
- F. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
  - 1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

- H. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
  - 1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
  - 2. Do not remove container-grown stock from containers before time of planting.
  - 3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

#### **1.11 FIELD CONDITIONS**

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion of planting installation.
  - 1. Spring Planting: Before April 1st.
  - 2. Fall Planting: After November 1st.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

#### **1.12 WARRANTY**

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
    - b. Structural failures including plantings falling or blowing over.
    - c. Faulty performance of tree stabilization, edgings, and tree-watering devices.
    - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 2. Warranty Periods: From date of Substantial Completion of planting installation.
    - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
    - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
  - 3. Include the following remedial actions as a minimum:
    - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.

- b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
- c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.

## **PART 2 - PRODUCTS**

### **2.1 PLANT MATERIAL**

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
  - 1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
  - 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Owner's Representative, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.
- E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.
- F. Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

### **2.2 FERTILIZERS**

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
  - 1. Size: 21 grams.
  - 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

## **2.3 MULCHES**

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
  - 1. Type: Shredded hardwood.
  - 2. Size Range: 3 inches maximum, 1/2 inch minimum.
  - 3. Color: Natural.
  
- B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 1-inch sieve; soluble-salt content of 2 to 5 dS/m; not exceeding 0.5 percent inert contaminants and free of
  - 1. Organic Matter Content: 50 to 60 percent of dry weight.
  - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
  
- C. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of the following type, size range, and color:
  - 1. Type: Decomposed granite.
  - 2. Size Range: 3/4 inch maximum, 1/4 inch minimum.
  - 3. Color: Orange-brown or readily available natural gravel color range acceptable to Owner's Representative.

## **2.4 PESTICIDES**

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
  
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
  
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

## **2.5 TREE-STABILIZATION MATERIALS**

- A. Trunk-Stabilization Materials:
  - 1. Proprietary Staking-and-Guying Devices: Proprietary stake or anchor and adjustable tie systems to secure each new planting by plant stem; sized as indicated and according to manufacturer's written recommendations.
    - a. ArborTie anchoring system manufactured by DeepRoot Green Infrastructure ([www.deeproot.com](http://www.deeproot.com)).



## **2.6 LANDSCAPE EDGINGS**

- A. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
  - 1. Edging Size: 1/4 inch thick by 5 inches deep.
  - 2. Stakes: Tapered steel, a minimum of 15 inches long.
  - 3. Accessories: Standard tapered ends, corners, and splicers.
  - 4. Finish: Manufacturer's standard paint.
    - a. Paint Color: Black.

## **2.7 MISCELLANEOUS PRODUCTS**

- A. Root Barrier: Black, molded, modular panels 24 inches high (deep), 85 mils thick, and with vertical root deflecting ribs protruding 3/4 inch out from panel surface; manufactured with minimum 50 percent recycled polyethylene plastic with UV inhibitors.
- B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- C. Burlap: Non-synthetic, biodegradable.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
  - 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Owner's Representative and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Owner's Representative's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Lay out plants at locations directed by Owner's Representative. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

### **3.3 PLANTING AREA ESTABLISHMENT**

- A. General: Prepare planting area for planting soil placement according to Section 329113 "Soil Preparation."
- B. Placing Planting Soil: Place planting soil according to Section 329113 "Soil Preparation."
- C. Before planting, obtain Owner's Representative's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### **3.4 EXCAVATION FOR TREES AND SHRUBS**

- A. Planting Pits and Trenches: Excavate circular planting pits.
  - 1. Excavate planting pits with sides sloping inward at a 45- to 60-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
  - 2. Excavate approximately two times as wide as ball diameter for balled and burlapped, balled and potted, and container-grown stock.
  - 3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
  - 4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
  - 5. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
  - 6. Maintain supervision of excavations during working hours.
  - 7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
- B. Backfill Soil: Native soil removed from excavations may not be used as backfill soil unless otherwise indicated.
- C. Obstructions: Notify Owner's Representative if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
  - 1. Hardpan Layer: Drill 6-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.
- D. Drainage: Notify Owner's Representative if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

### **3.5 TREE, SHRUB, AND VINE PLANTING**

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove planting soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
  - 1. Backfill: Planting soil according to Section 329113 "Soil Preparation."
  - 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
  - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  - 4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
    - a. Quantity: As indicated on Drawings.
  - 5. Continue backfilling process. Water again after placing and tamping final layer of planting soil.
- D. Balled and Potted and Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch adjacent finish grades.
  - 1. Backfill: Planting soil according to Section 329113 "Soil Preparation."
  - 2. Carefully remove root ball from container without damaging root ball or plant.
  - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  - 4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
    - a. Quantity: As indicated on Drawings.
  - 5. Continue backfilling process. Water again after placing and tamping final layer of planting soil.
- E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding planting soil on the slope; the edge of the root ball on the downhill side will be above the surrounding planting soil. Apply enough planting soil to cover the downhill side of the root ball.

### **3.6 TREE, SHRUB, AND VINE PRUNING**

- A. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Owner's Representative, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character. Limit pruning of top growth to 15 percent unless otherwise directed by Owner's Representative.
- B. Do not apply pruning paint to wounds.

### **3.7 TREE STABILIZATION**

- A. Trunk Stabilization by Proprietary Staking-and-Guying Devices: Install trunk stabilization as follows unless otherwise indicated on Drawings. Stake and guy trees more than 14 feet in height and more than 3 inches in caliper unless otherwise indicated.
  - 1. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

### **3.8 ROOT-BARRIER INSTALLATION**

- A. Install root barrier where trees are planted within 48 inches of paving or other hardscape elements, such as walls, curbs, and walkways, unless otherwise indicated on Drawings.
- B. Align root barrier vertically, and run it linearly along and adjacent to the paving or other hardscape elements to be protected from invasive roots.
- C. Install root barrier continuously for a distance of 60 inches in each direction from the tree trunk, for a total distance of 10 feet per tree. If trees are spaced closer, use a single continuous piece of root barrier.
  - 1. Position top of root barrier according to manufacturer's written recommendations.
  - 2. Overlap root barrier a minimum of 12 inches at joints.
  - 3. Do not distort or bend root barrier during construction activities.
  - 4. Do not install root barrier surrounding the root ball of tree.

### **3.9 GROUND COVER AND PLANT PLANTING**

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing unless otherwise directed by Owner's Representative.
- B. Use planting soil according to Section 329113 "Soil Preparation" for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.
- E. Work planting soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

- F. Water thoroughly after planting, taking care not to cover plant crowns with wet planting soil.
- G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

### **3.10 PLANTING AREA MULCHING**

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
  - 1. Trees and Treelike Shrubs in Turf Areas: Apply mulch ring of size and thickness as indicated on Drawings. Do not place mulch within 3 inches of trunks or stems.
  - 2. Organic Mulch in Planting Areas: Apply 4-inch average thickness of organic mulch to extents of planting beds as indicated on Drawings. Do not place mulch within 3 inches of trunks or stems.
  - 3. Mineral Mulch in Planting Areas: Apply 4-inch average thickness of organic mulch to extents of planting beds as indicated on Drawings. Do not place mulch within 3 inches of trunks or stems.

### **3.11 EDGING INSTALLATION**

- A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

### **3.12 PLANT MAINTENANCE**

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Adjust watering rates based on any regulatory-enforced drought restrictions in effect.
- B. Fill in, as necessary, planting soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and planting soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

### **3.13 PESTICIDE APPLICATION**

- A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

### **3.14 REPAIR AND REPLACEMENT**

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Owner's Representative.
  - 1. Submit details of proposed pruning and repairs.
  - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
  - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Owner's Representative.
  
- B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition or are damaged during construction operations that Owner's Representative determines are incapable of restoring to normal growth pattern.
  - 1. Provide new trees of same size as those being replaced for each tree of 4 inches or smaller in caliper size.
  - 2. Provide one new tree of 4-inch caliper size for each tree being replaced that measures more than 4 inches in caliper size.
  - 3. Species of Replacement Trees: Same species being replaced.

### **3.15 CLEANING AND PROTECTION**

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
  
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
  
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
  
- D. After installation and before Substantial Completion of planting installation, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

### **3.16 MAINTENANCE SERVICE**

- A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
  - 1. Maintenance Period: 60 days from date of Substantial Completion of planting installation.
  
- B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
  - 1. Maintenance Period: Two months from date of Substantial Completion of planting installation.

END OF SECTION 329300

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**ITEM NO. 812**  
**WATER MAIN INSTALLATION**

- 812.1 DESCRIPTION:** This item shall consist of water main installation in accordance with these specifications and as directed by the Inspector.
- 812.2 SUBMITTALS:** Contractor shall submit manufacturer's product data, installation instructions, recommendations, shop drawings, and any required installer certification(s).
- 812.3 MATERIALS:** The materials for water main installation shall conform to the specifications contained within the latest revision of SAWS Material Specifications "Ductile Iron Pipe," Item No. 05-11, "Steel Water Pipe," Item No. 05-30, "PVC C-900 Water Pipe," Item No. 05-12, "PVC C-905 Water Pipe," Item No. 819-01, "PVC C-909 Water Pipe," Item No. 05-13, and "Reinforced Concrete Water Pipe Steel Cylinder Type", Item No. 05-20. The pressure rating for pipe materials apply to any work performed in SAWS Pressure Zones 9-16 shall be in accordance with Table HP-1, "High Pressure Zones." Minimum pressure rating for all pipes in high pressure zones shall be 200 psi.
1. PVC water pipe shall be blue in color. PVC pipe markings shall include:
    - a. Manufacturer's name or trademark;
    - b. Standard to which it conforms;
    - c. Pipe size;
    - d. Material designation code;
    - e. Pressure rating;
    - f. SDR number or schedule number;
    - g. Potable water laboratory seal or mark attesting to suitability for potable water;
    - h. A certifier's mark may be added; and
    - i. Manufactured date (installation shall not exceed one year from this date)



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2. White-colored PVC pipe is acceptable if labeled in accordance with item 1.

### **812.4 CONSTRUCTION:**

1. Start of Work: The Contractor shall start his work at a tie-in or point designated by the Inspector. Pipe shall be laid with bell ends facing in the direction of pipe laying, unless otherwise authorized or directed by the Inspector. All valves and fire hydrants must be installed as soon as pipe laying reaches their established location. All pipe shall be installed to the required lines and grades with fittings, valves, and hydrants placed at the required locations. Spigots shall be centered in bells or collars, all valves and hydrant stems shall be set plumb, and fire hydrant nozzles shall face as per SAWS standard details or as directed by the Engineer. No valve or other control on the existing system shall be operated for any purpose by the Contractor unless a representative of SAWS is present.
2. Crossing Other Underground Lines: New water mains crossing any other utility shall have a minimum of 30 inches of cover over the top of the pipe, unless otherwise waived or modified by the Engineer. Excavation around other utilities shall be done by hand for at least 12 inches all around. Any damage to the protective wrap on gas lines or electrodes shall be reported immediately to the CPS Energy, phone (210) 353-4357. Any damage to other utilities shall be reported to their proper governing entity. In both these cases of utility damage, Contractor shall also promptly notify the Inspector.
3. Pipe Separation - Parallel Lines:
  - a. Where a new potable waterline parallels an existing, non-pressure or pressure-rated wastewater main or lateral and the licensed professional engineer licensed in the State of Texas is able to determine that the existing wastewater main or lateral is not leaking, the new potable waterline shall be located at least two feet above the existing wastewater main or lateral, measured vertically, and at least four feet away, measured horizontally, from the existing wastewater main or lateral. Every effort shall be exerted not to disturb the bedding and backfill of the existing wastewater main or lateral.

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- b. Where a new potable waterline parallels an existing pressure-rated wastewater main or lateral and it cannot be determined by the licensed professional engineer if the existing line is leaking, the existing wastewater main or lateral shall be replaced with at least 150 psi pressure-rated pipe. The new potable waterline shall be located at least two feet above the new wastewater line, measured vertically, and at least four feet away, measured horizontally, from the replaced wastewater main or lateral.
- c. Where a new potable waterline parallels a new wastewater main, the wastewater main or lateral shall be constructed of at least 150 psi pressure-rated pipe. The new potable waterline shall be located at least two feet above the wastewater main or lateral, measured vertically, and at least four feet away, measured horizontally, from the wastewater main or lateral.

#### 4. Pipe Separation - Crossing Lines:

- a. Where a new potable waterline crosses an existing, non-pressure-rated wastewater main or lateral, one segment of the waterline pipe shall be centered over the wastewater main or lateral such that the joints of the waterline pipe are equidistant and at least nine feet horizontally from the centerline of the wastewater main or lateral. The potable waterline shall be at least two feet above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. If the existing wastewater main or lateral is disturbed or shows signs of leaking, it shall be replaced for at least nine feet in both directions (18 feet total) with at least 150 psi pressure-rated pipe.
- b. Where a new potable waterline crosses an existing, pressure-rated wastewater main or lateral, one segment of the waterline pipe shall be centered over the wastewater main or lateral such that the joints of the waterline pipe are equidistant and at least nine feet horizontally from the centerline of the wastewater main or lateral. The potable waterline shall be at least six inches above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. If the existing wastewater main or lateral shows signs of leaking, it shall be replaced for at least nine feet in both directions (18 feet total) with at least 150 psi pressure-rated pipe.

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- c. Where a new potable waterline crosses a new, non-pressure-rated wastewater main or lateral and the standard pipe segment length of the wastewater main or lateral is at least 18 feet, one segment of the waterline pipe shall be centered over the wastewater main or lateral such that the joints of the waterline pipe are equidistant and at least nine feet horizontally from the centerline of the wastewater main or lateral. The potable waterline shall be at least two feet above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. The wastewater pipe shall have a minimum pipe stiffness of 115 psi at 5.0% deflection. The wastewater main or lateral shall be embedded in cement stabilized sand for the total length of one pipe segment plus 12 inches beyond the joint on each end.
  
- d. Where a new potable waterline crosses a new, non-pressure-rated wastewater main or lateral and a standard length of the wastewater pipe is less than 18 feet in length, the potable water pipe segment shall be centered over the wastewater line. The materials and method of installation shall conform with one of the following options:
  - (1) Within nine feet horizontally of either side of the waterline, the wastewater pipe and joints shall be constructed with pipe material having a minimum pressure-rating of at least 150 psi. An absolute minimum vertical separation distance of two feet shall be provided. The wastewater main or lateral shall be located below the waterline.
  
  - (2) All sections of wastewater main or lateral within nine feet horizontally of the waterline shall be encased in an 18-foot (or longer) section of pipe. Flexible encasing pipe shall have a minimum pipe stiffness of 115 psi at 5.0% deflection. The encasing pipe shall be centered on the waterline and shall be at least two nominal pipe diameters larger than the wastewater main or lateral. The space around the carrier pipe shall be supported at five-foot (or less) intervals with spacers or be filled to the springline with washed sand. Each end of the casing shall be sealed with watertight non-shrink cement grout or a manufactured watertight seal. An absolute minimum separation distance of six inches between the encasement pipe and the

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waterline shall be provided. The wastewater line shall be located below the waterline.

5. Pipe Grade: Water mains 16" or smaller shall have a minimum of 48 inches of cover from the proposed final finish ground/street/elevation and 60 inches of cover when the main is installed in an unpaved area or under the pavement where there are no existing/proposed curb or existing drainage facilities. Water mains 20" and above shall have a minimum of 60 inches of cover over the top of the pipe from the proposed final finish ground/street/elevation unless otherwise waived or modified by the Engineer. Pipe grades shall be as required by the plans or as directed by the Engineer. Grades shall be met as specified by Item No. 804 "Excavation, Trenching and Backfilling." Precaution shall be taken to ensure that the pipe barrel has uniform contact with the cushion material for its full length except at couplings. The couplings shall not be in contact with the original trench bottom prior to backfilling. Cushion material shall be placed under the coupling and compacted by hand prior to backfilling so as to provide an even bearing surface under the coupling and pipe. Changes in grade shall be made only at joints.
6. Cushion and Cushion Materials: Prior to placing pipe in a trench, the trench shall have been excavated to the proper depth as required in Item No. 804 "Excavation, Trenching, and Backfilling." Approved imported materials or Engineer-approved materials selected from suitable fines derived from the excavation shall be smoothly worked across the entire width of the trench bottom to provide a supporting cushion.
7. Structures to Support Pipe: When either the Inspector or Engineer note that the material at the bottom of a trench is unstable or unsuitable, it shall be removed and replaced with approved material which may be properly compacted in place to support the pipe. The Contractor shall also construct a foundation for the pipe consisting of piling, concrete beams, or other supports in accordance with plans prepared by the Engineer. Extra compensation will be allowed for the Contractor for the additional work done. All claims for extra compensation must first be agreed to by SAWS, prior to any such work occurring. In this event it shall be paid for in accordance with the provisions of ARTICLE VI. CONTRACT CHANGES of the General Conditions of the Contract.
8. Lowering Pipe and Appurtenances into Trench: Proper implements, tools, and facilities satisfactory to the Inspector shall be provided and used by

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the Contractor for the safe and convenient completion of work. All pipe, fittings, valves, and hydrants shall be carefully lowered into the trench piece by piece, by means of a derrick, ropes, or other suitable tools or equipment in such a manner as to prevent damage to water main materials and protective coatings, polywrap sleeving, and linings. Under no circumstances shall water main materials, pipes, fittings, etc., be dropped or dumped into the trench. Extreme care shall be taken to avoid damaging polywrap films. No chains or slings shall be allowed unless the entire sling is wrapped with a protective nylon web sock.

9. Pipe Laying: Every precaution shall be taken to prevent foreign material from entering the pipe during installation. Under adverse trenching conditions, work stoppage for more than 24 hours and/or as otherwise required by the Engineer, a manufactured cap/plug is to be used to prevent any foreign type material entering the pipe. The cap/plug shall be left in place until it is connection to an adjacent pipe. The interior of each pipe shall be inspected for foreign material or defects, and the pipe shall be cleaned or rejected if any defects are found, respectively.

After placing a length of pipe in the trench, the jointed end shall be centered on the pipe already in place, forced into place, brought to correct line and grade, and completed in accordance with these requirements. The pipe shall be secured in place with approved backfill material tamped around it. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be rejected by the Engineer and/or Inspector and shall be replaced with pipe and fittings of proper dimensions. Precautions shall be taken to prevent dirt or other foreign matter from entering the joint space.

At times when pipe laying is halted, the open end of pipe in the trench shall be closed by a watertight plug or other means approved by the Inspector. Pipe in the trench which cannot temporarily be jointed shall be capped or plugged at each end to make it watertight. This provision shall apply during all periods when pipe laying is not in progress. Should water enter the trench, the seal shall remain in place until the trench is pumped completely dry. The Contractor shall provide all plugs and caps of the various sizes required.

10. Deviations in Line or Grade: Wherever obstructions not shown in the contract documents are encountered during the progress of the work and interfere to an extent that an alteration in the plan is required, the Engineer shall have the authority to change the plans and direct a deviation from the

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line and grade or to arrange with the owners of the structures for the removal, relocation, or reconstruction of the obstructions. Any deviation from the line shall be accomplished by the use of appropriate bends unless such requirement is specifically waived by the Engineer. These deviations shall clearly and accurately be reflected in the Contractor's submittal of their redline drawings for permanent recording purposes.

Whenever it is necessary to deflect pipe from a straight line, the deflection shall be as directed by the Engineer and as described herein. In no case shall the amounts shown in Table 812-1, "Maximum Deflections of Ductile Iron Pipe" and Table 812-2, "Maximum Deflections of Concrete Steel Cylinder Pipe," be exceeded.

11. Cutting Pipe: The cutting of pipe for inserting valves, fittings, or closure pieces shall be accomplished in a neat and workmanlike manner so as to produce a smooth end at right angles to the axis of the pipe. The recommendations of the pipe manufacturer shall be strictly followed by the Contractor. Only qualified and experienced workmen shall be used and, under no circumstances, shall a workman not equipped with proper safety goggles, helmet and all other required safety attire be permitted to engage in this work.

Asbestos Cement (AC): No field cutting, breaking, or crushing will be allowed on AC pipe. Repairs to AC pipe shall be accomplished by removing one full joint of AC pipe and replacing with appropriate PVC or Ductile Iron pipe and fittings. All work associated with removing and disposing of AC pipe shall conform to the provisions of Item No. 3000, "Handling of Asbestos Cement Pipe."

All cuts made on ductile-iron pipe shall be done with a power saw. The cuts shall be made at right angles to the pipe axis and shall be smooth. The edges of the cut shall be finished smoothly with a hand or machine tool to remove all rough edges. The outside edge of pipe should be finished with a small taper at an angle of about 30 degrees. Solid sleeves or cast couplings shall be allowed on precast/prefab vaults only. All other fire line services shall be installed with full joints of pipe.

To facilitate future repair work on water mains, no sections less than 3 feet in length between fittings shall be allowed.

12. Joint Assembly:

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- a. Rubber Gasketed Joints: The installation of pipe and the assembly of rubber gasketed joints for ductile iron pipe, concrete and steel cylinder pipe shall conform to the pipe manufacturer's assembly instructions. The method of inserting spigot ends of pipe in bells or collars known as "stabbing" shall not be permitted with pipe larger than 6 inches in size. Spigot ends of pipe larger than 6 inches in size must be properly inserted in the joint by means of suitable pushing/pulling devices or an approved manufacture's method.
- b. Mechanical Couplings: Mechanical couplings shall be assembled and installed according to the standards recommended by the manufacturer.

Mechanical coupling consists of a cylindrical steel middle ring, two steel follower rings, two rubber compound gaskets, and a set of steel bolts. The middle ring is flared at each end to receive the wedge-shaped gasket which is compressed between the middle ring flare and the outer surface of the pipe by pressure exerted on the follower rings through the bolt circle.

Prior to the installation of the mechanical coupling, the pipe ends shall be cleaned by wire brush or other acceptable method to provide a smooth bearing surface for the rubber compression gasket. The pipe shall be marked to align the end of the coupling which will center it over the joint. After positioning, the nuts shall be drawn up finger tight. Uniform pressure on the gaskets shall be applied by tightening alternate bolts on the opposite side of the circle in incremental amounts. Final tensioning shall be accomplished with a torque wrench and in a manner similar to the tightening procedure. The coupling shall then be left undisturbed for 24 hours to allow the gaskets to "pack in." Final torque check shall then be made prior to coating and wrapping the joint. Table 812-3 ("Torque for Mechanical Couplings)," sets forth the proper torque for various sized mechanical couplings and is included for the convenience of the Contractor.

- c. Restraint Joints: Restraint Joints shall be installed as shown on the plans or as directed by the Engineer. Installation shall conform to the manufacturer's recommendation.

### 13. Abandonment/Removal of Old Mains: Regarding planned main

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abandonment, the Contractor shall accomplish all cutting, capping, plugging, and blocking necessary to isolate those existing mains retained in service from those abandoned. The open ends of abandoned mains and all other openings or holes in such mains occasioned by cutting or removal of outlets shall be blocked off by manually forcing cement grout or concrete into and around the openings in sufficient quantity to provide a permanent substantially watertight seal. Abandonment of old, existing water mains will be considered subsidiary to the work required, and no direct payment will be made.

When specified or shown otherwise in the contract documents, Contractor shall remove the main and all related appurtenances that are to be replaced, or will no longer be in service, and all effort to accomplish this requirement will be considered subsidiary to the work required, and no direct payment will be made.

14. Abandoned Valves: Valves abandoned in the execution of the work shall have the valve box and extension packed with sand to within 8 inches of the street surface. The remaining 8 inches shall be filled with 2,500 psi concrete or an equivalent sand-cement mix and finished flush with the adjacent pavement or ground surface. The valve covers shall be salvaged and returned to the Owner.
15. New/Existing Valves: At no time during the project work shall any valves be covered or rendered inaccessible for operation due to any activities by the Contractor. Any work during construction activities will be suspended until this requirement is met. No claims for cost or schedule delays will be accepted.

**812.5 MEASUREMENT:** Water main installed will be measured by the linear foot for each size and type as follows:

Measurements will be from the center line intersection of runs and branches of tees to the end of the valve of a dead end run.

Measurements will also be between the center line intersection of runs and branches of tees. Where the branch is plugged for future connection, the measurement will include the entire laying length of the branch or branches of the fitting.

The measurement of each line of pipe of each size will be continuous and shall include the full laying lengths of all fittings and valves installed between the ends



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of such line except that the laying length of reducers will be divided equally between the connected pipe sizes. Lines leading to a tapping connection with an existing main will be measured to the center of the main tapped.

**812.6 PAYMENT:** Payment for water main installed will be made at the unit price bid per linear foot of pipe of the various sizes installed by the open cut method. Such payment shall also include excavation, selected embedment material, backfill, compaction, polyethylene sleeve, hauling and disposition of surplus excavated material, including all existing pipe, fittings, appurtenances to be abandoned or removed (where specified or shown in the contract documents)

Removed AC pipe shall be manifested and disposed of in accordance with Item No. 3000, "Handling Asbestos Cement Pipe."

<b>TABLE 812-1</b>					
<b>MAXIMUM DEFLECTIONS OF DUCTILE-IRON</b>					
<b>Nominal Pipe Diameter</b>	<b>Maximum Deflection Angle</b>	<b>Maximum Deflection In Inches</b>		<b>Approximate Radius Of Curve In Inches</b>	
		<b>18 Ft.</b>	<b>20 Ft.</b>	<b>18 Ft.</b>	<b>20 Ft.</b>
6"	4°25'	16.7	18.5	234	260
8"	3°51'	14.6	16.2	268	297
10"	3°42'	14.0	15.5	279	310
12"	3°08'	11.9	13.2	327	363
16"	2°21'	8.8	9.7	440	488
20"	1°55'	7.2	8.0	540	600
	1°35'	6.0	6.7	648	720

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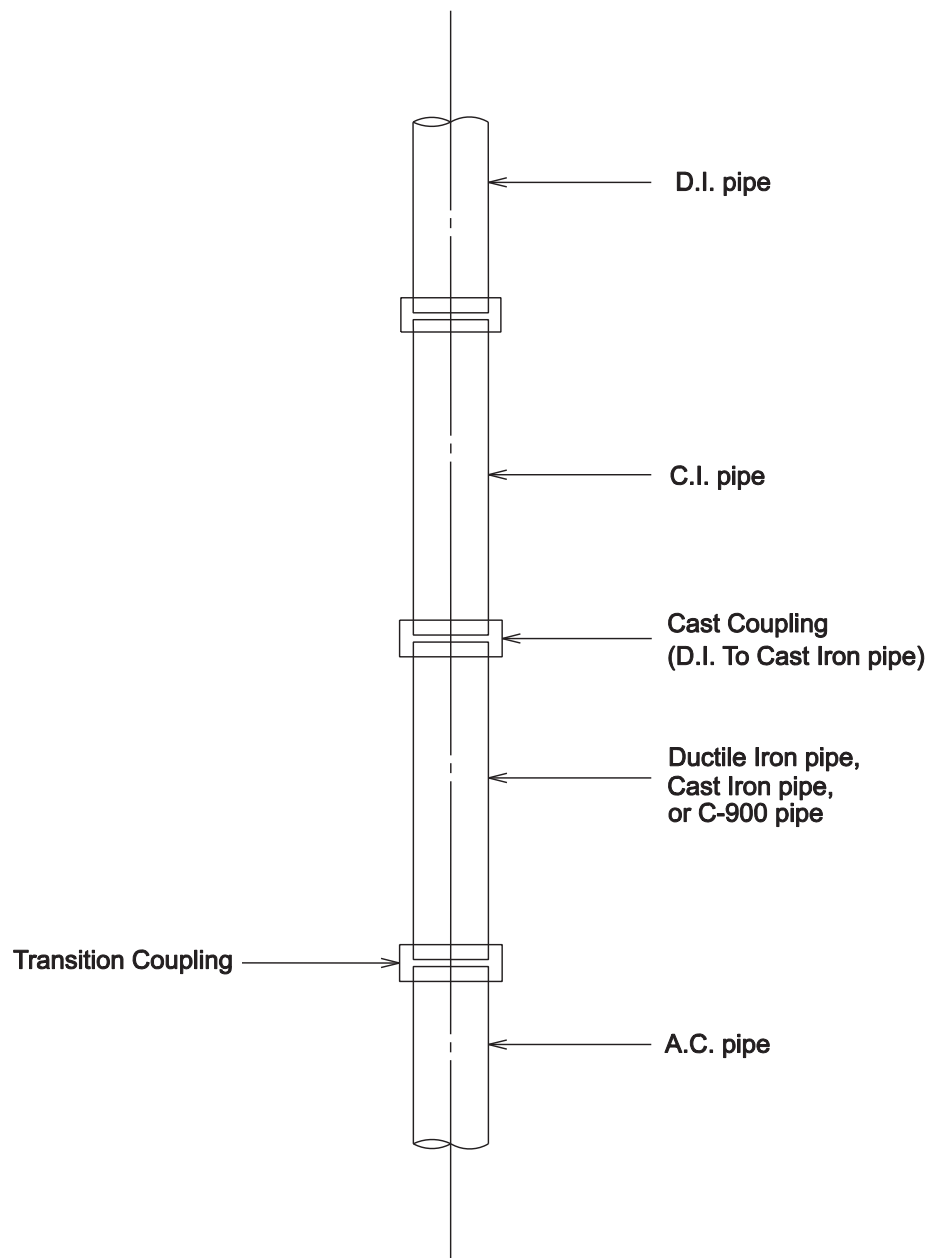
<b>TABLE 812-2</b>					
<b>MAXIMUM DEFLECTIONS OF CONCRETE STEEL CYLINDER</b>					
<b>Nominal Pipe Diameter</b>	<b>Maximum Deflection Angle</b>	<b>Maximum Deflection In Inches</b>		<b>Approximate Radius Of Curve In Inches</b>	
		<b>16 Ft.</b>	<b>20 Ft.</b>	<b>16 Ft.</b>	<b>20 Ft.</b>
16"	2°20'	--	9.8	--	500
20"	1°52'	--	7.8	--	600
24"	1°34'	--	6.6	--	750
30"	1°16'	--	5.3	--	900
36"	1°02'	--	4.3	--	1100
42"	0°54'	--	3.8	--	1300
48"	0°47'	2.6	--	1170	--
54"	0°44'	2.5	----	1237	--
60"	0°54'	3.0		1024	-

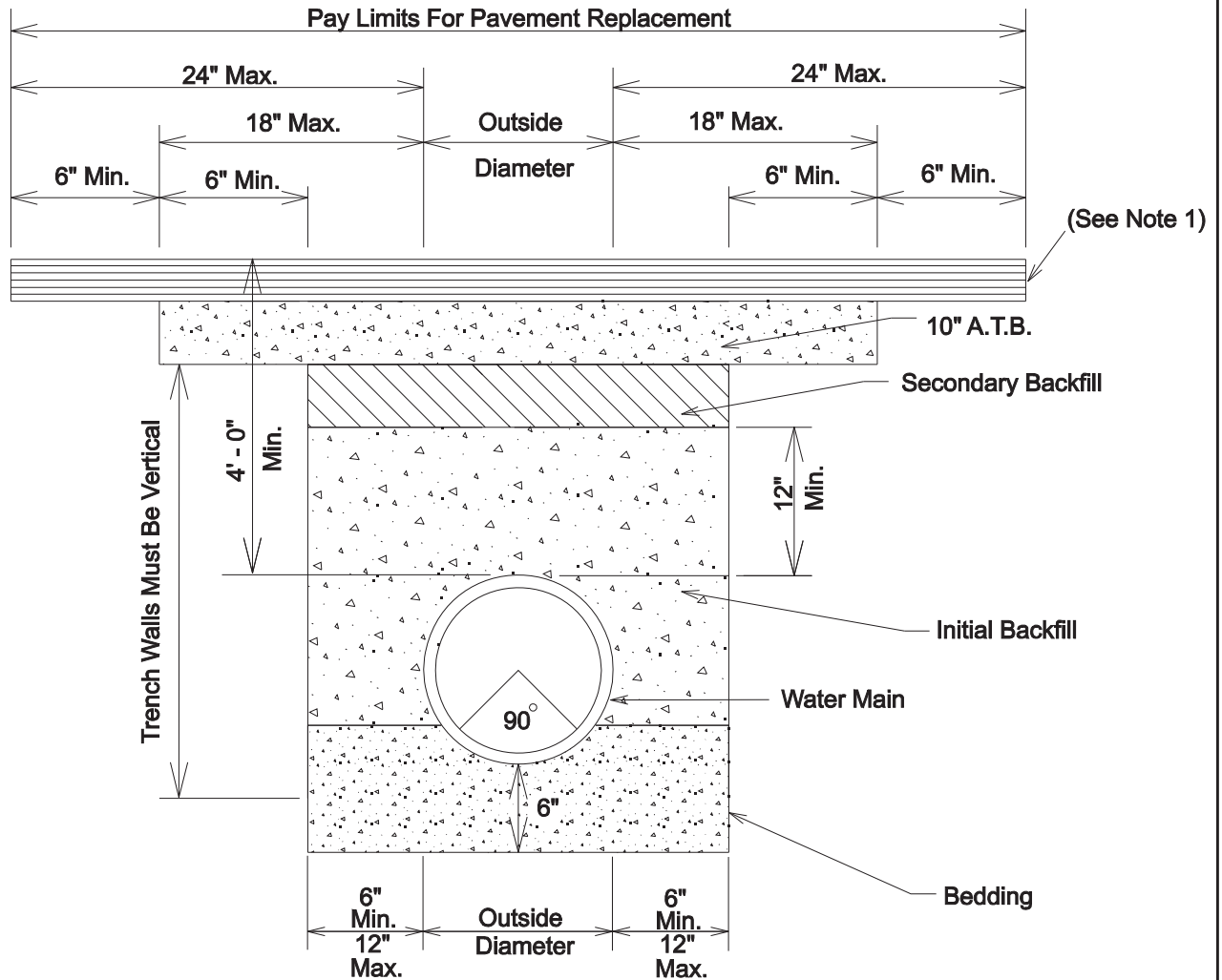
<b>TABLE 812-3</b>		
<b>TORQUE FOR MECHANICAL COUPLINGS</b>		
	<b>Bolt</b>	

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<b>Coupling Size</b>	<b>Diameter</b>	<b>Torque</b>
2" to 24"	5/8"	75 ft-lb
2" to 24"	3/4"	90 ft-lb
30" & 36" (1/4" x 7" Middle Rings)	5/8"	65 ft-lb
30" thru 36" (3/8" & heavier Middle Rings)	5/8"	70 ft-lb
30" to 48"	3/4"	80 ft-lb
48" to 72"	3/4"	70 ft-lb

- End of Specification -





1) REPLACEMENT OF SURFACE LAYER SHALL BE OF THE TYPE AND THICKNESS BASED ON FUNCTIONAL CLASSIFICATION.

a. Min 2" HMAC Type "D" for trench repair in Local / Residential streets.

b. Min 3" HMAC Type "C" for trench repair in Collector / Arterial streets.

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**ITEM NO. 813  
WATER SERVICE FOR FIRELINES**

**813.1**      **DESCRIPTION:** This item shall consist of water service for fire line installations in accordance with these specifications and as directed by the Engineer.

**813.2**      **MATERIALS:** The materials for water service for fire lines shall conform to the specifications contained within the latest revision of SAWS' Material Specification Item Nos. 05-11, "Ductile Iron Pipe," 05-12, "PVC C-900 Water Pipe," Item No. 819, "PVC C-905 Water Pipe." The pressure rating for pipe materials shall be in accordance with Table HP-1, "High Pressure Zone Information." Minimum pressure rating for all pipes in these high pressure zones shall be to DR 18 standards.

**813.3**      **CONSTRUCTION:**

1.      Start of Work: Three working days notice will be given to the Inspector prior to start of a project after the permit has been issued. The Contractor shall start his work at a tie-in or at a point designated by the Engineer. All pipe shall be laid with bell ends facing in the direction of laying, unless otherwise authorized or directed by the Engineer. All valves and fire hydrants must be installed as soon as pipe laying reaches their established location. Pipe shall be installed to the required lines and grades with fittings, valves, and hydrants placed at the required locations. Spigots shall be centered in bells or collars, all valves and hydrant stems shall be set plumb, and fire hydrant nozzles shall face as shown in the contract documents or as directed by the Engineer. No valve or other operational control mechanism on the existing system shall be operated for any purpose by the Contractor unless a representative of the SAWS is present.
2.      Crossing Other Underground Lines: New fire line services crossing any other utility shall have a minimum of 48 inches of cover over the top of the pipe unless otherwise waived or modified by the Engineer. Excavation around other utilities shall be done by hand for at least 12 inches in all directions. Any damage to other utilities shall be reported to the governing entity/owner of said utility as well as the Inspector.
3.      Pipe Grade: Fire line services shall have a minimum of 48 inches of cover for mains 16" and below, and 60 inches for mains 20" and above, over the top of the pipe, unless otherwise waived or modified by the Engineer.

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Pipe grades shall be as required by the contract documents or as directed by the Engineer. Grades shall be met as specified by Item No. 804, "Excavation, Trenching and Backfilling." Precautions shall be taken to insure that the pipe barrel has uniform contact with the Modified Grade 5 for its full length, except at couplings. Couplings shall not be in contact with the original trench bottom prior to backfilling. Modified Grade 5 material shall be placed under the coupling and compacted by hand prior to backfilling so as to provide an even bearing surface under the coupling and pipe. Changes in grade shall be made only at joints.

4. Modified Grade 5 Materials: Prior to placing pipe in a trench, the trench shall have been excavated to the proper depth as required in Item No. 804, "Excavation, Trenching, and Backfilling" of these specifications. Approved imported materials or Engineer-approved materials selected from suitable fines derived from the excavation shall be smoothly worked across the entire width of the trench bottom to provide a supporting cushion.
5. Structures to Support Pipe: When either the Inspector or Engineer note that the material at the bottom of a trench is unstable or unsuitable, it shall be removed and replaced with approved material may be properly compacted in place to support the pipe. The Contractor shall also construct a foundation for the pipe consisting of piling, concrete beams, or other supports in accordance with plans prepared by the Engineer.
6. Lowering Pipe and Appurtenances into Trench: Proper implements, tools, and facilities satisfactory to the Inspector shall be provided and used by the Contractor for the safe and convenient completion of work. All pipe, fittings, valves, and hydrants shall be carefully lowered into the trench piece by piece, by means of a derrick, ropes, or other suitable tools or equipment in such a manner as to prevent damage to water service materials and protective coatings, polywrap sleeving, and linings. Under no circumstances shall water service materials, pipes, fittings, etc., be dropped or dumped into the trench. Extreme care shall be taken to avoid damaging polywrap films. No chains or slings shall be allowed unless the entire sling is wrapped with a protective nylon web sock.
7. Pipe Laying: Every precaution shall be taken to prevent foreign material from entering the pipe during its installation. Under adverse trench conditions, work stoppage for more than 24 hours and/or as otherwise required by the Engineer, a manufactured cap/plug is to be used to prevent any foreign type material entering the pipe. The cap/plug shall be left in place until it is connection to an adjacent pipe. The interior of each pipe

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shall be inspected for foreign material or defects, and the pipe shall be cleaned or rejected if any defects are found, respectively.

After placing a length of pipe in the trench, the jointed end shall be centered on the pipe already in place, forced into place, brought to correct line and grade, and completed in accordance with these requirements. The pipe shall be secured in place with approved backfill material tamped around it. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be rejected by the Engineer and/or Inspector and shall be replaced with pipe and fittings of proper dimensions. Precautions shall be taken to prevent dirt or other foreign matter from entering the joint space.

At times when pipe laying is halted, the open end of pipe in the trench shall be closed by a watertight plug or other means approved by the Inspector. Pipe in the trench which cannot temporarily be joined shall be capped or plugged at each end to make it watertight. This provision shall apply during all periods when pipe laying is not in progress. Should water enter the trench, the seal shall remain in place until the trench is pumped completely dry. The Contractor shall provide all plugs and caps of the various sizes required.

8. Deviations in Line or Grade: Wherever obstructions not shown on the plans are encountered during the progress of the work and interfere to an extent that an alteration in the plan is required, the Construction Inspector shall have the authority to change the plans and direct a deviation from the line and grade or to arrange with the owners of the structures for the removal, relocation, or reconstruction of the obstructions. Any deviation from the line shall be accomplished by the use of appropriate bends unless such requirement is specifically waived by Engineer. These deviations shall be clearly and accurately be reflected in the Contractor's submittal of their redline drawings for permanent recording purposes.

Whenever it is necessary to deflect pipe from a straight line, the deflection shall be as directed by the Construction Inspector and as described herein. In no case shall the amounts exceed those shown in Table 813-1, "Maximum Deflections of Ductile Iron Pipe" for ductile iron pipe or the manufacturer's recommendations for PVC pipe.

9. Cutting Pipe: The cutting of pipe for inserting valves, fittings, or closure pieces shall be accomplished in a neat and workmanlike manner so as to produce a smooth end at right angles to the axis of the pipe. The recommendations of the pipe manufacturer shall be strictly followed by



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the Contractor. Only qualified and experienced workmen shall be used and, under no circumstances, shall a workman not equipped with proper safety goggles, helmet and all other required safety attire be permitted to engage in this work.

Asbestos Cement (AC): No field cutting, breaking, or crushing will be allowed on AC pipe. Installation of fire line services to AC pipe mains shall be accomplished by removing one full joint of AC pipe and replacing with appropriate PVC or Ductile Iron pipe and fittings. All work associated with removing and disposing of AC pipe shall conform to the provisions of Item 3000, "Handling of Asbestos Cement Pipe."

All cuts made on ductile-iron pipe shall be done with a power saw. The cuts shall be made at right angles to the pipe axis and shall be smooth. The edges of the cut shall be finished smoothly with a hand or machine tool to remove all rough edges. The outside edge of pipe should be finished with a small taper at an angle of about 30 degrees. Solid sleeves or cast couplings shall be allowed on precast/prefab vaults only. All other fire line services shall be installed with full joints of pipe.

To facilitate future repair work on water mains, no sections less than 3 feet in length between fittings shall be allowed.

### 10. Joint Assembly:

- a. Rubber Gasketed Joints: The installation of pipe and the assembly of rubber gasketed joints for ductile iron pipe shall conform to the pipe manufacturer's assembly instructions. The method of inserting spigot ends of pipe in bells or collars known as "stabbing" shall not be permitted with pipe larger than 6 inches in size. Spigot ends of pipe larger than 6 inches in size must be properly inserted in the joint by means of suitable pushing/pulling devices or an approved manufacture's method.
- b. Mechanical Couplings: Mechanical couplings shall be assembled and installed according to the standards recommended by the manufacturer.

Mechanical coupling consists of a cylindrical steel middle ring, two steel follower rings, two rubber compound gaskets, and a set of steel bolts. The middle ring is flared at each end to receive the wedge-shaped gasket which is compressed between the middle ring flare and the outer surface of the pipe by pressure exerted on

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the follower rings through the bolt circle.

Prior to the installation of the mechanical coupling, the pipe ends shall be cleaned by wire brush or other acceptable method to provide a smooth bearing surface for the rubber compression gasket. The pipe shall be marked to align the end of the coupling which will center it over the joint. After positioning, the nuts shall be drawn up finger tight. Uniform pressure on the gaskets shall be applied by tightening alternate bolts on the opposite side of the circle in incremental amounts. Soap and final tensioning shall be accomplished with a torque wrench and in a manner similar to the tightening procedure after 15 minutes.

- c. Restrained Joints: Restrained Joints shall be installed as shown in the contract documents or as directed by the Construction Inspector. Installation shall conform to the manufacture's recommendation.

**813.4 MEASUREMENT:** Fire lines installed will be measured by the linear foot for each size and type as follows:

Measurements will be from the center line intersection of fire line with the main distribution line to the property line.

The measurement of each line of pipe of each size will be continuous and shall include the full laying lengths of all fittings and valves installed between the ends of such line. Lines leading to a tapping connection with an existing main will be measured to the center of the main tapped.

**813.5 PAYMENT:** Payment for fire lines main installed will be made at the unit price bid per linear foot of pipe of the various sizes installed by the open cut method. Such payment shall also include excavation, selected embedment material, backfill, compaction of trench backfill, testing of compaction, tie-in, polyethylene sleeve, hauling, disposition of surplus excavated material, and restoration of the surface, including asphalt, concrete, curbing, sidewalks, sod, grass, landscaping, etc. All replacement mains shall include tie-in costs for existing fire lines.

Removed AC pipe shall be manifested and disposed of in accordance with Item No. 3000, "Handling Asbestos Cement Pipe."

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<b>TABLE 813-1</b>					
<b>MAXIMUM DEFLECTIONS OF DUCTILE-IRON</b>					
<b>Nominal Pipe Diameter</b>	<b>Maximum Deflection Angle</b>	<b>Maximum Deflection In Inches</b>		<b>Approximate Radius Of Curve In Inches</b>	
		<b>18 Ft.</b>	<b>20 Ft.</b>	<b>18 Ft.</b>	<b>20 Ft.</b>
6"	4°25'	16.7	18.5	234	260
8"	3°51'	14.6	16.2	268	297
10"	3°42'	14.0	15.5	279	310
12"	3°08'	11.9	13.2	327	363
16"	2°21'	8.8	9.7	440	488
20"	1°55'	7.2	8.0	540	600
	1°35'	6.0	6.7	648	720

- End of Specification -

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**ITEM NO. 814  
DUCTILE IRON PIPE**

**814.1 DESCRIPTION:** This item shall consist of ductile iron pipe installation in accordance with these specifications and as directed by the Engineer.

**814.2 SUBMITTALS:** Contractor shall submit manufacturer's product data, installation recommendations, shop drawings, and certifications.

**814.3 MATERIALS:** The materials for ductile iron pipe shall conform to the specifications contained within the latest revision of SAWS Material Specification Item Nos. 05-11, "Ductile-Iron Pipe," 10-10, "Gray-Iron and Ductile-Iron Fittings," and 100-34, "Ductile-Iron Couplings."

**814.4 CONSTRUCTION METHOD:**

1. Excavations at Bells and Collars: Ductile iron pipe shall be installed as specified within Item No. 812, "Water Main Installation." Bell holes of sufficient size shall be provided at each joint to permit the joints to be made properly. For mechanical type joints, the minimum clearance between the bell and natural ground shall be 6 inches in all directions. Subject to the above provisions, the length of excavation for bell holes below grade of the trench bottom shall be kept to a minimum.
2. Corrosion Protection for Ferrous Pipe, Fittings, and Valves: Except as otherwise shown in the contract documents or as directed by the Engineer, anti-corrosion embedment shall be provided for all ductile iron pipe, fittings, and valves and at all valves, fittings, or outlets for nonferrous or reinforced concrete steel cylinder pipe. The embedding material shall be Modified Grade 5 gravel washed sand which conforms to the requirements as set forth in the Item No. 804, subsection 804.4.2.

The preparation of the trench shall be in accordance with applicable provisions of Item 804, "Excavation, Trenching and Backfilling." After the subgrade has been prepared, the pipe shall be laid to grade. The pipe, fitting, or valve shall be firmly embedded in and surrounded by an insulating blanket of the embedding material. The minimum thickness of this blanket shall be 6 inches in all directions.

3. Coating and Wrapping of Underground Pipe:

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- a. Ductile Iron Pipe In Casing: Where ductile iron pipe is to be installed in a bore, the pipe shall be thoroughly cleaned down to the coal-tar enamel pipe coating by approved methods. Where damaged, a prime coat, compatible to the polyvinyl tape to be used, shall then be applied to the pipe. Following the application of the prime coat, the pipe shall be wrapped with Scotchrap, Trantex V-10 polyvinyl tape, or other approved equal product. The tape shall not be applied until the prime coat is completely dry.

The tape shall be spirally and tightly wrapped on each section of the pipe with a 50% lap. The wrap shall be made to the bell on the bell end and to a point 6 inches from the spigot end. The joint shall be protected with tape 6 inches in width on pipe 12 inches or less in size and with tape 8 inches in width on pipe greater than 12 inches in size.

- b. Open Trench: Ductile iron pipe to be installed in a trench shall be protected in the following manner. Each pipe joint shall be covered with a 4 mil thick polyethylene sleeve that is 2 feet longer than the pipe joint. The sleeve shall cover the full length of the pipe joint, lap over 1 foot on each end of the adjoining pipe joints, and be secured with a minimum of two circumferential turns of pressure sensitive polyvinyl tape. Excess material should be neatly drawn up around the pipe barrel, folded into an overlap on top of the pipe, and held in place by means of pieces of pressure sensitive tape at approximately 5 foot intervals. After assembling the joint, the polywrap tube from the previously installed pipe shall be pulled over the joint and secured by the Contractor. The polywrap tube from the new joint shall be pulled over the first tube and secured by the Contractor to provide a double seal.

Cast iron and ductile iron fittings and valves shall be completely wrapped in 8 mil thick polyethylene film with a minimum of a 1 foot overlap on each end and appropriately taped. Laps shall cover joints with adjoining pipe joints or fittings when installed. Also, the fire Hydrant barrel, from the surface to the valve, shall be wrapped as specified herein.

Any damaged areas in the polyethylene film shall be repaired by covering the area with a sheet of polyethylene film large enough to lap over the damaged area 1 foot minimum in any direction and

## *San Antonio Water System Standard Specifications for Construction*

appropriately taped. Extreme care shall be taken at service tap locations to insure that the tape extends beyond the corporation and onto the service line pipe by a minimum of 1 foot.

Prior to placing pipe in the trench, a cushion of approved materials shall be placed in the trench as required by Item No. 804, "Excavation, Trenching and Backfill." Backfill material shall be carefully placed on the pipe so as to avoid any damage to the polyethylene sleeve.

The Contractor shall use care to protect and preserve the polyethylene wrap around ductile iron water mains when installing service corporations. The required method is to wrap pipe tape around the pipe over the polywrap in the area to be tapped. The tap is to be made through the tape and polywrap. It is not necessary to remove and replace poly wrap. All exposed pipe, the corporation, and the first 3 feet of the service shall be wrapped and taped to achieve a complete seal. In addition, a sand envelope shall extend over and around the connection to a depth of eight inches above the main.

- c. Protective Coating on Joints: All bolts and nuts destined for underground service on valves, fire hydrants, cast-iron mechanical joint fittings, pipe joints, and other ferrous metal appurtenances shall be packed in an approved protective coating material after installation. After the joint has been made and bolts drawn to the proper tension, the joint including glands, flanges, bolt heads, and nuts shall be covered with an approved SAWS coating. Such protective coating shall be supplemental to anti-corrosive sand embedment as set forth in Item No. 804, "Excavation, Trenching and Backfill." Coating and wrapping of joints will be considered incidental to the installation, and no separate payment will be made for this item. Asphaltic material such as Talcote shall not be used.
4. Cutting Ductile Iron Pipe: All cuts made on ductile-iron pipe shall be done with a power saw or approved mechanical cutter. The cuts shall be made at right angles to the pipe axis and shall be smooth. The edges of the cut shall be finished smoothly with a hand or machine tool to remove all rough edges.

The outside edge of pipe should be finished with a small taper at an angle of about 30 degrees.

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To facilitate future repair work on water mains, no sections less than 3 feet in length between fittings shall be allowed.

**814.5 MEASUREMENT:** Ductile iron pipe will be measured by the linear foot for each size and type as follows:

Measurements will be from the center line intersection of runs and branches of tees to the end of the valve of a dead end run.

Measurements will also be between the center line intersection of runs and branches of tees. Where the branch is plugged for future connection, the measurement will include the entire laying length of the branch or branches of the fitting.

The measurement of each line of pipe of each size will be continuous and shall include the full laying lengths of all fittings and valves installed between the ends of such line except that the laying length of reducers will be divided equally between the connected pipe sizes. Lines leading to a tapping connection with an existing main will be measured to the center of the main tapped.

**814.6 PAYMENT:** Payment for water main installed will be made at the unit price bid per linear foot of pipe of the various sizes installed by the open cut method. Such payment shall also include excavation, selected embedment material, backfill, compaction, polyethylene sleeve, hauling and disposition of surplus excavated material, including all existing pipe, fittings, appurtenances to be abandoned (where specified or shown in the contract documents).

- End of Specification -

*San Antonio Water System Standard Specifications for Construction*

**ITEM NO. 818**

**PVC (C-900, C-905 and C-909) PIPE INSTALLATION**

- 818.1 DESCRIPTION:** This item shall consist of PVC (C-900, C-905 and C-909) pipe installation in accordance with these specifications and as directed by the Engineer. Deflection of PVC (C-900, C-905 and C-909) pipe shall not be allowed.
- 818.2 SUBMITTALS:** Contractor shall submit manufacturer's product data instructions, recommendations, shop drawings, and certifications.
- 818.3 MATERIALS:** The materials for PVC pipe installation shall conform to the specifications contained within the latest revision of SAWS Material Specification Item Nos. 05-12, 819-01, and 05-13, "Polyvinyl Chloride (PVC) Pipe."
- 818.4 CONSTRUCTION METHOD:** PVC (C-900, C-905 and C-909) pipe shall be installed as specified within Item No. 812, "Water Main Installation" of these specifications. PVC (C-900, C-905 and C-909) mains shall be laid to the depth and grades shown in the contract documents. The pipe shall be laid by inserting the spigot end into the bell flush with the insertion line or as recommended by the manufacturer. At no time shall the bell end be allowed to go past the "insertion line." A gap between the end of the spigot, and the adjoining pipe is necessary to allow for expansion and contraction.

Joint Restraints: For all mains consisting of PVC (C-900, C-905 and C-909) joint restraints as specified in SAWS' Material Specification Item No. 95-10, "Pipe Joint Restraint Systems," and shall be installed in accordance with manufacturer's recommendations. Joint restraints shall be bi-directional and installed to fully restrain the system as shown in Standard Drawing Details DD-839-04 through DD-839-8, or indicated in the contract documents.

PVC (C-900, C-905 and C-909) pipe shall be field cut using a power saw with a steel blade or abrasive disc, depending on the size of pipe. If a bevel is needed after field cutting, it should be in accordance with the latest applicable recommendations of: Uni-Bell or ASTM/AWWA standards. Such work will be subject to approval by the Inspector.

Tracer Wire: Tracer wire shall be utilized for location purposes and taped directly to the pipe. Tracer wire shall be of solid core (14 gauge insulated), and shall be taped to the main in minimum of 10 inch increments. Wire shall also come up to



**San Antonio Water System Standard Specifications for Construction**

the top of valve extensions and fire hydrant stems, as directed by the Inspector.

**818.5**      **MEASUREMENT:** PVC pipe will be measured by the linear foot for each size and type as follows:

Measurements will be from the center line intersection of runs and branches of tees to the end of the valve of a dead end run.

Measurements will also be between the center line intersection of runs and branches of tees. Where the branch is plugged for future connection, the measurement will include the entire laying length of the branch or branches of the fitting.

The measurement of each line of pipe of each size will be continuous and shall include the full laying lengths of all fittings and valves installed between the ends of such line except that the laying length of reducers will be divided equally between the connected pipe sizes. Lines leading to a tapping connection with an existing main will be measured to the center of the main tapped.

**818.6**      **PAYMENT:** Payment for PVC Pipe installed will be made at the unit price bid per linear foot of pipe of the various sizes installed by the open cut method. Such payment shall also include excavation, selected embedment material, backfill, compaction, polyethylene sleeve, hauling and disposition of surplus excavated material, including all existing pipe, fittings, appurtenances to be abandoned (where specified or shown in the contract documents).

- End of Specification -

*San Antonio Water System Standard Specifications for Construction*

**ITEM NO. 834  
FIRE HYDRANTS**

**834.1 DESCRIPTION:** This item shall consist of fire hydrant installations using joint restraints in accordance with these specifications and as directed by the Engineer with the contract documents.

**834.2 MATERIALS:** The materials for fire hydrant installations shall conform to the specifications contained within the latest revision of SAWS' Material Specification Item No. 95-10, "Specifications of Pipe Joint Restraint Systems," Item No. 95-10, Item No. 113-02, "Ductile Iron Restrained Joint Fittings for Use on Ductile Iron and Polyvinyl Chloride Pipe," and Item No. 21-30, "Fire Hydrants."

**834.3 CONSTRUCTION:**

1. General: Hydrants shall be connected to mains as shown in the contract documents or as directed by the Engineer. They shall be installed in accordance with Standard Drawings DD-834-01, DD-834-02, and DD-834-03. Hydrants shall also be installed in a location where there is accessibility and in a safe location where there is a minimum possibility of damage from vehicles or injury to pedestrians. In situations where hydrants are placed directly behind curbs, hydrant barrels shall be set so that no portion of the hydrant will be less than 12 inches nor more than 7 feet from the back of the curb. Where hydrants are set in the lawn spaces between the curb and the sidewalk or between the sidewalk and the property line, no portion of the hydrant or nozzle cap shall be within 6 inches of the sidewalk.

Setting final grade of fire hydrants to match proposed or existing field conditions is the responsibility of Contractor.

Hydrants shall be set in accordance with Standard Drawings DD-834-01, DD-834-02, and DD-834-03 and shall be set plumb and shall have their nozzles parallel with, or at right angles to, the curb with the pumper nozzle facing the curb. Drainage and concrete pads shall be provided at the base of hydrants as specified. No fire hydrant drainage system or pit shall be connected to a storm or sanitary sewer.

The Contractor shall install anchored or flanged style fittings in accordance with Standard Drawings DD-834-01, DD-834-02, and DD-834-03.

## *San Antonio Water System Standard Specifications for Construction*

2. Restrained Joints: Restrained mechanical joints that require field welding or groove cuts into the pipe barrel for restraint will not be accepted. Restrained joints shall be furnished for pipe at all changes in direction as indicated in the contract documents, or as directed by the Engineer. Restrained mechanical joints shall be locked mechanical joints. All joints shall conform to the San Antonio Water System Material Specification Item No. 95-10, "Pipe Joint Restraint Systems." The restraint system shall be capable of a test pressure twice the maximum sustained working pressure of 350 psi for ductile iron and PVC pipe.
3. Replacing and Relocating Existing Fire Hydrants: When existing fire hydrants are to be replaced or relocated, the work shall be accomplished by either of the following:
  - a. Cutting or installing a tee of the size and type as indicated in the contract documents or as directed by the Engineer.
  - b. Using a tapping sleeve and valve of the size and type as indicated in the contract documents to install a new fire hydrant to an existing or new water main. Size on size taps will not be permitted.
  - c. Relocating the existing fire hydrant by closing the existing fire hydrant branch valve, removing the existing fire hydrant, extending the fire hydrant branch and installing the existing fire hydrant as specified herein.

The Contractor shall salvage the existing fire hydrants and other materials as designated in the field by the Inspector and shall deliver this material to the SAWS materials storage yard, located at 3930 East Houston Street. Fire hydrant branches shall be abandoned by cutting and capping the fire hydrant cast iron tee at the service main and the surface restored to its original condition.

After a fire hydrant has been set, hydrants shall be painted with a suitable primer and finished with oil-based aluminum paint from the top of the hydrant to a point 18-20 inches below the center line of the pumper nozzle and applied to all exposed metal surfaces above the hydrant base flange. The payment for fire hydrant painting shall be included in the unit cost for installing the fire hydrant.

**San Antonio Water System Standard Specifications for Construction**

4. **Installation on Water Mains:** Ductile iron pipe, cast iron and ductile iron fittings, and valves used in the placement of fire hydrants and connections to the main will be considered part of the fire hydrant installation and not a part of the main construction. No separate payment will be made for this pipe. Hydrants shall be connected to the mains as shown in the contract documents or as directed by the Engineer. Hydrants shall also be installed in a location where there is accessibility and in a safe location where there is a minimum possibility of damage from vehicles or injury to pedestrians.

**834.4 MEASUREMENT:** Standard Fire Hydrants with 6 inch Valve and Box will be measured by the unit of each fire hydrant, valve, and box installed. Relocate Fire Hydrants will be measured by the unit of each fire hydrant relocated.

Standard Fire Hydrants with Tapping Sleeve, 6 inch Valve, and Box will be measured by the unit of each fire hydrant, including the various sizes of tapping sleeves, valves and boxes installed.

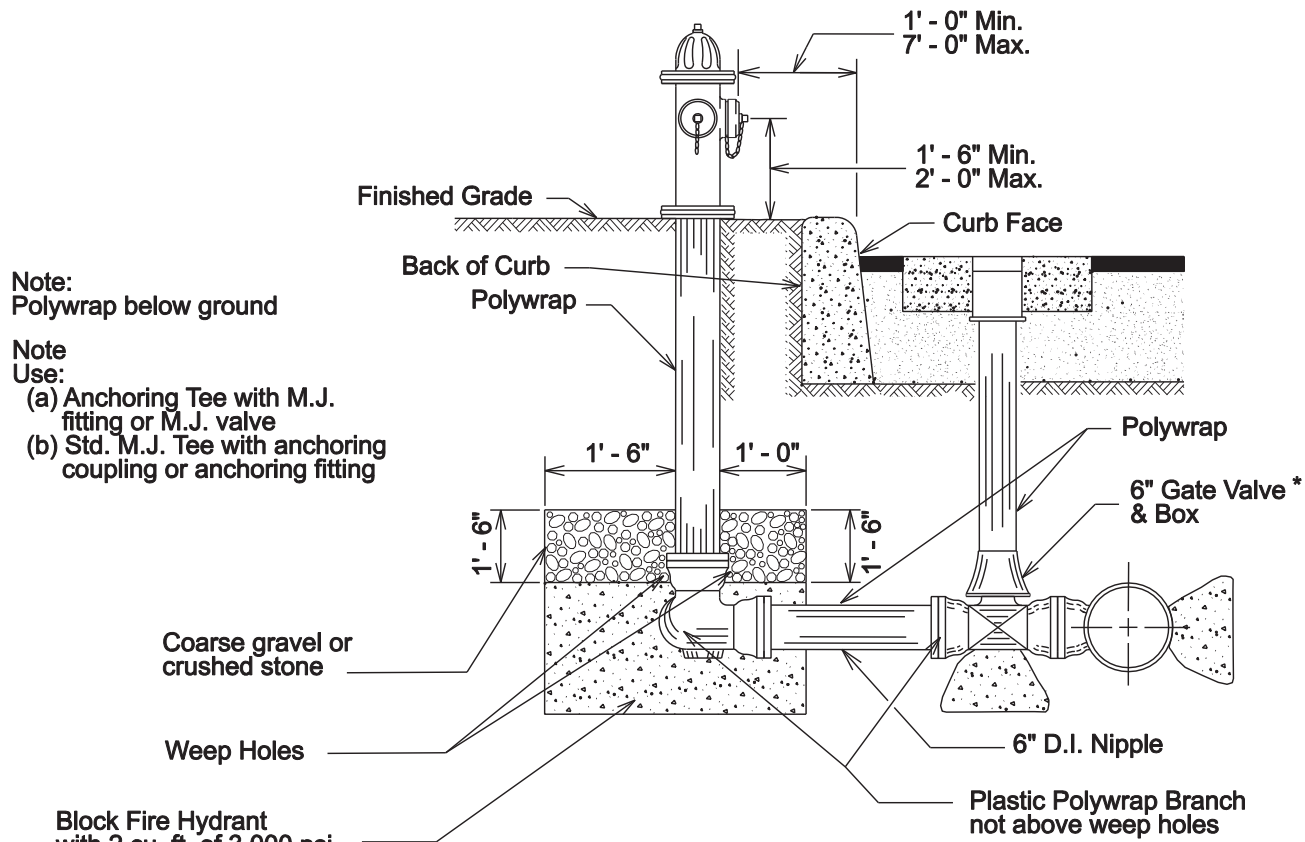
**834.5 PAYMENT:** Payment included in following bid pay items shall include: excavation, backfill, selected material, anti corrosion embedment when specified, hauling and disposition of surplus excavated materials, backfill, branch line pipe, nipples, and fittings exclusive of the tee from the main line pipe, polyethylene sleeve where required, asphalted material for ferrous surfaces, joint restraints, concrete pad, restoration of existing fire hydrant sites and removal and relocation of existing fire hydrant as specified.

PAY ITEM No. 834.1 – Fire Hydrant: Installation of a new fire hydrant as specified in the contract documents and as specified herein for a fire hydrant with 6 inch valve and box.

PAY ITEM No. 834.2 – Tapped Fire Hydrant: Payment for installation of a new fire hydrant by tapping an existing or new water main as specified in the contract documents and as specified herein for a Fire Hydrant with tapping sleeve, 6 inch valve and box.

PAY ITEM No. 834.3 – Relocate Fire Hydrant: Payment for Relocate Fire Hydrant shall include relocating an existing fire hydrant to a new location as specified in the contract documents and as specified herein. Restoration of the existing fire hydrant site shall be inclusive to this line item.

- End of Specification -



Note:  
Polywrap below ground

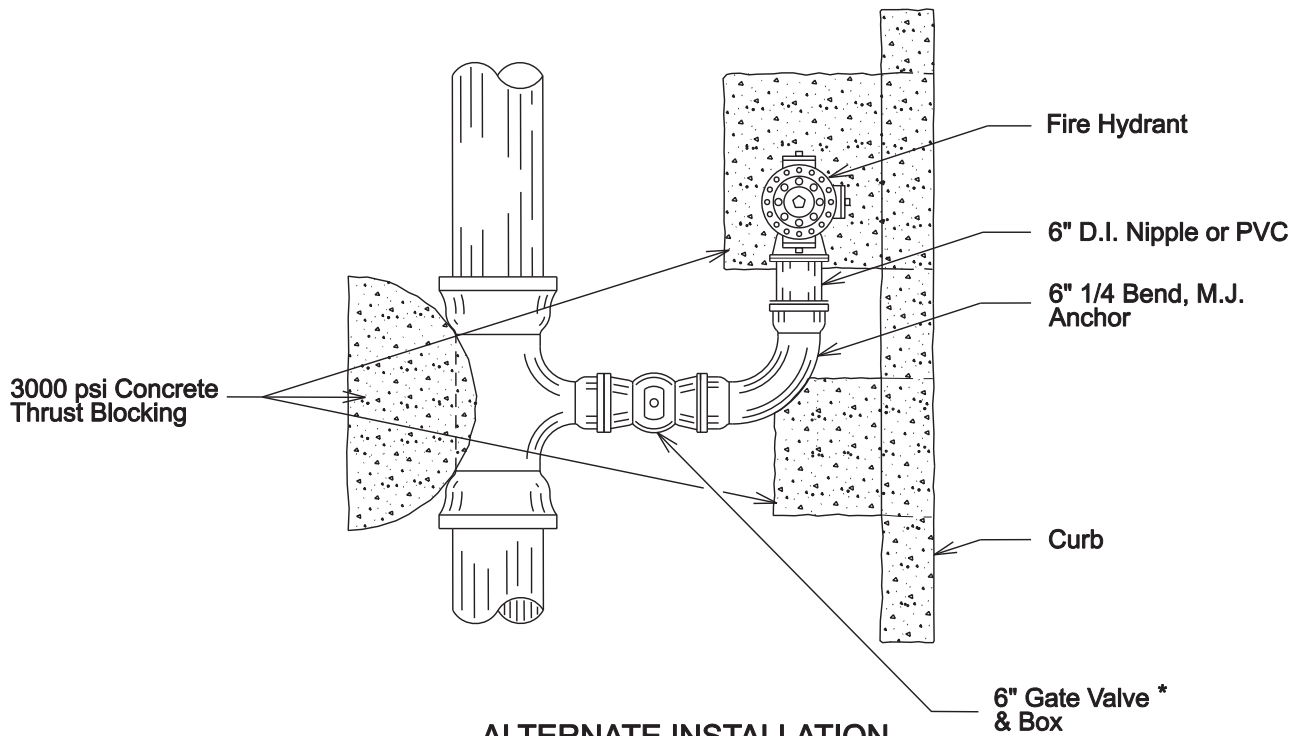
Note  
Use:

- (a) Anchoring Tee with M.J. fitting or M.J. valve
- (b) Std. M.J. Tee with anchoring coupling or anchoring fitting

**PREFERRED INSTALLATION**

Profile shown, without Horizontal Bend

Block Fire Hydrant with 2 cu. ft. of 3,000 psi concrete (Bituminous felt paper between F.H. and concrete)

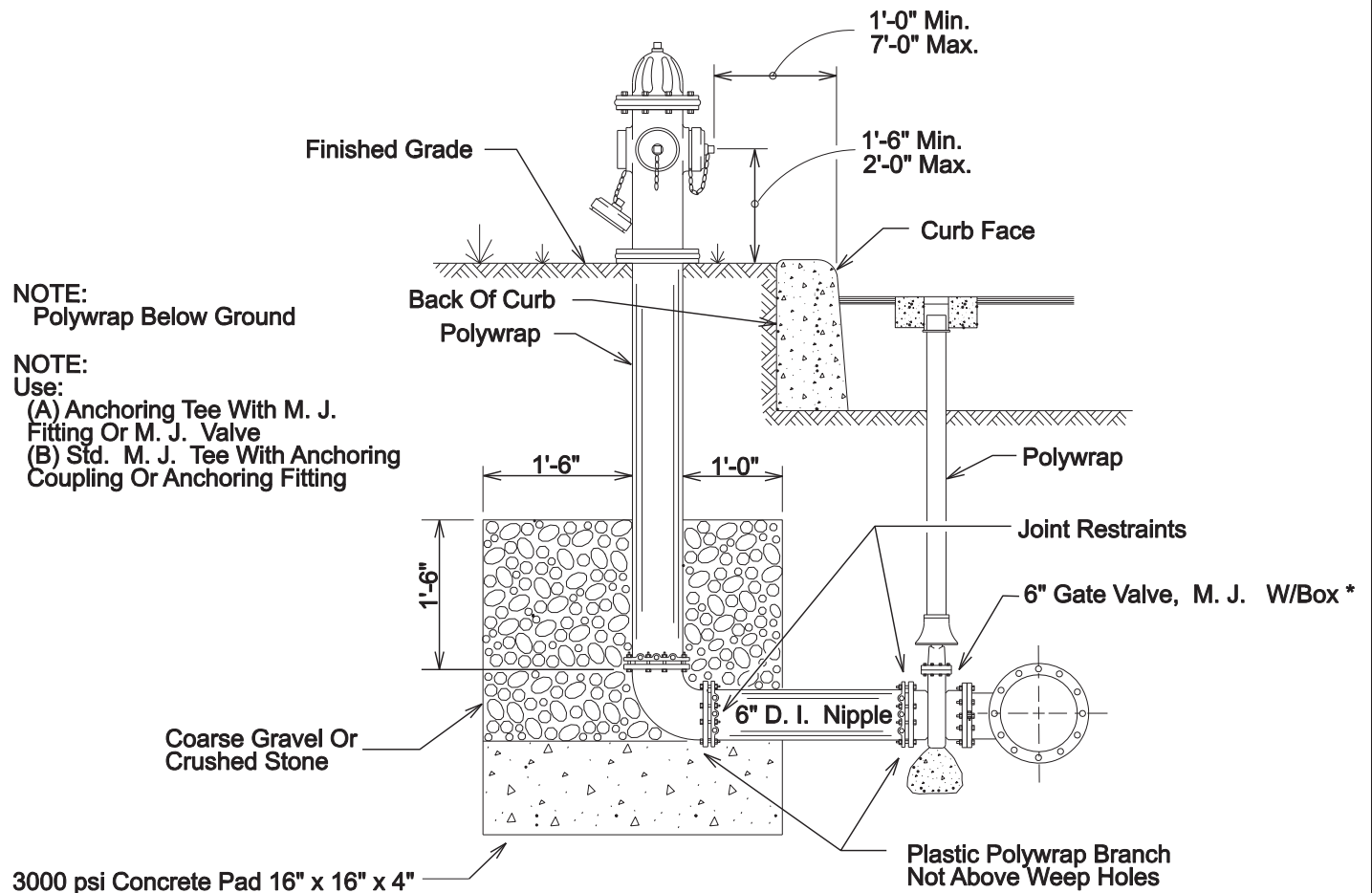


**ALTERNATE INSTALLATION**

Plan shown, with Bend

\* Resilient Seat

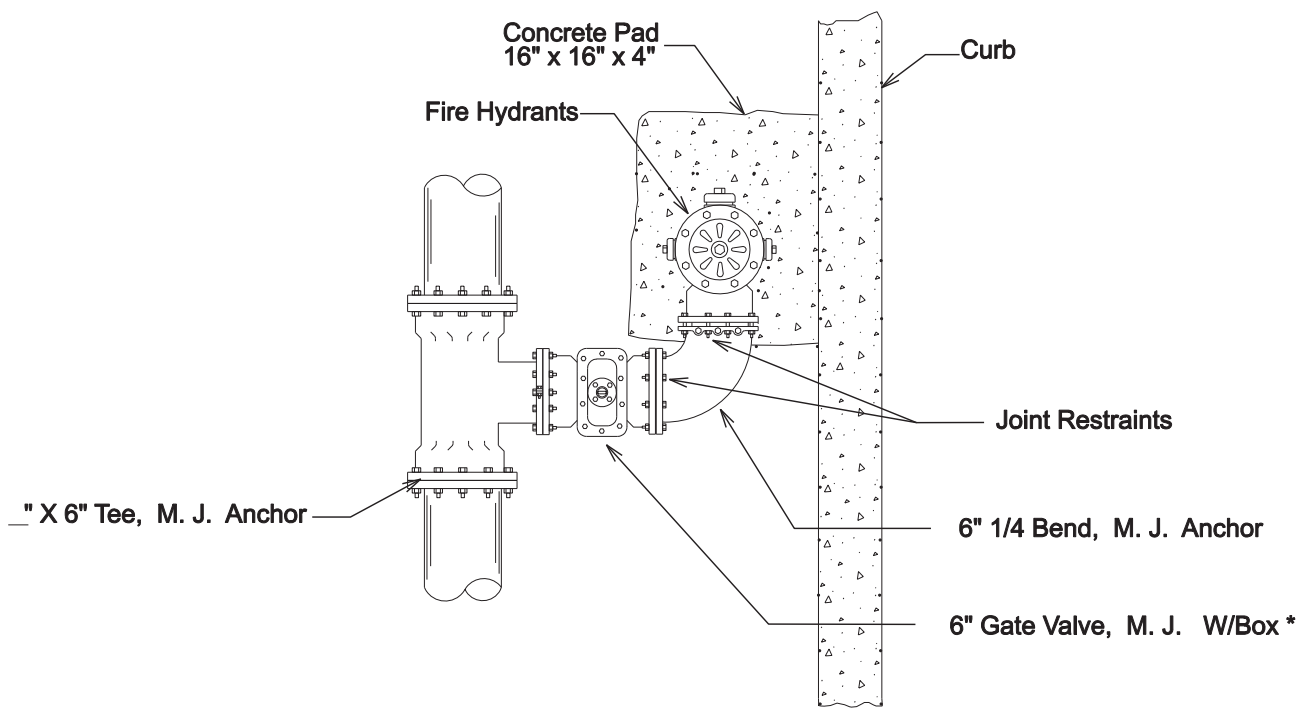
PROPERTY OF <b>SAN ANTONIO WATER SYSTEM</b> SAN ANTONIO, TEXAS	<b>FIRE HYDRANT INSTALLATION</b>	APPROVED	REVISED
		MARCH 2008	APRIL 2014
<b>DD-834-01</b>			SHEET <b>1</b> OF <b>2</b>



NOTE:  
Polywrap Below Ground

NOTE:  
Use:  
(A) Anchoring Tee With M. J. Fitting Or M. J. Valve  
(B) Std. M. J. Tee With Anchoring Coupling Or Anchoring Fitting

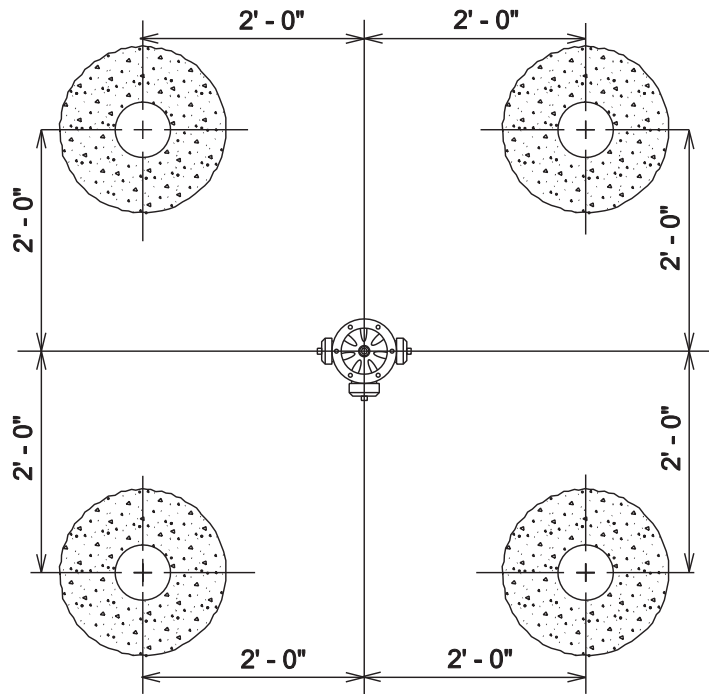
**PREFERRED INSTALLATION**  
PROFILE SHOWN, WITHOUT HORIZONTAL BEND



**ALTERNATE INSTALLATION**  
PLANVIEW SHOWN, WITH BEND

\* RESILIENT SEAT

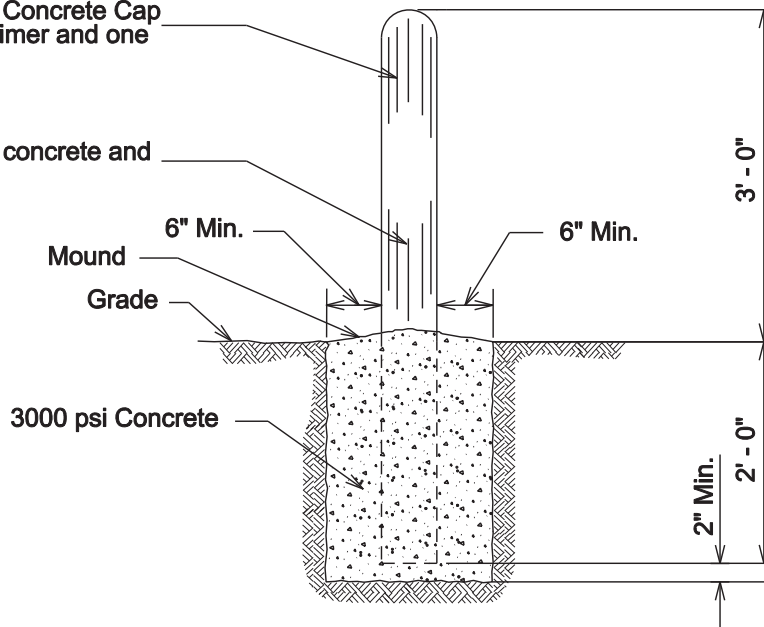
PROPERTY OF <b>SAN ANTONIO WATER SYSTEM</b> SAN ANTONIO, TEXAS	FIRE HYDRANT INSTALLATION (JOINT RESTRAINT)	APPROVED	REVISED
		MARCH 2008	APRIL 2014
		<b>DD-834-01</b>	SHEET <b>2 OF 2</b>



**Note:**  
For Highway installation, see TxDOT Specifications.

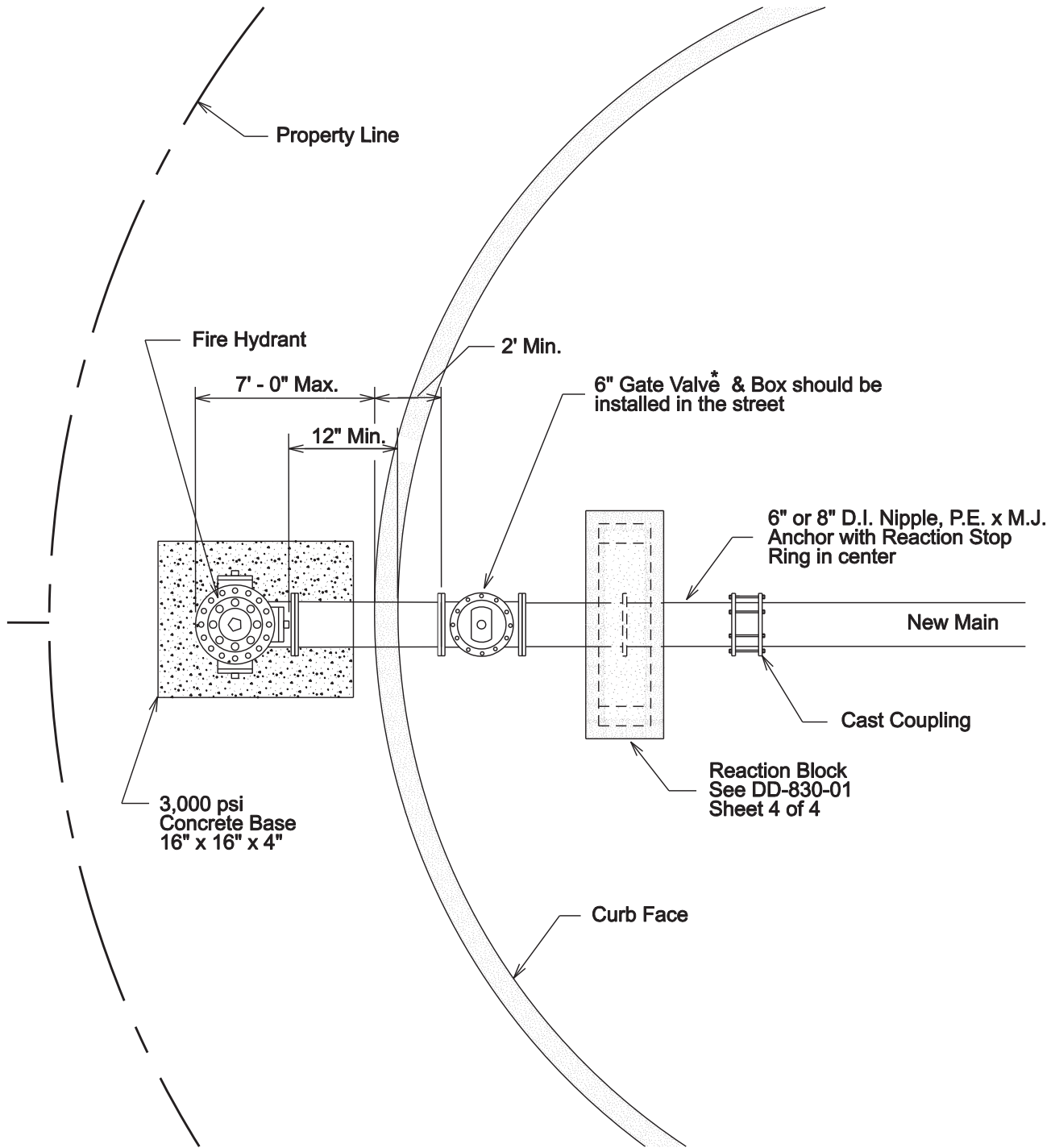
Paint exposed 6" Steel pipe and Concrete Cap with one coat of rust-inhibitive primer and one coat of safety yellow paint

6" Steel pipe filled with concrete and rounded on top



**Note:**  
Install Guard Post as required to protect Fire Hydrant from vehicular traffic.

PROPERTY OF <b>SAN ANTONIO WATER SYSTEM</b> SAN ANTONIO, TEXAS	<b>FIRE HYDRANT GUARD POST</b>	APPROVED	REVISED
		MARCH 2008	APRIL 2014
		<b>DD-834-02</b>	SHEET <b>1</b> OF <b>1</b>



\* Resilient Seat

PROPERTY OF  
**SAN ANTONIO WATER SYSTEM**  
 SAN ANTONIO, TEXAS

**FIRE HYDRANT  
 INSTALLATION AT  
 CUL-DE-SAC**

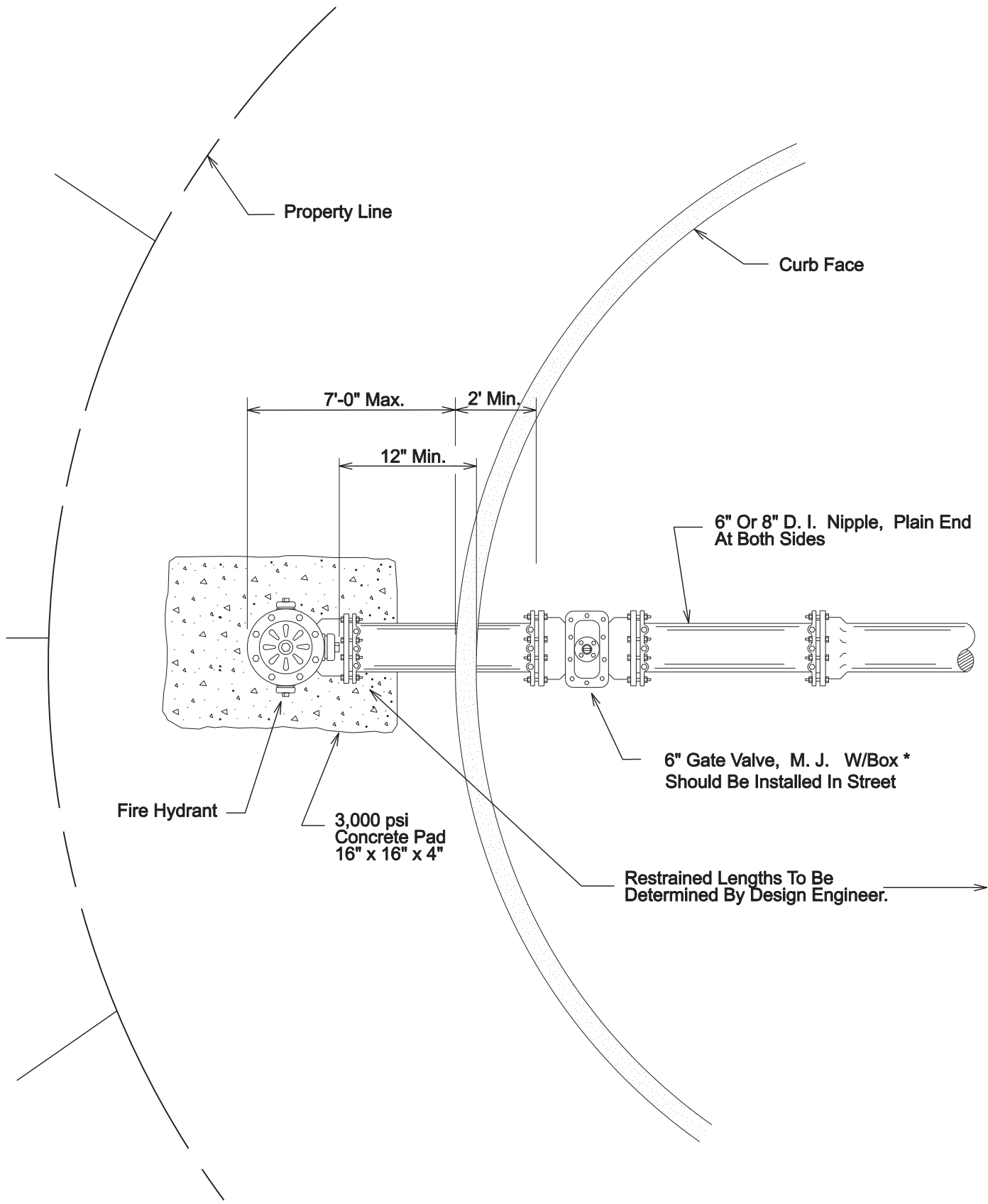
APPROVED  
 MARCH 2008

REVISED  
 APRIL 2014

**DD-834-03**

SHEET  
**1 OF 2**





Fire Hydrant

3,000 psi  
Concrete Pad  
16" x 16" x 4"

6" Or 8" D. I. Nipple, Plain End  
At Both Sides

6" Gate Valve, M. J. W/Box \*  
Should Be Installed In Street

Restrained Lengths To Be  
Determined By Design Engineer.

\* RESILIENT SEAT

PROPERTY OF  
SAN ANTONIO WATER SYSTEM  
SAN ANTONIO, TEXAS

FIRE HYDRANT INSTALLATION  
AT CUL-DE-SAC  
(JOINT RESTRAINT)

APPROVED  
MARCH 2008

REVISED  
APRIL 2014

**DD-834-03**

SHEET  
2 OF 2

*San Antonio Water System Standard Specifications for Construction*

**ITEM NO. 839**

**ANCHORAGE/THRUST BLOCKING AND JOINT RESTRAINT**

- 839.1**      **DESCRIPTION:** This item shall consist of anchorage/thrust blocking installation and adjustment, in accordance with these specifications and as directed by the Engineer. Pipe restraint devices shall be installed according to the lengths prescribed herein or as noted in the contract documents, whichever is more restrictive.
- 839.2**      **MATERIALS:** The materials for anchorage/thrust blocking installation shall conform to the appropriate specifications contained within the latest revision of SAWS Material Specifications. Pipe restraint devices shall conform to the latest revision of SAWS Material Specification Item Nos. 95-10 and 113-02.
- 839.3**      **CONSTRUCTION:** Suitable anchorage/thrust blocking or joint restraint shall be provided at all of the following main locations: dead ends, plugs, caps, tees, crosses, valves, and bends, in accordance with the Standard Drawings DD-839 Series. All mechanical (joint) restraints shall be bidirectional. Anchor blocks shall be constructed solidly behind the fitting and symmetrical with the axis of resultant thrust, except where this is not possible as in the case of gravity anchorage for vertical bends. Special ties and anchor fittings may be utilized in conjunction with blocking when shown in the contract documents or as directed by the Engineer.

All thrust blocking shall be a minimum of 3,000 psi concrete placed between solid ground and the fitting except as otherwise shown in the contract documents. The area of bearing in contact with solid ground shall be that shown in the contract documents or as directed by the Engineer.

All thrust blocking placed in conjunction with mains and appurtenances constructed in Pressure Zones 9 through 16 shall be in accordance with Standard Drawings DD-839 Series. In all cases, the design of thrust blocking shall be of sufficient size to withstand an assumed soil lateral load bearing capacity of 3,000 psf, unless specified otherwise in the contract documents. When specifically requested by the Contractor and approved by the Engineer, the maximum soil lateral load bearing capacity that will be allowed for the design of thrust blocking shall be 5,000 psf. When soil lateral load bearing capacities of 4,000 psf or 5,000 psf are recorded for design of thrust blocks, copies of soil tests made for determining the lateral load bearing capacity of the subject soil shall be submitted to the Engineer for approval.

The blocking shall be placed so that pipe and fitting joints will be accessible.

**San Antonio Water System Standard Specifications for Construction**

Pipe polywrap shall be placed between the pipe or fitting and the concrete.

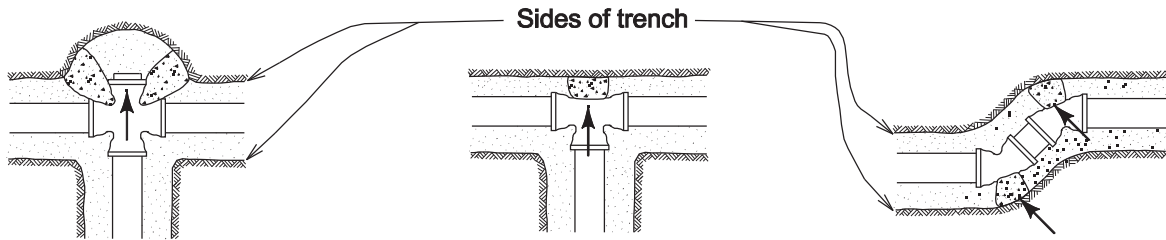
The reaction block on the unused branch of a fitting shall be poured separately from the block across the back of the fitting. If they are poured simultaneously, a rigid partition shall be placed between the blocks.

Valves 12 inches or larger in size shall be supported on a concrete pad extending vertically from 12 inches below the bottom of the valve to the lower quarter point of the hub and laterally from face to face of hubs and transversely from wall to wall of the trench.

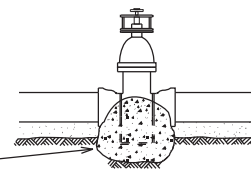
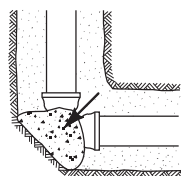
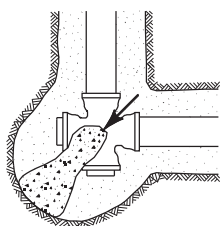
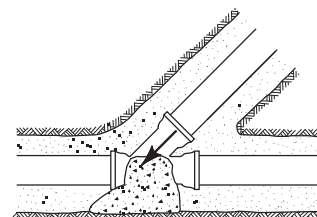
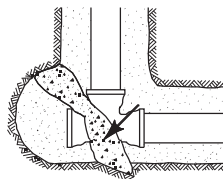
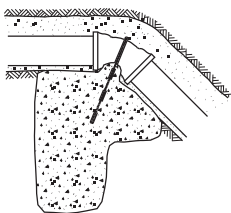
**839.4**      **MEASUREMENT:** Anchorage/Thrust Blocking or Joint Restraints are considered subsidiary to the work and no separate payment will be made to the Contractor for this work.

**839.5**      **PAYMENT:** Anchorage/Thrust Blocking or Joint Restraints are considered subsidiary to the work and no separate payment will be made to the Contractor for this work.

- End of Specification -

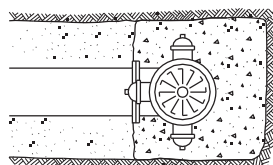


Sides of trench



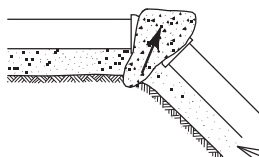
Concrete blocking required for all 12" & larger, except in high pressure distribution system where blocking is required for all valves

Select Material

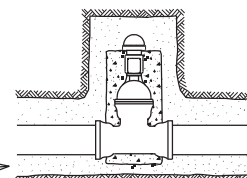


PLAN

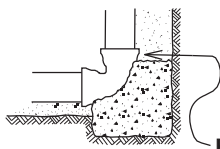
Pour base after Hydrant has been placed



Select Material

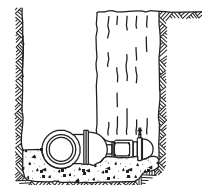
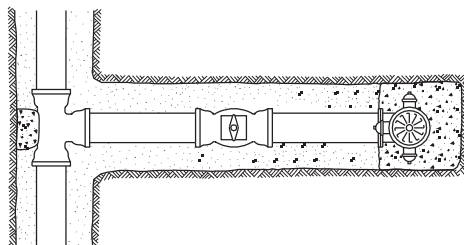


PLAN

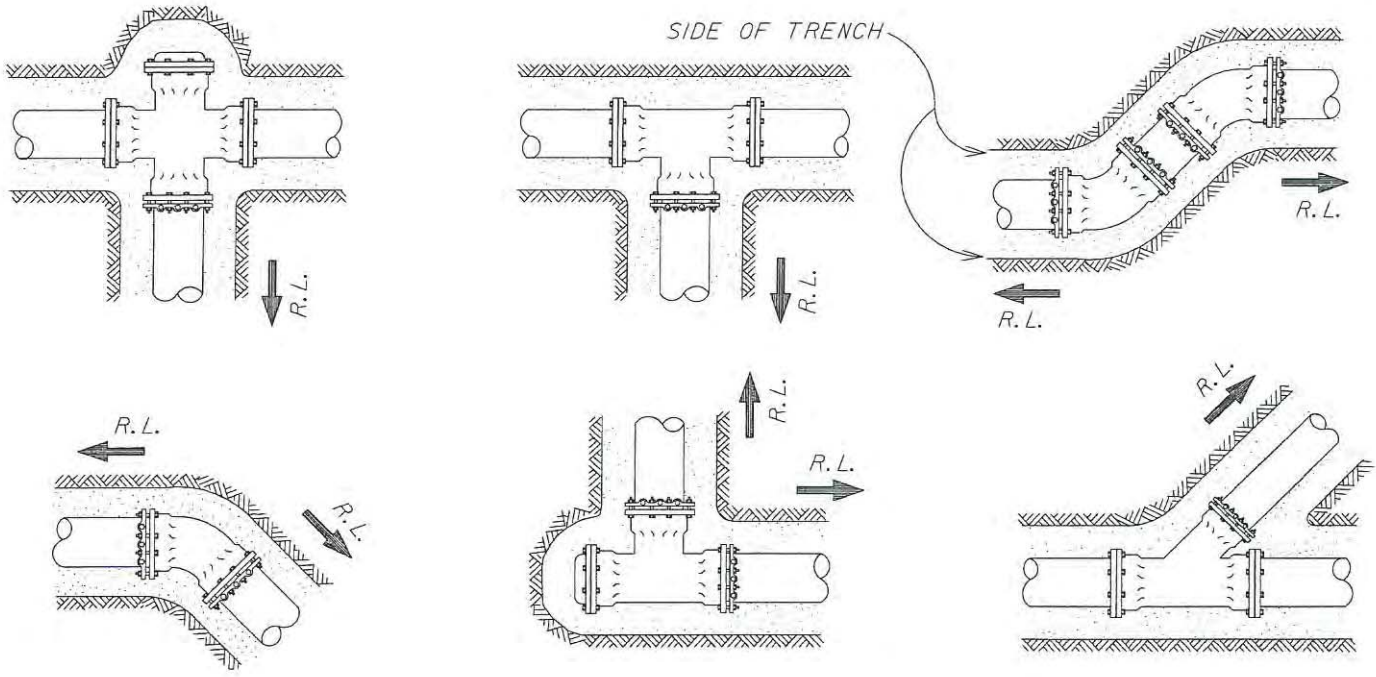


ELEVATION

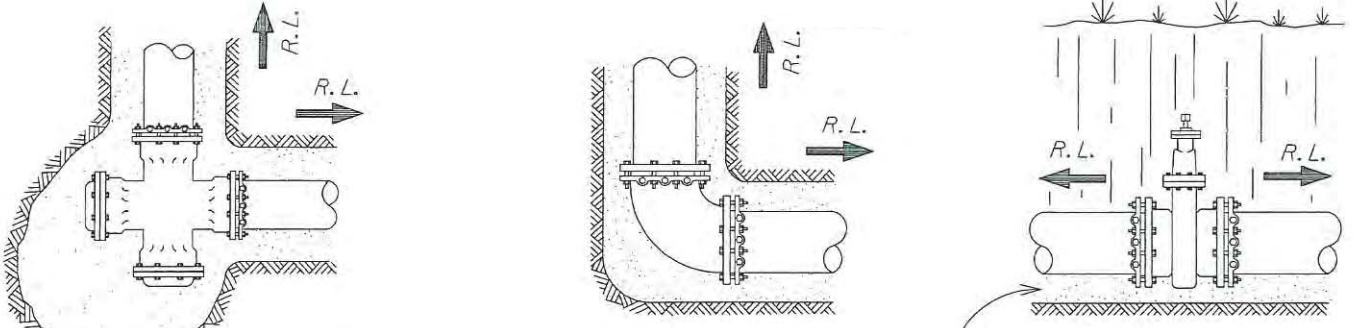
Hydrant Drain



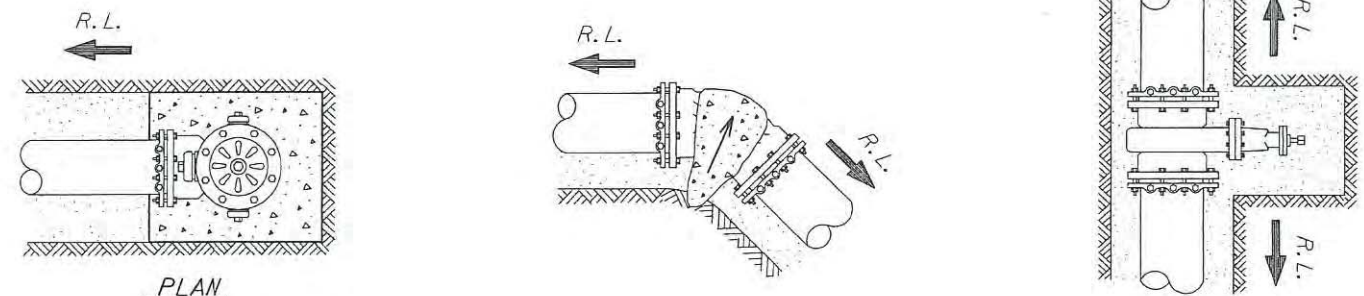
ELEVATION



R.L. = RESTRAINED LENGTHS TO BE DETERMINED BY DESIGN ENGINEER

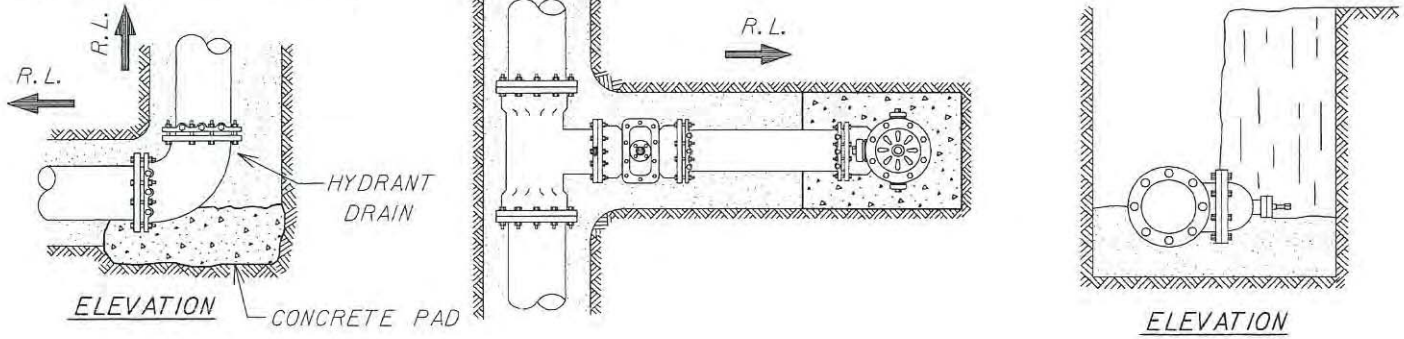


SELECT MATERIAL



PLAN

POUR CONCRETE PAD AFTER HYDRANT HAS BEEN PLACED



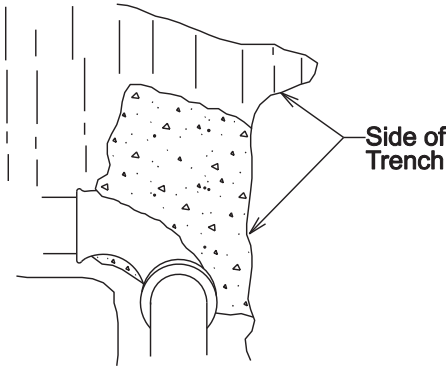
ELEVATION

CONCRETE PAD

ELEVATION

Typical blocking for 90° Bend

Area in Sq. Ft. for each of the following pipe sizes

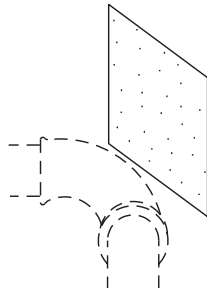


Area Sq. Ft.

### THRUST BLOCKING DESIGN

On basis of 200 psi water pressure used for tests, the blocking required for two types of soils are noted below. In one case, a soil pressure of 5000 psi is used for rock excavation and for soils other than rock a 3000 psi bearing soil pressure is used. The distribution on system is pressure of 175 psi all calculations apply to A.C. Pipe Class 200 and Ductile Iron Pipe Class 2. PVC Pipe Class 200 (SDR 13.5)

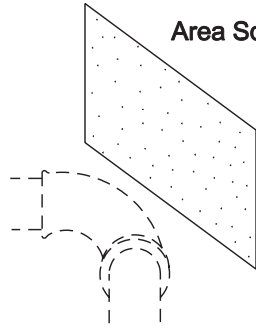
2 Sq. Ft. in rock & 4 Sq. Ft. in other soils



6" Class 200

Area Sq. Ft.

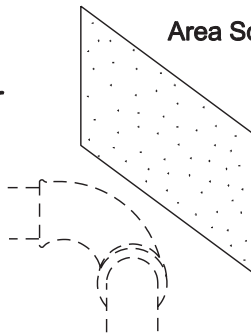
4 Sq. Ft. in rock & 6 Sq. Ft. in other soils



8" Class 200

Area Sq. Ft.

9 Sq. Ft. in rock & 14 Sq. Ft. in other soils



12" Class 200

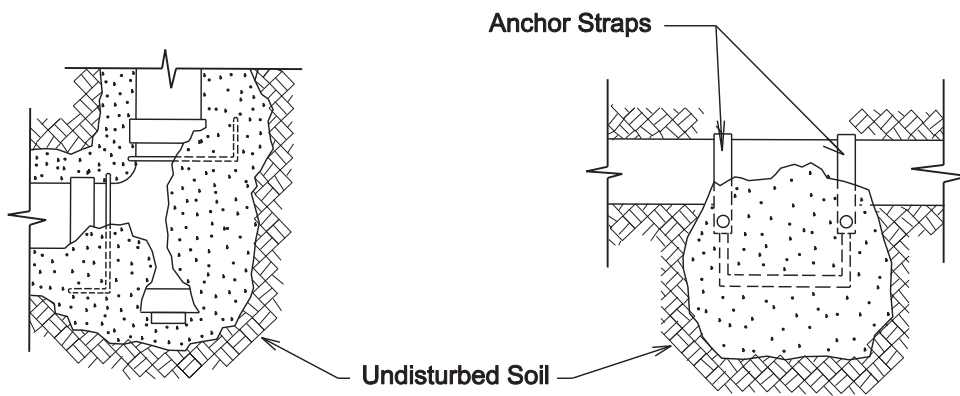
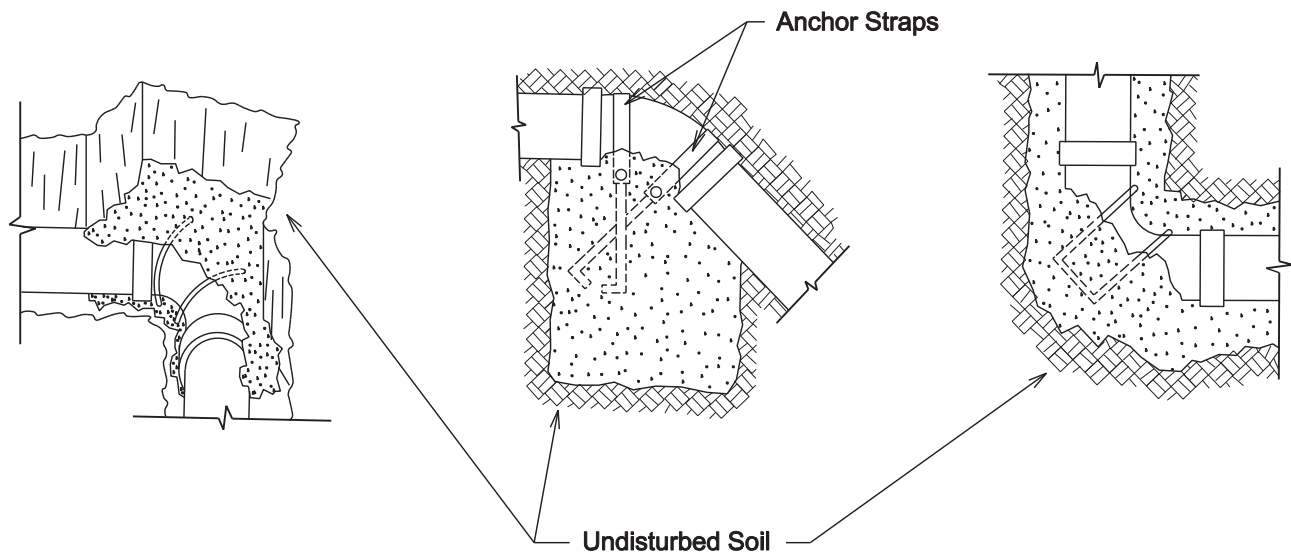
Blocking area for 200 psi tests & 175 psi working pressures.

Square feet of blocking required for rock excavation

SIZE PIPE	TEES & DEAD ENDS	90° BENDS	45° BENDS	22 1/2° BENDS
6"	2	2	1	1
8"	3	4	2	1
12"	6	9	5	2
16"	11	15	8	4

Square feet of blocking required for other than rock excavation

SIZE PIPE	TEES & DEAD ENDS	90° BENDS	45° BENDS	22 1/2° BENDS
6"	3	4	2	1
8"	4	6	4	2
12"	10	14	8	4
16"	18	25	14	7



**Note:**

All concrete used for thrust blocking shall have a minimum concrete strength of 3,000 psi.

PROPERTY OF  
**SAN ANTONIO WATER SYSTEM**  
 SAN ANTONIO, TEXAS

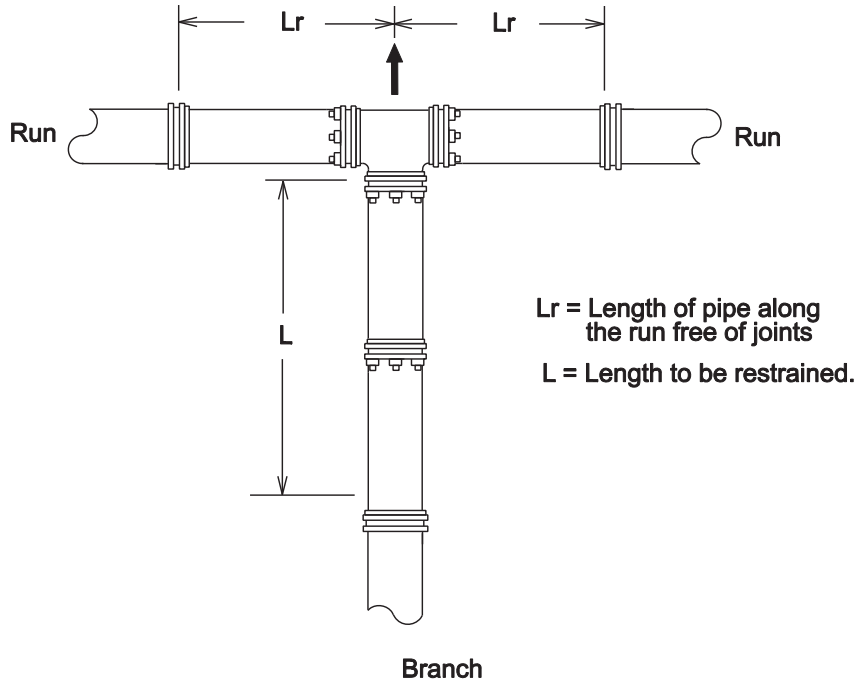
**TYPICAL THRUST BLOCKS**  
 ( SEWER ONLY )

APPROVED  
 MARCH 2008

REVISED  
 APRIL 2014

**DD-839-03**

SHEET  
**1 OF 1**



#### RESTRAINED LENGTH FOR TEES

PIPE SIZE (inch)	BRANCH SIZE (inch)	LENGTH OF RUN (ft.)	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 200 psi	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 150 psi
6	4	0	42	31
6	4	5	7	1
6	4	10	1	1
6	6	0	59	44
6	6	5	35	20
6	6	10	11	1
8	4	0	42	31
8	4	5	1	1
8	6	0	59	44
8	6	5	28	13
8	6	10	1	1
8	8	0	77	58
8	8	5	53	34
8	8	10	30	11
8	8	15	6	1

#### RESTRAINED LENGTH DESIGN

Restrained length calculations are for P.V.C pipe bedded in compacted granular material extending to the top of the pipe. The native soil material is assumed to be inorganic clay of high plasticity. Depth of bury is assumed to be 4 feet.

**Note:**

These calculations are provided for reference. The restrained length shall be designed based upon the conditions encountered during the installation.

PROPERTY OF <b>SAN ANTONIO WATER SYSTEM</b> SAN ANTONIO, TEXAS	<b>RESTRAINED LENGTHS FOR TEES</b>	APPROVED	REVISED
		MARCH 2008	APRIL 2014
		<b>DD-839-04</b>	SHEET <u>1</u> OF <u>2</u>



RESTRAINED LENGTH FOR TEES (Cont'd)

PIPE SIZE (inch)	BRANCH SIZE (inch)	LENGTH OF RUN (ft.)	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 200 psi	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 150 psi
12	4	0	42	31
12	4	5	1	1
12	6	0	59	44
12	6	5	13	1
12	6	10	1	1
12	8	0	77	58
12	8	5	42	23
12	8	10	7	1
12	8	15	1	1
12	12	0	109	82
12	12	5	86	59
12	12	10	63	35
12	12	15	39	12

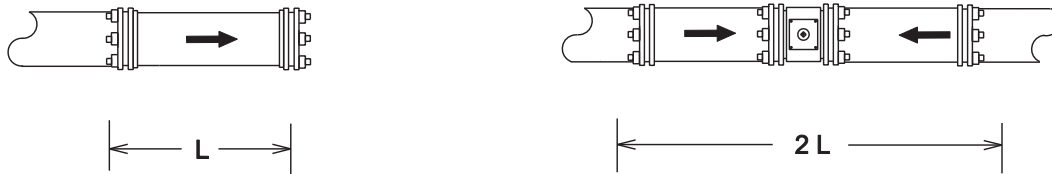
RESTRAINED LENGTH DESIGN

Restrained length calculations are for P.V.C pipe bedded in compacted granular material extending to the top of the pipe. The native soil material is assumed to be inorganic clay of high plasticity. Depth of bury is assumed to be 4 feet.

Note:

These calculations are provided for reference. The restrained length shall be designed based upon the conditions encountered during the installation.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	RESTRAINED LENGTHS FOR TEES	APPROVED	REVISED
		March 2008	
		<b>DD-839-04</b>	SHEET 2 OF 2



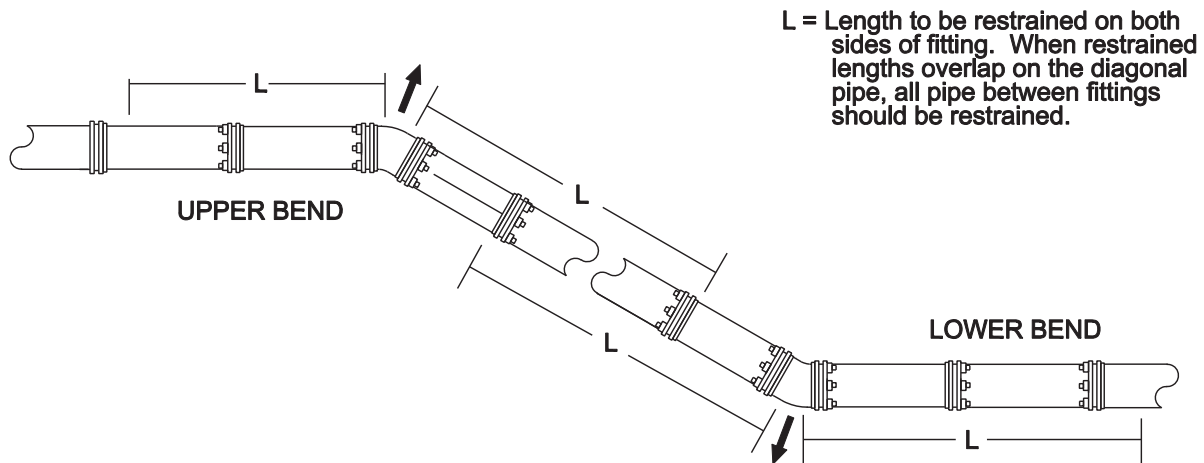
L=LENGTH TO BE RESTRAINED

PIPE SIZE (inch)	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 200 psi	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 150 psi
6	59	44
8	77	58
10	93	69
12	109	82

RESTRAINED LENGTH DESIGN

Restrained length calculations are for P.V.C. pipe bedded in compacted granular material extending to the top of the pipe. The native soil material is assumed to be inorganic clay of high plasticity. Depth of bury is assumed to be 4 feet.

**Note:**  
 These calculations are provide for reference. The restrained length shall be designed based upon the conditions encountered during the installation.



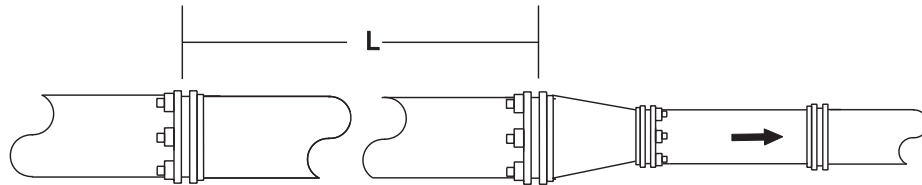
PIPE SIZE (inch)	BEND ANGLE (deg.)	LOW SIDE DEPTH	UPPER BEND RESTRAINED LENGTH IN FEET TEST PRESSURE = 200 psi	LOWER BEND RESTRAINED LENGTH IN FEET TEST PRESSURE = 200psi	UPPER BEND RESTRAINED LENGTH IN FEET TEST PRESSURE = 150 psi	LOWER BEND RESTRAINED LENGTH IN FEET TEST PRESSURE = 150 psi
6	45	5	24	8	18	6
6	22.5	5	12	4	9	3
6	11.25	5	6	2	4	1
6	45	10	24	5	18	4
6	22.5	10	12	2	9	2
6	11.25	10	6	1	4	1
8	45	5	32	11	24	8
8	22.5	5	15	5	11	4
8	11.25	5	8	3	6	2
8	45	10	32	7	24	5
8	22.5	10	15	3	11	2
8	11.25	10	8	2	6	1
12	45	5	45	16	34	12
12	22.5	5	22	7	16	6
12	11.25	5	11	4	8	3
12	45	10	45	10	34	7
12	22.5	10	22	5	16	3
12	11.25	10	11	2	8	2

**RESTRAINED LENGTH DESIGN**

Restrained length calculations are for P.V.C. pipe bedded in compacted granular material extending to the top of the pipe. The native soil material is assumed to be inorganic clay of high plasticity. Depth of bury is assumed to be 4 feet.

**Note:**

These calculations are provided for reference. The restrained length shall be designed based upon the conditions encountered during the installation.



L=Length to be restrained

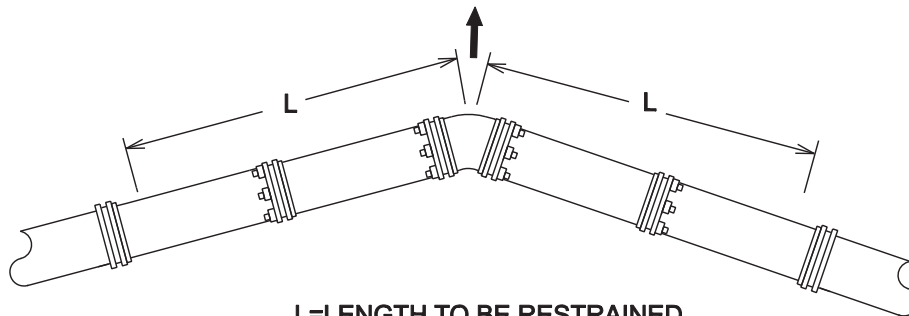
PIPE SIZE (inch)	SMALL SIZE (inch)	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 200 psi	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 150 psi
6	4	30	23
8	4	55	42
8	6	32	24
12	4	95	71
12	6	80	60
12	8	58	43

#### RESTRAINED LENGTH DESIGN

Restrained length calculations are for P.V.C. pipe bedded in compacted granular material extending to the top of the pipe. The native soil material is assumed to be inorganic clay of high plasticity. Depth of bury is assumed to be 4 feet.

#### Note:

These calculations are provided for reference. The restrained length shall be designed based upon the conditions encountered during the installation.



L=LENGTH TO BE RESTRAINED  
ON BOTH SIDES OF FITTING

PIPE SIZE (inch)	BEND ANGLE (deg)	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 200 psi	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 150 psi
6	90	23	17
6	45	9	7
6	22.5	5	3
6	11.25	2	2
8	90	30	22
8	45	12	9
8	22.5	6	4
8	11.25	3	2
12	90	43	32
12	45	18	13
12	22.5	8	6
12	11.25	4	3

**RESTRAINED LENGTH DESIGN**

Restrained length calculations are for P.V.C pipe bedded in compacted granular material extending to the top of the pipe. The native soil material is assumed to be inorganic clay of high plasticity. Depth of bury is assumed to be 4 feet.

**Note:**

These calculations are provided for reference. The restrained length shall be designed based upon the conditions encountered during the installation.

*San Antonio Water System Standard Specifications for Construction*

**ITEM NO. 840  
WATER TIE-INS**

- 840.1**      **DESCRIPTION:** This item shall consist of water main tie-ins installed in accordance with these specifications and as directed by the Engineer.
- 840.2**      **MATERIALS:** The materials for water main tie-ins shall conform to the specifications contained within the latest revision of SAWS' Material Specifications for all appropriate items.
- 840.3**      **CONSTRUCTION:** The Contractor shall make tie-ins from new water mains to existing water mains as shown in the contract documents or as directed by the Engineer. The Contractor shall be responsible for all shutdowns and isolation of the existing mains; cutting pipe for the connection; dewatering the excavation; customer notification of the shutdown; and all other requirements as directed by the Inspector in order to provide completion of this effort in a safe and secure manner. Work performed by the Contractor on mains 16 inches and larger, will require operation of any valves by SAWS forces. Therefore ample coordination beforehand (2 work days) shall be provided by the Contractor for this interaction to occur. All tie-ins shall be done after normal work hours, (8am-5pm). During construction, the planned shutdown and tie-in work shall be coordinated through and approved by the Inspector with a minimum of two weeks prior notice of such activity and accomplished at a time which will be at the least inconvenience to the customers. No additional compensation will be provided for tie-ins accomplished after normal working hours.
- 840.4**      **MEASUREMENT:** Tie-ins will be measured by the unit of each such assembly of the various sizes of tie-ins installed at the proposed main to be accepted.
- 840.5**      **PAYMENT:** Payment for "Tie-ins" will be made at the unit price bid for each tie-in of the various types and sizes completed from an existing main to the proposed main to be accepted. Such payment shall include; shut-down and isolation of the existing main to which the new main is to be connected, cutting pipe for the connection, dewatering the excavation, and customer notification of service interruption where required. Connections between new and existing mains which are made with tapping sleeves and valves and by cutting-in tees will be processed as a no separate pay item.

- End of Specification -

*San Antonio Water System Standard Specifications for Construction*

**ITEM NO. 841**  
**HYDROSTATIC TESTING OPERATIONS**

**841.1 DESCRIPTION:** This item shall consist of hydrostatic testing operations, of water mains in accordance with these specifications.

**841.2 MATERIALS:** The materials for hydrostatic testing operations installation and adjustment shall conform to the appropriate specifications contained within the latest revision of SAWS' Material Specifications.

**841.3 PROTOCOL:**

1. Flushing: Immediately upon completion of water main work, the Contractor shall flush all mains affected by the scope of the work. This flushing shall consist of completely filling sections of main between valves and then displacing such initial volumes of water by introducing clear water from existing facilities into and through the main to the point of discharge from the main being flushed. The flow-through shall continue until it is determined all dust, debris, or foreign matter that may have entered during pipe laying operations has been flushed out. All new mains shall then be left under system pressure for testing.

To avoid damage to pavement and inconvenience to the public, fire hoses shall be used to direct flushing water from the main into suitable drainage channels or sewers. The contractor is to coordinate with the Inspector prior to flushing.

2. Operation of Valves: No valve in the Owner's water distribution system shall be operated by the Contractor without prior permission of the Inspector. The Contractor shall notify the Inspector when a valve is to be operated and shall only operate the valve in the presence of the Inspector.
3. Hydrostatic Test: Except in the high pressure sections of the water distribution system (Pressure Zones 9-16) where test pressures will exceed 150 psi, all new mains shall be hydrostatically field tested at a maximum test pressure of 150 psi before acceptance by the Engineer or Inspector. Where designated as "High Pressure Area," all new mains shall be hydrostatically field tested at a maximum test pressure of 200 psi before acceptance by the Engineer or Inspector. It is the intent of these Specifications that all joints be

## *San Antonio Water System Standard Specifications for Construction*

watertight and that all joints which are found to leak by observation during any test shall be made watertight by the Contractor. When repairs are required, the hydrostatic field test shall be repeated until the pipe installation conforms to the specified requirements and is acceptable to the Engineer/Inspector. The Contractor shall insure that the Engineer/Inspector be present for the duration of the pressure test.

4. Test Procedures: After the new main has been laid and backfilled as specified (but prior to chlorination and replacement of pavement), it shall be filled with water for a minimum of 24 hours and then subjected to a hydrostatic pressure test.

The specified test pressure shall be supplied by means of a pump connected to the main in a satisfactory manner. The pump, pipe connection, and all necessary appurtenances including gauges and meters shall be furnished by the Contractor. Unless otherwise specified, the Owner will furnish water for filling lines and making tests through existing mains. Before applying the specified test pressure, all air shall be expelled from the main. To accomplish this, taps shall be made, if necessary, at the points of highest elevation and afterwards tightly plugged at no cost to the Owner. At intervals during the test, the entire route of the new main shall be inspected to locate any leaks or breaks. If any are found, they shall be stopped or repaired, and the test shall be repeated until satisfactory results are obtained. The hydrostatic test shall be made so that the maximum pressure at the lowest point does not exceed the specified test pressure.

The duration of each pressure test shall be a minimum of 4 hours for new mains in excess of 1000 linear feet and a minimum of 1 hour for new mains less than 1000 linear feet after the main has been brought up to test pressure. The test pressure shall be measured by means of a tested and properly calibrated pressure gauge acceptable to the Engineer/Inspector. All pressure tests shall be continued until the Inspector is satisfied that the new main meets the requirements of these Specifications.

Should any test of pipe in place disclose leakage greater than that listed in Table 841-1 or 841-2, "Hydrostatic Test Leakage Allowances," as applicable, the Contractor shall, at his own expense, locate and repair the defective joints until the leakage is within the specified allowance.



## *San Antonio Water System Standard Specifications for Construction*

Leakage is defined as the quantity of water supplied into the newly laid main, or any valved section of it, necessary to maintain the specified leakage test pressure after the main has been filled with water and the air expelled.

Exhibit S-841 is a schematic showing the arrangement of the test apparatus as well as the detailed procedure for conducting the hydrostatic field test.

**841.4**      **MEASUREMENT:** Hydrostatic Pressure Test will be measured by the unit of each successful test conducted.

**841.5**      **PAYMENT:** Payment for "Hydrostatic Pressure Test" will be made at the unit price bid for each successful test. Such payment shall also include all pipe, valves, fittings, pumping equipment, pressure gauge, and other required apparatus incidental to the conduct of the test.

**San Antonio Water System Standard Specifications for Construction**

<b>TABLE 841-1</b>														
<b>HYDROSTATIC TEST LEAKAGE ALLOWANCES (MAXIMUM) @ 150 PSI</b>														
<b>Nominal Diameter &amp; Type Pipe</b>	<b>ALLOWABLE LEAKAGE IN GALLONS PER HOUR (GPH)*</b>													
	<b>100 L.F.</b>	<b>200 L.F.</b>	<b>300 L.F.</b>	<b>400 L.F.</b>	<b>500 L.F.</b>	<b>600 L.F.</b>	<b>700 L.F.</b>	<b>800 L.F.</b>	<b>900 L.F.</b>	<b>1000 L.F.</b>	<b>2000 L.F.</b>	<b>3000 L.F.</b>	<b>4000 L.F.</b>	<b>5000 L.F.</b>
6" DI**	0.11	0.22	0.33	0.44	0.55	0.66	0.77	0.88	0.99	1.10	2.20	3.30	4.40	5.50
8" DI**	0.15	0.29	0.44	0.59	0.71	0.88	1.03	1.18	1.32	1.47	2.94	4.41	5.88	7.35
12" DI**	0.22	0.44	0.66	0.88	1.10	1.32	1.54	1.76	1.98	2.20	4.40	6.60	8.80	11.00
16" DI**	0.29	0.59	0.88	1.18	1.47	1.76	2.06	2.35	2.65	2.94	5.88	8.82	11.76	14.70
20" DI**	0.39	0.74	1.10	1.47	1.84	2.21	2.55	2.94	3.31	3.68	7.63	11.04	14.72	18.40
20" CSC	0.08	0.16	0.24	0.32	0.40	0.47	0.55	0.63	0.71	0.79	1.58	2.37	3.16	3.95
24" DI**	0.44	0.88	1.32	1.76	2.21	2.65	3.09	3.53	3.97	4.41	8.82	13.23	17.64	22.05
24" CSC	0.1	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.95	1.90	2.85	3.80	4.75
30" DI**	0.55	1.1	1.66	2.21	2.76	3.31	3.86	4.42	4.97	5.52	11.04	16.56	22.08	27.60
30" CSC	0.12	0.24	0.35	0.47	0.59	0.71	0.83	0.94	1.06	1.18	2.36	3.54	4.72	5.90
36" DI**	0.66	1.32	1.99	2.65	3.31	3.97	4.63	5.3	5.96	6.62	13.24	19.86	26.48	33.10
36" CSC	0.14		0.28	0.57	0.71	0.85	0.99	1.14	1.28	1.42	2.84	4.26	5.68	7.10
42" DI**	0.77	1.54	2.32	3.09	3.86	4.63	5.4	6.18	6.95	7.72	15.44	22.16	30.88	38.60
42" CSC	0.17	0.33	0.5	0.66	0.83	1	1.16	1.33	1.49	1.66	3.32	4.98	6.64	8.30
48" DI**	0.88	1.77	2.65	3.53	4.42	5.3	6.18	7.06	7.95	8.83	17.66	26.16	35.32	44.15
48" CSC	0.19	0.38	0.57	0.76	0.95	1.13	1.32	1.51	1.7	1.89	3.78	4.98	6.64	8.30
54" CSC	0.21	0.42	0.63	0.84	1.05	1.26	1.47	1.68	1.89					
60" CSC	0.24	0.48	0.72	0.96	1.2	1.44	1.68	1.92	2.16					

\* PVC pipe shall be tested to DI pressures. GPH for CSC Pipe are manufacturer's maximum.

\*\* DI pipe includes mechanical and push-on joints.

**San Antonio Water System Standard Specifications for Construction**

**TABLE 841-2**

**Hydrostatic Test Leakage Allowances (Maximum) @ 200 PSI**

Nominal Pipe Diameter	Allowable Leakage in Gallons Per Hour (GPH)*									
	100 L.F.	200 L.F.	300 L.F.	400 L.F.	500 L.F.	600 L.F.	700 L.F.	800 L.F.	900 L.F.	1000 L.F.
6" DI**	0.13	0.25	0.38	0.51	0.64	0.6	0.89	1.02	1.14	1.27
8" DI**	0.17	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.7
12" DI**	0.26	0.51	0.77	1.02	1.28	1.53	1.79	2.04	2.3	2.55
16" DI**	0.34	0.68	1.02	1.36	1.7	2.04	2.38	2.72	3.06	3.4
20" DI**	0.43	0.85	1.28	1.7	2.13	2.55	2.98	3.4	3.83	4.25
20" CSC	0.08	0.16	0.24	0.32	0.4	0.47	0.55	0.63	0.71	0.79
24" DI**	0.51	1.02	1.53	2.04	2.55	3.06	3.57	4.08	3.59	5.1
24" CSC	0.1	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.95
30" DI**	0.64	1.27	1.91	2.55	3.19	3.82	4.46	5.1	5.73	6.37
30" CSC	0.12	0.24	0.35	0.47	0.59	0.71	0.83	0.94	1.06	1.18
36" DI**	0.76	1.53	2.29	3.06	3.82	4.58	5.35	6.11	6.88	7.64
36" CSC	0.14	0.28	0.43	0.57	0.71	0.85	0.99	1.14	1.28	1.42
42" DI**	0.89	1.78	2.68	3.57	4.46	5.35	6.24	7.14	8.03	8.92
42" CSC	0.17	0.33	0.5	0.66	0.83	1	1.16	1.33	1.49	1.66
48" DI**	1.02	2.04	3.06	4.08	5.1	6.11	7.13	8.15	9.17	10.19
48" CSC	0.19	0.38	0.7	0.76	0.95	1.13	1.32	1.51	1.7	1.89
54" CSC	0.21	0.42	0.63	0.84	1.05	1.26	1.47	1.68	1.89	2.1
60" CSC	0.23	0.46	0.69	0.92	1.15	1.38	1.61	1.84	2.07	2.3

\* PVC pipe shall be tested to DI pressures. GPH for CSC pipe are manufacturer's maximum.

\*\* DI pipe includes mechanical and push-on joints.

- End of Specification -

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**ITEM NO. 848  
SANITARY SEWERS**

**848.1**      **DESCRIPTION:** This item shall govern the furnishing, installation, adjustment, or replacement of sanitary sewer pipe of the size and type specified in the contract documents.

**848.2**      **SUBMITTALS:** Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawings, and certifications.

All plans, materials and specifications shall be in accordance with the Texas Administrative Code (TAC) rules to include: 30 TAC § 213 ("Edwards Aquifer"), and 30 TAC § 217 ("Design Criteria for Sewerage Systems") or any revisions thereto as applicable.

**848.3**      **MATERIALS:** Materials for sanitary sewer pipe and fittings shall be either rigid or flexible. All pipe not listed shall be subject to pre-approval by the Engineer.

1.      Rigid Pipe: Ductile iron pipe shall, for the purpose of this specification, be known as rigid pipe.
2.      Flexible Pipe: Pipe consisting of materials other than those listed above.
  - a.      Any flexible pipe having a deflection of the inside diameter greater than 5% after 30 days of installation will not be accepted.

Unless directed otherwise by the Engineer, a "GO, NO-GO" Deflection Testing Mandrel built in accordance with the detail drawing, as shown in the DD-848 Standard Drawing Series, and 30 TAC § 217, shall be furnished at the Contractor's expense and shall be used in testing pipe deflection for acceptance. Refer to SAWS Specification Item No. 849, "Air and Deflection testing," for more information about mandrel deflection testing.

- b.      Working room: The working room for flexible pipe shall be a minimum of 6 inches.
- c.      Pipe Stiffness: All mains are to be SDR 26 PVC (ASTM D3034-08) with a pressure rating of 115 psi.
- d.      At waterline crossings and where water and sewer mains are

## San Antonio Water System Standard Specifications for Construction

parallel and separation distance cannot be achieved as per 30 TAC § 217.53, use extra stiff pipe SDR 26 PVC (ASTM D2241-09) with a pressure rating of 150 psi. This shall include all lateral piping as well.

e. All sanitary sewer piping shall pass the low pressure test, as described in 30 TAC § 217.57.

3. Concrete Pipe: Concrete pipe shall not be used.
4. Asbestos-Cement (AC) Pipe: AC pipe shall not be used. Refer to Item No. 3000, "Handling Asbestos Cement Pipe."
5. Fiberglass Reinforced Sewer Pipe, Non-Pressure Type: Fiberglass reinforced sewer pipe, non-pressure type, shall be a factory-formed conduit of polyester resin, continuous roving fiberglass and silica sand built up in laminates and shall conform to the requirements of ASTM D3262-11, including the appendix and subsequent specifications, and in accordance with SAWS' material specifications. Depths shall comply with requirement of ASTM D3681-12.

Coupling Joints: Joints for pipe and fittings shall be confined compression rubber gasket bell and spigot type joints conforming to the material and performance requirements of ASTM D4161-01. Depths shall comply with requirement of ASTM D3681-12.

Fittings: Flanges, elbows, reducers, tees, wyes, laterals, and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber reinforced overlays. For pipe diameters 15 inches or larger, lateral openings 6 inch or greater in size shall be made using PVC sewer saddles conforming to ASTM D2661-11 or service connections conforming to ASTM D3034-08, approved by the Engineer, and found in SAWS' Material Specifications.

Minimum pipe stiffness shall not be less than 115 psi for direct bury applications.

6. PSM Polyvinylchloride (PVC) Sewer Pipe: Pipe shall be made from class 12454-B materials as prescribed in ASTM D1784-11. For pipes 4 inches to 15 inches in diameter, fittings and joints shall conform to ASTM D3034-08 and D3212-07, with the exception that solvent cement joints

## *San Antonio Water System Standard Specifications for Construction*

shall not be used. All pipes that are 18 inches to 36 inches in diameter shall meet the requirements of ASTM F679-08.

7. Pressure Pipe/Force Mains: Pipe shall be made from Class 1254-A or 1254-B, as defined in ASTM D1784-11. All pipe, fittings, and joints shall meet or exceed the requirements of ASTM D2241-09, with the exception that solvent cement joints shall not be used. The pressure rating, size, and pressure class shall be as shown in the contract documents. Pipe shall have an integral bell and gasket seal with the locked-in type gasket reinforced with a steel band or other rigid material conforming to ASTM F477-10. The joint shall comply with the requirements of ASTM D3139-98(2011). All required joint restraint shall be approved by the Engineer prior to the work being accepted. Pressure pipe/Force mains are required to have modified grade 5 material used as bedding. Pipes also shall be hydrostatically tested at a minimum of 100 psi after their construction to ensure proper construction.
8. Mechanical or compression joints, concrete jointing collars, or non-reinforced rubber adaptors shall be used only as approved by the Engineer.
9. Ductile Iron Pipe and Fittings: Ductile iron pipe shall be centrifugally cast of 60-42-10 iron and shall conform to the requirements of the latest revision of ANSI Standard A21.51/American Water Works Association (AWWA) C151-09. Ductile iron pipe may be "thickness designed" in accordance with requirements of the latest revision of ANSI Standard A21.50/AWWA C150-08. Thickness design shall be based on standard laying conditions 4 or 5 in accordance with conditions at the site. Fittings for ductile iron pipe shall have not less than the thickness, class, or pressure rating specified for ductile iron pipe. Fittings shall be furnished with all necessary glands, gaskets, bolts, etc. as may be required to complete the joints.

Rubber gasket joints for mechanical joints or push on type joints shall conform to the requirements of ANSI Standard A21/AWWA C111-12.

All ductile iron pipe and fittings shall be cement mortar-lined or polyethylene-lined. The cement mortar lining shall be in accordance with ANSI A21.4/AWWA C104-08. Contractor shall also be required to protect the pipe by externally wrapping it in accordance with Item No. 814, "Ductile Iron Pipe."

The polyethylene lining material for pipe and fitting shall be virgin

## *San Antonio Water System Standard Specifications for Construction*

polyethylene complying with ANSI/ASTM D1248-12, compounded with inert filler and with sufficient carbon black to resist ultraviolet rays during storage of the pipe and fittings. The polyethylene shall be bonded to the interior of the pipe or fitting by heat. Polyethylene lining in pipe and in fittings shall be 40 mils nominal thickness. Minimum lining thickness shall be 30 mils.

10. Concrete Steel Cylinder Pipe: Concrete Steel Cylinder Pipe shall not be used.
11. All sanitary sewer pipe and fittings produced within the jurisdiction of SAWS shall be tested by a SAWS-approved laboratory method at the source of supply. All shipments of pipe not tested shall be accompanied by a certificate of compliance to these specifications prepared by an independent testing laboratory and signed by a Texas registered professional engineer.

### **848.4**

**CONSTRUCTION:** All sanitary sewer mains shall be constructed in accordance with the specifications herein outlined and in conformity with the required lines, grades, and details shown in the contract documents and as directed by the Engineer. Successful passage of the air test and mandrel test (for flexible pipe, 30 days after installation), as described under TCEQ criteria, shall be required for the acceptance of the mains.

1. Water Main Crossings: Where gravity or force main sewers are constructed in the vicinity of water mains, the requirements of the 30 TAC § 217.53 shall be met.
2. For excavation, trenching and backfill requirements see Item No. 804, "Excavation, Trenching and Backfill."
3. Pipe Installation: The Inspector will inspect all pipe before it is placed in the trench and will reject any sections found to be damaged or defective to a degree that would affect the structural integrity of the pipe. Rejected pipe shall be immediately removed from the site of the work and replaced with new acceptable pipe. The Contractor shall commence installation of the pipe at the downstream end of the sanitary sewer line and proceed non-stop in a forward upstream direction. No pipe shall be laid within 10 feet of any point where excavation is in progress. Pipe installation shall proceed upgrade with the bell pointing in the upstream direction of flow. Pipe shall be lowered into the trench without disturbing the prepared foundation or the trench sides. The drilling of lifting holes in the field will

## *San Antonio Water System Standard Specifications for Construction*

not be permitted. Pipe shall be installed by means of a concentric pressure being applied to the pipe with a mechanical pipe puller. Pulling or pushing a joint of pipe in place by using a crane, bulldozer, or backhoe will not be permitted. Pipe shall be “pulled home” in a straight line with all parts of the pipe on line and grade at all times. No side movement or up and down movement of the pipe will be permitted during or after the pulling operation. Should coupled joints of pipe be out of line or off grade, they shall be removed one joint at a time in the presence of the Inspector and brought to the proper line and grade. The lifting or moving of several joints of coupled pipe at one time to close a partially open joint or to fine grade under laid joints of pipe will not be permitted.

Also, Contractor shall insure that all existing or proposed manholes or structures shall remain visible and accessible at all times. No manhole or structure covers shall be covered by pavement, equipment, or other obstructions other than a removable, temporary lid provided for safety. Inspector shall cause all work to be suspended until this requirement is met without any valid claims of costs or schedule delays.

4. Pipe Separation: Sewer pipe separation distances shall be maintained in accordance with TCEQ rules 30 §217.53.
  - a. A sewer collection system that parallels a public water supply pipe must have a vertical separation of at least two feet between outside diameters of the pipes.
  - b. A sewer collection system that parallels a public water supply pipe must have a horizontal separation of at least four feet between outside diameters of the pipes.
  - c. A sewer system that crosses a public water supply pipe shall have a minimum separation distance of six inches between outside diameters of pipes. All sewer collection piping must be below a public water supply pipe.
  - d. A sewer collection system that crosses over a public water supply pipe shall be encased in a joint of at least 150 psi pressure class pipe.
    - (1) Pipe shall be centered on the crossing;
    - (2) Pipe shall be sealed at both ends with cement grout or



**San Antonio Water System Standard Specifications for Construction**

manufactured seal;

- (3) Pipe shall be at least 18 feet long;
- (4) Pipe casing shall be at least two nominal sizes larger than the wastewater collection pipe. Steel or PVC pipe may be used for casing of at least 150 psi pressure class.
- (5) Pipe shall be supported by spacers between the collection system pipe and the encasing pipe at a maximum of five-foot intervals.

5. **Laser Beams**: The use of laser beams for vertical control shall be required. Contractor shall also make available to the Inspector, when requested, a level and rod, of sufficient sensitivity, to accurately determine differences in elevation between points 300 feet apart with one instrument set-up. **Contractor shall provide a written summary to the Inspector of all elevations that all installed, repaired, or replaced sewer main enter and exit a manhole or structure.**

No pipe shall be installed in tunnels except as noted in the contract documents or by approval of the Engineer. If the Contractor finds it necessary to install pipe in tunnels not provided in the contract documents, he shall submit to the Engineer a detailed outline of procedures, methods, and use of materials depending on existing soil conditions. This information requires review and approval prior to the commencement of work.

No horizontal or vertical curves shall be permitted in conformance with appropriate regulatory agency requirements.

Before leaving the work unattended, the upper ends of all pipelines shall be securely closed with a tight fitting plug or closure. The interior of laid pipe shall be kept free from dirt, silt, gravel, or foreign material at all times. All pipes in place must be approved by the Inspector before backfilling.

When replacing an existing system in place, Contractor shall maintain screens to prevent the entrance of construction debris into the sewer system.

**848.5 MEASUREMENT:** All sewer pipes will be measured from center of manhole to

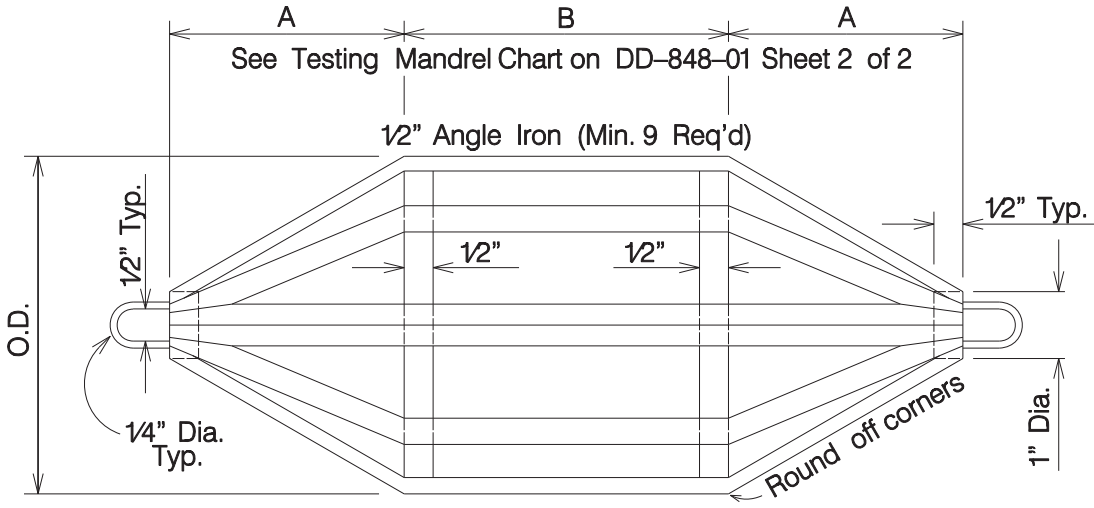
**San Antonio Water System Standard Specifications for Construction**

center of manhole or end of main. Measurement will be continuous through any fittings in the main, even though the fittings are pay items of the contract.

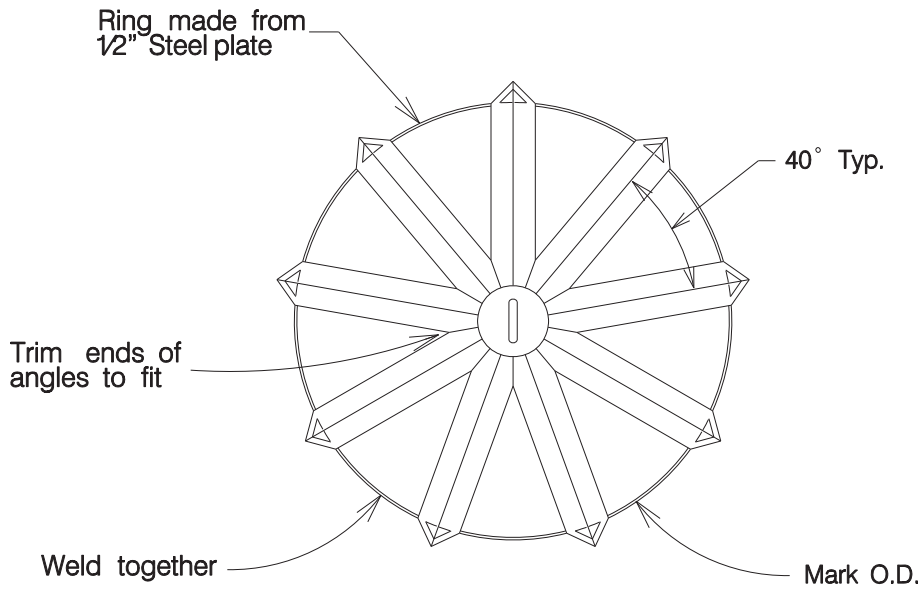
**848.6 PAYMENT:**

1. Sewer pipe will be paid for at the contract bid price per linear foot complete in place for the types, size and depth constructed. Said price shall be full compensation for furnishing all materials, including pipe, couplings, trenching, pumping, concrete, plugs, laying and jointing, backfilling, select bedding and initial backfill material, tamping, water, labor, tools, equipment, and other incidentals necessary to complete the work.
2. When the minimum separation distances for any water and sewer piping facilities cannot be maintained per 30 TAC §217.53, Contractor shall install SDR-26 PVC pipe (150 psi pressure rated). Payment for this higher pressure rated pipe shall be made the contract bid price per linear foot complete in place for the type, and size constructed.
3. Sewer pipe fittings, as part of the main line such as wyes and tees, are inclusive in the cost of Item No.854, (“Sanitary Sewer Laterals.”)
4. Pay cuts will be measured from the top of ground prior to the Contractor's operation and along the centerline of the pipe to the invert of the pipe.

- End of Specification -



SIDE OR TOP VIEW



END VIEW

Note:  
All mandrels must be approved by SAWS Construction Inspections and stamped before use.

PROPERTY OF <b>SAN ANTONIO WATER SYSTEM</b> SAN ANTONIO, TEXAS	<b>GO, NO GO DEFLECTION TESTING MANDREL</b>	APPROVED	REVISED
		March 2008	
		<b>DD-848-01</b>	SHEET <u>1</u> OF <u>2</u>

SIZE	A	B*	MANDREL O.D.	RING O.D.
			PVC (SDR-26)	PVC (SDR-26)
6"	4.0"	4.5"	5.50	4.79
8"	5.5"	6"	7.37	6.66
10"	7.0"	7.5"	9.21	8.50
12"	8.0"	9"	10.96	10.25
15"	10.0"	11"	13.42	12.71
18"	12.0"	13.5"	—	—
21"	14.0"	16"	—	—
24"	16.0"	18"	—	—
27"	18.0"	20"	—	—

\* Minimum Length

CHART

Notes:

PVC pipes and fittings 6" to 15" in diameter shall conform to ASTM D-3034-08.

PVC pipes and fittings 18" to 27" in diameter shall conform to ASTM F-679-08.

This information is provided as a reference. All deflection testing shall be done in accordance with TCEQ Chapter 217.

*San Antonio Water System Standard Specifications for Construction*

**ITEM NO. 852**  
**SANITARY SEWER MANHOLES**

**852.1 DESCRIPTION:** This item shall govern the construction of standard sanitary sewer manholes complete in place and the materials therein, including manhole rings and covers. All material and construction work shall be in accordance with current Texas Commission on Environmental Quality (TCEQ) rules to include: Design Criteria for Sewage Systems (30 TCEQ § 217). All constructed manholes shall be watertight. Manhole covers may be either watertight or water resistant, depending on their specific location. Every manhole cover located in an identified 100-year floodplain, or in the Edwards Aquifer Recharge Zone, shall be watertight. Sewer manhole ring and cover castings shall meet the current requirements of AASHTO Designation M306-10.

Unless otherwise shown in the contract documents or approved by the Engineer, standard sanitary sewer manholes shall be constructed with influent and effluent piping less than or equal to 24 inches in diameter with precast reinforced concrete manhole sections. A standard sanitary sewer manhole shall be a single entrance cylindrical structure, having a minimum internal diameter of 4 feet between the cone and base sections. The base of the structure shall include the load bearing portion beneath and exterior of the structure, invert channels and the fill or bench portions adjacent to the lower sewer pipes within the structure. The maximum vertical height of the diameter adjustment section or cone shall be 36 inches. Adjustment or throat rings may be used for final elevation adjustment of the manhole ring and cover. Concrete encasement of the manhole's ring shall be as shown in the DD-852 Standard Drawing Series. Specifically, they shall attach the ring and cover to the diameter adjustment section or cone. Manholes which differ from the above description shall be governed by Item No. 850, "Sanitary Sewer Structures."

An internal drop manhole shall be required, when sewer lines enter a manhole more than 24 inches above the manhole invert, while an external drop manhole shall be provided for a sewer entering a manhole more than 30 inches above the invert. Both conditions will require prior approval by the Engineer.

**852.2 SUBMITTALS:** Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawings, and certifications.

**852.3 MATERIALS:**

## *San Antonio Water System Standard Specifications for Construction*

1. Precast Reinforced Concrete Manhole Sections: Precast reinforced concrete manhole sections shall conform to the requirements of ASTM Designation C478-12a.
2. Mortar: Mortar shall be composed of 1 part Portland Cement, 2 parts sand and sufficient water to produce a workable mixture. When used to plaster manholes, it may be composed of 1 part cement to 3 parts sand. Lime up to 10% may be used.
3. Manhole Ring and Cover: The standard manhole ring and cover shall be ductile iron and manufactured to the dimensions shown herein. The ring and cover shall be hinged. Lifting slots cast into the covers shall be provided for lifting purposes. A water-resistant (cam lock) ring and cover shall be used in areas of minimal infiltration potential to allow venting. A watertight (bolt down) ring and cover must be used in areas of high infiltration potential, such as in the Edward's Aquifer Recharge Zone, an identified 100-year floodplain, or as otherwise directed by the Engineer. The nominal cover diameter shall be 32 inches, with a 30 inch clear opening, as required by TCEQ. Rings shall have a minimum of four 1 inch holes/slots for anchoring purposes. Rings shall be a minimum of 4-1/2 inches in height, or as otherwise accepted by the Engineer. Slots for embedment/lightening are not allowed in ring flanges.
  - a. Water-resistant Rings and Covers: Rings and covers shall have two hinges for added stability. The hinge shall have a drain to allow for proper debris and foreign object removal. Prior to acceptance of the work, a stainless steel keyed "cam" lock shall be provided by the Contractor to the Inspector. When the key is inserted in the cam, it shall remain in the lid while the cam is in the open (unlocked) position. When in the closed (locked) position, the key can be removed. When not in use, the cam lock key hole shall be covered with a plastic plug to prevent infiltration of debris. The cover shall positively lock at 90° to prevent accidental closure and open fully to 120°. The cover shall also include a single multi-tool lifting slot adjacent to the edge of the cover to facilitate opening/lifting/prying once it is unlocked. Covers shall be provided with a continuous vulcanized (one piece) EPDM gasket with a shore durometer of 70 ±5 permanently attached to the cover.
  - b. Watertight Rings and Covers: Rings and covers shall be the same as above for water-resistant version, except the covers shall be bolted to the ring instead of secured with the cam lock mechanism.

## San Antonio Water System Standard Specifications for Construction

No vent hole(s) shall be provided. A minimum of four 1/2 inch diameter, stainless steel, hex head bolts shall be provided for each cover. The 4 bolt holes in the covers shall be evenly spaced and provided with a minimum 1-1/2 inch diameter counter sink for the bolt heads. On the fastened and bolted position, the bolt heads shall not extend above the surface or the cover. Washers of a size and material as approved by the Engineer shall be provided for the bolts to insure air and water tightness.

The finished ring and cover shall have the bearing surfaces machined ground and sets of rings and covers shall be marked in such a way that they can be matched for assembly in the field. All covers shall have the words "SAN ANTONIO WATER SYSTEM Sanitary Sewer" cast thereon. Ring and cover shall have the approved foundry's name, part number, country of origin preceded by "Made in" (example: MADE IN USA) in compliance with the country of origin law of 1984, and production date (example: mm/dd/yy) for tracking purposes. Each casting must be marked with DI and ASTM A536 or A536 80-55-06 to verify the materials used. Castings without proper markings shall be rejected.

4. Throat Rings: Throat rings shall be made of either HDPE or reinforced concrete and have a maximum thickness of 2 inches. The internal diameter shall match that of the ring and cover's opening. Concrete shall conform to the provisions of Item No. 300 "Concrete (Natural Aggregate)." If concrete throat rings are to be utilized, they must be used in conjunction with a UV stabilized polyethylene liner. I/I barrier must meet the following ASTM standards: ASTM D790/1505 Density of Polyethylene Materials, ASTM D1238-10 Melt Flow index, ASTM 638-10 Tensile Strength @ Yield (50mm/mm), ASTM 790-10 Flexural Modulus, ASTM 648-07 Heat Deflection Temperature @IGEPAL, ASTM 1693-12 EsCR, 100% IGEPAL/10% IGEPAL. A minimum of two and a maximum of four throat rings may be used at each manhole installed.
5. Coating: All manholes shall be watertight and coated with a SAWS-approved sewer coating. Prior to coating, all manholes shall be vacuum tested, and approved.

For existing and rehabilitated manholes, apply a combination of both products with the cementitious coating first, followed by the epoxy coating. Kerneos SewperCoat 2000 HR regular, applied at the required one inch thick application, is the only product approved which does not require a subsequent epoxy coating. New manholes installed do not

**San Antonio Water System Standard Specifications for Construction**

require the cementitious coating. Other approved materials are as follows:

- a. Cementitious coating: With required one inch thick application:
  - (1) Permaform CR-5000;
  - (2) Strong - Seal MS-2C;
  - (3) Standard Cement Material Inc. Reliner;
  - (4) Quadex Aluminaliner;
  - (5) ConShield Biotech Armor.
  
- b. Epoxy coating: With specified thickness application:
  - (1) Raven 405 Series High Build Epoxy Liner: Required thickness – 125 mils;
  - (2) Spray Wall polyurethane System: Required thickness – 125 mils;
  - (3) Carboline “Plasite 4500” System: Required thickness – 125 mils.

**852.4 CONSTRUCTION:** Manholes shall be constructed of materials and workmanship as prescribed by these specifications, at such places shown in the contract documents or as designated by the Engineer, and in conformity with the typical details and sketches shown.

- 1. Footings or bases of manholes shall be a minimum of 6 inches in depth below the bottom of the pipe.
  
- 2. All invert channels shall be constructed and shaped accurately so as to be smooth, uniform and cause minimum resistance to flow. The bench shall be finished smooth with a slope of ½ inch per foot from the manhole walls to the edges of the invert. The top half of all sewer pipes within the invert channel or bench zone shall be removed flush to the inside manhole walls.
  
- 3. Joints on sewer pipes shall not be cast or constructed within the wall sections of manholes.



**San Antonio Water System Standard Specifications for Construction**

4. Concrete cradles shall be required for new pre-cast manholes. Concrete cradles shall extend beyond the outside walls of the manhole a minimum of 36 inches.
5. Voids between exterior pipe walls and manhole walls at all pipe connections in manholes shall be filled with a non-shrink grout, concrete or mortar, as approved by the Engineer or as shown in the contract documents and inspected prior to backfilling.
6. Where connections to existing manholes are required, the adjacent pipe bedding shall be prepared to proper grade, the existing manhole neatly cut and the new pipe inserted so that the end is projecting 2 inches from the inside wall. The invert shall then be reshaped to properly channel new flows. Debris of any kind shall be kept out of new or existing manholes or mains.
7. Throat rings shall be mortared between all bearing surfaces sufficient to provide a minimum, in place, mortar thickness of  $\frac{1}{4}$  inch. No more than 4 throat rings may be used on any new manhole or no more than 21 inches from the top of the cone to the top of the ring and cover.
8. Manhole Ring Encasement: All manhole rings shall be encased with 4,000 psi reinforced concrete as shown in the contract documents or as approved by the Engineer.
  - a. Concrete manhole ring encasement shall extend 6 inches below the top of the cone and have a minimum width when measured at the manhole ring of 1 foot. The surface of the encasement shall be flush with the top of the manhole ring.
  - b. Where manholes are constructed in existing streets and where directed by the Engineer or shown in the contract documents, the exterior exposed surfaces of the ring, mortar; throat rings and manhole surface shall be coated with a  $\frac{1}{8}$  inch minimum thickness of mastic or plastic prior to placement of concrete.

**852.5 TESTING:** The Contractor shall perform the testing for all sanitary sewer manholes in accordance with the following.

1. Leakage Testing: All manholes must pass a leakage test. The contractor shall test each manhole (after assembly and backfilling) for leakage, separate and independent of all other sanitary sewer piping, by means of

## *San Antonio Water System Standard Specifications for Construction*

either a hydrostatic test, vacuum test, or other methods approved by the Engineer. The Contractor is hereby instructed to conduct either of the two identified tests in the following manner:

- a. **Hydrostatic Testing:** Hydrostatic testing shall be conducted by utilizing approved plugs to seal all influent and effluent pipes in the manhole and filling the manhole to the top of the cone with water. Additional water may be added over a 24-hour period to compensate for absorption and evaporation losses. At the conclusion of the 24-hour saturation period, the manhole shall be filled to the top and observed. Any measureable loss within a 30 minute period shall be considered an unsuccessful test and thus require the Contractor to assess the needed repairs, perform such repairs (subject to the approval of the Engineer), and notify the Inspector when the retest will be performed. All effort, materials, or other costs shall be solely at the Contractor's expense.
- b. **Vacuum Testing:**
  - (1) **General:** Manholes shall be tested after construction/installation and backfilling with all connections (existing and/or proposed) in place. Drop-connections and gas sealing connections shall be installed prior to testing.
  - (2) **Test Procedure:** The lines entering the manhole shall be temporarily plugged with the plugs braced to prevent them from being drawn into the manhole. The plugs shall be installed in the lines beyond drop connections, gas sealing connections, etc. Prior to performing the test, the Contractor shall plug all lift holes and exterior joints with a non-shrink grout and plug all pipes entering the manhole. No grout shall be placed in horizontal joints prior to testing. Contractor shall use a minimum 60 inch/lb torque wrench to tighten the external clamps that secure the test cover to the top of the manhole. The test head shall be inflated in accordance with the manufacturer's recommendations. A vacuum of 10 inches of mercury shall be drawn, and the vacuum pump will be turned off. With the valve closed, the level vacuum shall be read after the required test time. If the drop in the level is less than 1 inch of mercury (final vacuum greater than 9 inches of mercury), the manhole

**San Antonio Water System Standard Specifications for Construction**

will have passed the vacuum test. The required test time is 2 minutes.

- (3) Acceptance: Manholes will be accepted with relation to vacuum test requirements, if they meet the criteria above. Any manhole which fails the initial test must be repaired with a non-shrink grout or other suitable material based on the material of which the manhole is constructed. The manhole shall be retested as described above until a successful test is attained. After a successful test, the temporary plugs will be removed. To ensure that the plugs have been removed, Contractor shall only do so in the presence of the Inspector.
  - (4) Repairs to Existing Manholes: Any existing manhole which fails to pass the vacuum test shall be closely examined by the Inspector and the Contractor to determine if the manhole can be repaired. Thereafter, the Contractor shall either repair or remove and replace the manhole as directed. The manhole shall then be retested and coated with a SAWS-approved sewer coating as stated above. The Owner may elect to simply remove and replace the existing manhole with a new one. Any manhole excavated for repairs or excavated for tie in, shall be backfilled with flowable fill up to 1 foot below the top of the cone. The Contractor also has the option of backfilling with approved secondary materials, subject to the provisions of Item No. 804, "Excavation, Trenching and Backfill."
  - (5) Measurement and Payment: Vacuum testing of new structures will not be a pay item. The cost of this work will be included in the bid price for the new manhole. Each vacuum test of an existing manhole shall be a separate pay item. Repairs to existing manholes shall be a separate pay item when authorized.
2. Holiday Testing: Inspect each sanitary sewer manhole using high-voltage holiday detection equipment. All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper, or other hand tooling method. After abrading and cleaning, additional protective coating material shall be applied to the repair area. All touch-up repair procedures shall follow the protective coating manufacturer's recommendations.

**San Antonio Water System Standard Specifications for Construction**

If a sanitary sewer manhole fails to pass one of the above tests, it shall be repaired in accordance with the manufacturer's recommendations and re-tested. It shall not be accepted until it passes all tests. All repairs and re-testing shall be at no additional cost to SAWS.

**852.6 MEASUREMENT:**

1. All manholes zero feet to 6 feet deep and designated in the contract documents will be measured as the total number of such manholes constructed, including those exceeding 6 feet in depth from the lowest invert elevation to the top of the ring.
2. Manholes deeper than 6 feet shall be measured by the number of vertical feet in excess of 6 feet.

**852.7 PAYMENT:**

1. All manholes shall be paid at the contract unit price bid for each such manhole, which price shall be full compensation for all precast sections or throat rings, UV stabilized polyethylene liner, cones, bases, rings and covers, manhole ring encasement, concrete, flowable fill, mortar, drop pipes and fittings, labor, tools, equipment, testing, tees, wyes, and incidentals necessary to complete the work.
2. Extra depth manholes shall be paid for at the contract unit price bid per vertical foot as measured above.
3. Concrete cradles for pipes shall be measured and paid for at the contract unit price bid as provided for in Item No. 858, "Concrete Encasement, Cradles, Saddles and Collars."
4. Gravel subgrade filler for manholes shall not be measured separately for payment.

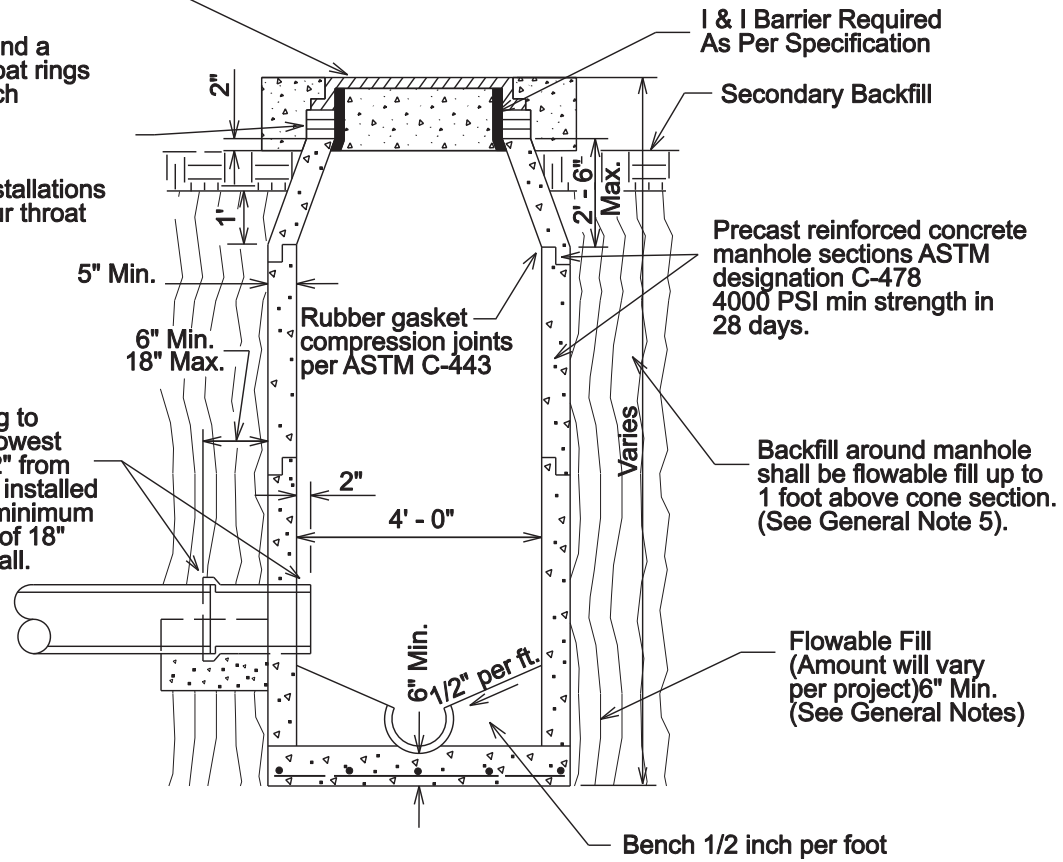
- End of Specification -

Manhole Ring and Cover  
(See DD-852-02)

Adjusted:  
A minimum of two and a maximum of six throat rings shall be used at each adjusted manhole.

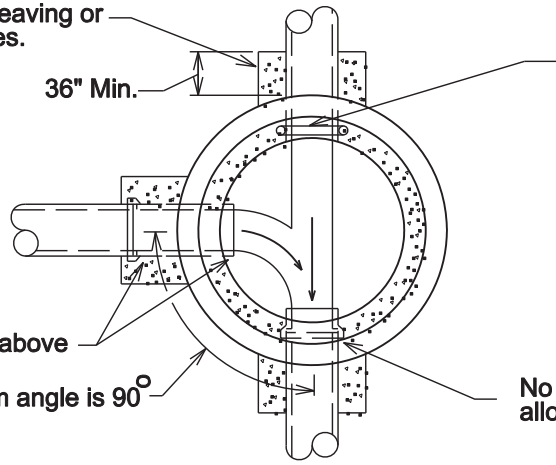
New:  
All new manhole installations shall not exceed four throat rings.

Note "A"  
Sewer pipe connecting to manholes above the lowest sewer shall protrude 2" from the inside wall and be installed with a joint located a minimum of 6" and a maximum of 18" from outer manhole wall.



**PRECAST MANHOLE**

Concrete Cradle to nearest point of all lines leaving or entering manholes.



If PVC pipe is used, provide rubber gaskets one size smaller than pipe at each wall crossing of manhole.

**MANHOLE FLOOR PLAN**

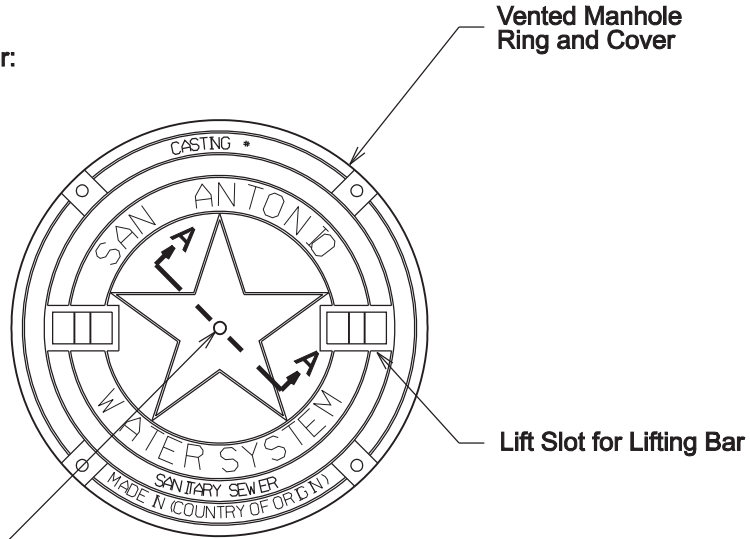
**General Notes:**

- 1) Material for sanitary sewer pipe must be the same from manhole to manhole. Changes in type of pipe may be made only at manholes, or special structures, except as approved by the SAWS inspector.
- 2) Adaptors and Concrete Collars shall be used as directed and approved by the SAWS inspector.
- 3) Watertight manhole rings and covers shall be Trans-Tex A77 "O" Ring or approved equal.
- 4) The minimum angle of flow for a connecting sewer to the direction of flow defined by a collection system is 90 degrees, unless approved by the engineer.
- 5) Contractor can opt to backfill with approved secondary material, subject to provisions of item 304.5.2.C.

PROPERTY OF <b>SAN ANTONIO WATER SYSTEM</b> SAN ANTONIO, TEXAS	<b>STANDARD          PRECAST MANHOLE</b>	APPROVED	REVISED
		MARCH 2008	APRIL 2014
		<b>DD-852-01</b>	

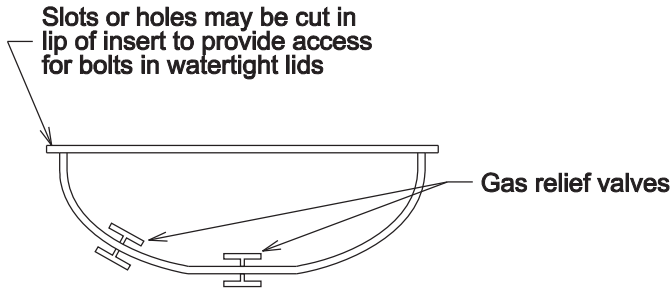
Note:  
Standard Manhole Ring and Cover:  
All applicable dimensions shall  
conform to the dimensions shown  
here

Note:  
The bearing surfaces and  
O-Ring groove shall be  
Machine ground

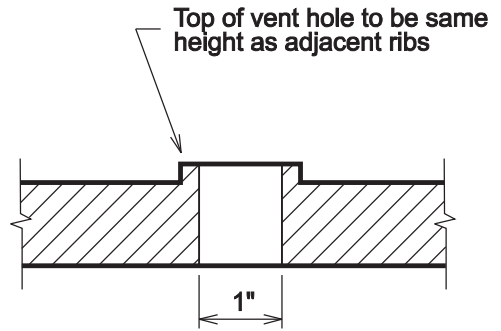


1" Dia. Cast Hole

**VENTED MANHOLE RING AND COVER**



**WATERTIGHT MANHOLE  
INSERT DETAIL**



**VENT HOLE DETAIL  
SECTION A-A**

Manhole cover inserts shall be installed in strict accordance with the manufacturer's recommendations. The contractor shall be responsible for making the necessary field measurements for the manufacturer prior to production.

PROPERTY OF  
**SAN ANTONIO WATER SYSTEM**  
SAN ANTONIO, TEXAS

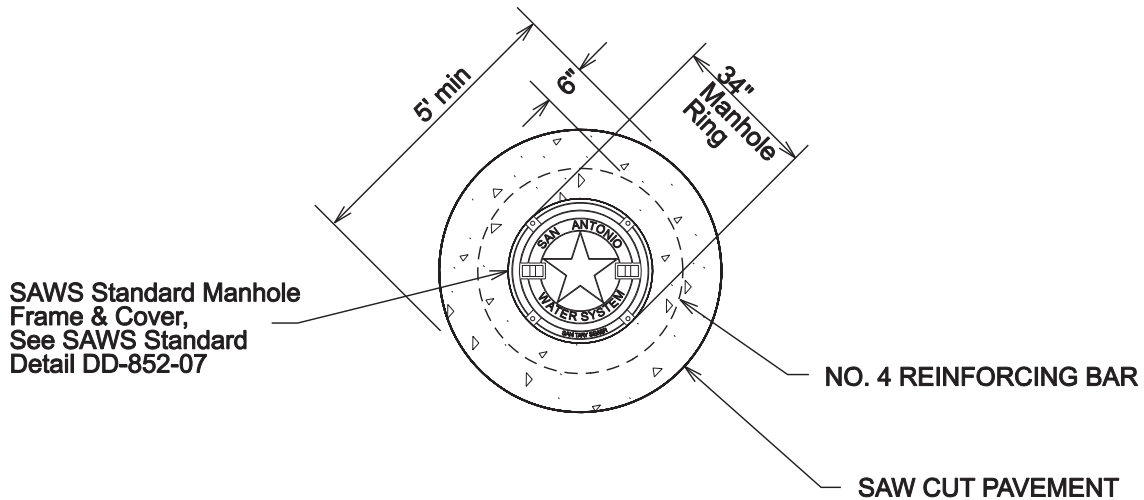
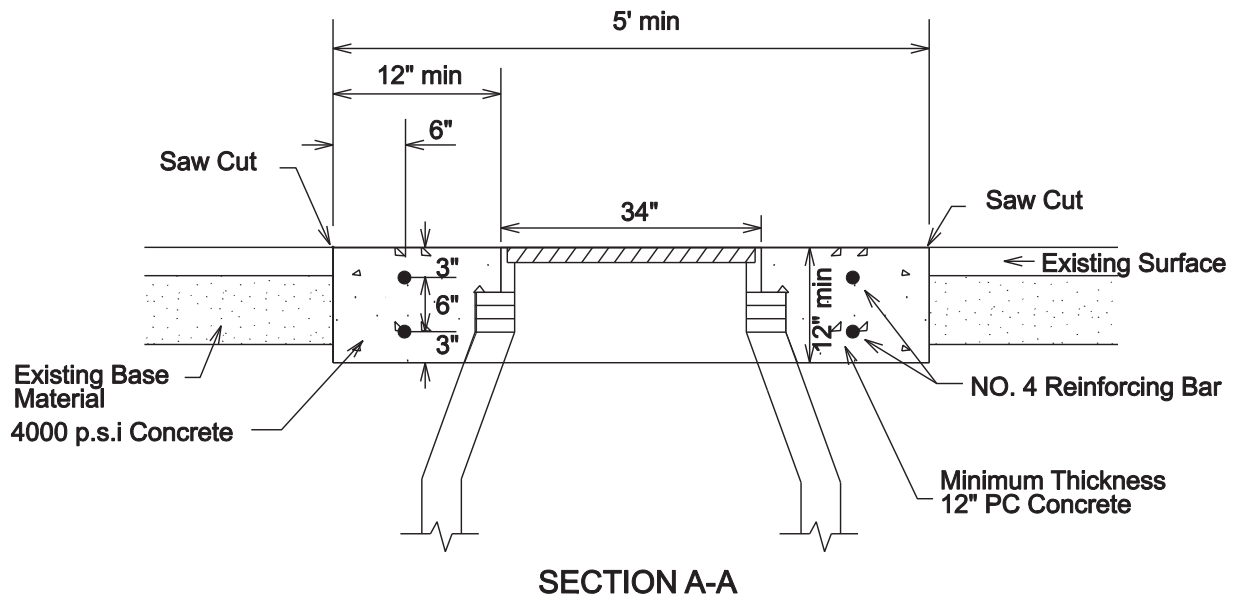
**VENTED MANHOLE RING  
AND COVER DETAIL  
(WHEN SPECIFIED)**

APPROVED  
JANUARY 2005

REVISED  
APRIL 2014

**DD-852-02**

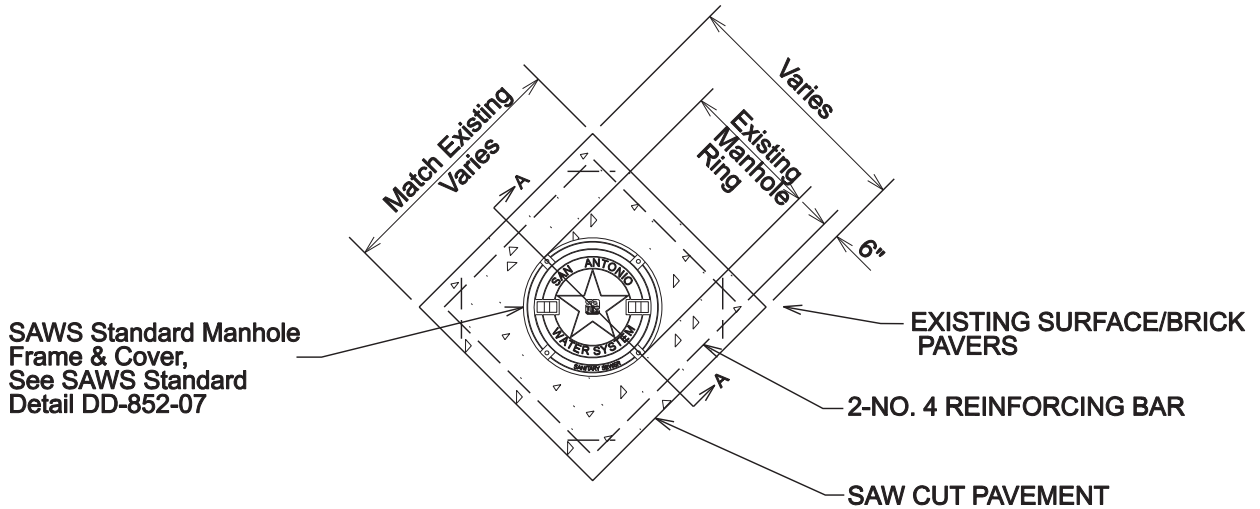
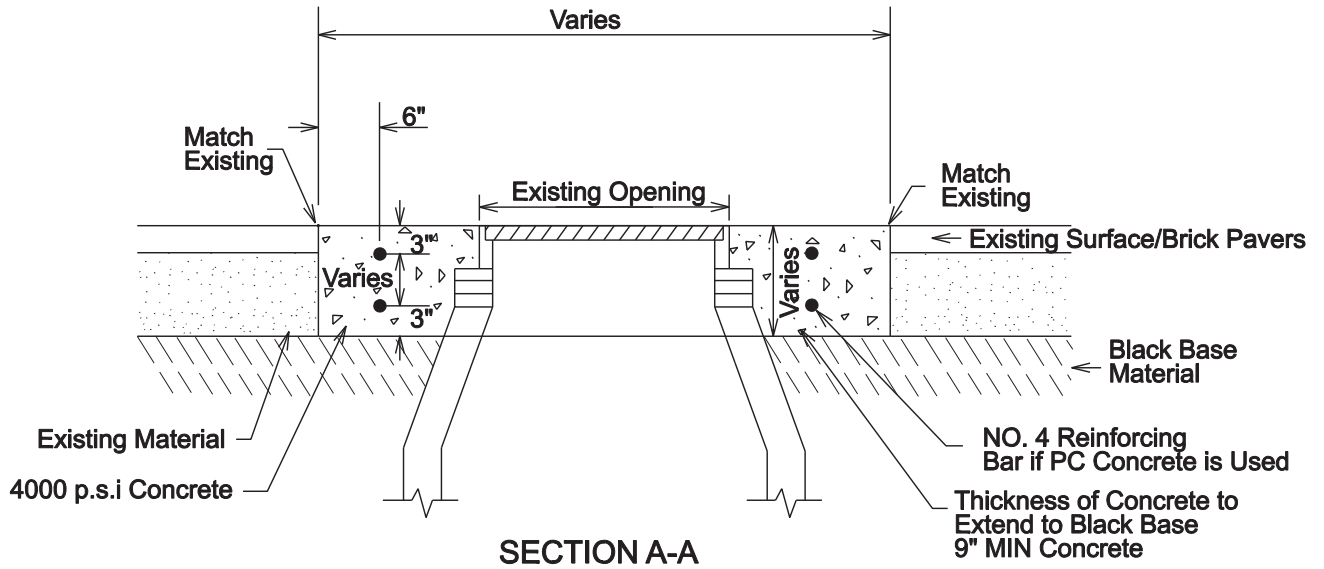
SHEET  
**1 OF 1**



**NOTE:**

1. The concrete shall be 4000 psi, min, and reinforced with No. 4 bars, as shown.
2. The concrete shall extend to edge of saw cut pavement.
3. Manhole Ring Encasement is required on all manholes.

PROPERTY OF <b>SAN ANTONIO WATER SYSTEM</b> SAN ANTONIO, TEXAS	<b>MANHOLE RING          ENCASEMENT DETAIL</b>	APPROVED	REVISED
		AUGUST 2009	APRIL 2014
		<b>DD-852-03</b>	
		SHEET <b>1</b> OF <b>2</b>	

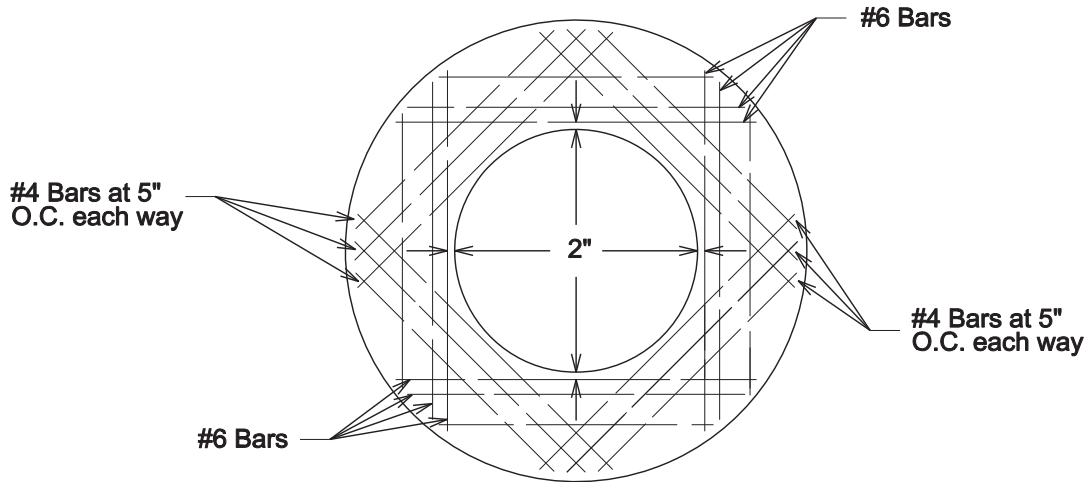


**NOTE:**

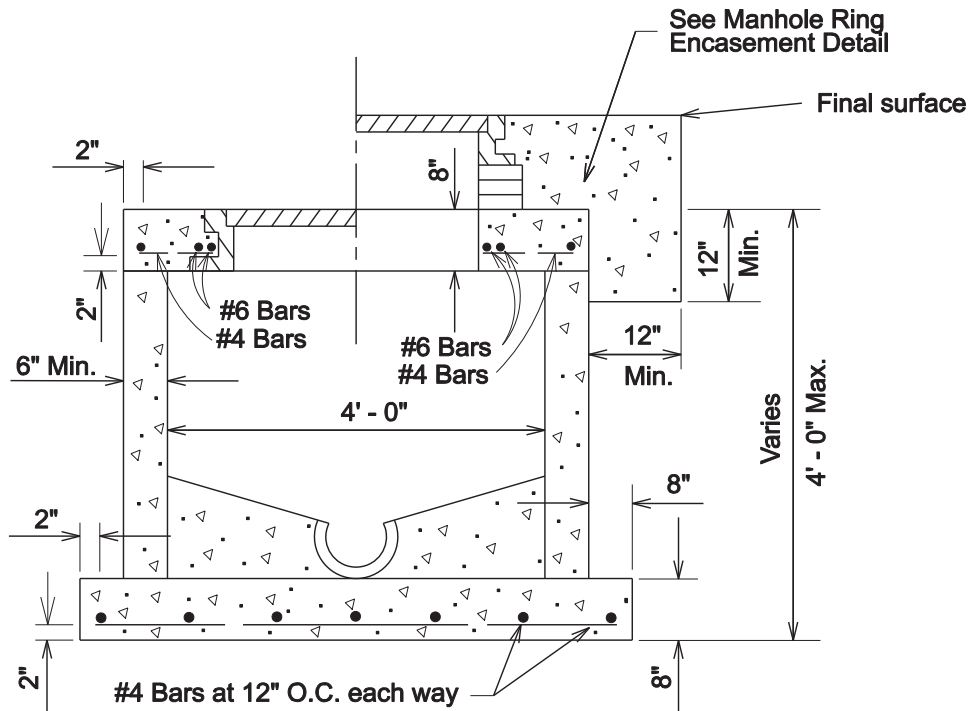
1. The concrete shall be 4000 psi, min, and reinforced with 2-No. 4 bars, as shown.
2. The concrete shall extend to edge of saw cut pavement.
3. Manhole Ring Encasement is required on all manholes.

PROPERTY OF <b>SAN ANTONIO WATER SYSTEM</b> SAN ANTONIO, TEXAS	<b>MANHOLE RING          ENCASUREMENT DETAIL          (DOWNTOWN LOCATIONS ONLY)</b>	APPROVED	REVISED
		DRAFT	MAY 2013
		<b>DD-852-03</b>	
		SHEET <b>2</b> OF <b>2</b>	

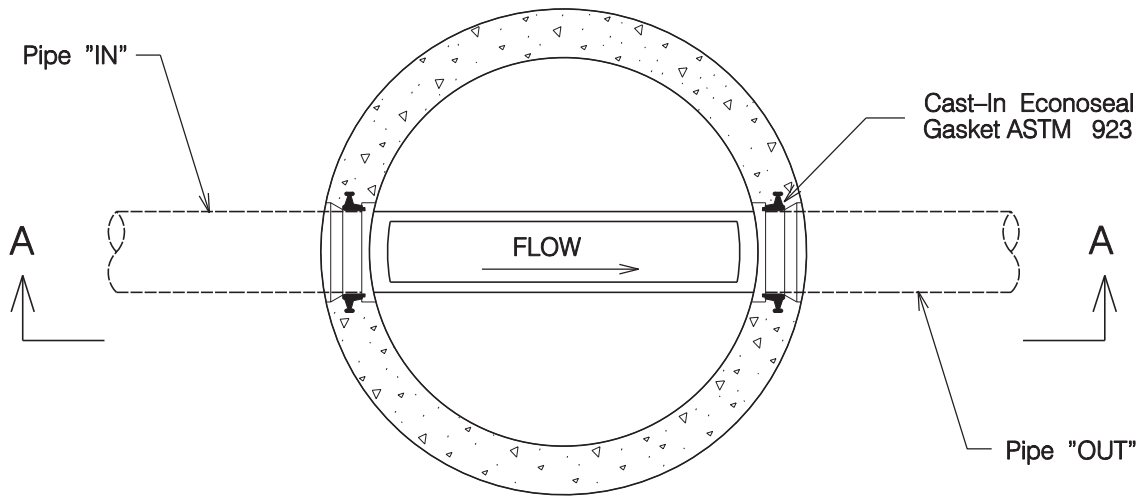




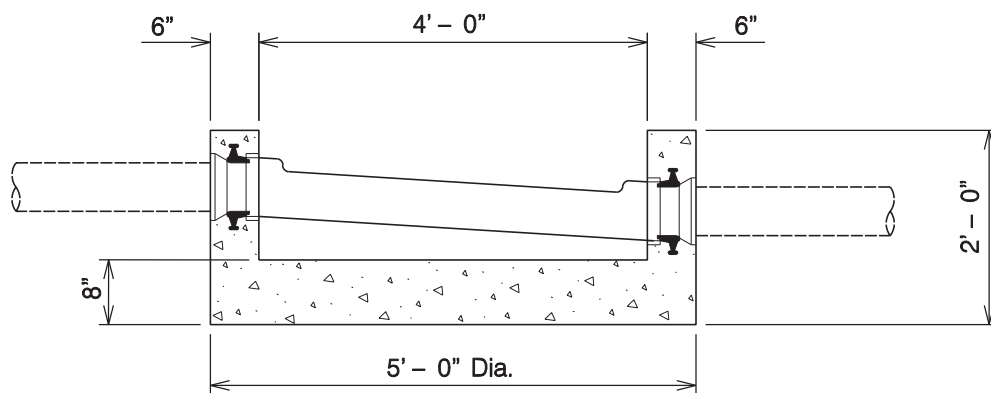
**TOP SLAB**



**SHALLOW PRECAST MANHOLE**



PLAN



SECTION A-A

PROPERTY OF  
**SAN ANTONIO WATER SYSTEM**  
 SAN ANTONIO, TEXAS

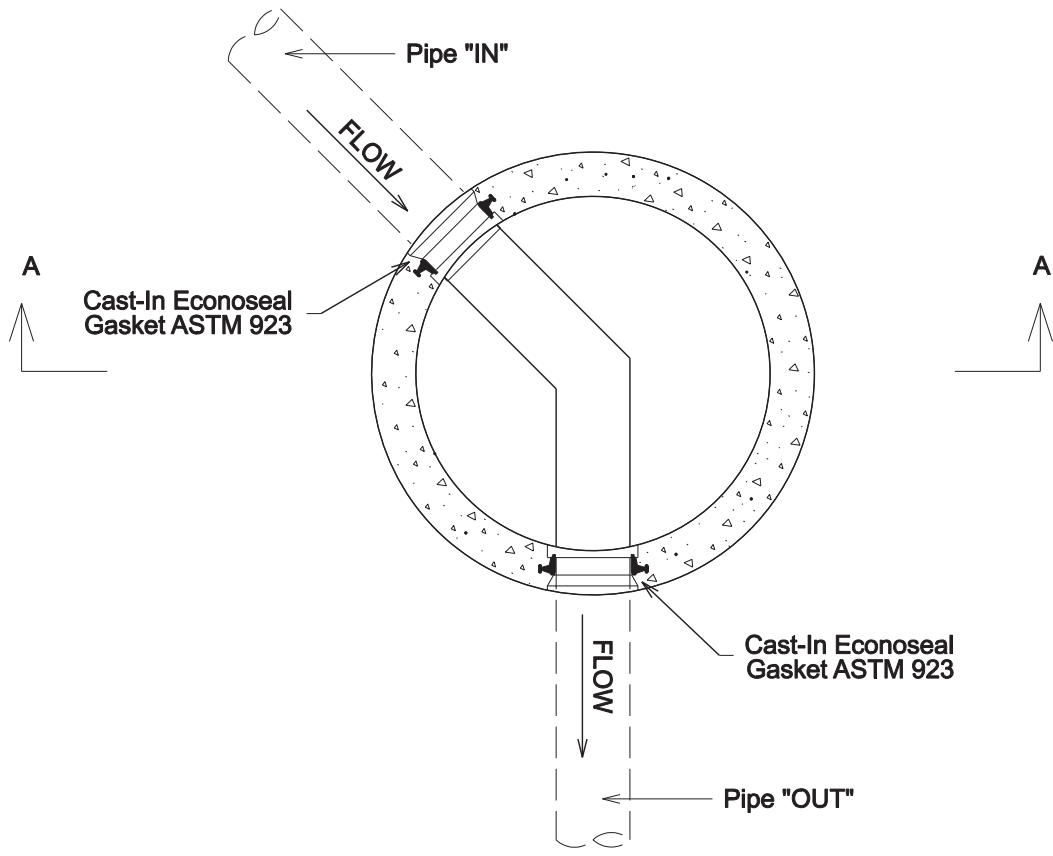
**PRECAST MANHOLE BASE  
 STRAIGHT THROUGH**

APPROVED  
 March 2008

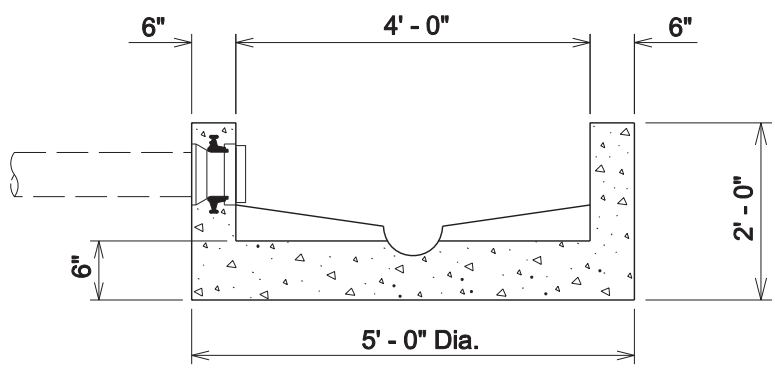
REVISED

**DD-852-05**

SHEET  
 1 OF 1



**PLAN**



**SECTION A-A**

PROPERTY OF  
**SAN ANTONIO WATER SYSTEM**  
 SAN ANTONIO, TEXAS

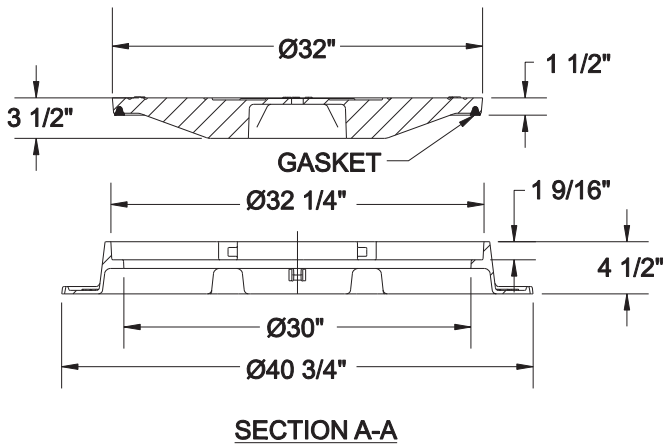
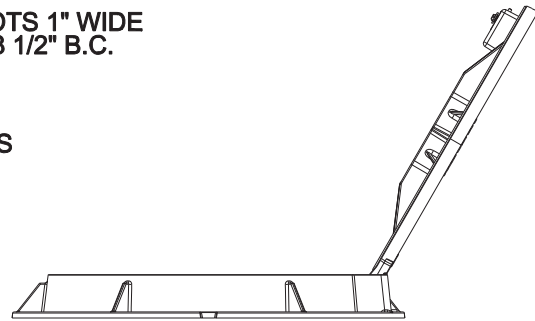
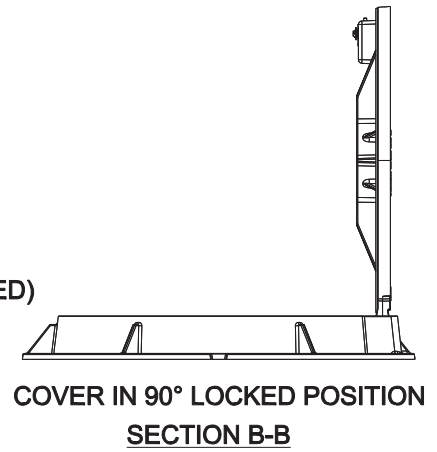
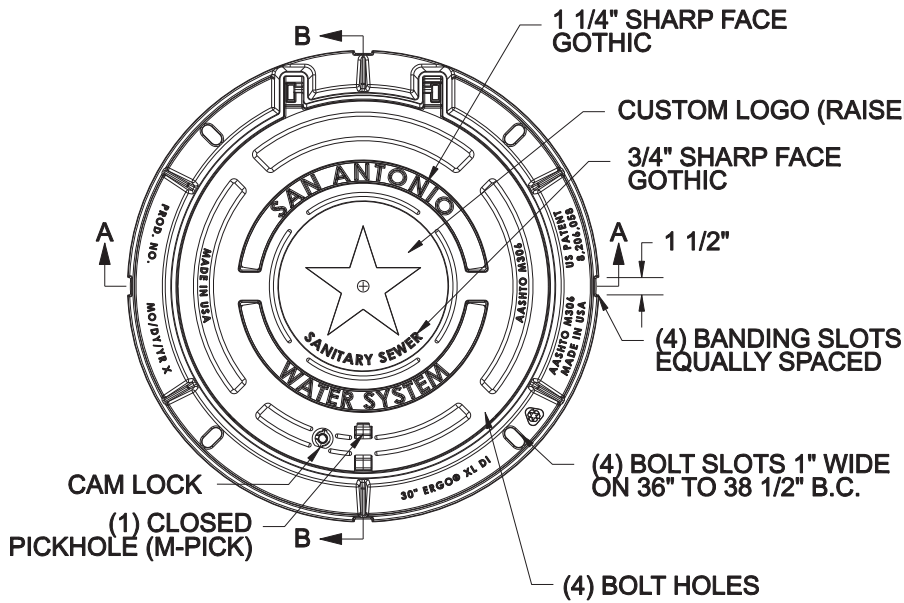
**PRECAST MANHOLE BASE**  
 45° ANGLE

APPROVED  
 MARCH 2008

REVISED  
 APRIL 2014

**DD-852-06**

SHEET  
 1 OF 1



PRODUCT NUMBER  
41421075L01  
DESIGN FEATURES

MATERIALS:  
COVER: DUCTILE IRON (80-55-06)  
FRAME: DUCTILE IRON (80-55-06)

PROPERTY OF  
SAN ANTONIO WATER SYSTEM  
SAN ANTONIO, TEXAS

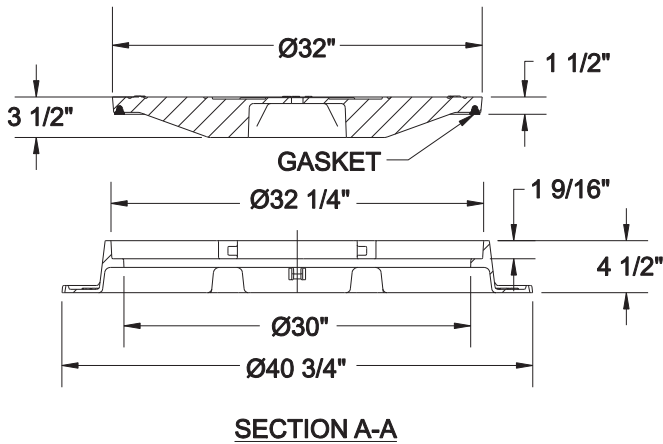
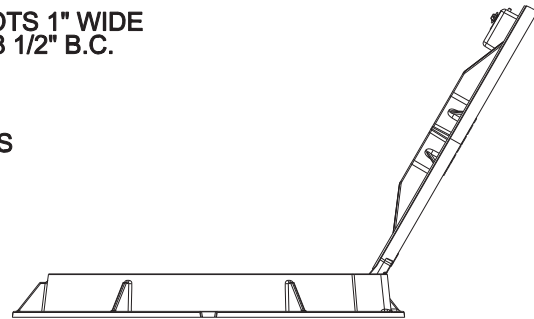
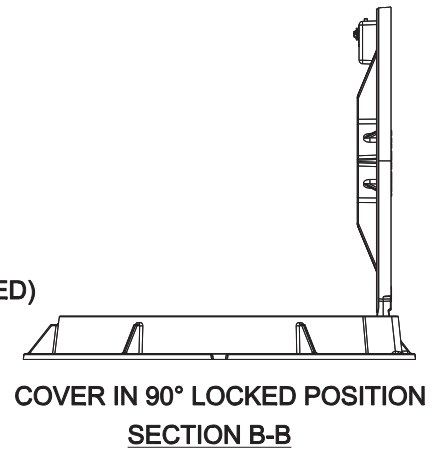
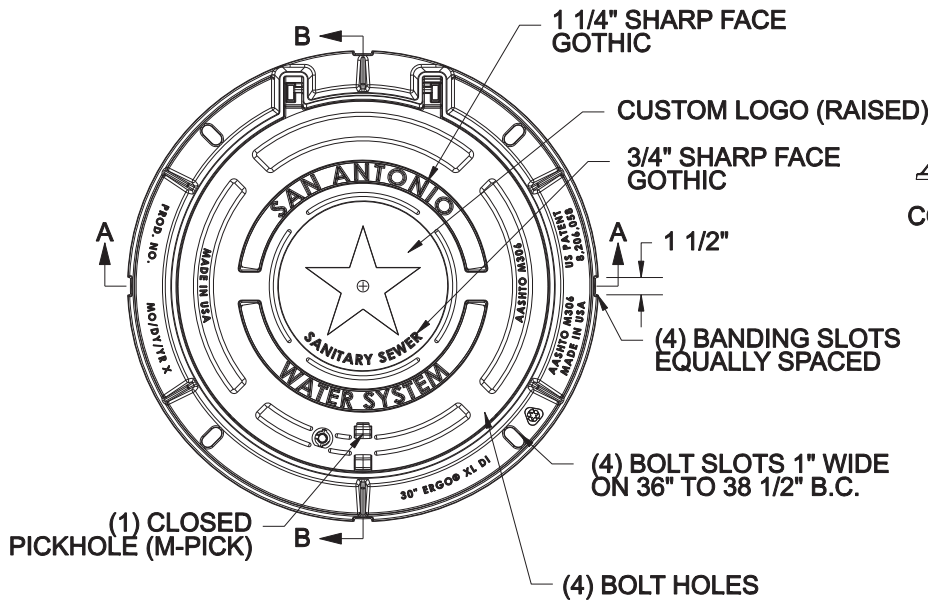
WATER RESISTANT MANHOLE  
RING & COVER DETAIL

APPROVED  
APRIL 2014

REVISED

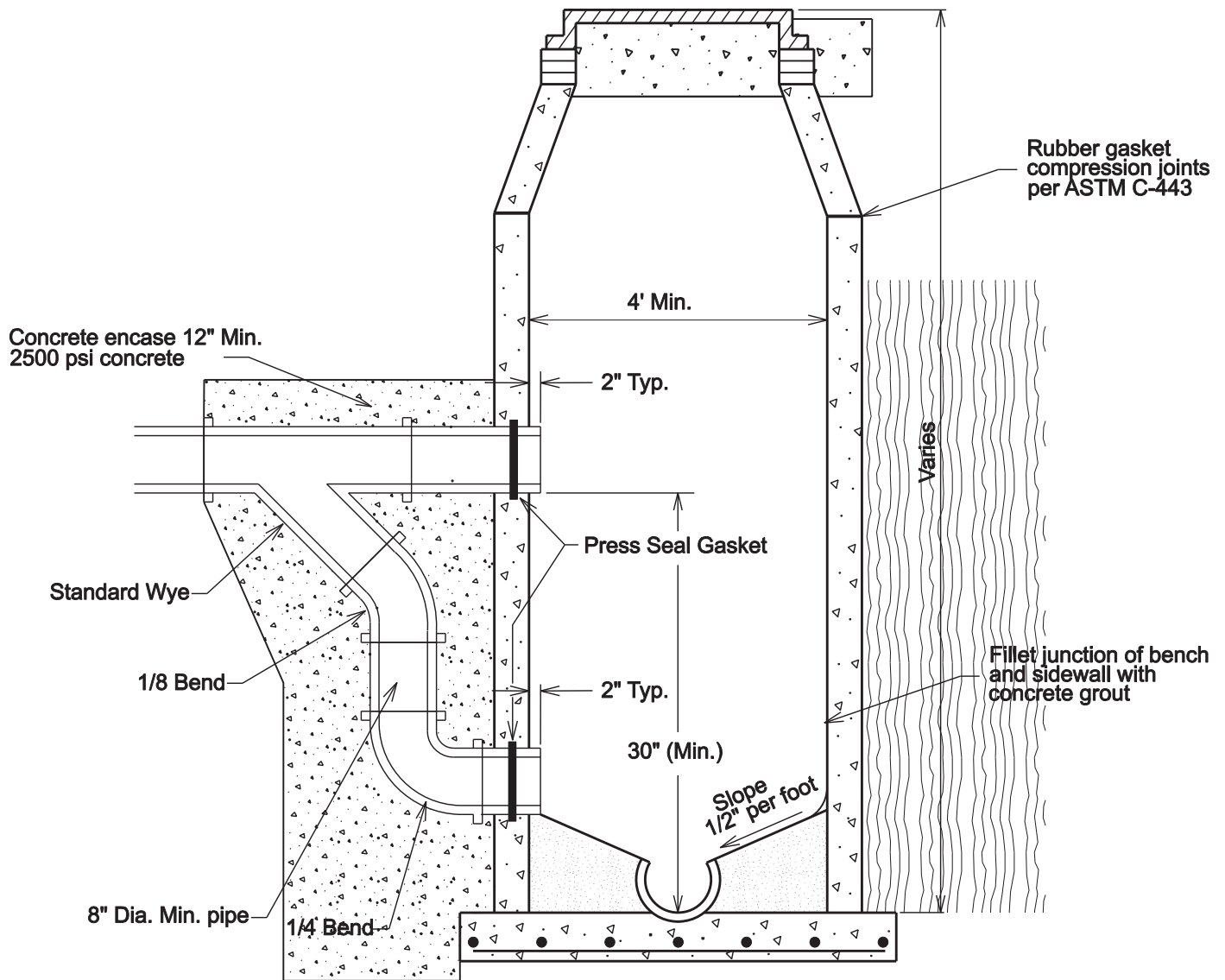
DD-852-07

SHEET  
1 OF 2



REMOVE LIFT ASSIST BOLT & REMOVE COVER @ 90°  
SECTION B-B





Note:  
Price for drop fittings and encasement to be included with the price of manhole.

PROPERTY OF  
SAN ANTONIO WATER SYSTEM  
SAN ANTONIO, TEXAS

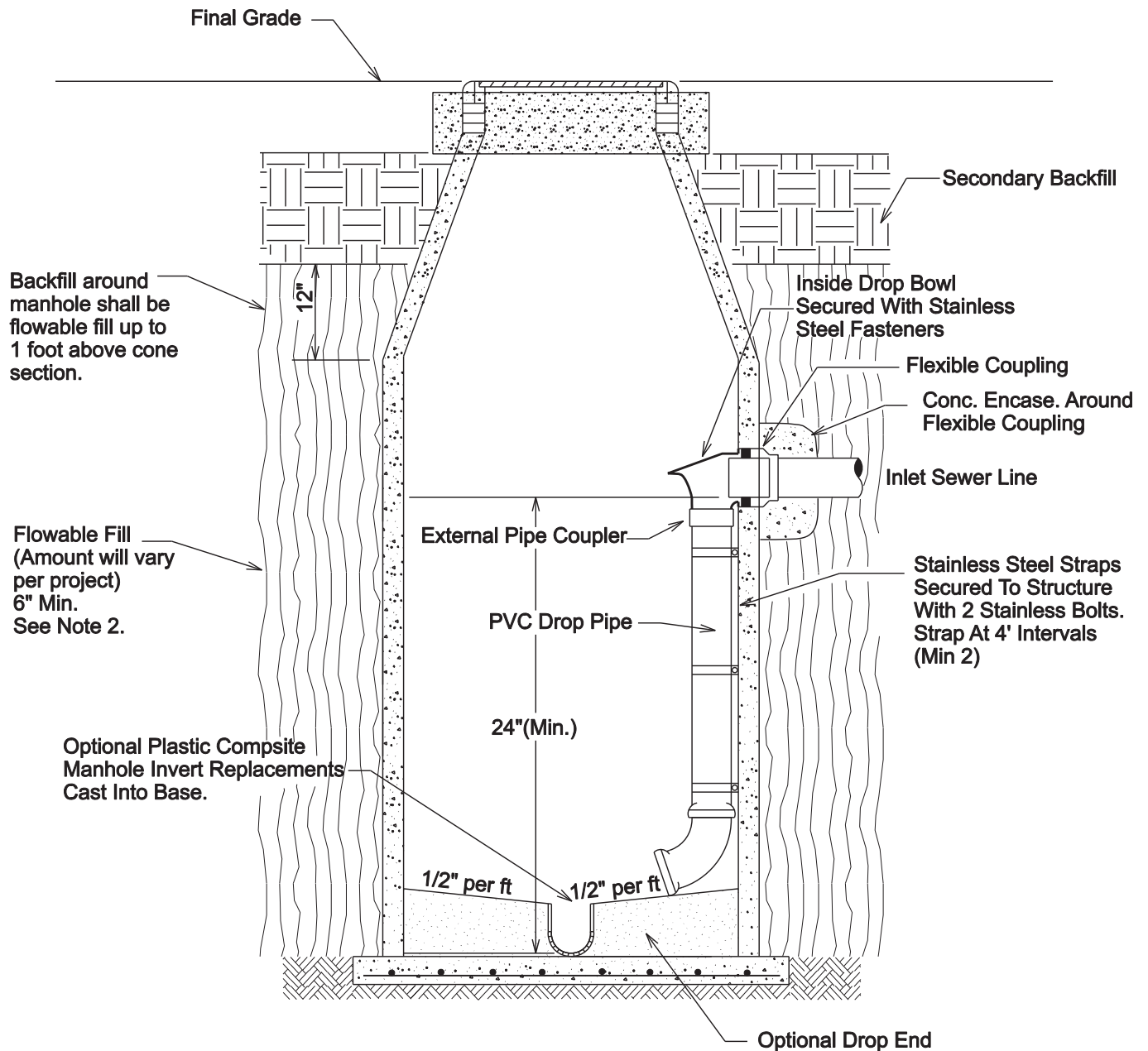
EXTERNAL  
DROP MANHOLE DETAIL

APPROVED  
March 2008

REVISED  
APRIL 2014

DD-852-08

SHEET  
1 OF 1



**NOTES:**

1. THIS MANHOLE IS TO BE APPROVED BY SAWS INSPECTION AND ENGINEERING PRIOR TO CONSTRUCTION.
2. CONTRACTOR CAN OPT TO BACK FILL WITH APPROVED SECONDARY MATERIAL

PROPERTY OF  
**SAN ANTONIO WATER SYSTEM**  
 SAN ANTONIO, TEXAS

**INTERNAL  
 DROP MANHOLE  
 DETAIL**

APPROVED  
 MARCH 2008

REVISED  
 APRIL 2014

**DD-852-09**

SHEET  
**1 OF 1**

## ITEM

### 103 REMOVE CONCRETE

**103.1. DESCRIPTION:** *This item shall govern the breaking up, removing, and satisfactorily disposing of existing concrete, as classified, at locations shown on the plans or as directed by the Engineer. Existing concrete not shown on the plans, located beneath the natural ground surface, not indicated by the Engineer or not obvious to the naked eye will not be covered under this item. Such materials will be removed as needed and paid for under Item 104 "Street Excavation," Item 105 "Channel Excavation," or Item 306 "Structural Excavation."*

**103.2. CLASSIFICATION:** Existing concrete to be removed under this item will be classified as follows:

- A. Concrete Curb.** "Concrete Curb" will include curb, curb and gutter, and low curb at driveways, and combinations thereof. The removal of monolithic concrete curb or doweled concrete curb will be included in the concrete pavement measurement.
- B. Concrete Traffic Barrier.** "Concrete Traffic Barrier" will include permanent concrete barrier used for channeling or dividing traffic that is not considered salvageable.
- C. Sidewalks and Driveways.** "Sidewalks and Driveways" will include concrete sidewalks and driveways.
- D. Miscellaneous Concrete.** "Miscellaneous Concrete" will include all other items that are not noted above or covered by other items.

**103.3. EQUIPMENT:** Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

**103.4. CONSTRUCTION:**

- A. General.** The existing concrete shall be broken up, removed, and disposed of by the Contractor in accordance with federal, state, and local regulations.
- B. Partial Removal of Concrete.** When only a portion of the existing concrete is to be removed, care shall be exercised to avoid damage to that portion to remain in place. The existing concrete shall be cut to neat lines shown on the plans or as established by the Engineer, by sawing with an appropriate type circular concrete saw to a minimum depth of ½-inch. Any existing concrete which is damaged or destroyed beyond the neat lines so established shall be replaced at the Contractor's expense. Where reinforcement is encountered in the removed portions of the concrete, a minimum of 1-foot shall be cleaned of all old concrete and left in place to tie into the new concrete construction.

**103.5. MEASUREMENT:** Measurement for this item will be conducted as follows:

- A. Concrete Curb.** Concrete curb removed as prescribed above will be measured by the linear foot in its original position regardless of the thickness and reinforcing steel encountered.
- B. Concrete Traffic Barrier.** Concrete Traffic Barrier as prescribed above will be measured by the linear foot in its original position regardless of the type or size encountered.



**C. Concrete Sidewalk and Driveway.** Concrete sidewalks and driveways removed as prescribed above will be measured by the square foot in its original position regardless of the thickness of the concrete and reinforcing steel encountered.

**D. Miscellaneous Concrete.** Miscellaneous Concrete will be measured by the square foot in its original position regardless of the thickness of the concrete and reinforcing steel encountered.

**103.6. PAYMENT:** This item will be paid for at the contract unit price bid for “Remove Concrete Curb,” “Remove Concrete Traffic Barrier,” “Remove Concrete Sidewalks and Driveways,” or “Remove Miscellaneous Concrete” which price shall be full compensation for all work herein specified, including the furnishing of all materials, equipment, tools, labor and incidentals necessary to complete the work.

**103.7. BID ITEM:**

Item 103.1 - Remove Concrete Curb - per linear foot

Item 103.2 - Remove Concrete Traffic Barrier - per linear foot

Item 103.3 - Remove Sidewalks and Driveways - per square foot

Item 103.4 - Remove Miscellaneous Concrete - per square foot

## ITEM

### 107 EMBANKMENT

**107.1. DESCRIPTION:** *Furnish, place, and compact materials for construction of roadways, embankments, levees, dikes, or any designated section of the roadway where additional material is required.*

**107.2. MATERIALS:** Furnish approved material capable of forming a stable embankment from required excavation in the areas shown on the plans or from sources outside the right of way. Provide material meeting the requirements of Type B unless one or more of the following types is shown on the plans or directed by the Engineer:

**A. Type A.** Granular material that is free from vegetation or other objectionable material and meets the requirements of Table 1.

**Table 1**  
**Testing Requirements**

Property	TxDOT Standard Laboratory Test Procedure	Specification Limit
Liquid limit	Tex-104-E	$\leq 45$
Plasticity index (PI)	Tex-106-E	$\leq 15$
Bar linear shrinkage	Tex-107-E	$\geq 2$

The Linear Shrinkage test only needs to be performed as indicated in TxDOT standard laboratory test procedure Tex-104-E.

**B. Type B.** Materials such as rock, loam, clay, or other approved materials.

**C. Type C.** Material meeting the specification requirements shown on the plans.

**D. Type D.** Material from required excavation areas shown on the plans.

Retaining wall backfill material must meet the requirements of the pertinent retaining wall Items.

**107.3. EQUIPMENT:** Provide applicable equipment to conduct work as described in this specification or as specified on the plans.

**107.4. CONSTRUCTION:** When offsite sources are used, the Contractor must comply with all Federal, State, County, City, and local laws, ordinances, and regulations pertaining to the work included in this item and demonstrate to the City that all applicable permits, contracts, or other legal documentation are in place prior to use of the offsite borrow source. To allow for required testing, notify the Engineer before opening a material source. Complete preparation of the right of way, in accordance with Item 101, "Preparing Right of Way," for areas to receive embankment.

Backfill tree-stump holes or other minor excavations with approved material and tamp. Restore the ground surface, including any material disked loose or washed out, to its original slope. Compact the ground surface by sprinkling in accordance with TxDOT Item 204, "Sprinkling" and by rolling using equipment complying with Item 210, "Rolling," when directed.

Scarify and loosen the unpaved surface areas, except rock, to a depth of at least 6-inches, unless otherwise shown on the plans. Bench slopes before placing material. Begin placement of material at the toe of slopes. Do not place trees, stumps, roots, vegetation, or other objectionable material in the embankment. Simultaneously recompact scarified material with the placed embankment material. Do not exceed the layer depth specified in Section 107.3.D, "Compaction Methods."

Construct embankments to the grade and sections shown on the plans. Construct the embankment in layers approximately parallel to the finished grade for the full width of the individual roadway cross sections, unless otherwise shown on the plans. Ensure that each section of the embankment conforms to the detailed sections or slopes. Maintain the finished section, density, and grade until the project is accepted.

- A. Earth Embankments.** Earth embankment is mainly composed of material other than rock. Construct embankments in successive layers, evenly distributing materials in lengths suited for sprinkling and rolling.

Obtain approval to incorporate rock and broken concrete produced by the construction project in the lower layers of the embankment. When the size of approved rock or broken concrete exceeds the layer thickness requirements in Section 107.3.D, "Compaction Methods," place the rock and concrete outside the limits of the completed roadbed. Cut and remove all exposed reinforcing steel from the broken concrete.

Move the material dumped in piles or windrows by blading or by similar methods and incorporate it into uniform layers. Featheredge or mix abutting layers of dissimilar material for at least 100-feet to ensure there are no abrupt changes in the material. Break down clods or lumps of material and mix embankment until a uniform material is attained.

Apply water free of industrial wastes and other objectionable matter to achieve the uniform moisture content specified for compaction.

When ordinary compaction is specified, roll and sprinkle each embankment layer in accordance with Section 107.3.D.1, "Ordinary Compaction." When density control is specified, compact the layer to the required density in accordance with Section 107.3.D.2, "Density Control." When rock and broken concrete are allowed in lower layers of earth embankments, proof-roll these layers as directed where density testing is not possible, in accordance with TxDOT Item 216, "Proof Rolling" to ensure proper compaction.

- B. Rock Embankments.** Rock embankment is mainly composed of rock. Construct rock embankments in successive layers for the full width of the roadway cross-section with a depth of 18-inches or less. Increase the layer depth for large rock sizes as approved. Do not exceed a depth of 2½ feet in any case. Fill voids created by the large stone matrix with smaller stones during the placement and filling operations.

Ensure the depth of the embankment layer is greater than the maximum dimension of any rock. Do not place rock greater than 2 feet in its maximum dimension, unless otherwise approved. Construct the final layer with graded material so that the density and uniformity is in accordance with Section 107.3.D, "Compaction Methods." Break up exposed oversized material as approved.

When ordinary compaction is specified, roll and sprinkle each embankment layer in accordance with Section 107.3.D.1, "Ordinary Compaction." When density control is specified, compact each layer to the required density in accordance with Section 107.3.D.2,

“Density Control.” When directed, proof-roll each rock layer where density testing is not possible, in accordance with TxDOT Item 216, “Proof Rolling” to ensure proper compaction.

- C. **Embankments Adjacent to Culverts and Bridges.** Compact embankments adjacent to culverts and bridges in accordance with Item 106, “Box Culvert Excavation and Backfilling.”
- D. **Compaction Methods.** Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least  $\frac{1}{2}$  the width of the roller. On super elevated curves, begin rolling at the lower side and progress toward the high side. Alternate roller trips to attain slightly different lengths. Compact embankments in accordance with one of the following methods as shown on the plans:
1. **Ordinary Compaction.** Use approved rolling equipment complying with Item 210, “Rolling,” to compact each layer. The plans or the Engineer may require specific equipment. Do not allow the loose depth of any layer to exceed 12 inches, unless otherwise approved. Before and during rolling operations, bring each layer to the moisture content directed. Compact each layer until there is no evidence of further consolidation. Maintain a level layer to ensure uniform compaction. If the required stability or finish is lost for any reason, recompact and refinish the subgrade at no additional expense to the City.
  2. **Density Control.** Compact each layer to the required density using equipment complying with Item 210, “Rolling.” Determine the maximum lift thickness based on the ability of the compacting operation and equipment to meet the required density. Do not exceed layer thickness of 12 inches loose material, unless otherwise approved. Maintain a level layer to ensure uniform compaction.

The Engineer will use TxDOT standard laboratory test procedure Tex-114-E to determine the maximum dry density ( $D_a$ ) and optimum moisture content ( $W_{opt}$ ). Meet the requirements for field density and moisture content in Table 2, unless otherwise shown on the plans.

Table 2  
Field Density Control Requirements

Description	Density	Moisture Content
	Tex-115-E	
$PI \leq 15$	$\geq 98\% D_a$	
$15 < PI \leq 35$	$\geq 98\% D_a$ and $\leq 102\% D_a$	$\geq W_{opt}$
$PI > 35$	$\geq 95\% D_a$ and $\leq 100\% D_a$	$\geq W_{opt}$

Each layer is subject to testing by the Engineer for density and moisture content. During compaction, the moisture content of the soil should not exceed the value shown on the moisture-density curve, above optimum, required to achieve:

- 98% dry density for soils with a PI greater than 15 but less than or equal to 35 or
- 95% dry density for soils with PI greater than 35.

When required, remove small areas of the layer to allow for density tests. Replace the removed material and recompact at no additional expense to the City. Proof-roll in accordance with TxDOT Item 216, “Proof Rolling,” when shown on the plans or as directed. Correct soft spots as directed.

- E. Maintenance of Moisture and Reworking.** Maintain the density and moisture content once all requirements in Table 2 are met. For soils with a PI greater than 15, maintain the moisture content no lower than 4 percentage points below optimum. Rework the material to obtain the specified compaction when the material loses the required stability, density, moisture, or finish. Alter the compaction methods and procedures on subsequent work to obtain specified density as directed.
- F. Acceptance Criteria.**
- 1. Grade Tolerances.**
    - a. Staged Construction.** Grade to within 0.1-foot in the cross-section and 0.1-foot in 16-feet measured longitudinally.
    - b. Turnkey Construction.** Grade to within ½-inch in the cross-section and ½-inch in 16-feet measured longitudinally.
  - 2. Gradation Tolerances.** When gradation requirements are shown on the plans, material is acceptable when not more than 1 of the 5 most recent gradation tests is outside the specified limits on any individual sieve by more than 5 percentage points.
  - 3. Density Tolerances.** Compaction work is acceptable when not more than 1 of the 5 most recent density tests is outside the specified density limits, and no test is outside the limits by more than 3 lb. per cubic foot.
  - 4. Plasticity Tolerances.** Material is acceptable when not more than 1 of the 5 most recent PI tests is outside the specified limit by no more than 2 points.

**107.5. MEASUREMENT:** Embankment will be measured by the cubic yard. Measurement will be further defined for payment as follows:

- A. Final.** The cubic yard will be measured in its final position using the average end area method. The volume is computed between the original ground surface or the surface upon which the embankment is to be constructed and the lines, grades, and slopes of the embankment. In areas of salvaged topsoil, payment for embankment will be made in accordance with TxDOT Item 160, "Topsoil." Shrinkage or swell factors will not be considered in determining the calculated quantities.
- B. Original.** The cubic yard will be measured in its original and natural position using the average end area method.
- C. Vehicle.** The cubic yard will be measured in vehicles at the point of delivery.

When measured by the cubic yard in its final position, this is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Change Order. Additional measurements or calculations will be made if adjustments of quantities are required.

Shrinkage or swell factors are the Contractor's responsibility. When shown on the plans, factors are for informational purposes only.

Measurement of retaining wall backfill in embankment areas is paid for as embankment, unless otherwise shown on plans. Limits of measurement for embankment in retaining wall areas are shown on the plans.

**107.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Embankment (Final)," "Embankment (Original)," or "Embankment (Vehicle)," of the compaction method and type specified. This price is full compensation for furnishing embankment; hauling; placing, compacting, finishing, and reworking; disposal of waste material; and equipment, labor, tools, and incidentals.

When proof rolling is directed, it will be paid for in accordance with TxDOT Item 216, "Proof Rolling."

All sprinkling and rolling, except proof rolling, will not be paid for directly, but will be considered subsidiary to this Item, unless otherwise shown on the plans.

Where subgrade is constructed under this contract, correction of soft spots in the subgrade will be at the Contractor's expense. Where subgrade is not constructed under this contract, correction of soft spots in the subgrade will be paid in accordance through the Change Order process.

**107.7. BID ITEM:**

Item 107.1 - Embankment (Final) - per cubic yard

Item 107.2 - Embankment (Original) - per cubic yard

Item 107.3 - Embankment (Vehicle) - per cubic yard

## DIVISION II - BASE & SURFACE COURSES

### ITEM

#### 200 FLEXIBLE BASE

- 200.1. DESCRIPTION:** *Construct a base course for surfacing, pavement, or other base courses composed of crushed stone, and constructed as herein specified in one or more courses in conformance with the typical sections shown on the plans and to the lines and grades as established by the Engineer.*
- 200.2. MATERIALS:** Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of the proposed material sources and of changes to material sources. The Engineer may sample and test project materials at any time before compaction throughout the duration of the project to assure specification compliance. Use the TxDOT standard laboratory test procedure Tex-100-E for material definitions.
- A. Aggregate.** Furnish aggregate of the type and grade shown on the plans and conforming to the requirements of Table 1. Each source must meet Table 1 requirements for liquid limit, plasticity index, and wet ball mill for the grade specified. Do not use additives such as but not limited to lime, cement, or fly ash to modify aggregates to meet the requirements of Table 1, unless shown on the plans.

**Table 1**  
**Aggregate Material Requirements**

Property	Test Method <sup>1</sup>	Grade 1	Grade 2	Grade 3	Grade 4
Master gradation sieve size (% retained)	Tex-110-E				As shown on the plans
2-½ in.		–	0	0	
1-¾ in.		0	0–10	0–10	
¾ in.		10–35	–	–	
¾ in.		30–50	–	–	
No. 4		45–65	45–75	45–75	
No. 40		70–85	60–85	50–85	
Liquid limit, % max. <sup>2</sup>	Tex-104-E	35	40	40	As shown on the plans
Plasticity index, max. <sup>2</sup>	Tex-106-E	10	12	12	As shown on the plans
Plasticity index, min. <sup>2</sup>		As shown on the plans			
Wet ball mill, % max. <sup>3</sup>	Tex-116-E	40	45	–	As shown on the plans
Wet ball mill, % max. increase passing the No. 40 sieve <sup>3</sup>		20	20	–	

1. TxDOT standard laboratory test procedures

2. Determine plastic index in accordance with Tex-107-E (linear shrinkage) when liquid limit is unattainable as defined in Tex-104-E.

3. ASTM C131 (Grad. A), Los Angeles Abrasion, can be used in lieu of the wet ball mill procedure. The maximum abrasion allowed to the crushed stone is forty (40) when subjected to the Los Angeles Abrasion test.

- 1. Material Tolerances.** The Engineer may accept material if no more than 1 of the 5 most recent gradation tests has an individual sieve outside the specified limits of the gradation.

When target grading is required by the plans, no single failing test may exceed the master grading by more than 5 percentage points on sieves No. 4 and larger or 3 percentage points on sieves smaller than No. 4 sieve.

The Engineer may accept material if no more than 1 of the 5 most recent plasticity index tests is outside the specified limit. No single failing test may exceed the allowable limit by more than 2 points.

2. **Material Types.** Do not use fillers or binders unless approved by the Engineer. Furnish the type specified on the plans in accordance with the following.
  - a. **Type A.** Crushed stone produced and graded from oversize quarried aggregate that originates from a single, naturally occurring source. Do not use gravel or multiple sources.
  - b. **Type B.** Crushed or uncrushed gravel. Blending of 2 or more sources is allowed. Use of this material must have written approval by the City Engineer prior to selection for bidding or construction.
  - c. **Type C.** Crushed gravel with a minimum of 60% of the particles retained on a No. 4 sieve with 2 or more crushed faces as determined by TxDOT's standard laboratory test procedure Tex-460-A, Part I. Blending of 2 or more sources is allowed.
  - d. **Type D.** Type A material or crushed concrete. Crushed concrete containing gravel will be considered Type D material. Crushed concrete must meet the requirements in Section 200.2.A.3.b, "Recycled Material (Including Crushed Concrete) Requirements," and be managed in a way to provide for uniform quality. The Engineer may require separate dedicated stockpiles in order to verify compliance.
  - e. **Type E.** As shown on the plans.
3. **Recycled Material.** Recycled asphalt pavement (RAP) and other recycled materials may be used when shown on the plans. Request approval to blend 2 or more sources of recycled materials.
  - a. **Limits on Percentage.** When RAP is allowed, do not exceed 20% RAP by weight unless otherwise shown on the plans. The percentage limitations for other recycled materials will be as shown on the plans.
  - b. **Recycled Material (Including Crushed Concrete) Requirements.**
    - (1) **Contractor Furnished Recycled Materials.** When the Contractor furnishes the recycled materials, including crushed concrete, the final product will be subject to the requirements of Table 1 for the grade specified. Certify compliance with TxDOT's DMS-11000, "Evaluating and Using Nonhazardous Recyclable Materials Guidelines," for Contractor furnished recycled materials. In addition, recycled materials must be free from reinforcing steel and other objectionable material and have at most 1.5% deleterious material when tested in accordance with TxDOT's standard laboratory test procedure Tex-413-A. For RAP, do not exceed a maximum percent loss from decantation of 5.0% when tested in accordance with TxDOT's standard laboratory test procedure Tex-406-A. Test RAP without removing the asphalt.



(2) **City Furnished Required Recycled Materials.** When the City furnishes and requires the use of recycled materials, unless otherwise shown on the plans:

- City required recycled material will not be subject to the requirements in Table 1,
- Contractor furnished materials are subject to the requirements in Table 1 and this Item,
- the final product, blended, will be subject to the requirements in Table 1, and
- for final product, unblended (100% City furnished required recycled material), the liquid limit, plasticity index, wet ball mill, classification, and compressive strength is waived.

Crush City-furnished RAP so that 100% passes the 2 inch sieve. The Contractor is responsible for uniformly blending to meet the percentage required.

(3) **City Furnished and Allowed Recycled Materials.** When the City furnishes and allows the use of recycled materials or allows the Contractor to furnish recycled materials, the final blended product is subject to the requirements of Table 1 and the plans.

- c. **Recycled Material Sources.** City-owned recycled material is available to the Contractor only when shown on the plans. Return unused City-owned recycled materials to the City stockpile location designated by the Engineer unless otherwise shown on the plans.

The use of Contractor-owned recycled materials is allowed when shown on the plans. Contractor-owned surplus recycled materials remain the property of the Contractor. Remove Contractor-owned recycled materials from the project and dispose of them in accordance with federal, state, and local regulations before project acceptance. Do not intermingle Contractor-owned recycled material with City-owned recycled material unless approved by the Engineer.

**B. Water.** Furnish water free of industrial wastes and other objectionable matter.

**C. Material Sources.** Only commercial sources may be used unless otherwise allowed by the City and shown on the plans.

**200.3. EQUIPMENT:** Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Item 210, "Rolling." Provide proof rollers in accordance with TxDOT Item 216, "Proof Rolling," when required.

**200.4. CONSTRUCTION:** Construct each layer uniformly, free of loose or segregated areas, and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or as directed.

Stockpile base material temporarily at an approved location before delivery to the roadway. Build stockpiles in layers no greater than 2 feet thick. Stockpiles must have a total height between 10 and 16 feet unless otherwise shown on the plans. After construction and acceptance of the

stockpile, loading from the stockpile for delivery is allowed. Load by making successive vertical cuts through the entire depth of the stockpile.

Do not add or remove material from temporary stockpiles that require sampling and testing before delivery unless otherwise approved. Charges for additional sampling and testing required as a result of adding or removing material will be deducted from the Contractor's estimates.

Haul approved flexible base in clean trucks. Deliver the required quantity to each 100 foot station or designated stockpile site as shown on the plans. Prepare stockpile sites as directed. When delivery is to the 100 foot station, manipulate in accordance with the applicable Items.

- A. Preparation of Subgrade or Existing Base.** Remove or scarify existing asphalt concrete pavement in accordance with Item 104, "Street Excavation," when shown on the plans or as directed. Shape the subgrade or existing base to conform to the typical sections shown on the plans or as directed.

When new base is required to be mixed with existing base, deliver, place, and spread the new flexible base in the required amount per station. Manipulate and thoroughly mix the new base with existing material to provide a uniform mixture to the specified depth before shaping.

When shown on the plans or directed, proof roll the roadbed in accordance with TxDOT Item 216, "Proof Rolling," before pulverizing or scarifying. Correct soft spots as directed.

- B. Placing.** Spread and shape flexible base into a uniform layer with an approved spreader the same day as delivered unless otherwise approved. Construct layers to the thickness shown on the plans. Maximum lift thickness shall be 10 inches of loose material. Maintain the shape of the course. Control dust by sprinkling, as directed. Correct or replace segregated areas as directed, at no additional expense to the City.

Place successive base courses and finish courses using the same construction methods required for the first course.

- C. Compaction.** Compact in courses not to exceed 8 inches compacted depth using density control unless otherwise shown on the plans. Multiple lifts are permitted when shown on the plans or approved. Bring each layer to the moisture content directed. When necessary, sprinkle the material in accordance with TxDOT Item 204, "Sprinkling."

Begin rolling longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least  $\frac{1}{2}$  the width of the roller unit. On superelevated curves, begin rolling at the low side and progress toward the high side. Offset alternate trips of the roller. Operate rollers at a speed between 2 and 6 mph as directed.

Rework, recompact, and refinish material that fails to meet or that loses required moisture, density, stability, or finish before the next course is placed or the project is accepted. Continue work until specification requirements are met. Perform the work at no additional expense to the City.

- 1. Ordinary Compaction.** Roll with approved compaction equipment as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing approved material as required, reshaping, and recompacting.

2. **Density Control.** Compact to at least 95% of the maximum density determined by TxDOT's standard laboratory test procedure Tex-113-E unless otherwise shown on the plans. Determine the moisture content of the material at the beginning and during compaction in accordance with TxDOT's standard laboratory test procedure Tex-103-E.

The Engineer will determine roadway density of completed sections in accordance with TxDOT's standard laboratory test procedure Tex-115-E. The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pounds per cubic foot below the specified density.

- D. **Finishing.** After completing compaction, clip, skin, or tight-blade the surface with a maintainer or subgrade trimmer to a depth of approximately  $\frac{1}{4}$  inch. Remove loosened material and dispose of it at an approved location. Seal the clipped surface immediately by rolling with a pneumatic tire roller until a smooth surface is attained. Add small increments of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines, and grades as shown on the plans or as directed.

In areas where surfacing is to be placed, correct grade deviations greater than  $\frac{1}{4}$  inch in 16 feet measured longitudinally or greater than  $\frac{1}{4}$  inch over the entire width of the cross-section. Correct by loosening, adding, or removing material. Reshape and recompact in accordance with Section 200.4.C, "Compaction."

- E. **Curing.** Cure the finished section until the moisture content is at least 3 percentage points below and above optimum or as directed before applying the next successive course or prime coat.

- 200.5. MEASUREMENT:** Flexible base will be measured by the square yard method per thickness shown in the proposal.

Measurement by the square yard is a plans quantity measurement. The quantity to be paid for is the quantity shown in the proposal unless modified by the Engineer. Additional measurements or calculations will be made if adjustments of quantities are required.

Measurement is further defined for payment by the square yard of surface area in the completed and accepted final position. The surface area of the base course is based on the width of flexible base as shown on the plans.

- 200.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the types of work shown below. No additional payment will be made for thickness or width exceeding that shown on the typical section or provided on the plans for square yard measurement.

Sprinkling and rolling will not be paid for directly but will be subsidiary to this Item unless otherwise shown on the plans.

Where subgrade is constructed under this Contract (Subgrade Treatment), correction of soft spots in the subgrade will be at the Contractor's expense. Where subgrade is not constructed under this project, correction of soft spots in the subgrade will be paid in accordance with pertinent Items.

Payment will be made for the type and grade specified. For square yard measurement, a depth will be specified. This price is full compensation for furnishing materials, temporary stockpiling, assistance provided in stockpile sampling and operations to level stockpiles for measurement,

loading, hauling, delivery of materials, spreading, blading, mixing, shaping, placing, compacting, reworking, finishing, correcting locations where thickness is deficient, curing, furnishing scales and labor for weighing and measuring, and equipment, labor, tools, and incidentals.

**200.7. BID ITEM:**

Item 200.1 - per square yard per \_\_\_ inches compacted depth

## ITEM

### 202 PRIME COAT

**202.1. DESCRIPTION:** *This item shall govern for the application of asphaltic material on the completed base course and/or other areas in accordance with this specification and as directed by the Engineer. Apply blotter material as required.*

**202.2. MATERIALS:** Provide materials in accordance with the following requirements:

**A. Bituminous.** Unless the type and grade are shown on the plans, utilize an MC-30 or AE-P asphalt cement in accordance with Item 300, "Asphalts, Oils, and Emulsions" of the Standard Specifications of the Texas Department of Transportation for prime coat. Where Emulsified Asphalts are used, the amount of emulsified asphalt as a percentage by volume of the total mixture shall be within the limits shown on the plans, or shall be of a percentage as directed by the Engineer.

**B. Blotter.** Unless otherwise shown on the plans or approved, use either base course sweepings obtained from cleaning the base or sand as blotter materials.

**202.3. EQUIPMENT:** Provide applicable equipment in accordance with this specification or as specified on the plans.

**A. Distributor.** Furnish a distributor that will apply the asphalt material uniformly at the specified rate or as directed.

**1. Transverse Variance Rate.** When a transverse variance rate is shown on the plans, confirm that the nozzles outside the wheel paths will output a predetermined percentage more of asphalt material by volume than the nozzles over the wheel paths.

**2. Calibration.**

**a. Transverse Distribution.** Furnish a distributor test report, no more than 1 year old, documenting that the variation in output for individual nozzles of the same size does not exceed 10% when tested at the greatest shot width in accordance with Tex-922-K, "Calibrating Asphalt Distribution Equipment," Part III.

Include the following documentation on the test report:

- the serial number of the distributor,
- a method that identifies the actual nozzle set used in the test, and
- the fan width of the nozzle set at a 12 inch bar height.

When a transverse variance rate is required, perform the test using the type and grade of asphalt material to be used on the project. The Engineer may verify the transverse rate and distribution at any time. If verification does not meet the requirements, correct deficiencies and furnish a new test report.

**B. Tank Volume.** Furnish a volumetric calibration and strap stick for the distributor tank in accordance with Tex-922-K, "Calibrating Asphalt Distribution Equipment," Part I.

Calibrate the distributor within the previous 3 years of the date first used on the project. The Engineer may verify calibration accuracy in accordance with Tex-922-K, "Calibrating Asphalt Distribution Equipment," Part II.

- C. **Computerized Distributor.** When paying for asphalt material by weight, the Engineer may allow use of the computerized distributor display to verify application rates. Verify application rate accuracy at a frequency acceptable to the Engineer.
- D. **Broom.** Furnish rotary, self-propelled brooms.
- E. **Rollers.** Rollers provided shall meet the requirements for their type as shown in Item 210, "Rollers."
- F. **Asphalt Storage and Handling Equipment.** When the plans or the Engineer allows storage tanks, furnish a thermometer in each tank to indicate the asphalt temperature continuously.

Keep equipment clean and free of leaks. Keep asphalt material free of contamination.

- G. **Digital Measuring Instrument.** Furnish a vehicle with a calibrated digital-measuring instrument accurate to  $\pm 6$  ft. per mile.

#### 202.4. CONSTRUCTION:

- A. **General.** Apply the mixture when the air temperature is 60°F and above, or above 50°F and rising. Measure the air temperature in the shade away from artificial heat. The Engineer will determine when weather conditions are suitable for application.

Do not permit traffic, hauling, or placement of subsequent courses over freshly constructed prime coats. Maintain the primed surface until placement of subsequent courses or acceptance of the work.

- B. **Surface Preparation.** Prepare the surface by sweeping or other approved methods. When directed, before applying bituminous material, lightly sprinkle the surface with water to control dust and ensure absorption.

- C. **Application.**

- 1. **Bituminous.** The Engineer will select the application temperature within the limits recommended in Item 300, "Asphalts, Oils, and Emulsions." Apply material within 15°F of the selected temperature.

Unless otherwise shown on the plans, prime coat shall be applied at a rate not to exceed 0.20 gallon per square yard of surface. The prime coat shall be applied evenly and smoothly, under a pressure necessary for proper distribution.

When emulsified asphalts are used as prime coat, agitate the water and emulsified asphalt to produce a uniform blend. Evenly distribute, at the rate specified, to locations shown on the plans or as directed. Regulate the percentage of emulsified asphalt in the mixture and distribute successive applications to achieve the specified rate, if necessary.

During the application of prime coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutters or structures. When directed, roll the freshly applied prime coat with a pneumatic-tire roller to ensure penetration.

- 2. Blotter.** Spread blotter material before allowing traffic to use a primed surface. When “Prime Coat and Blotter” is shown on the plans as a bid item, apply blotter material to primed surface at the rate shown in the plans or as directed. When “Prime Coat” is shown on the plans as a bid item, apply blotter to spot locations or as directed to accommodate traffic movement through the work area. Remove blotter material before placing the surface. Dispose of blotter material according to applicable state and federal requirements.
- 202.5. MEASUREMENT:** The asphaltic material for prime coat will be measured at the point of delivery on the project in gallons at the applied temperature. The quantity to be paid for shall be the number of gallons of asphaltic material used, as directed, in the accepted prime coat to the pay limits as shown on the plans. When emulsions are used, only that percentage of emulsified asphalt as a percentage by volume of the total mixture shall be paid for by the gallon of asphaltic material used in the accepted prime coat. Water used will not be measured for payment.
- 202.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Prime Coat” or “Prime Coat and Blotter” of the type and grade of bituminous material specified. This price is full compensation for cleaning and sprinkling the area to be primed; materials, including blotter material; and rolling, equipment, labor, tools, and incidentals.
- 202.7. BID ITEM:**
- Item 202.1 - Prime Coat - per gallon
- Item 202.2 - Prime Coat and Blotter - per gallon

## ITEM

### 205 HOT MIX ASPHALTIC CONCRETE PAVEMENT

**205.1. DESCRIPTION:** *Construct a leveling-up course, a surface course or any combination of these courses as shown on the plans, each to be composed of a compacted mixture of mineral aggregate and asphaltic material. The pavement shall be constructed on the newly constructed subgrade or base course, existing pavement, bituminous surface or in the case of bridges, on the prepared floor slab, as herein specified and in accordance with the details shown on the plans.*

**205.2. MATERIALS:** Materials used in Hot Mix Asphaltic Concrete Pavement shall meet the requirements as set forth herein. If shown on the plans, materials may also meet the requirements as described in Item 340, "Dense-Graded Hot-Mix Asphalt (Method)" or Item 341, "Dense-Graded Hot-Mix Asphalt (QC/QA)" of the Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.

Unless otherwise shown on the plans, provide aggregates that meet the aggregate quality requirements of TxDOT's Bituminous Rated Source Quality Catalog (BRSQC). Unapproved sources may be used if accepted by the Engineer and approved prior to use.

Furnish aggregates from sources that conform to the requirements shown in Table 1 herein, and as specified in this Section, unless otherwise shown on the plans. Provide aggregate stockpiles that meet the definition in this Section for either a coarse aggregate or fine aggregate. When reclaimed asphalt pavement (RAP) is used, provide RAP stockpiles in accordance with this Section. Aggregate from RAP is not required to meet Table 1 requirements unless otherwise shown on the plans.

Document all test results on a mixture design report and submit to the Engineer for approval. The Engineer may perform tests on independent or split samples to verify Contractor mix design results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in TxDOT standard laboratory test procedure Tex-200-F, Part II. Do not add material to an approved stockpile from other sources, unless otherwise approved by the Engineer.

Unless otherwise shown on the plans, reclaimed asphalt pavement (RAP) may be used in asphalt pavement maintenance or rehabilitation applications and shall be limited to a maximum of 20% RAP for surface or wearing courses and 30% RAP for courses below the surface or wearing course. Higher percentages of RAP may be used if requested in writing and approved by the Engineer prior to use.

**A. Coarse Aggregate.** Coarse aggregate stockpiles must have no more than 20% passing the #8 sieve. Provide aggregates with a surface aggregate classification (SAC) as shown below:

<u>Street Classification</u>	<u>Minimum Surface Aggregate Classification</u>
Primary and Secondary Arterials	A
Collector and Local Type B Streets	B
Local Type A Street With Bus Traffic	B
Local Type A Street Without Bus Traffic	C



SAC requirements apply only to aggregates used on the surface of travel lanes, unless otherwise shown on the plans. Blending aggregates to meet SAC criteria is allowable. Class B aggregate meeting all other requirements in Table 1 may be blended with a Class A aggregate in order to meet requirements for Class A materials. When blending Class A and B aggregates to meet a Class A requirement, ensure that at least 50% by weight of the material retained on the No. 4 sieve comes from the Class A aggregate source. Blend by volume if the bulk specific gravities of the Class A and B aggregates differ by more than 0.300. When blending, do not use Class C or D aggregates. For blending purposes, coarse aggregate from RAP will be considered as Class B aggregate.

- B. Reclaimed Asphalt Pavement (RAP).** RAP is defined as a salvaged, pulverized, broken or crushed asphalt pavement. The RAP to be used in the mix shall be crushed or broken to the extent that 100% will pass the two inch sieve.

The stockpiled RAP shall not be contaminated by dirt or other objectionable materials. Unless otherwise shown on the plans, stockpiled, crushed RAP shall have a decantation of 5% or less and a plasticity index of eight (8) or less, when tested in accordance with TxDOT standard laboratory test procedures Tex-406-A, Part I, and Tex-106-E, respectively. This requirement applies to stockpiles from which the asphalt has not been removed by extraction. When RAP is used, determine asphalt content and gradation for mixture design purposes.

- C. Fine Aggregate.** Fine aggregates may consist of manufactured sands, screenings and field sands. Supply fine aggregates that are free from organic impurities. Field sands and other uncrushed aggregates shall be limited to 15% of the total aggregate.

If 10% or more of the fine aggregate stockpile is retained on the No. 4 sieve, test the stockpile and verify that it meets the requirements in Table 1 for coarse aggregate angularity (TxDOT standard laboratory test procedure Tex-460-A) and flat and elongated particles (TxDOT standard laboratory test procedure Tex-280-F).

- D. Asphalt Binder.** Unless shown on the plans, provide the type and grade of performance-graded asphalt binder in accordance with TxDOT Item 300.2.J. “Performance-Graded Binders” and as specified below:

Street Classification	Minimum PG Asphalt Cement Grade		
	Surface Courses	Binder & Level Up Courses	Base Courses
Primary and Secondary Arterials	PG 76-22	PG 70-22	PG 64-22
Collector and Local Type B Streets	PG 70-22		
Local Type A Street With Bus Traffic		PG 64-22	
Local Type A Street Without Bus Traffic	PG 64-22		

- E. Mineral Filler.** Mineral filler consists of finely divided mineral matter such as agricultural lime, crusher fines, hydrated lime, cement, or fly ash. Mineral filler is allowed unless otherwise shown on the plans. Do not use more than 2% hydrated lime or cement, unless otherwise shown on the plans. The plans may require or disallow specific mineral fillers. When used, provide mineral filler that:

- is sufficiently dry, free-flowing, and free from clumps and foreign matter;

- does not exceed 3% linear shrinkage when tested in accordance with Tex-107-E; and
  - meets the gradation requirements of Table 3 herein.
- F. Baghouse Fines.** Fines collected by the baghouse or other dust collecting equipment may be reintroduced into the mixing drum.
- G. Tack Coat.** Unless otherwise shown on the plans or approved, furnish CSS-1H, SS-1H, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder and in accordance with Item 203, “Tack Coat.” Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.
- H. Additives.** When shown on the plans, use the type and rate of additive specified. Other additives that facilitate mixing or improve the quality of the mixture may be allowed when approved. If lime or a liquid antistripping agent is used, add in accordance with TxDOT Item 301, “Asphalt Antistripping Agents.” Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream, unless the plant has a baghouse or dust collection system that reintroduces the lime back into the drum.

**Table 1**  
**Aggregate Quality Requirements**

Property	TxDOT Standard Laboratory Test Procedure	Surface Courses	Binder, Level Up, & Base Courses
<b>Coarse Aggregate</b>			
Deleterious Material, %, max	Tex-217-F, Part I	1.0	1.5
Decantation, %, max	Tex-217-F, Part II	1.5	1.5
Micro-Deval Abrasion, %, max	Tex-461-A	Screening Only	Screening Only
Los Angeles Abrasion, %, max	Tex-410-A	35	40
Magnesium Sulfate Soundness, 5 cycles, %, max	Tex-411-A	25	30
Coarse Aggregate Angularity, 2 crushed faces, %, min	Tex-460-A, Part I	95 <sup>1</sup>	85 <sup>1</sup>
Flat and Elongated Particles @ 5:1, %, max	Tex-280-F	10	10
<b>Fine Aggregate</b>			
Linear Shrinkage, %, max	Tex-107-E	3	3
<b>Combined Aggregate<sup>2</sup></b>			
Sand Equivalent, %, min	Tex-203-F	45	45

Note 1: Applies to Gravel Only

Note 2: Aggregate without mineral filler, RAP, or additives combined as used in the job-mixed formula (JMF)

**Table 2**  
**Gradation Requirements for Fine Aggregates**

Sieve Size, in	% Passing by Weight or Volume
3/8	100
#8	70 – 100
#200	0 – 30

**Table 3**  
**Gradation Requirements for Mineral Filler**

Sieve Size, in	% Passing by Weight or Volume
#8	100
#200	55 – 100

**205.3. EQUIPMENT:** All equipment for the handling of all materials, mixing, placing and compacting of the mixture shall be maintained in good repair and operating condition and subject to the approval of the Engineer. Any equipment found to be defective and potentially having a negative effect on the quality of the paving mixture or ride quality will not be allowed.

**A. Spreading and Finishing Machine.** The spreading and finishing machine shall be approved by the Engineer and shall meet the requirements indicated below.

- 1. Screed Unit.** The spreading and finishing machine shall be equipped with a heated compacting screed. It shall produce a finished surface meeting the requirements of the typical cross sections and the surface test.

Extensions added to the screed shall be provided with the same compacting action and heating capability as the main screed unit, except for use on variable depth tapered areas and/or as approved by the Engineer.

The spreading and finishing machine shall be equipped with an approved automatic dual longitudinal screed control system and automatic transverse screed control system. The longitudinal controls shall be capable of operating from any longitudinal grade reference including a stringline, ski, mobile stringline, or matching shoe.

The Contractor shall furnish all equipment required for grade reference. It shall be maintained in good operating condition by personnel trained in the use of this type of equipment.

The grade reference used by the Contractor may be of any type approved by the Engineer. The contractor shall set the grade reference to have sufficient support so that the maximum deflection shall not exceed 1/16 inch between supports.

- 2. Tractor Unit.** The tractor unit shall be equipped with a hydraulic hitch sufficient in design and capacity to maintain contact between the rear wheels of the hauling equipment and the pusher rollers of the finishing machine while the mixture is being unloaded.

No portion of the weight of hauling equipment, other than the connection, shall be supported by the asphalt paver. No vibrations or other motions of the loading equipment, which could have a detrimental effect on the riding quality of the completed pavement, shall be transmitted to the paver.

The use of any vehicle which requires dumping directly into the finishing machine and which the finishing machine cannot push or propel to obtain the desired lines and grades without resorting to hand finishing will not be allowed.

**B. Material Transfer Equipment.** Equipment to transfer mixture from the hauling units or the roadbed to the spreading and finishing machine will be allowed unless otherwise shown on the plans. A specific type of material transfer equipment shall be required when shown on the plans.

**C. Motor Grader.** The motor grader, when used, shall meet the requirements as shown in Item 220, "Blading."

**D. Rollers.** Rollers provided shall meet the requirements for their type as shown in Item 210, "Rolling."

**205.4. CONSTRUCTION:** It shall be the responsibility of the Contractor to design, produce, transport, place and compact the specified paving mixture in accordance with the requirements herein. The Engineer will perform verification testing as needed. Provide quality control (QC) testing as needed to meet the requirements of this Item. Provide a certified Level I-A specialist at the plant during production hours. Provide a certified Level I-B specialist to conduct placement tests.

**A. Quality Control Plan (QCP).** Unless otherwise shown on the plans, develop and follow a QCP. Obtain approval from the Engineer for changes to the QCP made during the project. The Engineer may suspend operations if the Contractor fails to comply with the QCP.

Submit a written QCP to the Engineer and receive the Engineer's approval of the QCP before beginning production. Include the following items in the QCP.

**1. Project Personnel.** Provide:

- a. a list of individuals that will conduct tests as well their associated certifications (i.e. Level IA, IB, and II certifications), including when certifications will expire for each individual; and
- b. a list of individuals responsible for QC with authority to take corrective action and the contact information for each individual listed.

**2. Material Delivery and Storage.** Provide:

- a. the sequence of material processing, delivery, and minimum quantities to assure continuous plant operations;
- b. aggregate stockpiling procedures to avoid contamination and segregation;
- c. frequency, type, and timing of aggregate stockpile testing to assure conformance of material requirements before mixture production; and
- d. procedure for monitoring the quality and variability of asphalt binder.

**3. Production.** Detail:

- a. loader operation procedures to avoid contamination in cold bins;
- b. procedures for calibrating and controlling cold feeds;
- c. procedures to eliminate debris or oversized material;
- d. procedures for adding and verifying rates of each applicable mixture component (e.g., aggregate, asphalt binder, RAP, lime, liquid antistriper);
- e. procedures for reporting job control and acceptance test results; and
- f. procedures to avoid segregation and drain-down in the silo.

**4. Loading and Transporting.** Provide:

- a. the type and application method for release agents; and

- b. truck loading procedures to avoid segregation.

**5. Placement and Compaction.** Provide:

- a. the proposed agenda for mandatory pre-paving meeting including date and location;
- b. the type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils;
- c. procedures for the transfer of mixture into the paver while avoiding segregation and preventing material spillage;
- d. the process to balance production, delivery, paving, and compaction to achieve continuous placement operations;
- e. the paver operations (e.g., operation of wings, height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities; and
- f. procedures to construct quality longitudinal and transverse joints.

- B. Mixture Design.** Use a Level II specialist certified by a TxDOT-approved hot-mix asphalt certification program to develop the mixture design. Have the Level II specialist sign the design documents. Unless otherwise shown on the plans, use the typical weight design example given in TxDOT standard laboratory test procedure Tex-204-F, Part I or Part III, to design a mixture meeting the requirements listed in Tables 1 through 5. At the request of the Engineer, furnish representative samples of all materials used in the mixture design for verification. If the design cannot be verified by the Engineer, furnish another mixture design.

The Contractor may submit a new mixture design at anytime during the project. The Engineer will approve all mixture designs before the Contractor can begin production.

Provide the Engineer with a mixture design report that includes the following items:

- the combined aggregate gradation, source, specific gravity, and percent of each material used;
- results of all applicable tests;
- the mixing and molding temperatures;
- all applicable correlation and correction factors;
- the signature of the Level II person or persons who performed the design;
- the date the mixture design was performed; and
- a unique identification number for the mixture design.

The Hamburg Wheel Test is not required, unless otherwise shown on the plans. When required through plan note, the minimum number of passes shown in Table 6 shall be met, unless otherwise approved by the Engineer. The contractor will be responsible for submitting the results of the Hamburg Wheel test to the Engineer with the other mixture design data. Use an approved laboratory to perform the Hamburg Wheel test. The TxDOT Construction

Division maintains a list of approved laboratories that may be referenced. Hamburg Wheel Testing will not be performed or required for any Type “F” mixtures.

**Table 4**  
**Master Gradation Bands (% Passing by Weight or Volume) and Volumetric Properties**

Sieve Size	A Coarse Base	B Fine Base	C Coarse Surface	D Fine Surface	F Fine Mixture
1-½”	98.0–100.0	–	–	–	–
1”	78.0–94.0	98.0–100.0	–	–	–
¾”	64.0–85.0	84.0–98.0	95.0–100.0	–	–
½”	50.0–70.0	–	–	98.0–100.0	–
⅜”	–	60.0–80.0	70.0–85.0	85.0–100.0	98.0–100.0
#4	30.0–50.0	40.0–60.0	43.0–63.0	50.0–70.0	70.0–90.0
#8	22.0–36.0	29.0–43.0	32.0–44.0	35.0–46.0	35.0–50.0
#30	8.0–23.0	13.0–28.0	14.0–28.0	15.0–29.0	12.0–27.0
#50	3.0–19.0	6.0–20.0	7.0–21.0	7.0–20.0	6.0–19.0
#200	2.0–7.0	2.0–7.0	2.0–7.0	2.0–7.0	2.0–7.0
<b>Design Voids in the Mineral Aggregate (VMA), % minimum</b>					
	12.0	13.0	14.0	15.0	16.0
<b>Plant-Produced Voids in the Mineral Aggregate (VMA), % minimum</b>					
	11.0	12.0	13.0	14.0	15.0

**Table 5**  
**Laboratory Mixture Design Properties**

Property	TxDOT Standard Laboratory Test Procedure	Required	
Target laboratory-molded density, %	Tex-207-F	96.5	Base, Binder, and Level Up Courses
		<b>Surface or Wearing Courses</b>	
		96.5	Primary and Secondary Arterials
		97.0	Collectors, Local Type B Streets, and Local Type A Street With Bus Traffic
		97.5	Local Type A Street Without Bus Traffic
Boil test <sup>1</sup>	Tex-530-C	–	

1. Used to establish baseline for comparison to production results. May be waived when approved.

**Table 6**  
**Hamburg Wheel Test Requirements<sup>1</sup>**

High-Temperature Binder Grade	Minimum # of Passes <sup>2</sup> @ 0.5" Rut Depth, Tested @ 122°F
PG 64 or lower	5,000
PG 70	10,000
PG 76 or higher	20,000

1. Tested in accordance with Tex-242-F.

2. May be decreased if shown on the plans.

**C. Job-Mix Formula.** The laboratory mixture design shall be submitted to the Engineer for approval prior to production and placement. The submittal shall provide the laboratory

designed mixture target properties and data that demonstrate the contractor's ability to produce the mixture within the tolerances specified in Table 7 herein either through a trial batch or by submittal of previous production data from a City or TxDOT project.

Once approved, the contractor may begin production and placement of the approved JMF. Results from Lot 1 of the JMF may be used to modify the optimum mixture properties as long as the tested properties are within the tolerances specified in Table 7 herein. Further adjustments to the JMF may be allowed by the Engineer during production and placement, if warranted. JMF adjustment requests must be made in writing to the Engineer and the mixture must conform to the master gradation limits for the mixture type and be within the operational limits of Table 7 noted above for the initial JMF approved by the Engineer.

**Table 7**  
**Operational Tolerances**

Description	Test Method	Allowable Difference from Current JMF Target
Individual % Retained for #8 Sieve or Larger	Tex-200-F or Tex-236-F	$\pm 5.0^1$
Individual % Retained for Sieves Smaller than #8 and Larger than #200		$\pm 3.0^1$
% Passing the #200 Sieve		$\pm 2.0^1$
Asphalt Content, %	Tex-236-F	$\pm 0.3^2$
Laboratory-Molded Density, %	Tex-207-F	$\pm 1.0$
VMA, % minimum		Note 3

Note 1: When within these tolerances, mixture production gradations may fall outside the master grading limits; however, the % passing the #200 sieve will be considered out of tolerance when outside the master grading limits.

Note 2: Tolerance between Laboratory Mix and Plant Trial Batch may exceed  $\pm 0.3$ .

Note 3: Test and verify that Table 4 requirements are met.

- D. Production.** Do not heat the asphalt binder above the temperatures specified in TxDOT Item 300, "Asphalts, Oils, and Emulsions," or outside the manufacturer's recommended values. Do not store an asphaltic mixture for a period long enough to affect the quality of the mixture, nor in any case longer than 12 hr.

Notify the Engineer of the target discharge temperature and produce the mixture within 25°F of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed 350°F. The Engineer will not pay for, or allow placement of, any mixture produced at more than 350°F. Control the mixing time and temperature so that moisture is removed from the mixture before discharging from the plant. If requested, determine the moisture content by oven-drying in accordance with TxDOT standard laboratory test procedure Tex-212-F, Part II, and verify that the mixture contains no more than 0.2% of moisture by weight. Obtain the sample immediately after discharging the mixture into the truck, and perform the test promptly.

Perform a new trial batch when the plant or plant location is changed. The Engineer may suspend production for noncompliance with this Item. Take corrective action and obtain approval to proceed after any production suspension for noncompliance.

- E. Tack Coat.** The surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the Inspector. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification. Unless otherwise shown on the plans, tack

coat shall be applied with an approved sprayer at a rate directed by the Engineer between 0.04 and 0.10 gallon residual asphalt per square yard of surface.

**F. Transporting Asphaltic Concrete.** The asphaltic mixture shall be hauled to the work site in vehicles previously cleaned of all foreign material and with beds that do not discharge or lose materials during the haul. Trucks that do not meet the satisfaction of the Engineer or Inspector will not be allowed to deliver materials to City projects. The dispatching of the vehicles shall be arranged so that all material is delivered, placed, and rolled during daylight hours unless otherwise shown on the plans. In cool weather, or for long hauls, covering and insulating of the truck bodies may be required. If necessary, to prevent the mixture from adhering to the inside of the truck body, the inside of the truck may be given a light coating of release agent satisfactory to the Engineer.

**G. Placement.**

**1. Weather Conditions.** Place mixture, when placed with a spreading and finishing machine, or the tack coat when the roadway surface temperature is 60°F or higher unless otherwise approved. Measure the roadway surface temperature with a handheld infrared thermometer. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the Engineer.

The asphaltic mixture, when placed with a motor grader, shall not be placed when the surface temperature is below 65°F and is falling, but may be placed when the surface temperature is above 55°F and is rising. The maximum depth of asphalt mixture placed with a motor grader will not exceed 5 inches of compacted material.

Mat thicknesses of 1-½ inches and less shall not be placed when the temperature of the surface on which the mat is to be placed is below 60°F.

It is further provided that the tack coat or asphaltic mixture shall be placed only when the humidity, general weather conditions, temperature and moisture condition of the base are suitable.

**2. Placement Temperature.** If, after being discharged from the mixer and prior to placing, the temperature of the asphaltic mixture falls below 200°F, all or any part of the load may be rejected and payment will not be made for the rejected material.

**3. Placement Operations.** Placement and laydown operations shall be in conformance with this section and Section 205.4.H. - "Quality Control and Acceptance."

Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges.

The asphaltic mixture shall be dumped and spread on the approved prepared surface with the spreading and finishing machine. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. In addition, the placing of the asphaltic mixture shall be completed without tearing, shoving, gouging or segregating the mixture and without producing streaks in the mat.



Unloading into the finishing machine shall be controlled so that bouncing or jarring the spreading and finishing machine shall not occur and the required lines and grades shall be obtained without resorting to hand finishing.

When approved by the Engineer, level-up courses may be spread with a motor grader.

Construction joints of successive courses of asphaltic material shall be offset at least 6 inches. Construction joints on surface courses shall coincide with lane lines, or as directed by the Engineer.

The spreading and finishing machine shall be operated at a uniform forward speed consistent with the plant production rate, hauling capability, and roller train capacity to result in a continuous operation. The speed shall be slow enough that stopping between trucks is not ordinarily required. If, in the opinion of the Inspector, sporadic delivery of material is adversely affecting the mat, the Inspector may require paving operations to cease until acceptable methods are provided to minimize starting and stopping of the paver.

The hopper flow gates of the spreading and finishing machine shall be adjusted to provide an adequate and consistent flow of material. These shall result in enough material being delivered to the augers so that they are operating approximately 85 percent of the time or more. The augers shall provide means to supply adequate flow of material to the center of the paver. Augers shall supply an adequate flow of material for the full width of the mat, as approved by the Engineer. Augers should be kept approximately one-half to three-quarters full of mixture at all times during the paving operation.

When the asphaltic mixture is placed in a narrow strip along the edge of an existing pavement, or used to level up small areas of an existing pavement, or placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated when authorized by the Engineer.

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

If a pattern of surface irregularities or segregation is detected, the Contractor shall make an investigation into the causes and immediately take the necessary action. With the approval of the Inspector, placement may continue for no more than one full production day from the time the Contractor is first notified and while corrective actions are being taken. If the problem still exists after that time, paving shall cease until the Contractor further investigates the causes and the Engineer approves further corrective action to be taken.

Place mixture within the compacted lift thickness shown in Table 8, unless otherwise shown on the plans or allowed.

Use the guidelines in Table 9 to establish the temperature of mixture delivered to the paver.

**Table 8**  
**Compacted Lift Thickness and Required Core Height**

Mixture Type	Compacted Lift Thickness		Minimum Untrimmed Core Height (in.) Eligible for Testing
	Minimum (in.)	Maximum (in.)	
A	3.00	6.00	2.00
B	2.50	5.00	1.75
C	2.00	4.00	1.50
D	1.50	3.00	1.25
F	1.25	2.50	1.25

**Table 9**  
**Suggested Minimum Mixture Placement Temperature**

High-Temperature Binder Grade	Minimum Placement Temperature (Before Entering Paver)
PG 64 or lower	260°F
PG 70	270°F
PG 76	280°F
PG 82 or higher	290°F

- 4. Compaction.** The pavement shall be compacted thoroughly and uniformly with the necessary rollers to obtain the compaction and cross section of the finished paving mixture meeting the requirements of the plans and specifications.

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

Rolling with a trench roller will be required on widened areas, in trenches and other limited areas where satisfactory compaction cannot be obtained with the approved rollers.

- a. In-Place Compaction Control.** Use density control unless ordinary compaction control is specified on the plans. Use the control strip method given in Tex-207-F, Part IV, to establish the rolling pattern for density controlled areas.

Where specific density or air void requirements are waived, furnish and operate compaction equipment as approved.

Do not use pneumatic-tire rollers if excessive pickup of fines by roller tires occurs. Unless otherwise directed, use only water or an approved release agent on rollers, tamps, and other compaction equipment. Keep diesel, gasoline, oil, grease, and other foreign matter off the mixture.

When rolling with the three-wheel, tandem or vibratory rollers, it is recommended that rolling start by first rolling the joint with the adjacent pavement and then continue by rolling longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least 1 foot. Alternate trips of the roller should be slightly different in length. On super-elevated curves, rolling should begin at the low side and progress toward the high side.

When rolling with vibratory steel-wheel rollers, equipment operation shall be in accordance with Item 210, "Rolling", and the manufacturer's recommendations, unless otherwise directed by the Engineer. Vibratory rollers shall not be left vibrating

while not rolling or when changing directions. In addition, vibratory rollers shall not be allowed in the vibrating mode on mats with a plan depth of less than 1-½ inches, unless approved by the Engineer.

The motion of the rollers shall be slow enough to avoid other than usual initial displacement of the mixture. If any displacement occurs, it shall be corrected to the satisfaction of the Inspector. Ensure pavement is fully compacted before allowing rollers to stand on the pavement.

**(1) Ordinary Compaction Control.** One three-wheel roller, one pneumatic-tire roller, and one tandem roller shall be furnished for each compaction operation except as provided below or approved by the Engineer. The use of a tandem roller may be waived by the Engineer when the surface is already adequately smooth and further steel-wheel rolling is shown to be ineffective. With approval of the Engineer, the Contractor may substitute a vibratory roller for the three-wheel roller and/or the tandem roller. Use of at least one pneumatic-tire roller is required unless approved by the Engineer. Additional or heavier rollers shall be furnished if required by the Engineer.

Rolling patterns shall be established by the Contractor to achieve the maximum compaction. The selected rolling pattern shall be followed unless changes in the mixture or placement conditions occur which affect compaction. When changes in the mixture or placement conditions occur, a new rolling pattern shall be established.

**(2) Density Compaction Control.** Place and compact asphaltic concrete materials in accordance with the method specified in Section 205.4.H, “Quality Control and Acceptance.”

- 5. Compaction Cessation Temperature.** Regardless of the method required for in-place compaction control, all rolling for compaction shall be completed before the mixture temperature drops below 175°F.
- 6. Opening to Traffic.** Allow the compacted pavement to cool to 160°F or lower before opening to traffic unless otherwise directed. When directed, sprinkle the finished mat with water or limewater to expedite opening the roadway to traffic.

If the surface ravel, flushes, ruts or deteriorates in any manner prior to final acceptance of the work, it will be the Contractor's responsibility to correct this condition at their expense, to the satisfaction of the Inspector and in conformance with the requirements of this specification.

**H. Quality Control and Acceptance.** Control and acceptance of hot mixed asphaltic concrete pavement shall be followed as specified herein or as directed on the plans. The contractor shall conduct production and placement operations in accordance with the method specified. All testing will be conducted in accordance with the testing methods shown in Table 10.

**Table 10**  
**Acceptable Production and Placement Testing Methods**

Description	Test Method
Gradation including % passing the #200 sieve	Tex-200-F or Tex-236-F
Laboratory-molded density	Tex-207-F
VMA	
Laboratory-molded bulk specific gravity	
In-Place air voids	
Segregation (density profile)	Tex-207-F, Part V
Longitudinal joint density	Tex-207-F, Part VII
Moisture content	Tex-212-F, Part II
Theoretical maximum specific (Rice) gravity	Tex-227-F
Asphalt content	Tex-236-F
Hamburg Wheel test	Tex-242-F
Thermal profile	Tex-244-F
Asphalt binder sampling and testing <sup>1</sup>	Tex-500-C
Boil test <sup>1</sup>	Tex-530-C

1. The Engineer may waive the sampling and testing requirements at their discretion.

- 1. Production Sampling and Testing.** For a given project, sample asphaltic concrete materials at the production facility every 500 tons for each mixture type supplied or as directed by the Engineer. Unless otherwise shown on the plans, a production facility that supplies the same mixture to multiple City projects on the same day will not be required to sample and test at the required frequency for every project. A single test report may be used on two or more projects to represent the quality of the mixture for that day's production.

During production, do not exceed the operational tolerances in Table 7. Stop production if testing indicates tolerances are exceeded on:

- 3 consecutive tests on any individual sieve,
- 4 consecutive tests on any of the sieves, or
- 2 consecutive tests on asphalt content.

Suspend production and shipment of mixture if the asphalt content deviates from the current JMF by more than 0.5% for any test.

Begin production only when test results or other information indicate, to the satisfaction of the Engineer, that the next mixture produced will be within Table 7 tolerances.

The Contractor shall perform a Hamburg Wheel test at the direction of the Engineer at any time during production, including when the boil test indicates a change in quality from the materials submitted for the initial JMF. If the production sample fails the Hamburg Wheel test criteria in Table 6, suspend production until further Hamburg Wheel tests meet the specified values. The Engineer may require up to the entire subplot of any mixture failing the Hamburg Wheel test to be removed and replaced at the Contractor's expense.

If the Hamburg Wheel test results in a "remove and replace" condition, the Contractor may request that the Engineer confirm the results by retesting the failing material. An Independent laboratory retained by the Engineer will perform the Hamburg Wheel tests

and determine the final disposition of the material in question based on the initial test results.

## 2. Placement Sampling and Testing.

- a. **In-Place Density.** For every 500 tons of compacted asphaltic material or as directed by the Engineer, test the in place density. The in place density shall be in the range of 92.0% to 97.0% of the maximum density. Do not increase the asphalt content of the mixture to increase pavement density.

Unless otherwise shown on the plans, obtain 2 roadway specimens at each location selected by the Engineer for in-place density determination. Unless otherwise determined, the Engineer will witness the coring operation and measurement of the core thickness. Unless otherwise approved, obtain the cores within 1 working day after placement is completed. Obtain two 6 inch diameter cores side-by-side from within 1 foot of the location provided by the Engineer. For Type C, D and F mixtures, 4 inch diameter cores are allowed. Mark the cores for identification.

Visually inspect each core and verify that the current paving layer is bonded to the underlying layer. If an adequate bond does not exist between the current and underlying layer, take corrective action to insure that an adequate bond will be achieved during subsequent placement operations.

Immediately after obtaining the cores, dry the core holes and tack the sides and bottom. Fill the hole with the same type of mixture and properly compact the mixture. Repair core holes with other methods when approved.

If the core heights exceed the minimum untrimmed values listed in Table 8, trim the cores within 1 working day following placement operations unless otherwise approved. If the core height before trimming is less than the minimum untrimmed value shown in Table 8, decide whether or not to include the pair of cores in the density determination for that subplot. If the cores are to be included in density determination, trim the cores. If the cores will not be included in density determination, store untrimmed cores for the Engineer.

The Engineer will measure density in accordance with Tex-207-F and Tex-227-F. Before drying to a constant weight, cores may be predried using a vacuum device, or by other methods approved by the Engineer, to remove excess moisture. The Engineer will use the average density of the 2 cores to calculate the in-place density at the selected location.

If the in-place density in the compacted mixture is below 92% or greater than 97%, change the production and placement operations to bring the in-place density within requirements. The Engineer may suspend production until the in-place density is brought to the required level, and may require a test section as described below, before proceeding.

At the onset of production, or after production and placement operations have been altered to bring the in-place density into conformance, construct a test section of 1 lane-width and at most 0.2 miles in length to demonstrate that compaction to between 92.0% and 97.0% in-place density can be obtained. Continue this procedure until a test section with the correct density can be produced. The Engineer will allow only 2

test sections per day. When a test section producing satisfactory in-place air void content is placed, resume full production.

- (1) **Shoulders and Ramps.** Shoulders and ramps are subject to in-place density testing, unless otherwise shown on the plans.
- (2) **Miscellaneous Areas.** Miscellaneous areas include areas that are not generally subject to primary traffic, such as driveways, mailbox turnouts, crossovers, gores, spot level-up areas, and other similar areas. Miscellaneous areas also include level-ups and thin overlays if the layer thickness designated on the plans is less than the compacted lift thickness shown in Table 8.

Miscellaneous areas will not be included in the in place density testing. Compact areas that are not subject to in-place air void determination in accordance with ordinary compaction control.

- b. **Segregation (Density Profile).** If shown on the plans, test for segregation using density profiles in accordance with Tex-207-F, Part V. Provide the Engineer with the results of the density profiles as they are completed. Areas defined as “Miscellaneous Areas,” are not subject to density profile testing.

If density profiles are required by the plans, perform a density profile every time the screed stops, on areas that are identified by either the Contractor or the Engineer as having thermal segregation, and on any visibly segregated areas. If the screed does not stop, and there are no visibly segregated areas or areas that are identified as having thermal segregation, perform a minimum of 1 profile per 500 tons of compacted material or as directed by the Engineer.

Reduce the test frequency to a minimum of 1 profile per 2,000 tons of compacted material, or as directed by the Engineer, if 4 consecutive profiles are within established tolerances. Continue testing at this frequency unless a profile fails, at which point resume testing at a minimum frequency of 1 per 500 tons or as directed by the Engineer. The Engineer may further reduce the testing frequency based on a consistent pattern of satisfactory results.

Unless otherwise shown on the plans, the density profile is considered failing if it exceeds the tolerances in Table 11. No production or placement bonus will be paid for any subplot that contains a failing density profile. The Engineer may make as many independent density profile verifications as deemed necessary. The Engineer’s density profile results will be used when available.

Investigate density profile failures and take corrective actions during production and placement to eliminate the segregation. Suspend production if 2 consecutive density profiles fail, unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

**Table 11**  
**Segregation (Density Profile) Acceptance Criteria**

Mixture Type	Maximum Allowable Density Range (Highest to Lowest)	Maximum Allowable Density Range (Average to Lowest)
Type A & Type B	8.0 pcf	5.0 pcf
Type C, Type D, & Type F	6.0 pcf	3.0 pcf

**c. Longitudinal Joint Density.**

- (1) **Informational Tests.** While establishing the rolling pattern, perform joint density evaluations and verify that the joint density is no more than 3.0 pounds per cubic foot below the density taken at or near the center of the mat. Adjust the rolling pattern if needed to achieve the desired joint density. Perform additional joint density evaluations at least once per subplot unless otherwise directed.
- (2) **Record Tests.** If shown on the plans, for each 500 tons of compacted material or as directed by the Engineer, perform a joint density evaluation at each pavement edge that is or will become a longitudinal joint. Determine the joint density in accordance with Tex-207-F, Part VII. Record the joint density information and submit results to the Engineer. The evaluation is considered failing if the joint density is more than 3.0 pounds per cubic foot below the density taken at the core random sample location and the correlated joint density is less than 90.0%. The Engineer may make independent joint density verifications at the random sample locations. The Engineer's joint density test results will be used when available.

Investigate joint density failures and take corrective actions during production and placement to improve the joint density. Suspend production if 2 consecutive evaluations fail unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

- d. Recovered Asphalt DSR.** The Engineer may take production samples or cores from suspect areas of the project to determine recovered asphalt properties. Asphalt binders with an aging ratio greater than 3.5 do not meet the requirements for recovered asphalt properties and may be deemed defective when tested and evaluated by the Engineer. The aging ratio is the dynamic shear rheometer (DSR) value of the extracted binder divided by the DSR value of the original unaged binder (including RAP binder). DSR values are obtained according to AASHTO T 315 at the specified high temperature performance grade of the asphalt. The binder from RAP will be included proportionally as part of the original unaged binder. The Engineer may require removal and replacement of the defective material at the Contractor's expense. The asphalt binder will be recovered for testing from production samples or cores using Tex-211-F.
- e. Irregularities.** Immediately take corrective action if surface irregularities, including but not limited to segregation, rutting, raveling, flushing, fat spots, mat slippage, color, texture, roller marks, tears, gouges, streaks, or uncoated aggregate particles, are detected.

The Engineer may allow placement to continue for at most 1 day of production while taking appropriate action. If the problem still exists after that day, suspend paving until the problem is corrected to the satisfaction of the Engineer.

At the expense of the Contractor and to the satisfaction of the Engineer, remove and replace any mixture that does not bond to the existing pavement or that has other surface irregularities identified above.

- 3. Individual Loads of Hot Mix.** The Engineer can reject individual truckloads of hot mix. When a load of hot mix is rejected for reasons other than temperature, the Contractor may request that the rejected load be tested. Make this request within 4 hr. of rejection. The Engineer will sample and test the mixture. If test results are within the operational tolerances shown in Table 7, payment will be made for the load. If test results are not within operational tolerances, no payment will be made for the load and the Engineer may require removal.
  - 4. Ride Quality.** When required by the plans, measure ride quality in accordance with TxDOT Standard Specification Item 585, "Ride Quality for Pavement Surfaces." Surface Test Type A or B as well as Pay Schedule 1, 2, or 3 shall also be indicated on the plans.
- 205.5. MEASUREMENT:** Hot Mix Asphaltic Concrete Pavement shall be measured by square yard, complete in place, for the thickness specified on the plans. Limits of payment will be from face of curb to face of curb. Pavement area shall not exceed the limits shown on the plans without written authorization.
- 205.6. PAYMENT:** The work performed and materials furnished, as described by this item and measured as provided herein, shall be paid for at the contract unit bid price per square yard specified on the plans of "Hot Mix Asphaltic Concrete Pavement," which price shall be full compensation for furnishing and placing all materials, and for all labor, tools, equipment, and incidentals necessary to complete the work. The prime coat and tack coat, when required, shall be paid under the provisions of Item Nos. 202 and 203, respectively.

Trial batches will not be paid for unless they are incorporated into pavement work approved by the Engineer.

Pay adjustment for ride quality, when required on the plans, will be determined in accordance with TxDOT Standard Specification Item 585, "Ride Quality for Pavement Surfaces."

**205.7. BID ITEM:**

Item 205.1 - Hot Mix Asphaltic Pavement Type A - per square yard \_\_inches pavement thickness

Item 205.2 - Hot Mix Asphaltic Pavement Type B - per square yard \_\_inches pavement thickness

Item 205.3 - Hot Mix Asphaltic Pavement Type C - per square yard \_\_inches pavement thickness

Item 205.4 - Hot Mix Asphaltic Pavement Type D - per square yard \_\_inches pavement thickness

Item 205.5 - Hot Mix Asphaltic Pavement Type F - per square yard \_\_inches pavement thickness



## ITEM

### 209 CONCRETE PAVEMENT

**209.1. DESCRIPTION:** *Construct hydraulic cement concrete pavement with or without curbs on the concrete pavement.*

**209.2. MATERIALS:**

**A. Hydraulic Cement Concrete.** Provide hydraulic cement concrete in accordance with Item 300, "Concrete," except that strength over-design is not required. Provide Class P concrete designed to meet a minimum average compressive strength of 3,500 psi at 7-days or a minimum average compressive strength of 4,400 psi at 28-days. Test in accordance with TxDOT standard laboratory test procedure Tex-448-A or Tex-418-A.

When shown on the plans or allowed, provide Class HES concrete for very early opening of small pavement areas or leave-outs to traffic. Design Class HES to meet the requirements of Class P and a minimum average compressive strength of 2,600 psi in 24-hours, unless other early strength and time requirements are shown on the plans or allowed. No strength over-design is required. Type III cement is allowed for Class HES concrete.

Use Class A or P concrete for curbs that are placed separately from the pavement. Provide concrete that is workable and cohesive, possesses satisfactory finishing qualities, and conforms to the mix design and mix design slump.

**B. Reinforcing Steel.** Unless shown on the plans, provide Grade 60 deformed steel for bar reinforcement in accordance with Item 301, "Reinforcing Steel." Provide approved positioning and supporting devices (baskets and chairs) capable of securing and holding the reinforcing steel in proper position before and during paving in accordance with 209.B.3, "Positioning and Support Devices for Reinforcement and Joint Assemblies." Provide corrosion protection when shown on the plans.

**1. Dowels.** Provide smooth, straight dowels of the size shown on the plans, free of burrs, and conforming to the requirements of Item 301, "Reinforcing Steel." Coat dowels with a thin film of grease or other approved de-bonding material. Provide dowel caps on the lubricated end of each dowel bar used in an expansion joint. Provide dowel caps filled with a soft compressible material with enough range of movement to allow complete closure of the expansion joint.

**2. Tie Bars.** Provide straight deformed steel tie bars. Provide either multiple-piece tie bars or single-piece tie bars as shown on the plans. Provide multiple-piece tie bars composed of 2 pieces of deformed reinforcing steel with a coupling capable of developing a minimum tensile strength of 125% of the design yield strength of the deformed steel when tensile-tested in the assembled configuration. Provide a minimum length of 33 diameters of the deformed steel in each piece. Use multiple-piece tie bars from the list of "Prequalified Multiple Piece Tie Bar Producers" maintained by the TxDOT Construction Division, or submit samples for testing in accordance with TxDOT standard laboratory test procedure Tex-711-I. A laboratory test report from an independent laboratory that has conducted Tex-711-I on the unapproved multiple piece tie bar may also be submitted to the Engineer for consideration.

- C. Positioning and Support Devices for Reinforcement and Joint Assemblies.** These devices shall be of sufficient structural quality to prevent movement of the dowels or steel reinforcement during concrete placement and finishing. Devices shall be of a type approved by the Engineer.

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

Metal positioning and supporting devices for expansion and contraction joint assemblies (such as welded wire bar chairs, bar stakes, etc.) where used shall be as shown on the plans or may be similar devices of equivalent or greater strength, approved by the Engineer. The support devices shall secure the joint assembly and dowels within the allowable tolerances while providing no restraint against joint movement. Dowels used in joint assemblies shall be secured in parallel position by a transverse metal brace of the type and design shown on the plans, or may be secured by other devices approved by the Engineer. The devices shall provide positive mechanical connection between the brace and each unit (other than by wire tie) and prevent transverse movement of each load transmission device.

- D. Curing Materials.** Provide Type 2 membrane curing compound conforming to TxDOT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants." Provide SS-1 emulsified asphalt conforming to TxDOT Item 300, "Asphalts, Oils, and Emulsions," for concrete pavement to be overlaid with asphalt concrete under this Contract unless otherwise shown on the plans or approved. Provide materials for other methods of curing conforming to the requirements of Item 307, "Concrete Structures."
- E. Epoxy.** Provide Type III epoxy in accordance with TxDOT DMS-6100, "Epoxies and Adhesives," for installing all drilled-in reinforcing steel.
- F. Evaporation Retardant.** Provide evaporation retardant conforming to TxDOT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."
- G. Joint Sealants and Fillers.** Provide Class 5 or Class 8 joint-sealant materials and fillers unless otherwise shown on the plans or approved and other sealant materials of the size, shape, and type shown on the plans in accordance with TxDOT DMS-6310, "Joint Sealants and Fillers."
- 209.3. EQUIPMENT:** Furnish and maintain all equipment in good working condition. Use measuring, mixing, and delivery equipment conforming to the requirements of Item 300, "Concrete." Obtain approval for other equipment used.
- A. Placing, Consolidating, and Finishing Equipment.** Provide approved self-propelled paving equipment that uniformly distributes the concrete with minimal segregation and provides a smooth machine-finished consolidated concrete pavement conforming to plan line and grade. Provide an approved automatic grade control system on slip-forming equipment. Provide approved mechanically operated finishing floats capable of producing a uniformly smooth pavement surface. Provide equipment capable of providing a fine, light water fog mist.

Provide mechanically operated vibratory equipment capable of adequately consolidating the concrete. Provide immersion vibrators on the paving equipment at sufficiently close intervals to provide uniform vibration and consolidation of the concrete over the entire width and depth of the pavement and in accordance with the manufacturer's recommendations. Provide

immersion vibrator units that operate at a frequency in air of at least 8,000 cycles per minute. Provide enough hand-operated immersion vibrators for timely and proper consolidation of the concrete along forms, at joints and in areas not covered by other vibratory equipment. Surface vibrators may be used to supplement equipment-mounted immersion vibrators. Provide tachometers to verify the proper operation of all vibrators.

For small or irregular areas or when approved, the paving equipment described in this Section is not required.

**B. Forming Equipment.**

- 1. Pavement Forms.** Provide metal side forms of sufficient cross-section, strength, and rigidity to support the paving equipment and resist the impact and vibration of the operation without visible springing or settlement. Use forms that are free from detrimental kinks, bends, or warps that could affect ride quality or alignment. Provide flexible or curved metal or wood forms for curves of 100 foot radius or less.
- 2. Curb Forms.** Provide curb forms for separately placed curbs that are not slipformed that conform to the requirements of Item 500, "Concrete Curb, Gutter, and Concrete Curb and Gutter."

**C. Reinforcing Steel Inserting Equipment.** Provide inserting equipment that accurately inserts and positions reinforcing steel in the plastic concrete parallel to the profile grade and horizontal alignment in accordance to plan details.

**D. Texturing Equipment.**

- 1. Carpet Drag.** Provide a carpet drag mounted on a work bridge or a moveable support system. Provide a single piece of carpet of sufficient transverse length to span the full width of the pavement being placed and adjustable so that a sufficient longitudinal length of carpet is in contact with the concrete being placed to produce the desired texture. Obtain approval to vary the length and width of the carpet to accommodate specific applications. Use an artificial grass-type carpet having a molded polyethylene pile face with a blade length of  $\frac{5}{8}$  to 1 inch, a minimum weight of 70 oz. per square yard, and a strong, durable, rot-resistant backing material bonded to the facing.
- 2. Tining Equipment.** Provide a self-propelled transverse metal tine device equipped with 4 to 6 inch steel tines and with cross-section approximately  $\frac{1}{32}$  inch thick by  $\frac{1}{12}$  inch wide, spaced at 1 inch, center-to-center. Hand-operated tining equipment that produces an equivalent texture may be used only on small or irregularly shaped areas or, when permitted, in emergencies due to equipment breakdown.

**E. Curing Equipment.** Provide a self-propelled machine for applying membrane curing compound using mechanically pressurized spraying equipment with atomizing nozzles. Provide equipment and controls that maintain the required uniform rate of application over the entire paving area. Provide curing equipment that is independent of all other equipment when required to meet the requirements of Article 209.4.I, "Curing." Hand-operated pressurized spraying equipment with atomizing nozzles may be used on small or irregular areas or when permitted.

- F. Sawing Equipment.** Provide power-driven concrete saws to saw the joints shown on the plans. Provide standby power-driven concrete saws during concrete sawing operations. Provide adequate illumination for nighttime sawing.
  - G. Grinding Equipment.** When required, provide self propelled powered grinding equipment that is specifically designed to smooth and texture concrete pavement using circular diamond blades. Provide equipment with automatic grade control capable of grinding at least a 3 foot width longitudinally in each pass without damaging the concrete.
  - H. Testing Equipment.** Provide testing equipment regardless of job-control testing responsibilities in accordance with Item 300, "Concrete," unless otherwise shown in the plans or specified.
  - I. Coring Equipment.** When required, provide coring equipment capable of extracting cores in accordance with the requirements of TxDOT standard laboratory test procedure Tex-424-A.
  - J. Miscellaneous Equipment.** Furnish both 10 foot and 15 foot steel or magnesium long-handled standard straightedges. Furnish enough work bridges, long enough to span the pavement, for finishing and inspection operations. Furnish date stencils to impress pavement placement dates into the fresh concrete, with numerals approximately 2 inches high by 1 inch wide by ¼ inch deep.
- 209.4. CONSTRUCTION:** Obtain approval for adjustments to plan grade-line to maintain thickness over minor subgrade or base high spots while maintaining clearances and drainage. Maintain subgrade or base in a smooth, clean, compacted condition in conformity with the required section and established grade until the pavement concrete is placed. Keep subgrade or base damp with water sufficiently in advance of placing pavement concrete. Adequately light the active work areas for all nighttime operations. Provide and maintain tools and materials to perform testing.
- A. Paving and Quality Control Plan.** Unless otherwise shown on the plans, submit a paving and quality control plan for approval before beginning pavement construction operations. Include details of all operations in the concrete paving process, including longitudinal construction joint layout, sequencing, curing, lighting, early opening, leave-outs, sawing, inspection, testing, construction methods, other details and description of all equipment. List certified personnel performing the testing. Submit revisions to the paving and quality control plan for approval.
  - B. Job-Control Testing.** Unless otherwise shown on the plans, perform all fresh and hardened concrete job-control testing at the specified frequency. Provide job-control testing personnel meeting the requirements of Item 300, "Concrete." Provide and maintain testing equipment, including strength testing equipment at a location acceptable to the Engineer. Use of a commercial laboratory is acceptable. Maintain all testing equipment calibrated in accordance with pertinent test methods. Make strength-testing equipment available to the Engineer for verification testing.

Provide the Engineer the opportunity to witness all tests. The Engineer may require a retest if not given the opportunity to witness. Furnish a copy of all test results to the Engineer daily. Check the first few concrete loads for slump, air, and temperature on start-up production days to check for concrete conformance and consistency. Sample and prepare strength test specimens (2 specimens per test) on the first day of production and for each 3,000 square yards or fraction thereof of concrete pavement thereafter. Prepare at least 1 set of strength-test specimens for each production day. Perform slump, air, and temperature tests each time

strength specimens are made. Monitor concrete temperature to ensure that concrete is consistently within the temperature requirements. The Engineer will direct random job-control sampling and testing. Immediately investigate and take corrective action as approved if any Contractor test result, including tests performed for verification purposes, does not meet specification requirements.

When job-control testing by the Contractor is waived by the plans, the Engineer will perform the testing; however, this does not waive the Contractor's responsibility for providing materials and work in accordance with this Item.

- 1. Job-Control Strength.** Unless otherwise shown on the plans or permitted by the Engineer, use 7-day job-control concrete strength testing in accordance with TxDOT standard laboratory test procedure Tex-418-A.

For 7-day job-control by compressive strength, use a compressive strength of 3,200 psi or a lower job-control strength value proven to meet a 28-day compressive strength of 4,400 psi as correlated in accordance with TxDOT standard laboratory test procedure Tex-427-A.

Job control of concrete strength may be correlated to an age other than 7-days in accordance with TxDOT standard laboratory test procedure Tex-427-A when approved. Job-control strength of Class HES concrete is based on the required strength and time.

When a job-control concrete strength test value is more than 10% below the required job-control strength or when 3 consecutive job-control strength values fall below the required job-control strength, investigate the strength test procedures, the quality of materials, the concrete production operations, and other possible problem areas to determine the cause. Take necessary action to correct the problem, including redesign of the concrete mix if needed. The Engineer may suspend concrete paving if the Contractor is unable to identify, document, and correct the cause of low strength test values in a timely manner. If any job-control strength is more than 15% below the required job-control strength, the Engineer may evaluate the structural adequacy of the pavements. When directed, remove and replace pavements found to be structurally inadequate at no additional cost.

- 2. Split-Sample Verification Testing.** When indicated on the plans, perform split-sample verification testing with the Engineer on random samples taken and split by the Engineer at a rate of at least 1 for every 10 job-control samples. The Engineer will evaluate the results of split-sample verification testing. Immediately investigate and take corrective action as approved when results of split-sample verification testing differ more than the allowable differences shown in Table 1, or when the average of 10 job-control strength results and the Engineer's split-sample strength result differ by more than 10%.

**Table 1**  
**Verification Testing Limits**

<b>Test Method<sup>1</sup></b>	<b>Allowable Differences</b>
Temperature, Tex-422-A	2°F
Slump, Tex-415-A	1 inch
Air content, Tex-414-A or Tex-416-A	1%
Compressive strength, Tex-418-A	10%

<sup>1</sup> TxDOT standard laboratory test procedures

- C. Reinforcing Steel and Joint Assemblies.** Accurately place and secure in position all reinforcing steel as shown on the plans and in accordance with the requirements herein. Place dowels at mid-depth of the pavement slab, parallel to the surface. Place dowels for transverse contraction joints parallel to the pavement edge. Tolerances for location and alignment of dowels will be shown on the plans. Stagger the longitudinal reinforcement splices to avoid having more than  $\frac{1}{3}$  of the splices within a 2 foot longitudinal length of each lane of the pavement. Use multiple-piece tie bars or drill and epoxy grout tie bars at longitudinal construction joints. Verify that tie bars that are drilled and epoxied into concrete at longitudinal construction joints develop a pullout resistance equal to a minimum of  $\frac{3}{4}$  of the yield strength of the steel after 7-days. Test 15 bars using ASTM E-488, except that alternate approved equipment may be used. All 15 tested bars must meet the required pullout strength. If any of the test results do not meet the required minimum pullout strength, perform corrective measures to provide equivalent pullout resistance. Repair damage from testing. Acceptable corrective measures include but are not limited to installation of additional or longer tie bars.
- 1. Manual Placement.** Secure reinforcing bars at alternate intersections with wire ties or locking support chairs. Tie all splices with wire.
  - 2. Mechanical Placement.** If mechanical placement of reinforcement results in steel misalignment or improper location, poor concrete consolidation, or other inadequacies, complete the work using manual methods.
- D. Joints.** Install joints as shown on the plans. Joint sealants are not required on concrete pavement that is to be overlaid with asphaltic materials. Clean and seal joints in accordance with TxDOT Item 438, "Cleaning and Sealing Joints and Cracks (Rigid Pavement and Bridge Decks)." Repair excessive spalling of the joint saw groove using an approved method before installing the sealant. Seal all joints before opening the pavement to all traffic. When placing of concrete is stopped, install a rigid transverse bulkhead, accurately notched for the reinforcing steel and shaped accurately to the cross-section of the pavement.
- 1. Placing Reinforcement at Joints.** Where the plans require an assembly of parts at pavement joints, complete and place the assembly at the required location and elevation with all parts rigidly secured in the required position. Accurately notch joint materials for the reinforcing steel.
  - 2. Transverse Construction Joints.**
    - a. Jointed Concrete Pavement.** When the placing of concrete is intentionally stopped, install and rigidly secure a complete joint assembly and bulkhead in the planned transverse contraction joint location. When the placing of concrete is unintentionally

stopped, install a transverse construction joint either at a planned transverse contraction joint location or mid-slab between planned transverse contraction joints. For mid-slab construction joints, install tie bars of the size and spacing used in the longitudinal joints.

- b. Curb Joints.** Provide joints in the curb of the same type and location as the adjacent pavement. Use expansion joint material of the same thickness, type, and quality required for the pavement and of the section shown for the curb. Extend expansion joints through the curb. Construct curb joints at all transverse pavement joints. For non-monolithic curbs, place reinforcing steel into the plastic concrete pavement as shown on the plans unless otherwise approved. Form or saw the weakened plane joint across the full width of concrete pavement and through the monolithic curbs. Construct curb joints in accordance with Item 500, "Concrete Curb, Gutter, and Curb and Gutter."

- E. Placing and Removing Forms.** Use clean and oiled forms. Secure forms on a base or firm subgrade that is accurately graded and that provides stable support without deflection and movement by form riding equipment. Pin every form at least at the middle and near each end. Tightly join and key form sections together to prevent relative displacement.

Set side forms far enough in advance of concrete placement to permit inspection. Check conformity of the grade, alignment, and stability of forms immediately before placing concrete, and make all necessary corrections. Use a straightedge or other approved method to test the top of forms to ensure that the ride quality requirements for the completed pavement will be met. Stop paving operations if forms settle or deflect more than  $\frac{1}{8}$  inch under finishing operations. Reset forms to line and grade, and refinish the concrete surface to correct grade.

Avoid damage to the edge of the pavement when removing forms. Repair damage resulting from form removal and honeycombed areas with a mortar mix within 24 hours after form removal unless otherwise approved. Clean joint face and repair honeycombed or damaged areas within 24 hours after a bulkhead for a transverse construction joint has been removed unless otherwise approved. When forms are removed before 72 hours after concrete placement, promptly apply membrane curing compound to the edge of the concrete pavement.

Forms that are not the same depth as the pavement but are within 2 inches of that depth are permitted if the subbase is trenched or the full width and length of the form base is supported with a firm material to produce the required pavement thickness. Promptly repair the form trench after use. Use flexible or curved wood or metal forms for curves of 100 foot radius or less.

- F. Concrete Delivery.** Clean delivery equipment as necessary to prevent accumulation of old concrete before loading fresh concrete. Use agitated delivery equipment for concrete designed to have a slump of more than 5 inches. Segregated concrete is subject to rejection. Place agitated concrete within 60 minutes after batching. Place non-agitated concrete within 45 minutes after batching. In hot weather or under conditions causing quick setting of the concrete, times may be reduced by the Engineer. Time limitations may be extended if the Contractor can demonstrate that the concrete can be properly placed, consolidated, and finished without the use of additional water.

- G. Concrete Placement.** Do not allow the pavement edge to deviate from the established paving line by more than ½ inch at any point. Place the concrete as near as possible to its final location, and minimize segregation and re-handling. Where hand spreading is necessary, distribute concrete using shovels. Do not use rakes or vibrators to distribute concrete.
- 1. Pavement.** Consolidate all concrete by approved mechanical vibrators operated on the front of the paving equipment. Use immersion-type vibrators that simultaneously consolidate the full width of the placement when machine finishing. Keep vibrators from dislodging reinforcement. Use hand-operated vibrators to consolidate concrete in areas not accessible to the machine-mounted vibrators. Do not operate machine-mounted vibrators while the paving equipment is stationary. Vibrator operations are subject to review.
  - 2. Date Imprinting.** Imprint dates in the fresh concrete indicating the date of the concrete placement. Make impressions approximately 1 foot from the outside longitudinal construction joint or edge of pavement and approximately 1 foot from the transverse construction joint at the beginning of the placement day. Orient the impressions to be read from the outside shoulder in the direction of final traffic. Impress date in DD MM YY format. Imprinting of the Contractor name or logo in similar size characters to the date is allowed.
  - 3. Curbs.** Where curbs are placed separately, conform to the requirements of Item 500, “Concrete Curb, Gutter, and Curb and Gutter.”
  - 4. Temperature Restrictions.** Place concrete that is between 40°F and 95°F when measured in accordance with TxDOT standard laboratory test procedure Tex-422-A at the time of discharge, except that concrete may be used if it was already in transit when the temperature was found to exceed the allowable maximum. Take immediate corrective action or cease concrete production when the concrete temperature exceeds 95°F.

Do not place concrete when the ambient temperature in the shade is below 40°F and falling unless approved. Concrete may be placed when the ambient temperature in the shade is above 35°F and rising or above 40°F. When temperatures warrant protection against freezing, protect the pavement with an approved insulating material capable of protecting the concrete for the specified curing period. Submit for approval proposed measures to protect the concrete from anticipated freezing weather for the first 72-hours after placement. Repair or replace all concrete damaged by freezing.

- H. Spreading and Finishing.** Unless otherwise shown on the plans, finish all concrete pavements with approved self-propelled equipment. Use power-driven spreaders, power-driven vibrators, power-driven strike-off, and screed, or approved alternate equipment. Use the transverse finishing equipment to compact and strike off the concrete to the required section and grade without surface voids. Use float equipment for final finishing. Use concrete with a consistency that allows completion of all finishing operations without addition of water to the surface. Use the minimal amount of water fog mist necessary to maintain a moist surface. Reduce fogging if float or straightedge operations result in excess slurry.
- 1. Finished Surface.** Perform sufficient checks with long-handled 10 foot and 15 foot straightedges on the plastic concrete to ensure that the final surface is within the tolerances specified in Surface Test A in TxDOT standard test procedure Item 585, “Ride Quality for Pavement Surfaces.” Check with the straightedge parallel to the centerline.



2. **Maintenance of Surface Moisture.** Prevent surface drying of the pavement before application of the curing system by means that may include water fogging, the use of wind screens and the use of evaporation retardants. Apply evaporation retardant at the rate recommended by the manufacturer. Reapply the evaporation retardant as needed to maintain the concrete surface in a moist condition until curing system is applied. Do not use evaporation retardant as a finishing aid. Failure to take acceptable precautions to prevent surface drying of the pavement will be cause for shut down of pavement operations.
3. **Surface Texturing.** Complete final texturing before the concrete has attained its initial set. Drag the carpet longitudinally along the pavement surface with the carpet contact surface area adjusted to provide a satisfactory coarsely textured surface. Prevent the carpet from getting plugged with grout. Do not perform carpet dragging operations while there is excessive bleed water.

A metal-tine texture finish is required for all areas with a posted speed limit in excess of 45 mph. A metal-tine texture finish is required unless otherwise shown on the plans for areas with a posted speed limit less than 45 mph. Immediately following the carpet drag, apply a single coat of evaporation retardant at a rate recommended by the manufacturer. Provide the metal-tine finish immediately after the concrete surface has set enough for consistent tining. Operate the metal-tine device to obtain grooves spaced at 1 inch, approximately 3/16 inch deep, with a minimum depth of 1/8 inch, and approximately 1/12 inch wide. Do not overlap a previously tined area. Use manual methods to achieve similar results on ramps and other irregular sections of pavements. Repair damage to the edge of the slab and joints immediately after texturing. Do not tine pavement that will be overlaid or that is scheduled for blanket diamond grinding or shot blasting.

When carpet drag is the only surface texture required by the plans, ensure that adequate and consistent micro-texture is achieved by applying sufficient weight to the carpet and keeping the carpet from getting plugged with grout, as directed by the Engineer. Target a carpet drag texture of .04 inch, as measured by Tex-436-A Correct any location with a texture less than .03 inch by diamond grinding or shot blasting. The Engineer will determine the test locations at points located transversely to the direction of traffic in the outside wheel path.

4. **Small or Irregular Placements.** Where machine placements and finishing of concrete pavement are not practical, use hand equipment and procedures that produce a consolidated and finished pavement section to the line and grade.
  5. **Emergency Procedures.** Use hand-operated equipment for applying texture, evaporation retardant, and cure in the event of equipment breakdown.
- I. **Curing.** Keep the concrete pavement surface from drying as described in Section 209.4.H.2, "Maintenance of Surface Moisture," until the curing material has been applied. Maintain and promptly repair damage to curing materials on exposed surfaces of concrete pavement continuously for at least 3 curing days. A curing day is defined as a 24 hour period when either the temperature taken in the shade away from artificial heat is above 50°F for at least 19 hours or when the surface temperature of the concrete is maintained above 40°F for 24 hours. Curing begins when the concrete curing system has been applied. Stop concrete paving if curing compound is not being applied promptly and maintained adequately. Other methods of curing in accordance with Item 307, "Concrete Structures," may be used when specified or approved.

- 1. Membrane Curing.** Spray the concrete surface uniformly with 2 coats of membrane curing compound at an individual application rate of not more than 180 square feet per gallon. Do not allow the concrete surface to dry before applying the curing compound. Use a towel or absorptive fabric to remove any standing pools of bleed water that may be present on the surface before applying the curing compound. Apply the first coat within 10 min. after completing texturing operations. Apply the second coat within 30 minutes after completing texturing operations.

Before and during application, maintain curing compounds in a uniformly agitated condition, free of settlement. Do not thin or dilute the curing compound.

Where the coating shows discontinuities or other defects or if rain falls on the newly coated surface before the film has dried enough to resist damage, apply additional compound at the same rate of coverage to correct the damage. Ensure that the curing compound coats the sides of the tining grooves.

- 2. Asphalt Curing.** When an asphaltic concrete overlay is required, apply a uniform coating of asphalt curing at a rate of 90 to 180 square feet per gallon as required. Apply curing immediately after texturing and just after the free moisture (sheen) has disappeared. Obtain approval to add water to the emulsion to improve spray distribution. Maintain the asphalt application rate when using diluted emulsions. Maintain the emulsion in a mixed condition during application.
  - 3. Curing Class HES Concrete.** For all Class HES concrete pavement, provide membrane curing in accordance with Section 209.4.I.1, "Membrane Curing," followed promptly by water curing until opening strength is achieved but not less than 24 hours.
- J. Sawing Joints.** Saw joints to the depth shown on the plans as soon as sawing can be accomplished without damage to the pavement regardless of time of day or weather conditions. Some minor raveling of the saw cut is acceptable. Use a chalk line, string line, sawing template, or other approved method to provide a true joint alignment. Provide enough saws to match the paving production rate to ensure sawing completion at the earliest possible time to avoid uncontrolled cracking. Reduce paving production if necessary to ensure timely sawing of joints. Promptly restore membrane cure damaged within the first 72 hours of curing.
- K. Protection of Pavement and Opening to Traffic.** Testing for early opening is the responsibility of the Contractor regardless of job-control testing responsibilities unless otherwise shown in the plans or directed. Testing result interpretation for opening to traffic is subject to the approval of the Engineer.
- 1. Protection of Pavement.** Erect and maintain barricades and other standard and approved devices that will exclude all vehicles and equipment from the newly placed pavement for the periods specified. Before opening to traffic, protect the pavement from damage due to crossings using approved methods. Where a detour is not readily available or economically feasible, an occasional crossing of the roadway with overweight equipment may be permitted for relocating equipment only but not for hauling material. When an occasional crossing of overweight equipment is permitted, temporary matting or other approved methods may be required.

Maintain an adequate supply of sheeting or other material to cover and protect fresh concrete surface from weather damage. Apply as needed to protect the pavement surface from weather.

2. **Opening Pavement to All Traffic.** Pavement that is 7 days old may be opened to all traffic. Before opening to traffic, clean pavement, place stable material against the pavement edges, seal joints, and perform all other traffic safety related work.
3. **Opening Pavement to Construction Equipment.** Unless otherwise shown on the plans, concrete pavement may be opened early to concrete paving equipment and related delivery equipment after the concrete is at least 48 hours old and opening strength has been demonstrated in accordance with Section 209.4.K.4, "Early Opening to All Traffic," before curing is complete. Keep delivery equipment at least 2-feet from the edge of the concrete pavement. Keep tracks of the paving equipment at least 1 foot from the pavement edge. Protect textured surfaces from the paving equipment. Restore damaged membrane curing as soon as possible. Repair pavement damaged by paving or delivery equipment before opening to all traffic.
4. **Early Opening to All Traffic.** Concrete pavement may be opened after curing is complete and the concrete has attained a compressive strength of 2,800 psi, except that pavement using Class HES concrete may be opened after 24 hours if the specified strength is achieved.
  - a. **Strength Testing.** Test concrete specimens cured under the same conditions as the portion of the pavement involved.
  - b. **Maturity Method.** Unless otherwise shown on the plans, the maturity method, TxDOT standard laboratory test procedure Tex-426-A, may be used to estimate concrete strength for early opening pavement to traffic. Install at least 2 maturity thermocouples for each day's placement in areas where the maturity method will be used for early opening. Thermocouples, when used, will be installed near the day's final placement for areas being evaluated for early opening. Use test specimens to verify the strength-maturity relationship in accordance with TxDOT standard laboratory test procedure Tex-426-A, starting with the first day's placement corresponding to the early opening pavement section.

After the first day, verify the strength-maturity relationship at least every 10 days of production. Establish a new strength-maturity relationship when the strength specimens deviate more than 10% from the maturity-estimated strengths. Suspend use of the maturity method for opening pavements to traffic when the strength-maturity relationship deviates by more than 10% until a new strength-maturity relationship is established.

When the maturity method is used intermittently or for only specific areas, the frequency of verification will be as determined by the Engineer.

5. **Emergency Opening to Traffic.** Under emergency conditions, when the pavement is at least 72 hours old, open the pavement to traffic when directed in writing. Remove all obstructing materials, place stable material against the pavement edges, and perform other work involved in providing for the safety of traffic as required for emergency opening.

**L. Pavement Thickness.** Unless otherwise shown on the plans, the Engineer will perform 1 thickness test consisting of 1 reading at approximately the center of each lane every 500 feet or fraction thereof. The Engineer will check the thickness in accordance with TxDOT standard laboratory test procedure Tex-423-A unless other methods are shown on the plans. Core where directed in accordance with TxDOT standard laboratory test procedure Tex-424-A to verify deficiencies of more than 0.2 inch from plan thickness and to determine the limits of deficiencies of more than 0.75 inch from plan thickness. Fill core holes using a concrete mixture and method approved by the Engineer.

- 1. Thickness Deficiencies Greater than 0.2-inch.** When any depth test measured in accordance with TxDOT standard laboratory test procedure Tex-423-A is deficient by more than 0.2 inch from the plan thickness, take one 4-inch diameter core at that location to verify the measurement.

If the core is deficient by more than 0.2 inch but not by more than 0.75 inch from the plan thickness, take 2 additional cores from the unit (as defined in Section 209.4.L.3, "Pavement Units for Payment Adjustment") at intervals of at least 150 feet and at locations selected by the Engineer, and determine the thickness of the unit for payment purposes by averaging the length of the 3 cores. In calculations of the average thickness of this unit of pavement, measurements in excess of the specified thickness by more than 0.2 inch will be considered as the specified thickness plus 0.2 inch.

- 2. Thickness Deficiencies Greater than 0.75-inch.** If a core is deficient by more than 0.75 inch, take additional cores at 10 foot intervals in each direction parallel to the centerline to determine the boundary of the deficient area. The Engineer will evaluate any area of pavement found deficient in thickness by more than 0.75 inch but not more than 1 inch. As directed, remove and replace the deficient areas without additional compensation or retain deficient areas without compensation. Remove and replace any area of pavement found deficient in thickness by more than 1 inch without additional compensation.
- 3. Pavement Units for Payment Adjustment.** Limits for applying a payment adjustment for deficient pavement thickness from 0.2 inch to not more than 0.75 inch are 500-feet of pavement in each lane. Lane width will be as shown on typical sections and pavement design standards.

For greater than 0.75 inch deficient thickness, the limits for applying zero payment or requiring removal will be defined by coring or equivalent nondestructive means as determined by the Engineer. The remaining portion of the unit determined to be less than 0.75 inch deficient will be subject to the payment adjustment based on the average core thickness at each end of the 10 foot interval investigation as determined by the Engineer.

Shoulders will be measured for thickness unless otherwise shown on the plans. Shoulders 6 feet wide or wider will be considered as lanes. Shoulders less than 6 feet wide will be considered part of the adjacent lane.

Limits for applying payment adjustment for deficient pavement thickness for ramps, widenings, acceleration and deceleration lanes, and other miscellaneous areas are 500 feet in length. Areas less than 500 feet in length will be individually evaluated for payment adjustment based on the plan area.

**M. Ride Quality.** When required by the plans, measure ride quality in accordance with TxDOT Item 585, "Ride Quality for Pavement Surfaces." Surface Test Type A or B as well as Pay Schedule 1, 2, or 3 shall also be indicated on the plans.

**209.5. MEASUREMENT:** This Item will be measured as follows:

- A. Concrete Pavement.** Concrete pavement will be measured by the square yard of surface area in place. The surface area includes the portion of the pavement slab extending beneath the curb.
- B. Curb.** Curb on concrete pavement will be measured by the foot in place.

**209.6. PAYMENT:** Payment includes full compensation for materials, equipment, labor, tools, and incidentals.

- A. Concrete Pavement.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the adjusted unit price bid for "Concrete Pavement" of the type and depth specified as adjusted in accordance with Sections 209.6.B, "Deficient Thickness Adjustment" and 209.4.M, "Ride Quality."
- B. Deficient Thickness Adjustment.** Where the average thickness of pavement is deficient in thickness by more than 0.2 inch but not more than 0.75 inch, payment will be made using the adjustment factor as specified in Table 2 applied to the bid price for the deficient area for each unit as defined under Section 209.4.L.3, "Pavement Units for Payment Adjustment."

**Table 2**  
**Deficient Thickness Price Adjustment Factor (1 in = 25.4 mm)**

Deficiency in Thickness Determined by Cores (in.)	Proportional Part of Contract Price Allowed (adjustment factor)
Not deficient	1.00
Over 0.00 through 0.20	1.00
Over 0.20 through 0.30	0.80
Over 0.30 through 0.40	0.72
Over 0.40 through 0.50	0.68
Over 0.50 through 0.75	0.57

- C. Curb.** Work performed and furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Curb" of the type specified.

**209.7. BID ITEM:**

Item 209.1 - Concrete Pavement - per square yard at \_\_inches of depth

## ITEM

### 210 ROLLING

**210.1. DESCRIPTION:** *Compact embankment, subgrade, base, surface treatments, broken concrete pavement, or asphalt pavement using rollers. Break up asphalt mats, pit run material, or base materials.*

**210.2. EQUIPMENT:** The Contractor may use any type of roller to meet the production rates and quality requirements of the Contract unless otherwise shown on the plans or directed. When specific types of equipment are required, use equipment that meets the requirements of this Article. The Engineer may allow the use of rollers that operate in one direction only when turning does not affect the quality of work or encroach on traffic.

**Table 1**  
**Roller Requirements<sup>1</sup>**

Roller Type	Materials to be Compacted	Load (tons)	Contact Pressure	Roller Speed (mph)
Steel wheel	Embankment, subgrade, base, asphalt concrete	≥ 10	≥ 325 lb. per linear inch of wheel width	2–3
Tamping	Embankment, subgrade, base	–	125–550 psi per tamping foot	2–3
Heavy tamping	Embankment, subgrade, base	–	≤ 550 psi per tamping foot	2–3
Vibratory	Embankment, subgrade, base, asphalt concrete	Type A < 6 Type B > 6 Type C as shown on plans	Per equipment specification and as approved	As approved
Light pneumatic	Embankment, subgrade, base, surface treatment	4.5–9.0	≥ 45 psi	2–6
	Asphalt Concrete			4–12
Medium pneumatic	Same as light pneumatic	12–25	≥ 80 psi, as directed	Same as light pneumatic
Heavy pneumatic	Embankment, subgrade, base, previously broken concrete pavement, other pavements	≥ 25	≤ 150 psi	2–6
Grid	Embankment, base, breaking up existing asphalt mats or base	5–13	–	2–3

1. Unless otherwise specified in the Contract.

1 ton = 0.9 megagrams; 1 psi = 6.9 kPa, 1 lb = 0.45 kg, 1 in = 25.4 mm, 1 mph = 1 kph

**A. Static Steel Wheel Rollers.** Furnish single, double, or triple steel wheel, self-propelled power rollers weighing at least 10 tons capable of operating in a forward and backward

motion. Confirm all wheels are flat. When static steel wheel rollers are required, vibratory rollers in the static mode may be used.

For single steel wheel rollers, pneumatic rear wheels are allowed for embankment, subgrade, and base. For triple steel wheel rollers, provide rear wheels with a minimum diameter of 48 inches, a minimum width of 20 inches, and a minimum compression of 325 pounds per inch of wheel width.

**B. Tamping Rollers.** Furnish self-propelled rollers with at least 1 self-cleaning metal tamping drum capable of operating in a forward or backward motion with a minimum effective rolling width of 5 feet. For rollers with more than 1 drum, mount drums in a frame so that each drum moves independently of the other. Operate rollers in static or vibratory mode.

**1. Tamping Roller (Minimum Requirement).** For all tamping rollers except for heavy tamping rollers, provide tamping feet that exert a static load of 125 to 550 psi and extend outward at least 3 inches from the surface of the drum.

**2. Heavy Tamping Roller.** Provide tamping rollers that have:

- 2 metal tamping drums, rolls, or shells, each with a 60 inch minimum diameter and a 5 foot minimum width, or
- 1 rear and 2 forward drums, each with a 60 inch minimum diameter. Arrange drums so that the rear drum compacts the space between the 2 forward drums and the minimum overall rolling width is 10 feet.

Equip drums with tamping feet that:

- extend outward at least 7 inches from the drum surface,
- have an area of 7 to 21 square inches,
- are self-cleaning,
- exert a static load of at least 550 psi, and
- are spaced at 1 tamping foot per 0.65 to 0.70 square feet of drum area.

**C. Vibratory Rollers.** Furnish self-propelled rollers with at least 1 drum equipped to vibrate. Select and maintain amplitude and frequency settings per manufacturer's specifications to deliver maximum compaction without material displacement or shoving, as approved. Furnish the equipment manufacturer's specifications concerning settings and controls for amplitude and frequency. Operate rollers at speeds that will produce at least 10 blows per foot unless otherwise shown on the plans or approved. Pneumatic rear wheels are allowed for embankment, subgrade, and base. Equip each vibrating drum with:

- separate frequency and amplitude controls,
- controls to manually start and stop vibration, and
- a mechanism to continuously clean the face of the drum.

For asphalt-stabilized base and asphalt concrete pavement, furnish a roller that also has the ability to:

- automatically reverse the direction of the rotating eccentric weight,
  - stop vibration before the motion of the roller stops, and
  - thoroughly moisten the drum with water or approved asphalt release agent.
1. **Drum (Type A).** Furnish a roller with a static weight less than 6 tons and a vibratory drum.
  2. **Drum (Type B).** Furnish a roller with a minimum static weight of 6 tons and a vibratory drum.
  3. **Drum (Type C).** Furnish a roller as shown on plans.

**D. Pneumatic Tire Rollers.** Pneumatic tire rollers consist of rubber tire wheels on axles mounted in a frame with either a loading platform or body suitable for ballast loading. Arrange the rear tires to cover the gaps between adjacent tires of the forward group. Furnish rollers capable of forward and backward motion. Compact asphalt pavements and surface treatments with a roller equipped with smooth-tread tires. Compact without damaging the surface. When necessary, moisten the wheels with water or an approved asphalt release agent.

Select and maintain the operating load and tire air pressure within the range of the manufacturer's charts or tabulations to attain maximum compaction throughout the lift, as approved. Furnish the manufacturer's chart or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the particular tires furnished. Maintain individual tire inflation pressures within 5 psi of each other. Provide uniform compression under all tires.

1. **Light Pneumatic Tire.** Furnish a unit:

- with at least 9 pneumatic tires,
- with an effective rolling width of approximately 5 feet,
- capable of providing a total uniform load of 4.5 to 9 tons, and
- with tires capable of maintaining a minimum ground contact pressure of 45 psi.

2. **Medium Pneumatic Tire.** Furnish a unit:

- with at least 7 pneumatic tires,
- with an effective rolling width of approximately 7 feet,
- capable of providing a total uniform load of 12 to 25 tons, and
- with tires capable of maintaining a minimum ground contact pressure of 80 psi or 90 psi as directed.



**3. Heavy Pneumatic Tire.** Furnish a unit:

- with at least 4 pneumatic-tired wheels mounted on axles carrying at most 2 wheels,
- with wheels arranged to carry approximately equal loads on uneven surfaces,
- with a width between 8 and 10 feet that can turn 180° in the crown width,
- capable of providing a total uniform load of at least 25 tons,
- with tires capable of maintaining a maximum ground contact pressure of 150 psi, and
- with liquid-filled tires inflated to such a level that liquid will flow from the valve stem when the stem is in the uppermost position.

**E. Grid Rollers.** Furnish rollers that have 2 cylindrical cages with a minimum diameter of 66-inches and a minimum width of 32 inches. Mount cages in a rigid frame with weight boxes. Use a cage surface of cast or welded steel fabric grid with bars 1-½ inches wide, spaced on 5 inch centers in each direction, that undulate approximately 1-inch between the high and low points.

Furnish rollers capable of providing a total load of 5 to 13 tons and capable of being operated in a forward or backward motion

**F. Alternate Equipment.** Instead of the specified equipment, the Contractor may, as approved, operate other compaction equipment that produces equivalent results. Discontinue the use of the alternate equipment and furnish the specified equipment if the desired results are not achieved.

**210.2. CONSTRUCTION:** Perform this work in accordance with the applicable Items using equipment and roller speeds specified in Table 1. Use only rubber-tired equipment to push or pull compaction equipment on base courses. Use equipment that does not damage material being rolled.

**210.3. MEASUREMENT:** The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured directly but will be subsidiary to pertinent Items.

**210.4. PAYMENT:** The work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly but will be subsidiary to pertinent Items.

**210.5. BID ITEM:**

N/A

## ITEM

### 220 BLADING

- 220.1. DESCRIPTION:** *Blade portions of the project limits as shown on the plans or as directed by the Engineer.*
- 220.2. EQUIPMENT:** All equipment shall be approved by the Engineer prior to use and shall be able to efficiently produce the desired results. When work is measured and paid by the number of hours of blading, use a dual or four-wheel drive power maintainer equipped with pneumatic tires, a blade of at least 12 feet in length, and a wheelbase of not less than 16 feet. If the maintainer is not equipped with a scarifier attachment, provide a scarifier.
- 220.3. CONSTRUCTION:** Blade all areas to the section, line and grade shown on the plans. Use a scarifier when necessary to loosen materials prior to blading. Use hand methods or other means around structures, trees, and other obstructions if doing the work with a blade is impractical. Do not drag, push, or scrape material along or across completed pavement.
- 220.4. MEASUREMENT:** Unless otherwise shown on the plans as subsidiary to other pertinent items, this item will be measured by the 100-foot station, along the base line of each roadbed or by the number of hours of blading, including scarifying, performed. Roadbed is defined as the graded portion of a roadway prepared as foundation for the pavement structure and shoulders. On divided roadways, the depressed median type and the raised median type roadways are considered to have 2 roadbeds. Roadways with a flush median are considered to have 1 roadbed.
- 220.5. PAYMENT:** Unless otherwise shown on the plans as subsidiary to other items, the work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Blading." This price is full compensation for furnishing and operating equipment and for labor, materials, tools, and incidentals.

Work done by hand labor methods adjacent to structures, trees, and other obstructions is not paid for directly, but will be considered subsidiary to this Item. Work performed under this Item will not include work specified for payment under other Items.

**220.6. BID ITEM:**

N/A

## ITEM

### 230 BASE AND PAVEMENT REPLACEMENT

- 230.1. DESCRIPTION:** *Repair localized sections of flexible pavement and full depth repair of concrete pavement including subgrade, base, and surfacing as shown on the plans due to distress from traffic loading, environment, or other causes. Cutting and replacing existing pavements for utility trench construction (cuts up to 6 feet in width) is specified in Item 511, "Cutting and Replacing Pavements (Trench Repair)."*
- 230.2. MATERIALS:** Furnish materials in accordance with the requirements herein unless otherwise shown on the plans. Provide materials of the type and grade as shown on the plans and in accordance with the pertinent Items listed below:
- A. Embankment.** Item 107, "Embankment."
  - B. Lime Treated Subgrade.** Item 108, "Lime Treated Subgrade."
  - C. Cement Treated Subgrade.** Item 109, "Cement Treated Subgrade."
  - D. Flexible Base.** Item 200, "Flexible Base."
  - E. Cement Treated Base.** Item 201, "Cement Treated Base."
  - F. Asphalt Treated Base.** Item 206, "Asphalt Treated Base."
  - G. Prime Coat.** Item 202, "Prime Coat."
  - H. Surface Treatments.** Item 204, "Surface Treatments."
  - I. Hot Mix Asphaltic Concrete Pavement.** Item 205, "Hot Mixed Asphaltic Concrete Pavement."
  - J. Concrete Pavement.** Item 209, "Concrete Pavements."
  - K. Concrete.** Item 300, "Concrete."
  - L. Reinforcing Steel.** Item 301, "Reinforcing Steel."
  - M. Epoxy.** TxDOT DMS 6100, "Epoxies and Adhesives."
- 230.3. EQUIPMENT:** Furnish equipment in accordance with the pertinent Items. Use of a motor grader will be permitted for asphalt concrete pavement unless otherwise shown on the plans.
- 230.4. CONSTRUCTION:** Repair using one or more of the following operations as shown on the plans. Cut neat vertical faces around the perimeter of the work area when removing pavement structure layers. Removed materials are the property of the Contractor unless otherwise shown on the plans. Dispose of removed material in accordance with federal, state, and local regulations. Provide a smooth line and grade conforming to the adjacent pavement.
- A. Removing Pavement Structure.** All concrete and asphaltic concrete pavements shall be cut with a concrete saw or other approved equally capable equipment. If necessary, remove

adjacent soil and vegetation to prevent contamination of the repair area, and place it in a windrow. Do not damage adjacent pavement structure during repair operations.

1. **Existing Flexible Pavement.** The depth of the cut shall be such that upon removal of asphaltic concrete, the sides of the cut will be straight and square. Where existing base materials are to remain, pavements shall be removed to their full depth up to the top of the base material. Care shall be taken not to damage the existing base. If subgrade work is required, remove flexible pavement structure layers from work area.
2. **Existing Concrete Pavement.** Remove areas identified by the Engineer. Make repair areas rectangular, at least 6 feet long and at least ½ a full lane in width unless otherwise shown on the plans. Saw-cut and remove existing asphalt concrete overlay over the repair area and at least 6 inches outside each end of the repair area. Saw-cut full depth through the concrete around the perimeter of the repair area before removal. Do not spall or fracture concrete adjacent to the repair area. Schedule work so that concrete placement follows full-depth saw cutting by no more than 7 days unless otherwise shown on the plans or approved.

Remove or repair loose or damaged base material, and replace or repair it with approved base material to the original top of base grade. Place a polyethylene sheet at least 4 mils thick as a bond breaker at the interface of the base and new pavement. Allow concrete used as base material to attain sufficient strength to prevent displacement when placing pavement concrete.

- B. Preparing Subgrade.** Fill holes, ruts, and depressions with approved material. If required, thoroughly wet, reshape, and compact the subgrade as directed.

Where subgrade has failed, remove unstable subgrade material to the depth directed and replace with an approved material.

- C. Mixing and Placing Base Material.** Place, spread, and compact material in accordance with the applicable Item to the required or directed depth. For flexible pavement repair, when bituminous material is to remain in the pavement structure, pulverize to a maximum dimension of 2-½ inches and uniformly mix with existing base to the depth shown on the plans.

1. **Flexible Base.** Use existing base and add new flexible base as required in accordance with Item 200, "Flexible Base," and details shown on the plans to achieve required section.
2. **Cement-Treated Base.** Use existing base, add flexible base, and stabilize with a minimum cement content of 4% by weight of the total mixture. Construct in accordance with details shown on the plans and Item 201, "Cement Treated Base," to achieve required section.
3. **Asphalt-Treated Base.** Place asphalt-treated base in accordance with details shown on the plans and Item 206, "Asphalt Treated Base," or Item 205, "Hot Mix Asphaltic Concrete Pavement," to achieve required section.
4. **Concrete Base.** Unless otherwise shown on the plans or permitted, furnish pavement concrete for replacement base material when required. The Engineer may waive quality control tests for base material.

- D. Curing Base.** Cure in accordance with the appropriate Item unless otherwise directed or approved by the Engineer. Maintain completed base sections until surfacing.
- E. Surfacing.** Apply surfacing with materials as shown on the plans to the completed base section.
- 1. Prime Coat.** Protect the compacted, finished, and cured flexible or cement-treated base mixtures with a prime coat of the type and grade shown on the plans. Apply the prime coat at the rate shown on the plans.
  - 2. Surface Treatments.** Apply surface treatment with the type and grade of asphalt and aggregate as shown on the plans in accordance with Item 204, "Surface Treatments."
  - 3. Asphalt Concrete Pavement.** Apply tack coat of the type and grade and at the rate shown on the plans unless otherwise directed. Construct in accordance with Item 205, "Hot Mix Asphaltic Concrete Pavement," to achieve required section.
  - 4. Portland Cement Concrete Pavement.** Use only drilling operations that do not damage the surrounding operations when drilling holes for replacement steel. Place new deformed reinforcing steel bars of the same size and spacing as the bars removed or as shown on the plans. Lap all reinforcing steel splices in accordance with Item 301, "Reinforcing Steel." Place dowel bars and tiebars as shown on the plans. Epoxy-grout all tiebars for at least a 12 inch embedment into existing concrete. Completely fill the tiebar hole with Type III, Class A or Class C epoxy before inserting the tiebar into the hole.

Provide grout retention disks for all tiebar holes. Provide and place approved supports to firmly hold the new reinforcing steel, tiebars, and dowel bars in place. Demonstrate, through simulated job conditions, that the bond strength of the epoxy-grouted tiebars meets a pullout strength of at least  $\frac{3}{4}$  of the yield strength of the tiebar when tested in accordance with ASTM E 488 within 18 hr. after grouting. Increase embedment depth and retest when necessary to meet testing requirements. Perform tiebar testing before starting repair work.

If the time frame designated for opening to traffic is less than 72 hours after concrete placement, provide Class HES concrete designed to attain a minimum average flexural strength of 255 psi or a minimum average compressive strength of 1,800 psi within the designated time frame. Otherwise provide Class P concrete conforming to Item 209, "Concrete Pavement." Type III cement is permitted for Class HES concrete. Mix, place, cure, and test concrete to the requirements of Item 209, "Concrete Pavement," and Item 300, "Concrete," unless otherwise shown on the plans. Broom-finish the concrete surface unless otherwise shown on the plans.

Match the grade and alignment of existing concrete pavement. After concrete strength requirements have been met, replace any asphalt overlay and shoulder material removed with new asphalt concrete material in accordance with Item 205, "Hot Mixed Asphaltic Concrete Pavement."

For repair areas to be opened to traffic before 72 hours, use curing mats to maintain a minimum concrete surface temperature of 70°F when air temperature is less than 70°F. Cure repaired area for at least 72 hours or until overlaid with asphalt concrete, if required, or until the area is opened to traffic. Saw and seal contraction joints in the repair area in

accordance with Item 209, "Concrete Pavement." Remove repair area debris from the right of way each day.

- F. Finishing.** Regrade and compact disturbed topsoil. Clean roadway surface after repair operations.

**230.5. MEASUREMENT:**

- A. Flexible Pavement.** This Item will be measured by the square yard. In areas where material is excavated, as directed, to depths greater than those specified on the plans, measurement will be made by dividing the actual depth of such area by the plan depth and then multiplying this figure by the area in square yards of work performed. Calculations for each repaired area will be rounded up to the nearest 1/10 square yard. At each repair location, the minimum area for payment purposes will be 1 square yard.
- B. Concrete Pavement.** This Item will be measured by the square yard of concrete surface area repaired. No measurement will be made for areas damaged because of Contractor negligence.

**230.6. PAYMENT:**

- A. Flexible Pavement.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Flexible Pavement Structure Repair" of the specified depth. This price is full compensation for scarifying, removing, hauling, spreading, disposing of, and stockpiling existing pavement structure; removing objectionable or unstable material; furnishing and placing materials; maintaining completed section before surfacing; applying tack or prime coat; hauling, sprinkling, spreading, and compacting; and equipment, labor, tools, and incidentals.
- B. Concrete Pavement.** The work performed and the materials furnished in accordance with this Item and measured as specified under "Measurement" will be paid for at the unit price bid for "Concrete Full-Depth Repair" of the type and depth specified. This price is full compensation for removal, stockpiling, and disposal of waste material and for equipment, materials, labor, tools, and incidentals. Asphalt concrete, base material, and curbing will not be paid for directly but will be considered subsidiary to this Item.

**230.7. BID ITEM:**

Item 230.1 - Flexible Pavement Structure Repair - \_\_inches compacted depth - per square yard

Item 230.2 - Concrete Pavement Full-Depth Repair - \_\_inches compacted depth - per square yard

## ITEM

### 234 GEOGRID FOR BASE OR EMBANKMENT REINFORCEMENT

**234.1. DESCRIPTION:** *Furnish and place geogrid base reinforcement in accordance with the lines and grades shown on the plans or as directed by the Engineer.*

**234.2. MATERIALS:** Provide geogrid in conformance with the Items and requirements stated herein.

**A. Geogrid Reinforcement.** Texas Department of Transportation Materials Specification DMS 6240, "Geogrid for Base/Embankment Reinforcement," of the type as shown on the plans. The sampling, testing and rejection criteria of that specification shall govern.

**B. Unapproved Materials.** Material substitutions for geogrids not conforming to the physical requirements of TxDOT DMS 6240 must be submitted with an alternative design proposal to the Engineer for consideration. Alternate design proposals must be accompanied by the test data from an approved laboratory showing all design and index properties in accordance with the test properties shown in TxDOT DMS 6240. If approved, the Engineer will provide written authorization. Allow a minimum of 14 days for the approval process.

**234.3. CONSTRUCTION:**

**A.** Subgrade soil shall be prepared in accordance with Specifications Item 104, "Street Excavation" and Item 107, "Embankment," prior to placement of geogrid reinforcement.

**B.** Geogrid reinforcement shall be rolled out parallel to the road direction at the proper elevation and alignment as shown on the construction drawings.

**C.** Geogrid sections shall be overlapped a minimum of one 1 foot in both directions. Placement of geogrid around corners will require cutting of geogrid product and diagonal overlapping. Unless otherwise directed by the Engineer, plastic ties shall be used at overlaps. The transverse spacing of the ties shall be 4 to 5 feet and the longitudinal tie spacing shall be 10 to 20 feet, unless otherwise approved by the Engineer.

**D.** The geogrid shall be pinned at the beginning of the backfilling section, but shall be left free to stretch or relieve tension throughout the remainder of the work area.

**E.** Contractor shall take steps to ensure that geogrid sections do not separate at overlaps during construction.

**F.** Base material shall be placed and compacted in accordance with Specification Item 200, "Flexible Base." This material shall be back dumped from trucks riding on top of the reinforced base material and bladed on to the grid ahead.

**G.** If approved by the Engineer, geogrid may be placed directly under hot-mixed asphaltic concrete base in accordance with Specification Item 205, "Hot-Mixed Asphalt Concrete Pavement." The lift thickness of base material placed directly on the geogrid shall not be greater than 6 inches compacted. This material shall be back dumped from trucks riding on top of the reinforced base material and bladed on to the grid ahead.

**H.** Tracked construction equipment shall not operate directly upon the geogrid. A minimum base thickness of 6 inches is required prior to operation of trucked vehicles over the geogrid.

- I. Rubber tired equipment may pass over the geogrid at slow speeds, less than 5 miles per hour if the subgrade material is capable of supporting the loads without excessive rutting or causing damage to the grid. Equipment operators shall avoid sudden braking or sharp turning.
- J. If ruts are created in the base material due to construction traffic, they shall be filled with additional base material rather than blading adjacent material into the rut.
- K. Sections of geogrid, which are damaged by construction activity, shall be repaired or replaced at the Contractor's expense. All repaired sections shall contain a minimum 3 foot overlap in all directions.

**234.4. MEASUREMENT:** Accepted work as prescribed by this item will be measured by the square yard of base reinforcement complete in place in accordance with the plans with no allowance made for width of overlaps required.

**234.5. PAYMENT:** The work performed as prescribed by this item will be paid for at the contract unit price bid per square yard, measured as prescribed above, for "Base Reinforcement" which price shall be full compensation for furnishing all labor, materials, equipment and other items necessary and incidental to completion of work.

**234.6. BID ITEM:**

Item 234.1 - Base Reinforcement - per square yard



## DIVISION III - CONCRETE & CONCRETE STRUCTURES

### ITEM

### 300 CONCRETE

**300.1. DESCRIPTION:** *Furnish hydraulic cement concrete for concrete pavements, concrete structures, and other concrete construction.*

**300.2. MATERIALS:**

- A. Cement.** Furnish cement conforming to TxDOT's DMS-4600, "Hydraulic Cement."
- B. Supplementary Cementing Materials (SCM).**
1. **Fly Ash.** Furnish fly ash conforming to TxDOT's DMS-4610, "Fly Ash."
  2. **Ultra-Fine Fly Ash (UFFA).** Furnish UFFA conforming to TxDOT's DMS-4610, "Fly Ash."
  3. **Ground Granulated Blast-Furnace Slag (GGBFS).** Furnish GGBFS conforming to TxDOT's DMS-4620, "Ground Granulated Blast-Furnace Slag," Grade 100 or 120.
  4. **Silica Fume.** Furnish silica fume conforming to TxDOT's DMS-4630, "Silica Fume."
  5. **Metakaolin.** Furnish metakaolin conforming to TxDOT's DMS-4635, "Metakaolin."
- C. Chemical Admixtures.** Furnish admixtures conforming to TxDOT's DMS-4640, "Chemical Admixtures for Concrete." Do not use calcium chloride.
- D. 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. When using water from other sources, provide test reports showing compliance with Table 1 before use.

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)
Chloride (Cl)	ASTM C 114	
Prestressed concrete		500
Bridge decks and superstructure		500
All other concrete		1,000
Sulfate (SO <sub>4</sub> )	ASTM C 114	2,000
Alkalies (N <sub>A2</sub> O + 0.658K <sub>2</sub> O)	ASTM C 114	600
Total Solids	ASTM C 1603	50,000

**Table 2**  
**Acceptance Criteria for Questionable Water Supplies**

<b>Property</b>	<b>Test Method</b>	<b>Limits</b>
Compressive strength, min. % control at 7 days	ASTM C 31, ASTM C 39 <sup>1,2</sup>	90
Time of set, deviation from control, h:min.	ASTM C 403 <sup>1</sup>	From 1:00 early to 1:30 later

<sup>1</sup>. Base comparisons on fixed proportions and the same volume of test water compared to the control mix using 100% potable water or distilled water.

<sup>2</sup>. 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. When using white hydraulic cement, use mixing and curing water free of iron and other impurities that may cause staining or discoloration.

**E. Aggregate.** Supply aggregates that meet the definitions in TxDOT standard laboratory test procedure Tex-100-E. Provide coarse and fine aggregates from sources listed in TxDOT's Concrete Rated Source Quality Catalog (CRSQC). Provide aggregate from non-listed sources only when tested and approved by the Engineer before use. Allow 30 calendar days for the Engineer to sample, test, and report results for non-listed sources. Do not combine approved material with unapproved material.

**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 thereof that 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 that, when tested in accordance with TxDOT standard laboratory test procedure Tex-413-A, has:

- at most 0.25% by weight of clay lumps,
- at most 1.0% by weight of shale, and
- at most 5.0% by weight of laminated and friable particles.

Wear must not be more than 40% when tested in accordance with TxDOT standard laboratory test procedure Tex-410-A.

Unless otherwise shown on the plans, provide coarse aggregate with a 5 cycle magnesium sulfate soundness of not more than 18% when tested in accordance with TxDOT standard laboratory test procedure Tex-411-A. Crushed recycled hydraulic cement concrete is not subject to the 5 cycle soundness test.

The loss by decantation as tested in accordance with TxDOT standard laboratory test procedure Tex-406-A, plus the allowable weight of clay lumps, must not exceed 1.0% or the value shown on the plans, whichever is smaller. In the case of aggregates made primarily from crushing stone, if the material finer than the No. 200 sieve is established to be the dust of fracture and essentially free from clay or shale as established by TxDOT

standard laboratory test procedure Tex-406-A, Part III, the limit may be increased to 1.5%. When crushed limestone coarse aggregate is used in concrete pavements, the decant may exceed 1.0% but not more than 3.0% if the material finer than the No. 200 sieve is determined to be at least 67% calcium carbonate in accordance with TxDOT standard laboratory test procedure Tex-406-A, Part III.

Unless otherwise specified, provide aggregate conforming to the gradation requirements shown in Table 3 when tested in accordance with TxDOT standard laboratory test procedure Tex-401-A.

**Table 3**  
**Coarse Aggregate Gradation Chart**

Aggregate Grade No. <sup>1</sup>	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			0-5		
2 (467)	1-1/2"		100	95-100		35-70		10-30	0-5		
3	1-1/2"		100	95-100		60-90	25-60		0-5		
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 C 33 gradation shown in parentheses.

2. **Fine Aggregate.** Provide fine aggregate consisting of clean, hard, durable particles of natural or manufactured sand or a combination thereof with or without mineral filler. Provide fine aggregate free from frozen material and from injurious amounts of salt, alkali, vegetable matter, or other objectionable material, and containing no more than 0.5% clay lumps by weight in accordance with TxDOT standard laboratory test procedure Tex-413-A.

Provide fine aggregate that does not show a color darker than standard when subjected to the color test for organic impurities in accordance with TxDOT standard laboratory test procedure Tex-408-A.

Unless otherwise shown on the plans, use fine aggregate with an acid insoluble residue of at least 60% by weight when tested in accordance with TxDOT standard laboratory test procedure Tex-612-J in all concrete subject to direct traffic.

Unless otherwise shown on the plans, when necessary, blend the fine aggregate to meet the acid insoluble residue requirement. When blending, use the following equation:

$$\text{Acid insoluble (\%)} = \{(A1)(P1)+(A2)(P2)\}/100$$

where:

A1 = acid insoluble (%) of aggregate 1

A2 = acid insoluble (%) of aggregate 2

P1 = percent by weight of aggregate 1 of the fine aggregate blend

P2 = percent by weight of aggregate 2 of the fine aggregate blend

Provide fine aggregate or combinations of aggregates, including mineral filler, conforming to the gradation requirements shown in Table 4 when tested in accordance with TxDOT standard laboratory test procedure Tex-401-A unless otherwise specified.

**Table 4**  
**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 <sup>1</sup>
No. 100	0–10
No. 200	0–3 <sup>2</sup>

1. 6–35 when sand equivalent value is greater than 85.

2. 0–6 for manufactured sand.

Unless otherwise shown on the plans, provide fine aggregate with a sand equivalent of at least 80 in accordance with TxDOT standard laboratory test procedure Tex-203-F.

For all classes of concrete, provide fine aggregate with a fineness modulus between 2.30 and 3.10 as determined by TxDOT standard laboratory test procedure Tex-402-A.

- 3. Mineral Filler.** Provide mineral filler consisting of stone dust, clean crushed sand, or other approved inert material with 100% passing the No. 30 sieve and 65 to 100% passing the No. 200 sieve when tested in accordance with TxDOT standard laboratory test procedure Tex-401-A.
- F. Mortar and Grout.** When required or shown on the plans, provide mortar and grout consisting of 1 part hydraulic cement, 2 parts sand, and sufficient water to provide the desired consistency. Provide mortar with a consistency such that the mortar can be easily handled and spread by trowel. Provide grout of a consistency that will flow into and completely fill all voids. Section 300.4.A.6, “Mix Design Options,” does not apply for mortar and grout.

### 300.3. EQUIPMENT:

- A. Concrete Plants and Mixing Equipment.** Except for volumetric mixers (auger/mixer), each plant and truck mixer must be currently certified by the National Ready Mixed Concrete Association (NRMCA) or have an inspection report signed and sealed by a licensed professional engineer showing that concrete measuring, mixing, and delivery equipment meets all requirements of ASTM C-94. A new certification or signed and sealed report is required every time a plant is moved. Plants with a licensed engineer’s inspection require reinspection every 2-years. Provide a copy of the certification or the signed and sealed inspection report to the Engineer. When equipment or facilities fail to meet specification requirements, remove them from service until corrected. When allowed by the plans or the Engineer, for concrete classes not identified as structural concrete in Table 5 or for Class “C” concrete not used for bridge-class structures, the Engineer may inspect and approve all plants and trucks in lieu of the NRMCA or non-City engineer sealed certifications. The criteria and frequency of Engineer approval of plants and trucks is the same used for NRMCA certification.

1. **Scales.** Check all scales prior to beginning of operations, after each move, or whenever their accuracy or adequacy is questioned, and at least once every 6 months. Immediately correct deficiencies, and recalibrate. Provide a record of calibration showing scales in compliance with ASTM C-94 requirements. Check batching accuracy of volumetric water batching devices and admixture dispensing devices at least every 90 days. Perform daily checks as necessary to confirm measuring accuracy.
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 C-685. Provide test data showing mixers meet the uniformity test requirements of TxDOT standard laboratory test procedure Tex-472-A. Unless allowed by the plans or the Engineer, volumetric mixers may not supply classes of concrete identified as structural concrete in Table 5.
3. **Agitators and Truck and Stationary Mixers.** Inspect and furnish inspection reports on truck mixers and agitators annually. If an inspection within 12 months is not practical, a 2 month grace period (for a maximum of 14 months between inspections) is permitted. Include in the report the condition of blades and fins and their percent wear from the original manufacturer's design. Repair mixing equipment exhibiting 10% or more wear before use. Provide truck mixers and agitators equipped with means to readily verify the number of revolutions of the drum, blades, or paddles.

Provide stationary and truck mixers capable of combining the ingredients of the concrete within the specified time or the number of revolutions specified into a thoroughly mixed and uniform mass and capable of discharging the concrete so that at least 5 of the 6 requirements of TxDOT standard laboratory test procedure Tex-472-A are met.

As directed, to resolve issues of mix uniformity and mixer performance, perform concrete uniformity tests on mixers or agitators in accordance with TxDOT standard laboratory test procedure Tex-472-A.

Perform the mixer or agitator uniformity test at the full rated capacity of the equipment and within the maximum mixing time or maximum number of revolutions. Remove from service all equipment that fails the uniformity test.

Inspect and maintain mixers and agitators. Keep them reasonably free of concrete buildup, and repair or replace worn or damaged blades or fins.

Confirm all mixers have a plate affixed showing manufacturer's recommended operating speed and rated capacity for mixing and agitating.

Previous inspections performed for TxDOT are acceptable for submittal provided the inspection meets the 12-month inspection period referenced above.

- B. **Hauling Equipment.** Provide hauling equipment capable of maintaining the mixed concrete in a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

When using non-agitating equipment for transporting concrete, provide equipment with smooth, mortar-tight metal containers equipped with gates that prevent accidental discharge of the concrete.

**C. Testing Equipment.** Unless otherwise shown on the plans or specified, in accordance with the pertinent test procedure, furnish and maintain:

- test molds,
- curing facilities,
- maturity meters if used, and
- wheelbarrow or other container acceptable for the sampling of the concrete.

Provide strength-testing equipment in accordance with the Contract controlling test unless shown otherwise.

#### **300.4. CONSTRUCTION:**

**A. Classification and Mix Design.** Furnish mix designs using ACI 211, “Standard Practice for Selecting Proportions for Normal, Heavy Weight, and Mass Concrete,” or other approved procedures for the classes of concrete required in accordance with Table 5. Do not exceed the maximum water-to-cementitious-material ratio. Perform mix design and cement replacement using the design by weight method unless otherwise approved.

A higher-strength class of concrete with equal or lower water-to-cementitious-material ratio may be substituted for the specified class of concrete.

To account for production variability and confirm minimum compressive strength requirements are met, over-design the mix in accordance with Table 6.

**1. Cementitious Materials.** Use cementitious materials from TxDOT prequalified sources; otherwise, request sampling and testing for approval before use. Unless otherwise specified or approved, limit cementitious material content to no more than 700 pounds per cubic yard. When supplementary cementing materials are used, “cement” is defined as “cement plus supplementary cementing material.”

Use Type III cement only in precast concrete or when specified or permitted.

For monolithic placements, use cement of the same type and from the same source.

When sulfate-resistant concrete is required, use mix design options 1, 2, 3, or 4 given in Section 300.4.A.6, “Mix Design Options,” using Type I/II, II, V, IP, or IS cement. Do not use Class C fly ash in sulfate-resistant concrete.

Do not use supplementary cementing materials when white hydraulic cement is specified.

The upper limit of 35% replacement of cement with Class F fly ash specified by mix design options 1 and 3 may be increased to a maximum of 45% for mass placements, high performance concrete, and precast members when approved.

**Table 5**  
**Concrete Classes**

<b>Class of Concrete</b>	<b>Design Strength, Min. 28-day <math>f'_c</math> (psi)</b>	<b>Maximum W/C Ratio<sup>1</sup></b>	<b>Coarse Aggregate Grades<sup>2,3</sup></b>	<b>General Usage<sup>4</sup></b>
A	3,000	0.60	1–4, 8	Inlets, manholes, curb, gutter, curb & gutter, conc. retards, sidewalks, driveways, backup walls, anchors
B	2,000	0.60	2–7	Riprap, small roadside signs, and anchors
C <sup>5</sup>	3,600	0.45	1–6	Drilled shafts, bridge substructure, bridge railing, culverts except top slab of direct traffic culverts, headwalls, wing walls, approach slabs, concrete traffic barrier (cast-in-place)
C(HPC) <sup>5</sup>	3,600	0.45	1-6	As shown on the plans
D	1,500	0.60	2–7	Riprap
E	3,000	0.50	2–5	Seal concrete
F <sup>5</sup>	Note 6	0.45	2–5	Railroad structures; occasionally for bridge piers, columns, or bents
F(HPC) <sup>5</sup>	Note 6	0.45	2–5	As shown on the plans
H <sup>5</sup>	Note 6	0.45	3–6	Prestressed concrete beams, boxes, piling, and concrete traffic barrier (precast)
H(HPC) <sup>5</sup>	Note 6	0.45	3–6	As shown on the plans
S <sup>5</sup>	4,000	0.45	2–5	Bridge slabs, top slabs of direct traffic culverts
S(HPC) <sup>5</sup>	4,000	0.45	2-5	As shown on the plans
P	See Item 209	0.45	2–3	Concrete pavement, bus pads
DC <sup>5</sup>	5,500	0.40	6	Dense conc. overlay
CO <sup>5</sup>	4,600	0.40	6	Conc. overlay
LMC <sup>5</sup>	4,000	0.40	6–8	Latex-modified concrete overlay
SS <sup>5</sup>	3,600 <sup>7</sup>	0.45	4–6	Slurry displacement shafts, underwater drilled shafts
K <sup>5</sup>	Note 6	0.45	Note 6	Note 6
HES	Note 6	0.45	Note 6	Note 6

<sup>1</sup> Maximum water-cement or water-cementitious ratio by weight.

<sup>2</sup> Unless otherwise permitted, 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.

<sup>3</sup> Unless otherwise approved, use Grade 8 aggregate in extruded curbs.

<sup>4</sup> For information only.

<sup>5</sup> Structural concrete classes.

<sup>6</sup> As shown on the plans or specified.

<sup>7</sup> Use a minimum cementitious material content of 650 lb/cy of concrete. Do not apply Table 6 over design requirements to Class SS concrete.

**Table 6**  
**Over Design to Meet Compressive Strength Requirements<sup>1</sup>**

No. of Tests <sup>2,3</sup>	Standard Deviation, psi				
	300	400	500	600	700
15	470	620	850	1,120	1,390
20	430	580	760	1,010	1,260
30 or more	400	530	670	900	1,130

1. When designing the mix, add the tabulated amounts to the minimum design strength in Table 5.

2. Number of tests of a concrete mixture used to estimate the standard deviation of a concrete production facility. Test of another mix within 1,000 psi of the specified strength may be used.

3. If less than 15 prior tests are available, the overdesign should be 1,000 psi for specified strength less than 3,000 psi, 1,200 psi for specified strengths from 3,000 to 5,000 psi and 1,400 psi for specified strengths greater than 5,000 psi. For Class K and concrete classes not identified as structural concrete in Table 5 or for Class "C" concrete not used for bridge-class structures, the Engineer may designate on the plans an alternative over-design requirement up to and including 1,000 psi for specified strengths less than 3,000 psi and up to and including 1,200 psi for specified strengths from 3,000 to 5,000 psi.

2. **Aggregates.** Limit the use of recycled crushed hydraulic cement concrete as a coarse or fine aggregate to Class A, B, D, E, and P concrete. Limit recycled crushed concrete fine aggregate to a maximum of 20% of the fine aggregate.

When white hydraulic cement is specified, use light-colored aggregates.

3. **Chemical Admixtures.** Use only preapproved concrete chemical admixtures from the list of prequalified concrete admixtures maintained by the TxDOT Construction Division. Submit non-preapproved admixtures for testing to the Engineer for approval. Do not use high-range water-reducing admixtures (Type F or G) or accelerating admixtures (Type C or E) in bridge deck concrete.

When a corrosion-inhibiting admixture is required, use a 30% calcium nitrite solution. The corrosion inhibiting admixture must be set neutral unless otherwise approved. Dose the admixture at the rate of gallons of admixture per cubic yard of concrete shown on the plans.

4. **Slump.** Unless otherwise specified, provide concrete slump in accordance with Table 7 using the lowest slump possible that can be placed and finished efficiently without segregation or honeycombing.

Concrete that exceeds the maximum acceptable placement slump at time of delivery will be rejected.

When approved, the slump of a given concrete mix may be increased above the values shown in Table 8 using chemical admixtures, provided that the admixture-treated concrete has the same or lower water–cement or water–cementitious-material ratio and does not exhibit segregation or excessive bleeding. Request approval for the mix design sufficiently in advance for proper evaluation by the Engineer.



**Table 7  
Slump Requirements**

Concrete Designation	Recommended Design and Placement Slump, in.	Maximum Acceptable Placement Slump, in.
Drilled shafts	See TxDOT Item 416	See TxDOT Item 416
Thin walled section (9 in. or less)	4	6-1/2
Approach slabs, concrete overlays, caps, columns, piers, wall sections (over 9 in.)	3	5
Bridge slabs	4	5-1/2
Prestressed concrete members <sup>1</sup>	4	6-1/2
Concrete traffic barrier, concrete bridge railing	4	6-1/2
Dense concrete overlay	3/4	2
Latex-modified conc. for bridge deck overlays	3	7-1/2
Concrete placed underwater	6	8-1/2
Concrete pavement (slip-formed)	1-1/2	3
Concrete pavement (formed)	4	6-1/2
Riprap, curb, gutter, slip-formed, and extruded concrete	As approved	As approved

1. If a high-range water reducer (HRWR) is used, maximum acceptable placement slump will be 9 in.

- 5. Mix Design Options.** For structural concrete identified in Table 5 and any other class of concrete designed using more than 520 pounds of cementitious material per cubic yard, use one of the mix design Options 1–8 shown below.

For concrete classes not identified as structural concrete in Table 5 and designed using less than 520 pounds of cementitious material per cubic yard, use one of the mix design Options 1–8 shown below, except that Class C fly ash may be used instead of Class F fly ash for Options 1, 3, and 4 unless sulfate-resistant concrete is shown on the plans.

Do not use mix design options 6 or 7 when High Performance Concrete (HPC) is required. Option 8 may be used when HPC is required provided: a minimum of 20% of the cement is replaced with a Class C fly ash; TxDOT standard laboratory test procedure Tex-440-A, “Initial Time of Set of Fresh Concrete” is performed during mix design verification; the additional requirements for permeability are met; and the concrete is not required to be sulfate-resistant.

- a. Option 1.** Replace 20 to 35% of the cement with Class F fly ash.
- b. Option 2.** Replace 35 to 50% of the cement with GGBFS.
- c. Option 3.** Replace 35 to 50% of the cement with a combination of Class F fly ash, GGBFS, UFFA, metakaolin, or silica fume. However, no more than 35% may be fly ash, and no more than 10% may be silica fume.
- d. Option 4.** Use Type IP or Type IS cement. (Up to 10% of a Type IP or Type IS cement may be replaced with Class F fly ash, GGBFS, or silica fume.)

- e. **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.
- f. **Option 6.** Use a lithium nitrate admixture at a minimum dosage of 0.55 gallon of 30% lithium nitrate solution per pound of alkalis present in the hydraulic cement.
- g. **Option 7.** When using hydraulic cement only, confirm that the total alkali contribution from the cement in the concrete does not exceed 4.00 pounds per cubic yard of concrete when calculated as follows:

$$\text{lb. alkali per cu. yd.} = \frac{(\text{lb. cement per cu. yd.}) \times (\% \text{ Na}_2\text{O equivalent in cement})}{100}$$

In the above calculation, use the maximum cement alkali content reported on the cement mill certificate.

- h. **Option 8.** For any deviations from Options 1–7, perform testing on both coarse and fine aggregate separately in accordance with ASTM C 1567. Before use of the mix, provide a certified test report signed and sealed by a licensed professional engineer, from a laboratory on TxDOT's List of Approved ASTM C 1260 Laboratories, demonstrating that the ASTM C-1567 test result for each aggregate does not exceed 0.10% expansion.

When HPC is required, provide a certified test report signed and sealed by a licensed professional engineer demonstrating that AASHTO T 277 test results indicate the permeability of the concrete is less than 1,500 coulombs tested immediately after either of the following curing schedules:

- Moist cure specimens 56 days at 73°F.
- Moist cure specimens 7 days at 73°F followed by 21 days at 100°F.

- B. Trial Batches.** Perform all preliminary trial batches and testing necessary to substantiate the proposed mix designs, and provide documentation including mix design, material proportions, and test results substantiating that the mix design conforms to specification requirements. Once a trial batch substantiates the mix design, the proportions and mixing methods used in the trial batch become the mix design of record.

Make all final trial batches using the proposed ingredients in a mixer that is representative of the mixers to be used on the job. Make the batch size at least 50% of the mixer's rated capacity. Perform fresh concrete tests for air and slump, and make, cure, and test strength specimens for compliance with specification requirements. Test at least 1 set of design strength specimens, consisting of 2 specimens per set, at 7-day, 28-day, and at least one additional age. Before placing, provide the Engineer the option of witnessing final trial batches, including the testing of the concrete. If not provided this option, the Engineer may require additional trial batches, including testing, before the concrete is placed.

Establish 7-day compressive strength target values using the following formula for each concrete mix to be used:

$$\text{Target value} = \text{Minimum design strength} \times \frac{7\text{-day avg. trial batch strength}}{28\text{-day avg. trial batch strength}}$$

When there are changes in aggregates or in type, brand, or source of cement, SCM, or chemical admixtures, reevaluate the mix as a new mix design. A change in vendor does not necessarily constitute a change in materials or source. When only the brand or source of cement is changed and there is a prior record of satisfactory performance of the cement with the ingredients, new trial batches may be waived by the Engineer.

When the maturity method is specified or permitted, establish the strength–maturity relationship in accordance with TxDOT standard laboratory test procedure Tex-426-A. When using the maturity method any changes in any of the ingredients, including changes in proportions, will require the development of a new strength–maturity relationship for the mix.

### C. Storage of Materials.

1. **Cement, Supplementary Cementing Materials, and Mineral Filler.** Store all cement, supplementary cementing materials, and mineral filler in weatherproof enclosures that will protect them from dampness or absorption of moisture.

When permitted, small quantities of sacked cement may be stored in the open, on a raised platform, and under waterproof covering for up to 48 hours.

2. **Aggregates.** Handle and store concrete aggregates in a manner that prevents contamination with foreign materials. If the aggregates are stored on the ground, clear the sites for the stockpiles of all vegetation, level the sites, and do not use the bottom 6 inch layer of aggregate without cleaning the aggregate before use.

When conditions require the use of 2 or more grades of coarse aggregates, maintain separate stockpiles and prevent intermixing. Where space is limited, separate the stockpiles using physical barriers. Store aggregates from different sources in different stockpiles unless the Engineer authorizes pre-blending of the aggregates. 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.

3. **Admixtures.** Store admixtures in accordance with manufacturer's recommendations and prevent admixtures from freezing.

- D. **Measurement of Materials.** Except for volumetric mixers, measure concrete materials by weight. 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 weigh 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 in powdered form by weight. Measure concrete chemical admixtures in liquid form by weight or volume. Measure batch materials within the tolerances of Table 8.

**Table 8**  
**Measurement Tolerances – Non-Volumetric Mixers**

Material	Tolerance (%)
Cement, wt.	±1
Mineral admixture, wt.	±1
Cement + SCM (cumulative weighing), wt.	±1
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

When measuring cementitious materials at less than 30% of scale capacity, confirm that the quantity measured is accurate to not less than the required amount and not more than 4% in excess. When measuring aggregates in a cumulative weigh batcher at less than 30% of the scale capacity, confirm that the cumulative quantity is measured accurate to ±0.3% of scale capacity or ±3% of the required cumulative weight, whichever is less.

For volumetric mixers, base tolerances on volume–weight relationship established by calibration, and measure the various ingredients within the tolerances of Table 9.

Correct batch weight measurements for moisture.

When approved, under special circumstances, measure cement in bags of standard weight. Weighing of sacked cement is not required. Do not use fractional bags except for small hand-mixed batches of approximately 5 cubic feet or less and when an approved method of volumetric or weight measurement is used.

**Table 9**  
**Measurement 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

**E. Mixing and Delivering Concrete.** Mix and deliver concrete by means of one of the following operations:

- central-mixed,
- shrink-mixed,
- truck-mixed,
- volumetric mixer-mixed, or
- hand-mixed.

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.

For shrink-mixed and truck-mixed concrete, when there is a reason to suspect the uniformity of concrete delivered using a truck mixer or truck agitator, conduct slump tests of 2 individual samples taken after discharging approximately 15% and 85% of the load as a quick check of the probable degree of uniformity. Take the 2 samples within an elapsed time of at most 15 minutes. If the slumps of the 2 samples differ by more than the values shown in Table 10, investigate the causes and take corrective actions including adjusting the batching sequence at the plant and the mixing time and number of revolutions. Delivery vehicles that fail to meet the mixing uniformity requirements must not be used until the condition is corrected.

**Table 10**  
**Slump Tolerance<sup>1</sup>**

Average Slump	Slump Tolerance <sup>2</sup>
4 in. or less	1.0 in.
4 to 6 in.	1.5 in.

1. Do not apply these tolerances to the required slumps in Table 8.

2. Maximum permissible difference in results of test of samples from 2 locations in the concrete batch.

Re-tempering or adding concrete chemical admixtures is only permitted at the job site when concrete is delivered in a truck mixer. Do not add water after the introduction of mixing water at the batch plant except on arrival at the job site, with approval, to adjust the slump of the concrete. When this water is added, do not exceed the mix design water-cementitious-material ratio. Turn the drum or blades at least 30 additional revolutions at mixing speed to confirm thorough and uniform mixing of the concrete. Do not add water or chemical admixtures to the batch after any concrete has been discharged.

Maintain concrete delivery and placement rates sufficient to prevent cold joints.

Before unloading, furnish the computer generated delivery ticket for the batch of concrete containing the information required on TxDOT Form 596, "Concrete Batch Ticket."

When the concrete contains silica fume, adjust mixing times and batching operations as necessary to confirm the material is completely and uniformly dispersed in the mix. The dispersion of the silica fume within the mix will be verified by the City, using cylinders made from trial batches. If uniform dispersion is not achieved, make necessary changes to the batching operations until uniform and complete dispersion of the silica fume is achieved.

- 1. Central-Mixed Concrete.** Provide concrete that is mixed completely in a stationary mixer. Mix concrete for a period of 1 minute for 1 cubic yard and 15 seconds for each additional cubic yard of rated capacity of the mixer unless mixer performance test data demonstrate that shorter mixing times can be used to obtain a uniform mix in accordance with TxDOT standard laboratory test procedure Tex-472-A. Count the mixing time from the time all the solid materials are in the drum. Charge the mixer so that some water will enter before the cement and aggregate. Confirm that all water is in the drum by the end of the first  $\frac{1}{4}$  of the specified mixing time. Adjust the mixing time if necessary to achieve a uniform mix. Concrete mixed completely in a stationary mixer must be delivered to the project in a truck mixer, truck agitator, or non-agitating delivery vehicle. When a truck mixer or truck agitator is used for transporting concrete, use the manufacturer's designated agitating speed for any turning during transportation. Non-agitating delivery vehicles must be clean and free of built-up concrete with adequate means to control concrete discharge. Deliver the concrete to the project in a thoroughly mixed and uniform

mass, and discharge the concrete with a satisfactory degree of uniformity. Resolve questions regarding the uniformity of the concrete by testing when directed by the Engineer in accordance with TxDOT standard laboratory test procedure Tex-472-A.

2. **Shrink-Mixed Concrete.** Provide concrete that is first partially mixed in a stationary mixer and then mixed completely in a truck mixer. Partially mix for the minimum time required to intermingle the ingredients in the stationary mixer, and then transfer to a truck mixer and mix the concrete at the manufacturer's designated mixing speed for an adequate amount of time to produce thoroughly mixed concrete. Deliver the concrete to the project in a thoroughly mixed and uniform mass, and discharge the concrete with a satisfactory degree of uniformity.
  3. **Truck-Mixed Concrete.** Mix the concrete in a truck mixer from 70 to 100 revolutions at the mixing speed designated by the manufacturer to produce a uniform concrete mix. Deliver the concrete to the project in a thoroughly mixed and uniform mass and discharge the concrete with a satisfactory degree of uniformity. Additional mixing at the job site at the mixing speed designated by the manufacturer is allowed as long as concrete is discharged before the drum has revolved a total of 300 revolutions after the introduction of the mixing water to the cement and the aggregates.
  4. **Volumetric Mixer-Mixed Concrete.** Unless otherwise specified or permitted, perform all mixing operations in accordance with manufacturer's recommended procedures. Provide an accurate method of measuring all ingredients by volume, and calibrate equipment to assure correct measurement of materials within the specified tolerances.
  5. **Hand-Mixed Concrete.** When permitted, for small placements of less than 2 cubic yards, mix up to a 2 sack batch of concrete by hand methods or in a small motor-driven mixer. For such placements, proportion the mix by volume or weight.
- F. Placing, Finishing, and Curing Concrete.** Place, finish, and cure concrete in accordance with the pertinent Items.
- G. Sampling and Testing of Concrete.** Unless otherwise specified, all fresh and hardened concrete is subject to testing as follows:
1. **Sampling Fresh Concrete.** Provide all material to be tested. Fresh concrete will be sampled for testing at the discharge end if using belt conveyors or pumps. When it is impractical to sample at the discharge end, a sample will be taken at the time of discharge from the delivery equipment and correlation testing will be performed and documented to confirm specification requirements are met at the discharge end.
  2. **Testing of Fresh Concrete.**
    - a. **Air Content.** TxDOT standard laboratory test procedure Tex-414-A or Tex-416-A.
    - b. **Slump.** TxDOT standard laboratory test procedure Tex-415-A.
    - c. **Temperature.** TxDOT standard laboratory test procedure Tex-422-A.
    - d. **Making and Curing Strength Specimens.** TxDOT standard laboratory test procedure Tex-447-A.

- 3. Testing of Hardened Concrete.** Only compressive strength testing will be used unless otherwise specified or shown on the plans.

    - a. Compressive Strength.** TxDOT standard laboratory test procedure Tex-418-A.
    - b. Flexural Strength.** TxDOT standard laboratory test procedure Tex-448-A.
    - c. Maturity.** TxDOT standard laboratory test procedure Tex-426-A.
  - 4. Certification of Testing Personnel.** Contractor personnel performing testing must be ACI-certified for the tests being performed. Personnel performing these tests are subject to City approval. Use of a commercial laboratory is permitted. 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.
  - 5. Adequacy and Acceptance of Concrete.** The Engineer will sample and test the fresh and hardened concrete for acceptance. The test results will be reported to the Contractor and the concrete supplier. For any concrete that fails to meet the required strengths as outlined below, investigate the quality of the materials, the concrete production operations, and other possible problem areas to determine the cause. Take necessary actions to correct the problem including redesign of the concrete mix. The Engineer may suspend all concrete operations under the pertinent Items if the Contractor is unable to identify, document, and correct the cause of the low strengths in a timely manner. Resume concrete operations only after obtaining approval for any proposed corrective actions.

    - a. Structural Concrete.** For concrete classes identified as structural concrete in Table 5, the Engineer will make and test 7 day and 28 day specimens. Acceptance will be based on the design strength given in Table 5.

The Engineer will evaluate the adequacy of the concrete by comparing 7 day test results to the target value established in accordance with Section 300.4.B, "Trial Batches."
    - b. All Other Concrete.** For concrete classes not identified as structural concrete in Table 5, the Engineer will make and test 7-day specimens. The Engineer will base acceptance on the 7 day target value established in accordance with Section 300.4.B, "Trial Batches."
  - 6. Test Sample Handling.** Unless otherwise shown on the plans or directed, remove forms and deliver department test specimens to curing facilities, in accordance with pertinent test procedures. Clean and prepare forms for reuse.
- 300.5. MEASUREMENT AND PAYMENT:** The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be subsidiary to pertinent Items.

**300.6. BID ITEM:**

N/A

## ITEM

### 301 REINFORCING STEEL

**301.1. DESCRIPTION:** *Furnish and place reinforcing steel of the sizes and details shown on the plans.*

**301.2. MATERIALS:**

- A. Approved Mills.** Before furnishing steel, producing mills of reinforcing steel for the City must be pre-approved in accordance with TxDOT's DMS-7320, "Qualification Procedure for Reinforcing Steel Mills," by the TxDOT's Construction Division, which maintains a list of approved producing mills. Reinforcing steel obtained from unapproved sources will not be accepted.
- B. Deformed Bar and Wire Reinforcement.** Unless otherwise shown on the plans, reinforcing steel must be Grade 60, and bar reinforcement must be deformed. Reinforcing steel must conform to one of the following:
- ASTM A 615, Grades 40 or 60;
  - ASTM A 996, Type A, Grades 40 or 60;
  - ASTM A 996, Type R, Grade 60, permitted in concrete pavement only (Furnish ASTM A 996, Type R bars as straight bars only and do not bend them. Bend tests are not required.); or
  - ASTM A 706.

The provisions of this Item take precedence over ASTM provisions.

The nominal size, area, and weight of reinforcing steel bars covered by this Item are shown in Table 1. Designate smooth bars up to No. 4 by size number and above No. 4 by diameter in inches.

- C. Smooth Bar and Spiral Reinforcement.** Smooth bars and dowels for concrete pavement must have a minimum yield strength of 60 ksi and meet ASTM A 615. For smooth bars that are larger than No. 3, provide steel conforming to ASTM A 615 or meet the physical requirements of ASTM A 36.

Spiral reinforcement may be smooth or deformed bars or wire of the minimum size or gauge shown on the plans. Bars for spiral reinforcement must comply with ASTM A 615, Grade 40; ASTM A 996, Type A, Grade 40; or ASTM A 675, Grade 80, meeting dimensional requirements of ASTM A 615. Smooth wire must comply with ASTM A 82, and deformed wire must comply with ASTM A 496.

- D. Weldable Reinforcing Steel.** Reinforcing steel to be welded must comply with ASTM A 706 or have a carbon equivalent (C.E.) of at most 0.55%. A report of chemical analysis showing the percentages of elements necessary to establish C.E. is required for reinforcing steel that does not meet ASTM A 706 to be structurally welded. These requirements do not pertain to miscellaneous welds on reinforcing steel as defined in TxDOT's Section 448.4.B.1.a, "Miscellaneous Welding Applications."



Calculate C.E. using the following formula:

$$C.E. = \%C + \frac{\%Mn}{6} + \frac{\%Cu}{40} + \frac{\%Ni}{20} + \frac{\%Cr}{10} - \frac{\%Mo}{50} - \frac{\%V}{10}$$

- E. Welded Wire Fabric.** For fabric reinforcement, use wire that conforms to ASTM A 82 or A 496. Use wire fabric that conforms to ASTM A 185 or A 497. Observe the relations shown in Table 2 among size number, diameter in inches, and area when ordering wire by size numbers, unless otherwise specified. Precede the size number for deformed wire with “D” and for smooth wire with “W.”

Designate welded wire fabric 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.)	Size Number (mm)	Diameter (in.)	Area (sq. in.)
31	200	0.628	0.310
30	194	0.618	0.300
28	181	0.597	0.280
26	168	0.575	0.260
24	155	0.553	0.240
22	142	0.529	0.220
20	129	0.505	0.200
18	116	0.479	0.180
16	103	0.451	0.160
14	90	0.422	0.140
12	77	0.391	0.120
10	65	0.357	0.100
8	52	0.319	0.080
7	45	0.299	0.070
6	39	0.276	0.060
5.5	35	0.265	0.055
5	32	0.252	0.050
4.5	29	0.239	0.045
4	26	0.226	0.040
3.5	23	0.211	0.035
2.9	19	0.192	0.035
2.5	16	0.178	0.025
2	13	0.160	0.020
1.4	9	0.134	0.014
1.2	8	0.124	0.012
0.5	3	0.080	0.005

Note: Size numbers (in.) are the nominal cross-sectional area of the wire in hundredths of a square inch. Size numbers (mm) are the nominal cross-sectional area of the wire in square millimeters. Fractional sizes between the sizes listed above are also available and acceptable for use.

- F. Epoxy Coating.** Epoxy coating will be required as shown on the plans. Before furnishing epoxy-coated reinforcing steel, an epoxy applicator must be pre-approved in accordance with TxDOT’s DMS 7330, “Qualification Procedure for Reinforcing Steel Epoxy Coating Applicators.” The TxDOT Construction Division maintains a list of approved applicators.

Coat reinforcing steel in accordance with Table 3.

**Table 3**  
**Epoxy Coating Requirements for Reinforcing Steel**

Material	Specification
Bar	ASTM A 775 or A 934
Wire or fabric	ASTM A 884 Class A or B
Mechanical couplers	As shown on the plans
Hardware	As shown on the plans

Use epoxy coating material and coating repair material that complies with TxDOT's DMS 8130, "Epoxy Powder Coating for Reinforcing Steel." Do not patch more than 1/4-inch total length in any foot at the applicator's plant.

Epoxy-coated reinforcement will be sampled and tested in accordance with TxDOT standard laboratory test procedure Tex-739-I.

Maintain identification of all reinforcing throughout the coating and fabrication and until delivery to the project site.

Furnish 1 copy of a written certification that the coated reinforcing steel meets the requirements of this Item and 1 copy of the manufacturer's control tests.

- G. Mechanical Couplers.** When mechanical splices in reinforcing steel bars are shown on the plans, use couplers of the type specified in TxDOT's DMS-4510, "Mechanical Couplers," under the section "General Requirements."

Furnish only couplers that have been produced by a manufacturer that has been prequalified in accordance with TxDOT's DMS-4510. Do not use sleeve-wedge type couplers on coated reinforcing. Sample and test couplers for use on individual projects in accordance with TxDOT's DMS-4510. Furnish couplers only at locations shown on the plans.

### 301.3. CONSTRUCTION:

- A. Bending.** Cold-bend the reinforcement accurately to the shapes and dimensions shown on the plans. Fabricate in the shop if possible. Field-fabricate, if permitted, using a method approved by the Engineer. Replace improperly fabricated, damaged, or broken bars at no additional expense to the City. Repair damaged or broken bars embedded in a previous concrete placement using a method approved by the Engineer.

Unless otherwise shown on the plans, the inside diameter of bar bends, in terms of the nominal bar diameter (d), must be as shown in Table 4.

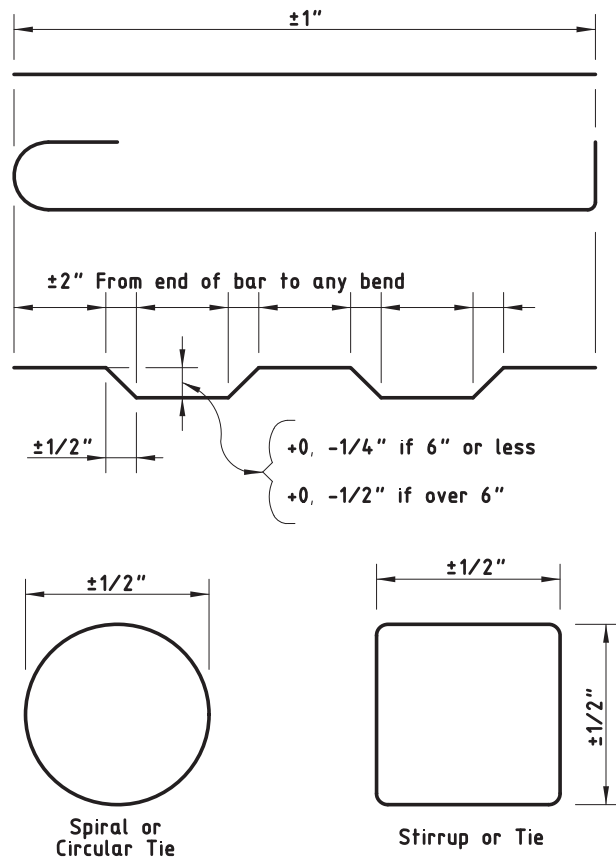
**Table 4**  
**Minimum Inside Diameter of Bar Bends**

Bend	Bar Size Number (in.)	Bar Size Number (mm)	Diameter
Bends of 90° and greater in stirrups, ties, and other secondary bars that enclose another bar in the bend	3, 4, 5	10, 13, 16	4d
	6, 7, 8	19, 22, 25	6d
Bends in main bars and in secondary bars not covered above	3 through 8	10 through 25	6d
	9, 10, 11	29, 32, 36	8d
	14, 18	43, 57	10d

Note: Bar size numbers (in.) are based on the number of eighths of an inch included in the nominal diameter of the bar. Bar size numbers (mm) approximate the number of millimeters included in the nominal diameter of the bar.

Where bending No. 14 or No. 18 Grade 60 bars is required, bend-test representative specimens as described for smaller bars in the applicable ASTM specification. Make the required 90° bend around a pin with a diameter of 10 times the nominal diameter of the bar.

**B. Tolerances.** Fabrication tolerances for bars are shown in Figure 1.



**Figure 1. Fabrication tolerances for bars.**

- C. Storage.** Store steel reinforcement above the ground on platforms, skids, or other supports, and protect it from damage and deterioration. Ensure that 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.
- D. Splices.** Lap-splice, weld-splice, or mechanically splice bars as shown on the plans. Additional splices not shown on the plans will require approval. Splices not shown on the plans will be permitted in slabs 15-inches or less in thickness, columns, walls, and parapets.
- Unless otherwise approved, splices will not be permitted in bars 30 feet or less in plan length. For bars exceeding 30 feet in plan length, the distance center-to-center of splices must be at least 30 feet minus 1 splice length, with no more than 1 individual bar length less than 10 feet. Make lap splices not shown on the plans, but otherwise permitted, in accordance with Table 5. Maintain the specified concrete cover and spacing at splices, and place the lap-spliced bars in contact, securely tied together.

**Table 5**  
**Minimum Lap Requirements for Bar Sizes through No. 11**

Bar Size Number (in.)	Bar Size Number (mm)	Uncoated Lap Length	Coated Lap Length
3	10	1 ft. 4 in.	2 ft. 0 in.
4	13	1 ft. 9 in.	2 ft. 8 in.
5	16	2 ft. 2 in.	3 ft. 3 in.
6	19	2 ft. 7 in.	3 ft. 11 in.
7	22	3 ft. 5 in.	5 ft. 2 in.
8	25	4 ft. 6 in.	6 ft. 9 in.
9	29	5 ft. 8 in.	8 ft. 6 in.
10	32	7 ft. 3 in.	10 ft. 11 in.
11	36	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. Bar size numbers (mm) approximate the number of millimeters 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 welded wire fabric using a lap length that includes the overlap of at least 2 cross wires plus 2-inches on each sheet or roll. Splices using bars that develop equivalent strength and are lapped in accordance with Table 5 are permitted.
- For box culvert extensions with less than 1-foot of fill, lap the existing longitudinal bars with the new bars as shown in Table 3. For extensions with more than 1-foot of fill, lap at least 1-foot 0-inch.
- Ensure that welded splices conform to the requirements of the plans and of TxDOT's 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 plans. Protect threaded male or female connections, and make sure 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.
- E. Placing.** Unless otherwise shown on the plans, dimensions shown for reinforcement are to the centers of the bars. Place reinforcement as near as possible to the position shown on the plans. In the plane of the steel parallel to the nearest surface of concrete, bars must not vary from plan placement by more than 1/12 of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of concrete, bars must not vary from plan placement by more than ¼-inch. Cover of concrete to the nearest surface of steel must be at least 1-inch unless otherwise shown on the plans.

For bridge slabs, the clear cover tolerance for the top mat of reinforcement is -0, +½-inch.

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 to keep the steel at the proper distance from the forms. Support bars by standard bar supports with plastic tips, approved plastic bar supports, or precast mortar or concrete blocks when supports are in contact with removable or stay-in-place forms. Use bright basic bar supports to support reinforcing steel placed in slab overlays on concrete panels or on existing concrete slabs. Bar supports in contact with soil or subgrade must be approved.

For bar supports with plastic tips, the plastic protection must be at least 3/32-inch thick and extend upward on the wire to a point at least ½-inch above the formwork.

All accessories such as tie wires, bar chairs, supports, or clips used with epoxy-coated reinforcement must be of steel, fully coated with epoxy or plastic. Plastic supports approved by the Engineer may also be used with epoxy-coated reinforcement.

Cast mortar or concrete blocks to uniform dimensions with adequate bearing area. Provide a suitable tie wire in each block for anchoring to the steel. Cast the blocks to the thickness required in approved molds. The surface placed adjacent to the form must be a true plane, free of surface imperfections. Cure the blocks by covering them with wet burlap or mats for a period of 72-hours. Mortar for blocks should contain approximately 1 part hydraulic cement to 3 parts sand. Concrete for blocks should contain 850 lb. of hydraulic cement per cubic yard of concrete.

Place individual bar supports in rows at 4 feet maximum spacing in each direction. Place continuous type bar supports at 4 feet 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 in precast box culverts or storm drains is not cause for rejection.

Tie reinforcing steel for bridge slabs, top slabs of direct traffic culverts, and top slabs of prestressed box beams at all intersections, except tie only alternate intersections where spacing is less than 1 foot in each direction. For reinforcing steel cages for other structural members, tie the steel at enough intersections to provide a rigid cage of steel. Fasten mats of wire fabric securely at the ends and edges.

Before concrete placement, clean mortar, mud, dirt, debris, oil, and other foreign material from the reinforcement. Do not place concrete until authorized.

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, stop placement until corrective measures are taken.

#### **F. Handling, Placement, and Repair of Epoxy-Coated Reinforcing Steel.**

- 1. Handling.** Provide systems for handling coated reinforcement 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.
- 2. Construction Methods.** Do not flame-cut coated reinforcement. Saw or shear-cut only when approved. Coat cut ends as specified in Section 301.3.F.3, "Repair of Coating."

Do not weld or mechanically couple coated reinforcing steel except where specifically shown on the plans. Remove the epoxy coating at least 6-inches beyond the weld limits before welding and 2-inches beyond the limits of the coupler before assembly. After welding or coupling, clean the steel of oil, grease, moisture, dirt, welding contamination (slag or acid residue), and rust to a near-white finish. Check the existing epoxy for damage. Remove any damaged or loose epoxy back to sound epoxy coating.

After cleaning, coat the splice area 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. Repair of Coating.** For repair of the coating, use material that complies with the requirements of this Item and ASTM D 3963. Make repairs in accordance with procedures recommended by the manufacturer of the epoxy coating powder. For areas to be patched, apply at least the same coating thickness as required for the original coating. 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 that they are free from surface contaminants. Make repairs in the shop or in the field as required.

**301.4. MEASUREMENT AND PAYMENT:** The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be considered subsidiary to pertinent Items.

**301.5. BID ITEM:**

N/A

**ITEM****306 STRUCTURAL EXCAVATION**

**306.1. DESCRIPTION:** *Only when indicated on the plan details and bid proposals will this item govern the excavation for the placing of structures, and for the disposal of all material obtained from such excavation, and for backfilling around completed structures to the level of the original ground. The work to be done under this item shall include all necessary pumping or bailing, sheathing, drainage and the removal of all structures or portions thereof, such as wingwalls, pipe culverts, inlets, trees and all other obstructions necessary to the proposed construction.*

**306.2. MATERIALS:** All structural excavation shall be unclassified, and shall include all materials encountered regardless of their nature or the manner in which they are removed, except those covered by other pay items of the contract. Use materials that meet the requirements of the following Items, when indicated on the plans or required:

- A. Flexible Base.** Item 200, "Flexible Base."
- B. Subgrade Filler.** Item 410, "Subgrade Filler."
- C. Cement Stabilized Sand.** Item 412, "Cement Stabilized Sand."
- D. Flowable Fill.** Item 413, "Flowable Fill."
- E. Filter Fabric.** TxDOT DMS 6200, "Filter Fabric," Type 1.

**306.3. EQUIPMENT:** Provide applicable equipment to conduct work as described in this specification or as specified on the plans.

**306.4. CONSTRUCTION:**

- A. Excavation.** In instances where the structure is stepped outward near the top, the limits of excavation will be increased accordingly. In all cases where excavation diagrams are shown on the plans, such diagrams shall take precedence over these provisions. Suitable excavated materials shall be utilized, insofar as practicable, in backfilling around the drainage structures or in constructing required embankments, if applicable. Excavated material suitable for backfilling may be stockpiled by the Contractor at points convenient for re-handling, provided stockpiles do not constitute a hazard and all hubs and survey lines are kept free of any obstruction. Unsuitable materials below footing grade shall be removed and replaced with gravel subgrade filler as defined in Item 410, "Subgrade Filler."

Excavated materials which are unsuitable for embankments or backfilling, or excavation in excess of that needed for construction shall become the property of the Contractor and it shall become his sole responsibility to properly dispose of this material outside the limits of the project. Proper disposal shall be in conformance with, but not limited to, the following provisions:

- Do not deposit excavated material within jurisdictional wetlands, and
- Obtain appropriate permits and apply provisions pertaining to soil erosion and stream pollution, when necessary, to meet federal, state, and/or local regulations, rules, and procedures.

1. **Hazardous Materials.** If the Contractor encounters hazardous substances, industrial waste, other environmental pollutants, underground storage tanks, or conditions conducive to environmental damage, Contractor shall immediately stop work in the area affected and report the condition to the Owner's representative in writing. Contractor shall not be responsible for or required to conduct any investigation, site monitoring, containment, cleanup, removal, restoration or other remedial work of any kind or nature (the "remedial work") under any applicable level, state or federal law, regulation or ordinance, or any judicial order. If the Contractor agrees in writing to commence and/or prosecute some or all of the remedial work, all costs and expenses, to include any extension of the contract time, of such remedial work shall be paid by Owner to Contractor as additional compensation.
  2. **Existing Structures/Obstructions.** Removal of structures and other obstructions prior to excavation and finishing of all other earthwork described herein shall be completed and paid for in accordance with Item 101, "Preparing Right-of-Way" unless otherwise stated on the plans.
- B. Backfilling.** Backfilling to the top of the pipe culvert or structure (initial backfill) shall be completed by one of the four methods 1., 2., 3., or 4. below. Backfilling from the top of the culvert to the top of the trench (secondary backfill), or proposed subgrade elevation, shall be completed in accordance with Item 400, "Excavation, Trenching, and Backfilling." Backfill behind cast-in-place culvert walls shall not begin until the concrete has attained a compressive strength of 2,000 psi. Backfill on top of cast-in-place supporting slabs shall not begin until the concrete has attained a compressive strength of 3,000 psi. Avoid wedging action of backfill against structures. If necessary to prevent such action, step or serrate slopes bounding the excavation. Place backfill along both sides of culverts equally and in uniform layers.
1. **Suitable On-Site Excavated Material.** Material for backfill shall be placed in uniform layers not more than 12 inches in depth (loose measurement) and shall be compacted to the density specified herein. Each layer of backfill material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density, by means of a mechanical tamper.

Each lift of fill shall be compacted to the required density and moisture content as shown below, unless otherwise shown on the plans:

Subgrade	Density	Moisture Content
<b>Material</b>		
PI ≤ 20	≥ 95% of Max Dry Density	- 2% of Opt. or greater
PI > 20	≥ 95% of Max Dry Density	≥ Opt. Moisture

The maximum dry density and optimum moisture content shall be determined in accordance with TxDOT Standard Laboratory Test Method Tex-114-E. Tests for in place



density shall be made in accordance with TxDOT standard laboratory test method Tex-115-E and within 24 hours after compacting operations are completed. If the material fails to meet the density specified, it shall be re-worked as necessary to obtain the density required.

2. **Select Fill.** A clean gravel, or gravel approved by the Engineer, conforming to the requirements of article 410.3.B. "Gravel" of Item No.410, "Subgrade Filler" may be used for backfill material from the bottom of the trench to the top of the conduit. The gravel shall be placed in the trench in loose lifts not to exceed 12 inches in depth and lightly tamped to consolidate and seat the mass against conduit and earthen surfaces.

A filter fabric shall be placed between the gravel backfill (initial backfill) and secondary backfill. The filter fabric shall conform to the requirements of Texas Department of Transportation Material Specification 6200, Type1. Filter fabric shall be considered incidental to construction and no separate payment for filter fabric will be made.

Where conditions permit and with approval of the Engineer, material conforming to Item 200, "Flexible Base" may be used from the top of the gravel filter bed to the top of the box culvert. This backfill material shall be placed in uniform layers not more than 12 inches in depth (loose measurement) and shall be compacted to the required density. Each layer of material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density by means of a mechanical tamper.

Compaction of the Flexible Base shall be such that the density of each layer shall be not less than 95% of the maximum dry density as determined by TxDOT Standard Laboratory Test Method TEX-113-E, unless otherwise shown on the plans.

3. **Controlled Low Strength Material (CLSM).** CLSM shall be placed by direct discharge from a mixer truck or other approved method. A minimum of 30 psi at 3 days and maximum strength of 800 psi at 28 days is required. There is no separate pay item for Controlled Low Strength Material, unless shown on the plans as a separate pay item for culvert backfill.
4. **Flowable Backfill.** When shown on the plans, backfill the excavation with flowable backfill that conforms to Item 413, "Flowable Backfill" to the elevations shown on the plans. Prevent the structure from being displaced during the placement of the flowable backfill and prevent flowable backfill from entering culverts. There is no separate pay item for Flowable Backfill material, unless shown on the plans as a separate pay item for culvert backfill.

- C. **Quality Control.** After each layer of embankment backfill or flexible base is complete, tests as necessary will be made by the Engineer. If the material fails to meet the density specified, the course shall be reworked, as necessary, to obtain the specified compaction.

Should the backfill, due to any reason or cause, lose the required stability, density/moisture, or finish before the next lift is placed, it shall be re-compacted and refinished at the sole expense of the Contractor. Excessive loss of moisture in the backfill shall be prevented by sprinkling or other approved methods.

- 306.5. **MEASUREMENT:** Limits of excavation for payment shall be to a vertical plane 1 foot outside and parallel to the footing and will be computed by the method of average end areas. No

measurement will be made of any excavation, made by the Contractor for his convenience, beyond the limits specified above.

**306.6. PAYMENT:** The work performed as prescribed by this item will be paid for at the unit price bid per cubic yard for “Structural Excavation,” which price shall be full compensation for all excavation (within the limits set forth) and backfill including compaction, pumping, bailing, sheathing, bracing, and for furnishing all materials, labor, equipment tools, and incidentals necessary to complete the work.

**306.7. BID ITEM:**

Item 306.1 - Structural Excavation - per cubic yard

## ITEM

### 307 CONCRETE STRUCTURES

**307.1. DESCRIPTION:** *Construct concrete structures.*

**307.2. MATERIALS:**

- A. Concrete.** Provide concrete conforming to Item 300, "Concrete." For each type of structure or unit, provide the class of concrete shown on the plans or in pertinent governing specifications.
- B. Grout or Mortar.** Provide grout or mortar conforming to Section 300.2.F, "Mortar and Grout."
- C. Latex.** Provide an acrylic-polymer latex admixture (acrylic resin emulsion per TxDOT's DMS-4640, "Chemical Admixtures for Concrete") suitable for producing polymer-modified concrete or mortar. Do not allow latex to freeze.
- D. Reinforcing Steel.** Provide reinforcing steel conforming to Item 301, "Reinforcing Steel."
- E. Expansion Joint Material.** Provide materials that conform to the requirements of TxDOT's DMS-6310, "Joint Sealants and Fillers":
- Provide preformed fiber expansion joint material that conforms to the dimensions shown on the plans. Provide preformed bituminous fiber material unless otherwise specified.
  - Provide a Class 4, 5, or 7 low-modulus silicone sealant unless otherwise directed.
  - Provide asphalt board that conforms to dimensions shown on the plans.
  - Provide re-bonded neoprene filler that conforms to the dimensions shown on the plans.
- F. Waterstop.** Provide rubber or polyvinyl chloride (PVC) waterstops that conform to TxDOT's DMS-6160, "Waterstops, Nylon Reinforced Neoprene Sheet, and Elastomeric Pads," unless otherwise shown on the plans.
- G. Evaporation Retardants.** Provide evaporation retardants that conform to the requirements of TxDOT's DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."
- H. Curing Materials.** Provide membrane curing compounds that conform to the requirements of TxDOT's 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 ounces 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 inches, or tuft both longitudinally and transversely at intervals less than 3 inches. Provide cotton mats that are free from tears and in good general condition. Provide a flap at least 6 inches 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 60°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.

- I. Epoxy.** Unless otherwise specified, provide epoxy materials that conform to TxDOT's DMS-6100, "Epoxy and Adhesives."
- J. Cast Iron Castings.** Provide cast iron castings that conform to Item 409, "Cast Iron Castings."
- K. Metal for Structures.** Provide metal for structures that conform to Item 302, "Metal for Structures."

### 307.3. EQUIPMENT:

- A. 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.
- B. 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 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 inches in diameter. For underwater placements, construct the tremie so that the bottom can be sealed and opened once the tremie has been fully charged with concrete.

Use pumps with lines at least 5 inches I.D. where Grade 2 or smaller coarse aggregate is used and at least 8 inches I.D. for Grade 1 coarse aggregate.

- C. Vibrators.** Use immersion-type vibrators that maintain a speed of 6,000 impulses per minute for consolidation of concrete. Provide at least 1 standby vibrator for emergency use.
- D. Screeds and Work Bridges for Bridge Slabs.** For bridge slabs use a self-propelled transverse screed or a mechanical longitudinal screed. Use transverse screeds that are able to follow the skew of the bridge for skews greater than 15° unless otherwise approved. 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.

- For bridge slabs, use sufficient work bridges for finishing operations. 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. Confirm that enough carpet is in contact longitudinally with the concrete being placed to provide the desired surface finish. Use artificial grass-type carpeting having a molded polyethylene pile face with a blade length between 5/8 and 1 inch and with a minimum weight of 70 oz. per square yard. Confirm that the carpet has a strong, durable backing not subject to rot and that 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.
- E. Temperature Recording Equipment.** For mass concrete operations or as otherwise specified, use strip chart temperature recording devices, recording maturity meters in accordance with TxDOT standard laboratory test procedure Tex-426-A, or other approved devices that are accurate to within  $\pm 2^{\circ}\text{F}$  within the range of 32 to 212 $^{\circ}\text{F}$ .
- F. Artificial Heating Equipment.** Use artificial heating equipment as necessary for maintaining the concrete temperatures as specified in Section 307.4.G.11, "Placing Concrete in Cold Weather."
- G. 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 inch deep and nominally 1/8 inch wide. Groove spacing may range from 5/8 to 1 inch. Use sawing equipment capable of cutting grooves in hardened concrete to within 18 inches of the barrier rail or curb.
- H. 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. If approved, use hand-pressurized spray equipment equipped with 2 or 3 fan-spray nozzles. Confirm that the spray from each nozzle overlaps the spray from adjacent nozzles by approximately 50%.
- I. Concrete Testing Equipment.** Provide testing equipment for use by the Engineer in accordance with Section 300.3.C, "Testing Equipment."
- 307.4. CONSTRUCTION:** Before starting work, obtain approval for proposed construction methods. Approval of construction methods and equipment does not relieve the Contractor's responsibility for safety or correctness of methods, adequacy of equipment, or completion of work in full accordance with the Contract.

Unless otherwise shown on the plans, it is the Contractor's option to perform testing on structural concrete (structural classes of concrete are identified in Table 5 of Section 300.4.A, "Classification and Mix Design") to determine the in-situ strength to address the schedule restrictions in Section 307.4.A, "Schedule Restrictions." The Engineer may require the Contractor to perform this testing for concrete placed in cold weather. For Contractor-performed testing, make enough test specimens to confirm that strength requirements are met for the operations listed in Section 307.4.A. 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. Confirm safe handling, curing, and storage of all test specimens. Provide testing personnel, and sample and test the hardened concrete in accordance with Section 300.4.G, "Sampling and Testing of Concrete." The maturity method, TxDOT standard laboratory test

procedure Tex-426-A, may be used for in-situ strength determination for schedule restrictions if approved. Coring will not be allowed for in-situ strength determination for schedule restrictions. Provide the Engineer the opportunity to witness all testing operations. Report all test results to the Engineer.

If the Contractor does not wish to perform schedule restriction testing, the Engineer's 7 day lab-cured tests, performed in accordance with Section 300.4.G.5, "Adequacy and Acceptance of Concrete," will be used for schedule restriction determinations. The Engineer may require additional time for strength gain to account for field curing conditions such as cold weather.

**A. Schedule Restrictions.** Unless otherwise shown on the plans, construct and open completed structures to traffic with the following limitations:

- 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 Section 307.4.J, "Curing Concrete." Place concrete only after the forms and reinforcing steel have been inspected by the Engineer.

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.

- 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 Section 307.4.K, "Removal of Forms and Falsework." Keep all forms for mass placements defined in Section 307.4.G.14, "Mass Placements," in place for 4 days following concrete placement.
- 3. Placement of Superstructure Members.** Do not place superstructure members before the substructure concrete has attained a compressive strength of 3,000 psi.
- 4. 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 hours. Place and screed the concrete after the previously placed slabs have aged at least 48 hours. Maintain curing of the previously placed slabs during placement.
- 5. Staged Placement of Bridge Slabs on Continuous Steel Units.** When staged placement of a slab is required, confirm that the previously placed concrete attains a compressive strength of 3,000 psi before placing the next stage placement. Multiple stages may be placed in a single day if approved.
- 6. 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.

- 7. 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 Section 300.4.A, "Classification and Mix Design," unless otherwise approved.
  - 8. Carting of Concrete.** Once the concrete has attained a compressive strength of 3,000 psi, it may be carted, wheeled, or pumped over completed slabs. Maintain curing during these operations.
  - 9. 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. If slipforming methods are used for railing concrete, confirm the slab concrete has attained its design strength specified in Section 300.4.A, "Classification and Mix Design," before placing railing concrete.
  - 10. Opening to Construction Traffic.** Bridges and direct-traffic culverts may be opened to all construction traffic when the design strength specified in Section 300.4.A, "Classification and Mix Design," has been attained if curing is maintained.
  - 11. Opening to Full Traffic.** Bridges and direct-traffic culverts may be opened to the traveling public when the design strength specified in Section 300.4.A, "Classification and Mix Design," has been attained for all structural elements including railing subject to impact from traffic, when curing has been completed for all slabs, and when the concrete surface treatment has been applied in accordance with TxDOT's Item 428, "Concrete Surface Treatment." Obtain approval before opening bridges and direct-traffic culverts to the traveling public. Other noncritical structural and nonstructural concrete may be opened for service upon the completion of curing unless otherwise specified or directed.
  - 12. Post-Tensioned Construction.** For structural elements designed to be post-tensioned confirm that strength requirements on the plans are met for stressing and staged loading of structural elements.
  - 13. Backfilling.** Backfill in accordance with TxDOT's Section 400.3.C, "Backfill."
- B. Plans for Falsework and Forms.** Submit 2 copies of plans for falsework and forms for piers, superstructure spans over 20 feet long, bracing systems for girders when the overhang exceeds 3 feet 6 inches, and bridge widening details. Submit similar plans for other units of the structure as directed. Show all essential details of proposed forms, falsework, and bracing. Have a licensed professional engineer design, seal, and sign these plans. City approval is not required, but the City reserves the right to request modifications to the plans. The Contractor is responsible for the adequacy of these plans.
- C. Falsework.** Design and construct falsework to carry the maximum anticipated loads safely, including wind loads, and to provide the necessary rigidity. Submit details in accordance with Section 307.4.B, "Plans 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 the City for the design of structures.

For commercially produced structural units used in falsework, do not exceed the manufacturer's maximum allowable working loads for moment and shear or end reaction.

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 plans.

Provide wedges made of hardwood or metal in pairs to adjust falsework to desired elevations to confirm even bearing. Do not use wedges to compensate for incorrectly cut bearing surfaces.

Use sills or grillages that are 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 TxDOT 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 TxDOT 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 or as indicated on the submitted falsework plan. Pull or cut off foundations for falsework at least 2 feet 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.

**D. Forms.** Submit formwork plans in accordance with Section 307.4.B, "Plans for Falsework and Forms."

**1. General.** Except where otherwise specified or permitted, provide forms of either timber or metal.

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 the allowable stresses used by the City for the design of structures.

For commercially produced structural units used for forms, do not exceed the manufacturer's maximum allowable working loads for moment and shear or end reaction. 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 unless otherwise approved. Refer to Item 311, "Concrete Surface Finish," 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 plans and specified in TxDOT's Section 427.4.B.2.d, "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 inch.

For forms to be left in place, use only material that is inert, non-biodegradable, and non-absorptive.

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 plans.
- Weld in accordance with Item 448, "Structural Field Welding."

Take into account:

- deflections due to cast-in-place slab concrete and railing shown in the dead load deflection diagram in the setting of slab forms,
- 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.

For bridge approach slabs, securely stake forms to line and grade and maintain in position. 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 requesting permission to place concrete.

If the forms show signs of bulging or sagging at any stage of the placement, cease placement and remove the portion of the concrete causing this condition immediately if necessary. Reset the forms and securely brace them against further movement before continuing the placement.

- 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 plans.

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 defects that will produce inferior work, and 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;
- the bottom of bridge slabs between beams or girders;
- surfaces that are subsequently covered by backfill material or are completely enclosed; and
- any surface formed by a single finished board 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  $\frac{3}{4}$  inch 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 that 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 feet 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.

For surfaces exposed to view and receiving only an ordinary surface finish as defined in Section 307.4.M, "Ordinary Surface Finish," place forms with the form panels symmetrical (long dimensions set in the same direction). Make horizontal joints continuous.

Make molding for chamfer strips or other uses of materials of a grade that will not split when nailed and that can be maintained to a true line without warping. Dress wood molding on all faces. Unless otherwise shown on the plans, fill forms at all sharp corners and edges with triangular chamfer strips measuring  $\frac{3}{4}$  inch on the sides.

To hold forms in place, use metal form ties of an approved type or a satisfactory substitute of a type that permits ease of removal of the metal. Cut back wire ties at least  $\frac{1}{2}$  inch 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.

- 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 that metal forms do not require lining unless specifically noted on the plans.

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 that line up properly. Keep metal free from rust, grease, and other foreign materials.

- 4. Form Supports for Overhang Slabs.** 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 plans.

When overhang brackets are used on prestressed concrete beam spans with slab overhangs not exceeding 3 feet 6 inches, use beam bracing as indicated in the plans. For spans with overhangs exceeding this amount, use additional support for the outside beams regardless of the type of beam used. Submit details of the proposed bracing system in accordance with Section 307.4.B, "Plans for Falsework and Forms."

Punch or drill holes full size in the webs of steel members for support of overhang brackets, or torch-cut them to 1/4 inch under size and ream them full size. Do not burn the holes full size. Leave the holes open unless otherwise shown on the plans. Never fill the holes by welding.

- E. Drains.** Install and construct weep holes and roadway drains as shown on the plans.

- F. Placing Reinforcement.** Place reinforcement as provided in Item 301, "Reinforcing Steel." Do not weld reinforcing steel supports to I beams or girders or to reinforcing steel except where shown on the plans.

Place post-tensioning ducts in accordance with the approved prestressing details and in accordance with TxDOT's Item 426, "Prestressing." Keep ducts free of obstructions until all post-tensioning operations are complete.

- G. Placing Concrete.** Give the Engineer sufficient advance notice before placing concrete in any unit of the structure to permit the inspection of forms, reinforcing steel placement, and other preparations.

Follow the sequence of placing concrete shown on the plans or specified.

Do not place concrete when impending weather conditions would impair the quality of the finished work. If conditions of wind, humidity, and temperature are such that concrete cannot be placed without the potential for shrinkage cracking, place concrete in early morning or at night or adjust the placement schedule for more favorable weather. Consult the evaporation rate nomograph in the Portland Cement Association's Design and Control of Concrete Mixtures for shrinkage cracking potential. When mixing, placing, and finishing concrete in non-daylight hours, adequately illuminate the entire placement site as approved.

If changes in weather conditions require protective measures after work starts, furnish adequate shelter to protect the concrete against damage from rainfall or from freezing temperatures as outlined in this Item. 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.

**1. Placing Temperature.** Place concrete according to the following temperature limits for the classes of concrete defined in Section 300.4.A, "Classification and Mix Design":

- Place Class C, F, H, K, or SS concrete only when its temperature at time of placement is between 50 and 95°F. Increase the minimum placement temperature to 60°F if ground-granulated blast furnace (GGBF) slag is used in the concrete.
- When used in a bridge slab or in the top slab of a direct-traffic culvert, place Class CO, DC, or S concrete only when its temperature at the time of placement is between 50 and 85°F. Increase the minimum placement temperature to 60°F if GGBF slag is used in the concrete. The maximum temperature increases to 95°F if these classes are used for other applications.
- Place Class A, B, and D concrete only when its temperature at the time of placement is greater than 50°F.
- Place mass concrete, defined by Section 307.4.G.14, "Mass Placements," only when its temperature at the time of placement is between 50 and 75°F.

**2. Transporting Time.** Place concrete delivered in agitating trucks within 60 minutes after batching. Place concrete delivered in non-agitating equipment within 45 minutes after batching. Revise the concrete mix design as necessary for hot weather or other conditions that contribute to quick setting of the concrete. Submit for approval a plan to demonstrate that these time limitations can be extended while ensuring the concrete can be properly placed, consolidated, and finished without the use of additional water.

**3. Workability of Concrete.** Place concrete with a slump as specified in Section 300.4.A.5, "Slump." Concrete that exceeds the maximum slump will be 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. After introduction of any additional water or chemical admixtures, mix concrete in accordance with Section 300.4.E, "Mixing and Delivering Concrete." Do not add water or chemical admixtures after any concrete has been discharged.

**4. Transporting Concrete.** Use a method and equipment capable of maintaining the rate of placement shown on the plans 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 that the concrete ingredients will not be separated. When necessary to prevent segregation, terminate such equipment in vertical downspouts. 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.

5. **Preparation of Surfaces.** Thoroughly wet all forms, prestressed concrete panels, T 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.

Confirm that the subgrade or foundation is moist before placing concrete for bridge approach slabs or other concrete placed on grade. Lightly sprinkle the subgrade if dry.

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 TxDOT's 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. To avoid expansion or contraction damage to the adjacent concrete, loosen these forms as soon as possible after final concrete set to permit free movement of the span without requiring full form removal.

When the plans show a Type A joint, provide preformed fiber joint material in the vertical joints of the roadway slab, curb, median, or sidewalk, and fill the top 1 inch with the specified joint sealing material unless noted otherwise. Install the sealer in accordance with TxDOT's 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.

Confirm 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 confirm full effectiveness of the expansion joint.

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 that 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 plans. Do not make joints in bridge slabs not shown on the plans unless approved. Additional joints in

other members are not permitted without approval. Place authorized additional joints using details equivalent to those shown on the plans for joints in similar locations.

Unless otherwise required, 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.

Draw forms tight against the existing concrete to avoid mortar loss and offsets at joints.

Coat the joint surface with bonding mortar, grout, epoxy, or other material as indicated in the plans or other Items. Provide Type V epoxy per TxDOT's 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 saturated surface-dry, and place the concrete before the bonding mortar or grout dries. Place other bonding agents in accordance with the manufacturer's recommendations.

- 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 feet 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 at 1 point and run or work the concrete along the forms.

Deposit concrete in the forms in layers of suitable depth but not more than 36 inches deep unless otherwise permitted.

Avoid cold joints in a monolithic placement. Sequence successive layers or adjacent portions of concrete so that they can be vibrated into a homogeneous mass with the previously placed concrete before it sets. When re-vibration of the concrete is shown on the plans, allow at most 1 hour to elapse between adjacent or successive placements of concrete except as otherwise allowed by an approved placing procedure. This time limit may be extended by ½ hour if the concrete contains at least a normal dosage of retarding admixture.

Use an approved retarding agent to control stress cracks and cold joints in placements where differential settlement and setting time may induce cracking.

- 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 confirm 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 confirm flushing of mortar to the surface of all forms.

- 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 unless noted otherwise. Form or drill holes for grouting.

Drill holes for anchor bolts to accommodate the bolt embedment required by the plans. Make holes for dowels at least 12 inches deep unless otherwise shown on the plans. When using grout or epoxy mortar, make the diameter of the hole at least twice the dowel or bolt diameter, but the hole need not exceed the dowel or bolt diameter plus 1 1/2 inches. When using epoxy, make the hole diameter 1/16 to 1/4 inch greater than the dowel or bolt diameter.

Thoroughly clean holes of all loose material, oil, grease, or other bond-breaking substance, and blow them clean with filtered compressed air. Confirm that holes are in a surface dry condition when epoxy type material is used and in a surface moist condition when hydraulic cement 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 prepackaged systems.

For cast-in-place or grouted systems, provide hydraulic cement grout in accordance with Section 300.2.F, "Mortar and Grout," epoxy, epoxy mortar, or other prepackaged grouts as approved. Provide a Type III epoxy per TxDOT's DMS-6100, "Epoxies and Adhesives," when neat epoxy is used for anchor bolts or dowels. Provide Type VIII epoxy per TxDOT's DMS-6100 when an epoxy grout is used. Provide grout, epoxy, or epoxy mortar as the binding agent unless otherwise indicated on the plans.

Provide other anchor systems as required in the plans.

- 11. Placing Concrete in Cold Weather.** Protect concrete placed under weather conditions where weather may adversely affect results. Permission given by the Engineer for placing during cold weather does not relieve the Contractor of responsibility for producing concrete equal in quality to that placed under normal conditions. If concrete placed under poor conditions is unsatisfactory, remove and replace it as directed at Contractor's expense.

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 unless approved. Concrete may be placed when the ambient temperature in the shade is 35°F and rising or above 40°F.

Provide and install recording thermometers, maturity meters, or other suitable temperature measuring devices to verify that all concrete is effectively protected as follows:

- Maintain the temperature of the top surface of bridge slabs and top slabs of direct-traffic culverts at 50°F or above for 72 hours from the time of placement and above 40°F for an additional 72 hours.
- Maintain the temperature at all surfaces of concrete in bents, piers, culvert walls, retaining walls, parapets, wingwalls, bottoms of bridge slab or culvert top slabs, and other similar formed concrete at 40°F or above for 72 hours 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 hours 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 Section 307.4.J, “Curing Concrete,” during this period until all requirements for curing have been satisfied.

When impending weather conditions indicate the possible need for temperature protection, have on hand all necessary heating and covering material, ready for use, before permission is granted to begin placement.

- 12. Placing Concrete in Hot Weather.** Use an approved 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 unless otherwise directed.

Keep the concrete at or below the maximum temperature at time of placement as specified in Section 307.4.G.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.

- 13. Placing Concrete in Water.** Deposit concrete in water only when shown on the plans 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 hours.

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 approximately level during placement.

Support the tremie or operate the pump so that 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.

For concrete to be placed under water, design the concrete mix in accordance with Item 300, “Concrete,” with a minimum cement content of 650 pounds per cubic yard. Include



an anti-washout admixture in the mix design as necessary to produce a satisfactory finished product.

**14. Mass Placements.** Mass placements are defined as placements with a least dimension greater than or equal to 5 feet, or designated on the plans. For monolithic mass placements, develop and obtain approval for a plan to confirm 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.

Base this plan on the equations given in the Portland Cement Association's Design and Control of Concrete Mixtures. Cease all mass placement operations and revise the plan as necessary if either of the above limitations is exceeded.

Include a combination of the following elements in this plan:

- 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; or
- use of a cooling system to control the core temperature.

Furnish and install 2 sets of temperature recording devices, maturity meters, or other approved equivalent devices at designated locations. 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. Maturity meters may not be used to predict strength of mass concrete.

**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 by the Engineer.

Placing of concrete footings upon seal concrete is permitted after the cofferdams are free from water and the seal concrete 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.

When footings can be placed in a dry excavation without the use of cofferdams, omit forms 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 unless otherwise directed. Columns and caps or tie beams supported on them may be placed in the same operation or separately. If placed in the same operation, allow for settlement and shrinkage of the column concrete by placing it to the lower level of the cap or tie beam, and delay placement between 1 and 2 hours before proceeding with the cap or tie beam placement.

- 16. Placing Concrete in Box Culverts.** Where the top slab and walls are placed monolithically in culverts more than 4 feet in clear height, allow between 1 and 2 hours to elapse 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 this Item. Give top slabs of fill type culverts a float finish.

- 17. Placing Concrete in Superstructure.** Unless otherwise shown on the plans, place simple span bridge slabs without transverse construction joints by using either a self-propelled transverse finishing machine or a mechanical longitudinal screed. For small placements or for unusual conditions such as narrow widening, variable cross slopes, or transitions, use of manually operated screeding equipment may be permitted. 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 plans. Before placing concrete on steel girder or truss spans, release falsework under the spans and swing the spans free on their permanent supports.

Make 1 or more passes with the screed over the bridge slab segment before placing concrete on it to confirm 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.

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.

For simple spans, retard the concrete only if necessary to complete finishing operations or as required by this Section. When filling curb forms, bring the top of curb and sidewalk section to the correct camber and alignment, and finish them as described in this Item.

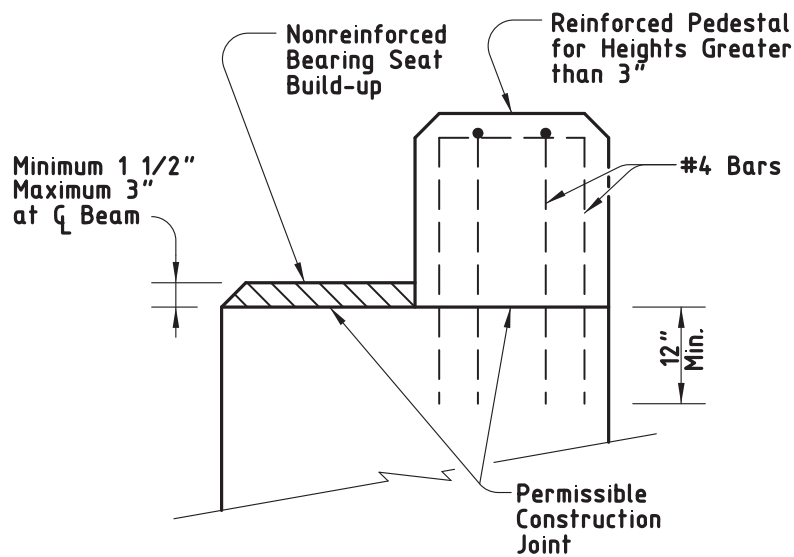
- a. Transverse Screeding.** Install rails for transverse finishing machines that are supported from the beams or girders so that the supports may be removed without damage to the slab. Prevent bonding between removable supports and the concrete in an acceptable manner. Do not allow rail support parts 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. Unless otherwise shown on the plans, for transverse screeding the minimum rate of concrete placement is 30 linear feet of bridge slab per hour. Deposit concrete parallel to the skew of the bridge so that all girders are loaded uniformly along their length. Deposit slab concrete between the exterior beam and the 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 confirm compliance with the specifications. Place concrete in transverse strips. On profile grades greater than 1½%, start placement at the lowest end.
- b. Longitudinal Screeding.** Unless otherwise shown on the plans, use of temporary intermediate headers will be permitted for placements over 50 feet 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. For spans on a profile grade of 1½% or more, start placing at the lowest end. Use strips wide enough that the concrete within each strip remains plastic until placement of the adjacent strip. Where monolithic curb construction is specified, place the concrete in proper sequence to be monolithic with the adjacent longitudinal strips of the slabs.
- c. Placements on Continuous Steel Units.** Unless otherwise shown on the plans, 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 confirm that 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 plans. When staged placement of a slab is required in the plans, confirm that the previously placed concrete attains a compressive strength of 3,000 psi before placing the next stage concrete. Multiple stages may be placed in a single day if approved. Where plans permit staged placing without specifying a particular order of placement, use an approved placing sequence that will not overstress of any of the supporting members.
- d. Slab and Girder Units.** Unless otherwise shown on the plans, place girders, slab, and 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. If using a transverse screed, place concrete in the stems for a short distance and then place the concrete in transverse strips. If using a longitudinal screed, fill the outside girder stem first, beginning at the low end or side, and continue placement in longitudinal strips.

**H. Treatment and Finishing of Horizontal Surfaces Other Than Bridge Slabs.** Strike off to grade and finish all unformed upper surfaces. Do not use mortar topping for surfaces constructed under this Section.

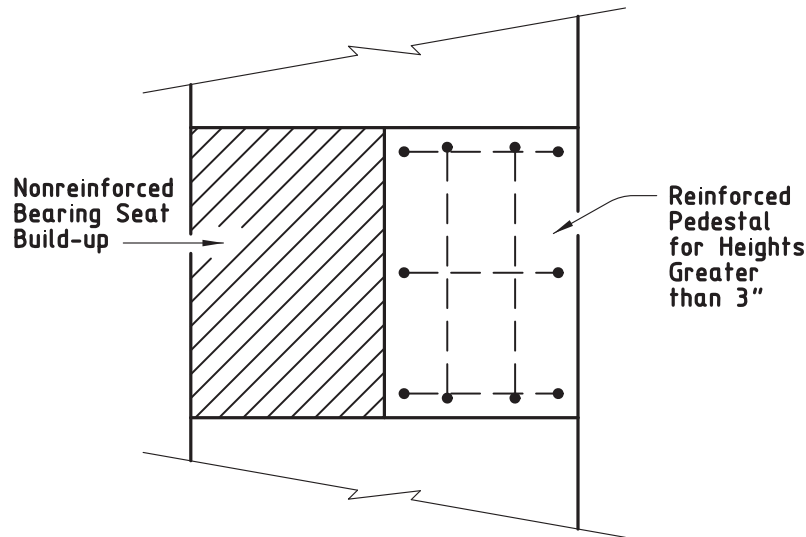
After the concrete has been struck off, float the surface with a suitable float. Give bridge sidewalks a wood float or broom finish, or stripe them with a brush.

Slightly slope the tops of caps and piers between bearing areas from the center toward the edge, and slope the tops of abutment and transition bent caps from the backwall to the edge, as directed, so that water drains from the surface. Give the concrete a smooth trowel finish. Construct bearing areas for steel units in accordance with TxDOT's Section 441.3.K.5, "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 inch in all directions.

Cast bearing seat buildups or pedestals for concrete units integrally with the cap or with 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 plans or as indicated in Figure 1 and Figure 2.



**Figure 1**  
Section through bearing seat buildups.



**Figure 2**  
**Plan view of bearing seat buildups.**

- I. Finish of Bridge Slabs.** Provide camber for specified vertical curvature and transverse slopes.

For concrete flat slab and concrete slab and girder spans cast in place on falsework, provide additional camber to offset the initial and final deflections of the span as indicated in the plans. For concrete slab and girder spans using pan forms, provide camber of approximately 3/8 inch for 30 foot spans and 1/2 inch for 40 foot spans to offset initial and final deflections unless otherwise directed. For concrete flat slab and concrete slab and girder spans not using pan forms, when dead load deflection is not shown on the plans, provide a camber of 1/8 inch per 10 feet of span length but no more than 1/2 inch

Provide a camber of 1/4 inch in addition to deflection for slabs without vertical curvature on steel or prestressed concrete beams.

Use work bridges or other suitable facilities to perform all finishing operations and to provide access, if necessary, for the Engineer to check measurements for slab thickness and reinforcement cover.

As soon as the concrete has been placed and vibrated in a section wide enough to permit working, level, strike off, and screed the surface, carrying a slight excess of concrete ahead of the screed to fill all low spots.

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.

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 overuse of finish water.

Perform sufficient checks, witnessed by the Engineer, with a long-handled 16 foot straightedge on the plastic concrete to confirm that 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 inch 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.

Finish the concrete surface to a uniform 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 inch. 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.

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 minutes 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.

Apply interim and final curing in accordance with Section 307.4.J, "Curing Concrete."

The Contractor is responsible for the ride quality of the finished bridge slab. The Engineer will use a 10 foot straightedge (1/8 inch in 10 feet) to verify ride quality and to determine locations where corrections are needed. If the Engineer determines that the ride quality is unacceptable, submit a plan for approval to produce a ride of acceptable quality. Make all corrections for ride before saw-cutting grooves.

Unless noted otherwise, 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 continuously across the slab to within 18 inches 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 that all grooves end within 6 inches of the joint, measured perpendicular to the centerline of the metal joint. Leave no ungrooved surface wider than 6 inches adjacent to either side of the joint. Confirm that 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 inch. Cut grooves continuously across construction joints or other joints in the concrete that are less than 1/2 inch 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 inches maximum dimension from the end of the grooves to the gutter line. Cut grooves continuously across formed concrete joints.

When saw-cut grooves are not required in the plans, provide either a carpet drag or broom finish for micro-texture. In this case insure that an adequate and consistent micro-texture is achieved by applying sufficient weight to the carpet and keeping the carpet or broom from getting plugged with grout. For surfaces that do not have adequate texture, the Engineer may require corrective action including diamond grinding or shot blasting.

When the plans call for a concrete overlay to be placed on the slab (new construction) or on prestressed concrete box beams or other precast elements, give a carpet drag, burlap drag, or broom finish to all concrete surfaces to be overlaid. Saw-grooving is not required in this case. Provide an average texture depth for the finish of approximately 0.035 inch with no individual test falling below 0.020 inch, unless otherwise shown on the plans, when tested in accordance with TxDOT standard laboratory test procedure Tex-436 A. If the texture depth falls below what is intended, revise finishing procedures to produce the desired texture.

When the plans require an asphalt seal, with or without overlay, on the slab (new construction), on prestressed concrete box beams, or on other precast elements, give all concrete surfaces to be covered a lightly textured broom or carpet drag finish. Provide an average texture depth of approximately 0.025 inch when tested in accordance with TxDOT standard laboratory test procedure Tex-436-A.

- J. Curing Concrete.** Obtain approval of the proposed curing methods, equipment, and materials before placing concrete. The Engineer may require the same curing methods for like portions of a single structure. Inadequate curing or facilities may delay all concrete placement on the job until remedial action is taken.

A curing day is a calendar day when the temperature, taken in the shade away from artificial heat, is above 50°F for at least 19 hours or, on colder days if the temperature of all surfaces of the concrete is maintained above 40°F, for the entire 24 hours. The required curing period begins when all concrete has attained its initial set. TxDOT standard laboratory test procedure 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 noted in Table 1.

**Table 1**  
**Exceptions to 4-Day Curing**

Description	Type of Cement	Required Curing Days
Upper surfaces of bridge slabs, top slab of direct-traffic culverts, and concrete overlays	I or III	8
	II or I/II	10
	All types with supplementary cementing materials	10
Concrete piling buildups	All	6

For upper surfaces of bridge slabs, bridge approach slabs, median and sidewalk slabs, and culvert top slabs constructed using Class S concrete, apply interim curing using a Type 1-D curing compound before the water sheen disappears but no more than 45 minutes after application of the evaporation retardant. Do not allow the concrete surface to dry before applying the interim cure, and do not place the interim cure over standing water. Apply membrane interim curing using a work bridge or other approved apparatus to confirm a uniform application. Water-cure for final curing in accordance with this Section, starting as soon as possible without damaging the surface finish. Maintain the water curing for the duration noted in Table 1. 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 hours of the curing period. Weigh down these curing materials with dry mats to maintain direct contact with the concrete and to provide insulation against cold weather. Supplemental heating or insulation may be required in cold and wet weather if the insulating cotton mats become wet or if the concrete drops below the specified curing temperature. Avoid applying heat directly to concrete surfaces.

For the top surface of any concrete unit upon which concrete is to be placed and bonded at a later interval (stub walls, risers, etc.) and other superstructure concrete (curbs, wingwalls, parapet walls, etc.), use only water curing in accordance with this Section.

Cure all other concrete as specified in the pertinent Items. Use the following methods for curing concrete, subject to the requirements of this Item.

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. If forms are removed before the 4 day required curing period, use another approved curing method.
2. **Water Curing.** Keep all exposed surfaces of the concrete wet continuously for the required curing time. Use water curing that meets the requirements for concrete mixing water in Section 300.2.D, "Water." Do not use seawater or water that stains or leaves an unsightly residue.
  - a. **Wet Mats.** Keep the concrete continuously wet by maintaining wet cotton mats in direct contact with the concrete for the required curing time. If needed, place damp burlap blankets made from 9 ounce stock on the damp concrete surface for temporary protection before applying cotton mats. Then place the dry mats and wet them immediately after they are placed. 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 that outside air cannot enter the enclosure. Provide sufficient moisture inside the enclosure to keep all surfaces of the concrete wet.
  - b. **Water Spray.** Overlap sprays or sprinklers to keep all unformed surfaces continuously wet.
  - c. **Ponding.** Cover the surfaces with at least 2 inches of clean granular material, kept wet at all times, or at least 1 inch deep water. Use a dam to retain the water or saturated granular material.
3. **Membrane Curing.** Unless otherwise shown on the plans, choose either Type 1-D or Type 2 membrane-curing compound when membrane curing is permitted. Type 1-D (Resin Base Only) is required for interim curing bridge slabs and top slabs of direct-traffic culverts and all other surfaces that require a higher grade of surface finish. For substructure concrete provide only 1 type of curing compound on any 1 structure.

Apply membrane curing just after free moisture has disappeared at a rate of approximately 180 square feet 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 that they are moist at the time of application of the membrane.

When membrane is used for complete curing, leave the film unbroken for the minimum curing period specified. 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.

- K. Removal of Forms and Falsework.** Unless otherwise directed, forms for vertical surfaces may be removed after the concrete has aged 12 hours after initial set provided the removal can be done without damage to the concrete. Keep forms for mass placements, defined in Section 307.4.G.14, "Mass Placements," in place for 4 days following concrete placement.

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 foot for all bridge components and culvert slabs except as directed otherwise 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 inch 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 unless otherwise directed.

- L. Defective Work.** Repair defective work as soon as possible. Remove and replace at the expense of the Contractor any defect that cannot be repaired to the satisfaction of the Engineer.

- M. Ordinary Surface Finish.** Apply an ordinary surface finish to all concrete surfaces as follows:

- Chip away all loose or broken material to sound concrete where porous, spalled, or honeycombed areas are visible after form removal.
- Repair spalls by saw-cutting and chipping at least 1/2 inch deep, perpendicular to the surface to eliminate feather edges. Repair shallow cavities using a latex adhesive grout, cement mortar, or epoxy mortar as approved. Repair large areas using concrete as directed or approved.

- 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 311, "Concrete Surface Finish," chip out exposed parts of metal chairs to a depth of 1/2 inch and repair the surface.
- Remove all fins, runs, drips, or mortar from surfaces that will be exposed. Smooth all form marks and chamfer edges by grinding or dry-rubbing.
- Confirm that 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.

Unless noted otherwise, 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,
- 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 inside of culvert barrels and the bottom of bridge slabs between girders or beams.

**307.5. MEASUREMENT:** This Item will be measured by the cubic yard, square yard, foot, square foot, or by each structure.

**A. General.** Concrete quantities will be based on the dimensions shown on the plans or those established in writing by the Engineer.

In determining quantities, no deductions will be made for chamfers less than 2 inches or for embedded portions of steel or prestressed concrete beams, piling, anchor bolts, reinforcing steel, drains, weep holes, junction boxes, electrical or telephone conduit, ducts and voids for prestressed tendons, or embedded portions of light fixtures.

For slab and girder spans using pan forms, a quantity will be included for the screed setting required to provide proper camber in the roadway surface after form removal.

For slabs on steel or prestressed concrete beams, an estimated quantity for the haunch between the slab and beams will be included. No measurement will be made during construction for variation in the amount of haunch concrete due to variations in camber of the beams.

For cast-in-place slabs on slab beams, double T beams, or box beams, the combination of span length, theoretical camber in beams, computed deflections, and plan vertical curve will be taken into account in determining the quantity for the slab.

Additional concrete that may be required by an adjustment of the profile grade line during construction, to insure proper slab thickness, will not be measured for payment.

Variation in concrete headwall quantity incurred when an alternate bid for pipe is permitted will not be cause for payment adjustment.

Mass placements may be either a plans quantity item or measured in place as indicated.

Quantities revised by a change in design, measured as specified, will be increased or decreased and included for payment.

- B. Plans Quantity.** Structure elements designated in Table 2 and measured by the cubic yard are plans quantity measurement items. The quantity to be paid for plans quantity items is the quantity shown in the proposal unless modified by TxDOT's Article 9.2, "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

No adjustment will be made for footings or other in-ground elements where the Contractor has been allowed to place concrete in an excavation without forms.

**Table 2**  
**Plans Quantity Payment**  
**(Cubic Yard Measurement Only)**

Culverts and culvert wing walls	Abutments
Headwalls for pipe	Slab and girder spans (pan form)
Retaining walls	Footings
Inlets and manholes	Pile bent caps
Shear key concrete for box and slab beams	Concrete wearing surface on pre-cast box beams, slab beams or double-T beams
Bridge approach slabs	Cast-in-place concrete slab spans

Note: Other structure elements, including pier and bent concrete, may be paid for as "plans quantity" when shown on the plans.

- C. Measured in Place.** Items not paid for as "plans quantity" will be measured in place.

- 307.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the various structure elements specified of the various classes of concrete. Mass placements, as defined in Section 307.4.G.14, "Mass Placements," will be paid for separately for the various classes of concrete. This price is full compensation for furnishing, hauling, and mixing concrete materials; furnishing, bending, fabricating, splicing, welding and placing the required reinforcement; clips, blocks, metal spacers, ties, wire, or other materials used for fastening reinforcement in place; placing, finishing, curing, and grooving concrete; applying ordinary surface finish; furnishing and placing drains, metal flashing strips, and expansion-joint material; excavation, subgrade preparation, and disposal of excavated material for bridge approach slabs; and forms and falsework, equipment, labor, tools, and incidentals.

Diaphragm concrete will not be paid for directly but is subsidiary to the slab unless otherwise shown on the plans.

Design and installation of foundations for falsework is at the Contractor's expense.

The following procedure will be used to evaluate concrete where 1 or more project acceptance test specimens fail to meet the required design strength specified in Item 300, "Concrete," or in the plans:

- The concrete for a given placement will be considered structurally adequate and accepted at full price if the average of all test results for specimens made at the time of placement meets the required design strength provided that no single test result is less than 85% of the required design strength.
- The Engineer will perform a structural review of the concrete to determine its adequacy to remain in service if the average of all test results for specimens made at the time of placement is less than the required design strength or if any test results are less than 85% of the required design strength. If cores are required to determine the strength of the in-situ concrete, take cores at locations designated by the Engineer in accordance with TxDOT standard laboratory test procedure Tex-424-A. The coring and testing of the cores will be at the Contractor's expense. The Engineer will test the cores.
- If all of the tested cores meet the required design strength, the concrete will be paid for at the full price.
- If any of the tested cores do not meet the required design strength but the average strength attained is determined to be structurally adequate, the Engineer will determine the limits of the pay adjustment. The average strength of the cores tested will be used in the pay adjustment formula.
- Remove concrete that is not structurally adequate.
- Concrete that has been determined to be structurally adequate may be accepted at an adjusted price based on the following formula:

$$A = B_p[-5.37(S_a/S_s)^2 + 11.69(S_a/S_s) - 5.32]$$

Where:

A = Amount to be paid

S<sub>a</sub> = Actual strength from cylinders or cores

S<sub>s</sub> = Specified design strength

B<sub>p</sub> = Unit bid price

- The decision to reject structurally inadequate concrete or to apply the pay adjustment will be made no later than 56 days after placement.

### **307.7. BID ITEM:**

Item 307.1 - Concrete Structure - per cubic yard

Item 307.2 - Concrete Structure - per square yard

Item 307.3 - Concrete Structure - per foot

Item 307.4 - Concrete Structure - per square foot

Item 307.5 - Concrete Structure - per each structure

**ITEM****311 CONCRETE SURFACE FINISH**

**311.1. DESCRIPTION:** *Finish concrete surface as specified.*

**311.2. MATERIALS:** Furnish materials in accordance with this Article for the type of surface finish specified.

**A. Coatings.**

1. **Adhesive Grout and Concrete Paint.** Provide coatings in accordance with TxDOT's DMS 8110, "Coatings for Concrete." Match color of coating with Federal Standard 595B color 35630, concrete gray, unless otherwise shown on the plans.
  2. **Opaque Sealer.** Provide penetrating-type sealer in accordance with TxDOT's DMS 8110, "Coatings for Concrete." Match color of coating with Federal Standard 595B color 35630, concrete gray, unless otherwise shown on the plans.
  3. **742 Appearance Coating.** Provide #742 gray appearance coating (Federal Standard 595B color 35630) in accordance with TxDOT's DMS 8100, "Structural Steel Paints-Formula."
  4. **Epoxy Paint.** Provide Type X epoxy coating in accordance with TxDOT's DMS 6100, "Epoxies and Adhesives."
- B. Exposed Aggregate Finish.** Provide approved aggregates meeting the grading requirements shown on the plans. Unless otherwise shown on the plans, provide gravel consisting of predominantly rounded particles. When a bush-hammered finish is desired, use crushed stone. Provide a concrete surface retardant. Provide clear acrylic resin sealer in accordance with TxDOT's DMS 8110, "Coatings for Concrete," or clear Type II permanent anti-graffiti coating in accordance with TxDOT's DMS 8111, "Anti-Graffiti Coatings."

**311.3. EQUIPMENT:** The Engineer may require demonstration of the equipment's capabilities.

- A. 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 plans.
- B. Abrasive Blasting.** Use equipment equipped with filters to produce oil-free air and also water-free air when dry air is required.
- C. 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.
- D. Spraying.** For spray applications, use equipment with fluid and air pressure regulators and gauges to allow for adjustment to produce a uniform spray pattern.
- E. Off-the-Form Finish Forms.** Use non-staining, 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.

- F. Form Liners.** Provide form liners capable of producing a patterned finish as shown on the plans. Use form liners that provide a clean release from the concrete surface without pulling or breaking the textured concrete.

**311.4. CONSTRUCTION:** Provide the finish specified on the plans for the specific surface areas.

- A. Surface Areas of Finish.** “Surface area of finish” designates the areas where the specified surface is to be applied.

**1. Surface Area I.** Surface Area I includes:

- 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 plans;
- vertical and underside surfaces of bents and piers;
- all surfaces of tie beams, abutments, bridge wingwalls, culvert headwalls and wingwalls and retaining walls exposed to view after all backfill and embankment is placed; and
- all other exposed surfaces shown in the plans to require surface treatment.

**2. Surface Area II.** Surface Area II includes surfaces of railing, all wingwalls, and the exterior vertical faces of slabs.

**3. Surface Area III.** Surface Area III includes only the top and roadway faces of all concrete railing and bridge wingwalls.

**4. Surface Area IV.** Surface Area IV includes areas designated on the plans.

- B. Surface Finishes.** Apply the coating or special finish from Table 1 as specified on the plans.

**Table 1**  
**Surface Finishes**

<b>Coatings</b>	<b>Special Surface Finishes</b>
Adhesive grout	Blast
Concrete paint	Rub
Opaque sealer	Off-the-form
742 appearance coating	Form liner
Epoxy paint	Exposed aggregate

**1. Application of Coatings.**

- a. Preparation.** Before applying a coating, thoroughly clean the surface by chemical cleaning, if required, and by blast cleaning.

(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.
- If beading is found, clean the surface.

(2) **Blast Cleaning.** Before applying a specified coating, blast-clean the designated surface to remove weak surface material, curing compound, and other contaminants, 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. When water-blasting, maintain the stand-off-distance of the nozzle to a maximum of 12-inches from the surface being cleaned.

Do not damage concrete surface by gouging, spalling, or exposing coarse aggregate by the blasting operation.

Immediately before application of any coating, blow clean oil- and moisture-free air on all surfaces with sufficient pressure to remove loose particles. Perform the following test to check for surface cleanliness as directed:

- Press a 10-inch long strip of 2-inches wide clear packing tape on the surface by rubbing with moderate pressure times.
- 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.

b. **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.

Do not apply coatings before the new concrete aging a minimum of 28-days unless approved otherwise. Do not apply coatings when weather conditions will be detrimental to the final surface finish as determined by the Engineer. Do not apply coatings when surface temperature of the concrete exceeds 110°F.

Apply coatings to obtain a consistent color and texture.



- (1) **Adhesive Grout.** Apply coating on a moistened surface to a uniform minimum thickness of 1/16-inch. Do not apply when ambient temperature is less than 50°F.
- (2) **Concrete Paint.** Apply the coating on a dry surface in 2 coats for a total maximum application rate of 150 square feet per gallon. Match the color of the applied coating with the color standard shown on the plans. Do not thin material unless approved. Apply when ambient temperature is between 50°F and 100°F.
- (3) **Opaque Sealer.** Apply the coating to a dry surface in 2 coats for a total maximum application rate of 200 square feet per gallon. Match the color of the applied coating with the approved color standard shown on the plans. Do not thin the material unless approved. Apply when ambient temperature is between 40°F and 95°F.
- (4) **742 Appearance Coating.** Apply the coating on a dry surface at a rate of at most 400 square feet per gallon. Apply when ambient temperature is above 40°F.
- (5) **Epoxy Paint.** Apply the coating on a dry surface at a maximum application rate of 100 square feet per gallon. Apply when ambient temperature is above 50°F.

Repair surface finish where coating has been applied that exhibits peeling, flaking, or discoloration or that has been damaged during construction. Remove defective or damaged coating. Clean and recoat repair area in accordance with the requirements of this Item.

2. **Special Surface Finishes.** Submit a work plan to the Engineer for any special finish shown on the plans. 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.
  - a. **Blast Finish.** Provide surface profile as shown in the plans, or meet the minimum requirements of Section 311.4.B.1.a, "Preparation." Construct a 4 feet by 4 feet 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.
  - b. **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. If rubbing surface is delayed to the point where the surface is dry and unable to be rubbed to produce an acceptable finish, provide blast finish or other finish as directed at no additional cost to the City. Perform the requirements to obtain the ordinary surface finish specified in Section 307.4.M, "Ordinary Surface Finish," concurrently with rubbing the surface. Where concrete patching is performed, rub these 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.

After form removal, keep the surface continuously wet 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. If required, apply membrane curing in accordance with Item 307, "Concrete Structures," after rubbing is complete.

- c. 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. If necessary, seal joints with compressible gasket material, caulk, tape or by other suitable means that are not detrimental to the concrete finish. Use one brand and type of form release agents for all surfaces unless another product produces a similar concrete surface appearance. 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. Do not use plywood that will 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-inches in accordance with the concrete surface repair procedures outlined in Item 307, "Concrete Structures," to obtain an ordinary surface finish as defined in Section 307.4.M, "Ordinary Surface Finish." For honeycombed and spall areas with least dimension greater than  $\frac{3}{4}$ -inch but smaller than 2-inches, patch by filling defect with repair material omitting the chipping operation. Do not patch honeycombed and spall areas with least dimension smaller than  $\frac{3}{4}$ -inch. 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  $\frac{1}{2}$ -inch 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 the Engineer determines that defective formwork is causing an excessive amount of repair work.

- d. Form Liner Finish.** Provide patterned finish as shown on the plans. 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 re-used. Replace form liners that have become damaged or worn.

Construct a sample panel for each form liner finish. Approval is required to verify that the sample panel meets the requirements of the plans and specifications before beginning work. Upon approval, the sample panel becomes the model panel that all other work will 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 the Engineer and in accordance with the surface finish requirements outlined in Item 307, "Concrete Structures," to obtain an ordinary surface finish as defined in Section 307.4.M, "Ordinary Surface Finish."

Seal all form liner joints in a manner acceptable to the Engineer to prevent leakage at the surface.

- e. **Exposed Aggregate Finish.** Provide exposed aggregate finish as indicated on the plans. Provide a depth of finish between 3/8-inch and 1/2-inch unless directed otherwise.

Apply a concrete surface retarder that penetrates approximately 1/4-inch 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 hours after concrete placement but not before concrete has gained sufficient strength to support the self-weight of the member unless directed otherwise. 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 the Engineer.

Re-clean exposed aggregate surfaces by an approved method. Apply a coat of acrylic resin sealer or clear Type II permanent anti-graffiti coating to cleaned exposed aggregate surface. Apply a single coat or multiple coats for a total maximum application rate of 250 square feet per gallon.

- 311.5. MEASUREMENT:** When surface finishes for concrete is shown on the plans to be a pay item, measurement will be by the square foot of the type of surface finish specified.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by TxDOT's Article 9.2, "Plans Quantity Measurement." Additional measurement or calculations will be made if adjustments of quantities are required.

- 311.6. PAYMENT:** Unless otherwise specified on the plans, the work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly, but will be considered subsidiary to pertinent Items.

When a surface finish for concrete is specified as a pay item, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Adhesive Grout Finish," "Concrete Paint Finish," "Opaque Sealer Finish," "742 Appearance Coating Finish," "Epoxy Paint Finish," "Blast Finish," or "Rub Finish." This price is full compensation for materials; cleaning and preparing surfaces; application of materials; and equipment, labor, tools, and incidentals.

Off-the-form, form liner, or exposed aggregate finishes (including anti-graffiti coating) will not be paid for under this Item but are subsidiary to other pertinent Items.

**311.7. BID ITEM:**

Item 311.1 - Concrete Surface Finish - Adhesive Grout Finish - per square yard

Item 311.2 - Concrete Surface Finish - Concrete Paint Finish - per square yard

Item 311.3 - Concrete Surface Finish - Opaque Sealer Finish - per square yard

Item 311.4 - Concrete Surface Finish - 742 Appearance Coating Finish - per square yard

Item 311.5 - Concrete Surface Finish - Epoxy Paint Finish - per square yard

Item 311.6 - Concrete Surface Finish - Blast Finish - per square yard

Item 311.7 - Concrete Surface Finish - Rub Finish - per square yard

**DIVISION IV - STORM SEWERS****ITEM****400 EXCAVATION, TRENCHING AND BACKFILLING**

**400.1. DESCRIPTION:** *Excavate, trench, and backfill storm drainage pipe, and pipe culverts, unless otherwise noted on the plans, details and the specifications. The work shall include all necessary pumping or bailing, sheeting, drainage and the construction and removal of any required cofferdams. All existing utilities shall be protected from damage during the excavation and backfilling of trenches, and if damaged, shall be replaced or repaired by the Contractor at his expense. Unless otherwise shown on the plans and bid proposal all excavation shall be unclassified, and shall include all materials encountered regardless of their nature or the manner in which they are removed.*

**400.2. MATERIALS:** Use materials that meet the requirements of the following Items:

- A. **Aggregate.** Item 200, "Flexible Base."
- B. **Gravel.** Item 410, "Subgrade Filler."
- C. **Cement Stabilized Sand.** Item 412, "Cement Stabilized Sand."
- D. **Glass Cullet.** Item 411, "Glass Cullet use for Utility Bedding and Backfill."
- E. **Flowable Fill.** Item 413, "Flowable Fill."
- F. **Filter Fabric.** TxDOT DMS 6200, "Filter Fabric," Type1.

**400.3. CONSTRUCTION:**

**A. Excavation.**

1. **General.** The Contractor shall perform all excavation of every description and of whatever substances encountered, to the lines and grades shown on the plans or determined by the Engineer. Unless otherwise indicated, excavation shall be by open cut except that short sections may be tunneled, if in the opinion of the Engineer, the pipe or structure can be safely and properly installed or constructed, and backfill can be properly tamped in such tunnel sections.
2. **Safety.** Provide slopes, benching, sheeting, bracing, pumping, and bailing as necessary to maintain the stability and safety of excavations. Excavation protection is governed by Item 550, "Trench Excavation Safety Protection," and Item 551, "Special Shoring."
3. **Excavated Materials.** During excavation, material suitable for backfilling shall be stockpiled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or not suitable for backfill shall be removed and properly disposed of by the Contractor or as directed by the Engineer. Proper disposal shall be in conformance with, but not limited to, the following provisions:
  - a. Do not deposit excavated material within jurisdictional wetlands, and

- b. Obtain appropriate permits and apply provisions pertaining to soil erosion and stream pollution, when necessary, to meet federal, state, and/or local regulations, rules, and procedures.
4. **Hazardous Materials.** If the Contractor encounters hazardous substances, industrial waste, environmental damage, underground storage tanks, or conditions conducive to environmental damage, Contractor shall immediately stop work in the area affected and report the condition to the Owner's representative in writing. Contractor shall not be responsible for or required to conduct any investigation, site monitoring, containment, cleanup, removal, restoration or other remedial work of any kind or nature (the "remedial work") under any applicable level, state or federal law, regulation or ordinance, or any judicial order. If the Contractor agrees in writing to commence and/or prosecute some or all of the remedial work, all costs and expenses, to include any extension of the contract time, of such remedial work shall be paid by Owner to Contractor as additional compensation.
5. **Existing Structures/Obstructions.** Unless otherwise stated on the plans, remove structures and other obstructions over the width of the excavation to a depth of 1 ft. below the bottom of excavation. If abandoned storm drains, sewers, or other drainage systems are encountered, remove as required to clear the new structure, and plug in an approved manner. After removing obstructions, restore the bottom of the excavation to grade by backfilling in accordance with this Item. Dispose of surplus materials in accordance with federal, state, and local regulations.
6. **Existing Asphaltic Materials.** All asphaltic material shall be disposed of or recycled at a facility authorized to accept the material for such purposes.
7. **Excavation in Streets.** When structures are installed in streets, highways, or other paved areas, cut pavement and base in accordance with Item 230, "Base and Pavement Replacement." Restore pavement structure after completion of excavation and backfilling in accordance with Item 230, "Base and Pavement Replacement."

Unless otherwise shown on the plans, maintain and control traffic in accordance with the approved traffic control plan or in conformance with the Texas MUTCD.

8. **Utilities.** Conduct work with minimum disturbance of existing utilities, and coordinate work in or near utilities with the utility owners. Inform utility owners sufficiently before work begins to allow them 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. If damage occurs, promptly notify the utility company. If an active sanitary sewer line is damaged during excavation, provide temporary flumes across the excavation while open, and restore the lines when backfilling has progressed to the original bedding lines of the cut sewer.

9. **De-Watering.** Do not construct or place structures in the presence of water unless approved. Place precast units or pour structural concrete only on a dry, firm surface. Remove water by bailing, pumping, well-point installation, deep wells, underdrains, or other approved method.

Do not pump or bail while placing structural concrete or for a period of at least 36 hr. thereafter unless from a suitable sump separated from the concrete work. Pump or bail during placement of seal concrete only to the extent necessary to maintain a static head of water within the cofferdam. Do not pump or bail to de-water inside a sealed cofferdam until the seal has aged at least 36 hours.

If the bottom of an excavation cannot be de-watered to the point that the subgrade is free of mud or it is difficult to keep reinforcing steel clean, place a stabilizing material in the bottom of the excavation. Stabilizing material may be controlled low strength material, flowable backfill, or other material approved by the Engineer. Stabilizing material placed for the convenience of the Contractor will be at the Contractor's expense.

## **B. Trenching.**

1. **General.** Trench walls shall be vertical in excavations through stable rock, as classified and substantiated during construction by a competent professional as defined by OSHA, and the practice of undercutting at the bottom or flaring at the top will not be permitted unless approved by the Engineer. In special cases where trench flaring is permitted and directed by the Engineer, the trench walls shall remain vertical to a depth of at least 1 foot above the top of the pipe. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of pipe on the undisturbed soil at every point along its entire length, except for the portions of pipe sections where it is necessary for bells and for the proper sealing of pipe joints. Bell holes and depressions for joints shall be dug after the trench bottom has been graded in order that the pipe may rest upon the prepared bottom for as much of its full length as practicable.
2. **Depth of Cut.** The depth of cut shall be measured from the offset or cut hub elevation to the invert of the pipe and shall be determined by the Contractor. The width of the trench shall be at least the outside diameter of the pipe plus 6 inches on each side of the pipe for pipe sizes less than 42 inches in diameter.

It shall be understood that the depth of cut as initially indicated may be more or less than the actual excavated depth due to ground conditions existing at the site. For this reason the Engineer shall determine the depth for pay purposes based on the surface elevation prior to the Contractor's operation and the invert of the sewer line. The Engineer's decision shall be final.

3. **Working Space.** The maximum working room for pipe 42 inches in diameter and under shall not exceed  $\frac{1}{2}$  of the outside diameter of the pipe or 12 inches whichever is greater, from the edge of the pipe to the face of the trench walls, or inside face of the shoring protection.

For pipe over 42 inches in diameter the maximum width of the trench shall be such that the working space from the pipe to the trench wall, or shoring protection as the case may be, will be a minimum of 12 inches, and a maximum of 24 inches. If allowable trench widths are exceeded through over-shooting of rock, caving of earth trenches or over-excavation, the Contractor shall employ corrective measures or alternative designs as determined by the Engineer.

**C. Over Excavation.**

1. **Unstable Material.** Whenever wet or otherwise unstable soil that is incapable of properly supporting the structure or pipe, as determined by the Engineer, is encountered in the bottom of the excavation or trench, such soil shall be removed to the depth shown on the plans or determined by the Engineer and the excavation or trench backfilled to the proper grade with a gravel subgrade filler as specified in Item No. 410, "Subgrade Filler" or other suitable bedding material.
2. **Incompressible Material.** Where trash, debris, rock, boulder or coarse gravel with a particle size larger than 1 ¾ inch is encountered at the bearing level, the Contractor shall, as directed by the Inspector, over-excavate and remove such materials to a depth not less than 4 inches below the bottom of the pipe and replace with a gravel material conforming to the requirements of Item 410, "Subgrade Filler" or other suitable bedding material.
3. **Unauthorized Excessive Excavation.** Whenever over-excavation occurs that is not a result of unstable or incompressible material as defined above, the under-cut trench shall be restored to grade, to the satisfaction of the Inspector, by replacement of excavated material compacted to the same density as the surrounding natural ground.

**D. Bedding.** When bedding material is required by the plans, place the material to the depth specified and in the manner described herein.

1. Bedding material may consist of lean clay, gravel, clean sand, cement stabilized sand, glass cullet that conforms to the requirements of Item 411, "Glass Cullet use for Utility Bedding and Backfill," or other materials approved by the Engineer.
2. Remove loose, sloughing, or caving soil from the bottom and sidewall of trenches immediately prior to placement of bedding materials. Place bedding to the depths shown on the Standard Details or project plans.
3. For pipe installation, manually spread bedding materials around pipe to provide uniform bearing and side support when compacted. Protect flexible pipe from damage during placing of pipe zone bedding material. Perform placement and compaction directly against undisturbed soils in trench sidewalls, or against sheeting which is to remain in place.
4. Do not place trench shields or shoring within the height of the bedding zone unless means to maintain density of compacted bedding material are used. If moveable supports are used in the bedding zone, lift supports incrementally to allow placement and compaction of material against undisturbed soil.
5. If shown on the plans or directed by the Engineer, place geotextile on the bottom of the excavated trench prior to the placement of any sand, glass cullet, or granular bedding to prevent particle migration from in-situ soil into open-graded bedding materials or drainage layers, when used.
6. Compact bedding material to its specific compaction requirements using pneumatic tampers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.



**E. Backfilling.**

1. **General.** Trench shall not be backfilled until the constructed structures or appurtenances as installed conform to the requirements specified. The trench shall be carefully backfilled with the materials approved for backfilling as described in 400.3.E.2. "Pipe Backfilling" or other materials approved by the Engineer.

Where pipe is specially coated for protection against corrosion, care shall be taken not to damage the coating.

Any trench improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and compacted with the surface restored to the required grade and compaction.

2. **Pipe Backfilling.** Initial backfill that is defined as backfilling to a point 12 inches above the top of the pipe shall be done by either method a., b., c., or d. below. Secondary backfill that is defined as backfilling from a point 12 inches above the top of the pipe to the top of the trench or proposed subgrade elevation shall be completed in accordance with 400.3.E.2.e. "Secondary Backfill."
  - a. **Suitable Excavated Material.** Fine compactable soil material may be used as the initial backfill; examples would include loam, sandy clay, sand and gravel, or soft shale, all of which shall be free from large clods of earth or stones. It shall be placed in uniform layers not more than 6 inches in depth (loose measurement) and shall be compacted to the density specified herein. Each layer of backfill material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density, by means of a hand or mechanical tamper.

The maximum dry density and optimum moisture content shall be determined in accordance with TxDOT Test Method Tex-114-E. Tests for in place density shall be made in accordance with TxDOT Test Method Tex-115-E and within 24 hours after compacting operations are completed. If the material fails to meet the density specified, it shall be re-worked as necessary to obtain the density required.

Care shall be exercised to thoroughly compact the backfill under the haunches of the pipe and to insure that the backfill soil is in intimate contact with the sides of the pipe. Backfill material shall be kept at the same elevation on both sides of pipe.

Each lift of fill shall be compacted to the required density and moisture content as shown below, unless otherwise shown on the plans:

Subgrade Material	Density	Moisture Content
PI ≤ 20	≥ 95% of Max Dry Density	- 2% of Opt. or greater
PI > 20	≥ 95% of Max Dry Density	≥ Opt. Moisture

- b. **Cement Stabilized Sand.** When shown on the plans, backfill the excavation with cement stabilized sand backfill that conforms to Item 412, "Cement Stabilized Sand" to the elevations shown on the plans. Prevent the structure from being displaced during the placement of the cement stabilized sand and prevent the backfill from entering pipes. There is no separate pay item for Cement Stabilized Sand material, unless shown on the plans as a separate pay item for pipe backfill.

Before placing cement stabilized sand, the trench shall be cleaned of any extraneous material and thoroughly wet. All surplus dirt excavated from the trench shall be removed from the site.

- c. **Flowable Backfill.** When shown on the plans, backfill the excavation with flowable backfill that conforms to Item 413, "Flowable Backfill" to the elevations shown on the plans. Prevent the structure from being displaced during the placement of the flowable backfill and prevent flowable backfill from entering pipes. There is no separate pay item for Flowable Backfill material, unless shown on the plans as a separate pay item for pipe backfill.

Before placing flowable backfill, the trench shall be cleaned of any extraneous material and thoroughly wet. All surplus dirt excavated from the trench shall be removed from the site.

- d. **Select Fill or Flexible Base.** A clean gravel, or gravel approved by the Engineer, conforming to the requirements of article 410.3.B. "Gravel" of Item No.410, "Subgrade Filler" may be used for backfill material from the bottom of the trench to the top of the pipe. The gravel shall be placed in the trench in loose lifts not to exceed 10 inches in depth and lightly tamped to consolidate and seat the mass against conduit and earthen surfaces. Backfill material shall be kept at the same elevation on both sides of pipe.

A filter fabric shall be placed between the gravel backfill (initial backfill) and secondary backfill completely covering the top and sides of the gravel backfill. The filter material shall have an apparent opening size of U.S. Sieve No. 40. The filter fabric shall conform to the requirements of TxDOT DMS 6200, "Filter Fabric," Type1.

Where conditions permit and with approval of the Engineer, a gravel material conforming to Item 200 "Flexible Base" may be used from the top of the gravel filter bed to the top of the pipe. This backfill material shall be placed in uniform layers not more than 10 inches in depth (loose measurement) and shall be compacted to the required density. Each layer of material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density by means of a mechanical tamper.

Compaction of the Flexible Base shall be such that the density of each layer shall be not less than 95% of the maximum dry density as determined by TxDOT Test Method TEX-114-E, unless otherwise shown on the plans.

- e. **Glass Cullet.** Glass cullet approved by the engineer, conforming to the requirements Item 411, "Glass Cullet use for Utility Bedding and Backfill," may be used for initial backfill. The glass cullet shall be placed in the trench and lightly tamped to consolidate and seat the mass against the conduit and earthen surfaces. Backfill material shall be kept at the same elevation on both sides of pipe.

A filter fabric shall be placed at the bottom of the trench directly on top of the exposed soil when bedding material is not used as well as between the top of the glass cullet (initial backfill) and the secondary backfill for the entire length and width of the trench. The filter fabric shall conform to the requirements of TxDOT DMS 6200, "Filter Fabric," Type1.

- f. **Secondary Backfill.** After the initial backfill has been completed to a point 12 inches above the top of the pipe by one of the methods outlined above, suitable rolling equipment may be used on these portions which are accessible to such equipment to obtain the compaction effect. Material for backfill shall be placed in uniform layers no more than 10 inches in depth (loose measurement) and shall be compacted to the density specified herein. Each layer of backfill material, if dry, shall be wetted uniformly prior to placement in the trench to the moisture content required to obtain the specified density, and shall be compacted to the required density by means of rolling equipment or other suitable mechanical method. No rolling equipment shall be used which may damage the pipe.

Each lift of fill shall be compacted to the required density and moisture content as shown below, unless otherwise shown on the plans:

<b>Subgrade Material</b>	<b>Density</b>	<b>Moisture Content</b>
PI ≤ 20	≥ 95% of Max Dry Density	- 2% of Opt. or greater
PI > 20	≥ 95% of Max Dry Density	≥ Opt. Moisture

- 3. **Quality Control.** In-place density tests shall be conducted by Engineer. The frequency and location of testing shall be in accordance with the following table:

<b>Secondary Backfill Depth (Ft)</b>	<b>Number of Tests per 400 Linear Feet</b>
0 – 6	3
6 – 12	5
> 12	7 or as directed by the Engineer

The number of tests shown above is a minimum. The Engineer may require more tests if there is a need.

Any failed test shall require the Contractor to remove and replace or rework as required the layer of backfill to points halfway to the next test location at no additional cost. Retests of these areas shall be at the Contractor’s expense

The Contractor shall provide access to the test area, associated trench excavation safety protection, and backfilling of the test areas at the Contractor’s expense.

**400.4. MEASUREMENT:** Excavation, Trenching and Backfill will not be measured for payment.

**400.5. PAYMENT:** No direct payment shall be made for excavation, trenching and backfilling for pipe culverts, pipe storm sewers, and all costs in connection therewith shall be included in the applicable contract price for the item to which the work pertains. No direct payment shall be made for placement of filter fabric and all costs in connection therewith shall be included in the applicable contract price for the item to which the work pertains.

**400.6. BID ITEM:**

N/A

## ITEM

### 401 REINFORCED CONCRETE PIPE

**401.1. DESCRIPTION:** *Furnish and install reinforced concrete pipe, materials for precast concrete pipe culverts, or precast concrete storm drain mains, laterals, stubs, and inlet leads.*

**401.2. MATERIALS:**

**A. Fabrication.** Provide precast reinforced concrete pipe that conforms to the design shown on the plans and to the following:

- ASTM C 76 or ASTM C 655 unless otherwise shown on the plans for circular pipe, or
- ASTM C 506 for arch pipe, or
- ASTM C 507 for horizontal elliptical pipe.

Provide precast concrete pipe that is machine-made or cast by a process that will provide for uniform placement of the concrete in the form and compaction by mechanical devices that will assure a dense concrete.

Mix concrete in a central batch plant or other approved batching facility where the quality and uniformity of the concrete is assured. Do not use transit-mixed concrete for precast concrete pipe. When sulfate-resistant concrete is required, do not use Class C fly ash.

Do not place more than 2 holes for lifting and placing in the top section of precast pipe. Cast, cut, or drill the lifting holes in the wall of the pipe. The maximum hole diameter is 3 in. at the inside surface of the pipe wall and 4 in. at the outside surface. Do not cut more than 1 longitudinal wire or 2 circumferential wires per layer of reinforcing steel when locating lift holes.

**B. Design.**

- 1. General.** The class and D-load equivalents are shown in Table 1. Furnish arch pipe in accordance with ASTM C 506 and the dimensions shown in Table 2. Furnish horizontal elliptical pipe in accordance with ASTM C 507 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 C 76 & ASTM C 655**

Class	D-Load (lb./ft./ft.)
I	800
II	1,000
III	1,350
IV	2,000
V	3,000

**Table 2**  
**Arch Pipe**

<b>Design Size</b>	<b>Equivalent Diameter, (in.)</b>	<b>Rise, (in.)</b>	<b>Span (in.)</b>
1	18	13-1/2	22
2	21	15-1/2	26
3	24	18	28-1/2
4	60	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**

<b>Design Size</b>	<b>Equivalent Diameter, (in.)</b>	<b>Rise, (in.)</b>	<b>Span (in.)</b>
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. **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. When requested, provide design notes and drawings signed and sealed by a Texas licensed professional engineer.
- C. **Physical Test Requirements.** Acceptance of the pipe will be determined by the results of the following tests:
- material tests required in ASTM C 76, C 655, C 506, or C 507,
  - absorption tests in accordance with ASTM C 497,
  - three-edge bearing tests in accordance with ASTM C 497 (Perform 3-edge bearing tests on 1 pipe for each 300 pipes or fraction thereof for each design or shape, size, class, or D-load produced within 30 calendar days. Test for the load to produce a 0.01-in. crack or 15% in excess of the required D-load, whichever is less. Test the pipe to ultimate load if so directed. Three-edge bearing test to ultimate load is not required for any class of pipe 60 in. or less in diameter listed in Tables 1-5 of ASTM C 76 provided all other requirements of ASTM C 76 are met.. Tested pipe that satisfies the requirements of Section 401.2.F., "Causes for Rejection," may be used for construction. As an alternate to

the 3-edge bearing test, concrete pipe 54 in. in diameter and larger may be accepted on the basis of compressive strength of cores cut from the wall of the pipe. The manufacturer must determine the compressive strength of the samples. Obtain, cure, prepare, and test the cores in accordance with ASTM C 497 (the manufacturer must plug and seal core holes in the pipe wall after testing), and

- inspection of the finished pipe to determine its conformance with the required design and its freedom from defects.

**D. Marking.** Clearly mark the following information on each section of pipe:

- class or D-load of pipe,
- ASTM designation,
- date of manufacture,
- name or trademark of the manufacturer, and
- pipe to be used for jacking and boring.

For pipe with elliptical reinforcement, clearly mark 1 end of each section during the process of manufacture or immediately thereafter. Mark the pipe on the inside and the 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.

**E. Inspection.** Provide facilities and access to allow for inspection regarding the quality of materials, the process of manufacture, and the finished pipe at the pipe manufacturing plant. In addition, provide access for inspection of the finished pipe at the project site before and during installation.

**F. Causes for Rejection.** Individual sections of pipe may be rejected for any of the following:

- fractures or cracks passing through the shell (wall), with the exception of a single end crack that does not exceed the depth of the joint;
- defects that indicate proportioning, mixing, and molding, not in compliance with the appropriate Section of ASTM C76, C655, C506, or C507;
- Surface defects indicating honeycombed or open texture that would adversely affect the function of the pipe;
- damaged ends where such damage would prevent making a satisfactory joint;
- any continuous crack having a surface width of 0.01 in. or more and extending for a length of 12 in. or more.

**G. Repairs.** Make repairs if necessary because of occasional imperfections in manufacture or accidental damage during handling. The Engineer may accept pipe with repairs that are sound, properly finished, and cured in conformance with pertinent specifications.

- H. Rejections.** Allow access for the marking of rejected pipe. Rejected pipe will be plainly marked by the Engineer by painting colored spots over the City monogram on the inside wall of the pipe and on the top outside wall of the pipe. The painted spots will be no larger than 4 in. in diameter. The rejected pipe will not be defaced in any other manner. Remove the rejected pipe from the project and replace with pipe meeting the requirements of this Item.
- I. Jointing Materials.** Use any of the materials described herein for the making of joints, unless otherwise shown on the plans. Furnish a manufacturer's certificate of compliance for all jointing materials except mortar.
- 1. Mortar.** Provide mortar for joints that meets the requirements of Section 401.4.C, "Jointing."
  - 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. The consistency is to be such that the ends of the pipe can be coated with a layer of the compound up to ½ 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. If any small separation occurs in the container, stir to a uniform mix before using.

Provide a material that meets the requirements of Table 4 when tested in accordance with TxDOT Standard Test Method 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 - 75
Consistency, cone penetration, 150 q, 5 sec., 77°F	150 - 275

- 3. Rubber Gaskets.** Provide gaskets that conform to ASTM C 361 or C 443. Meet the requirements of ASTM C 443 for design of the joints and permissible variations in dimensions.
  - 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 C 990. 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. Flexible joint sealants must be protected by a suitable wrapper, and the jointing material must maintain integrity when the wrapper is removed.
- 401.3. EQUIPMENT:** Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.
- 401.4. CONSTRUCTION:**
- A. Excavation, Shaping, Bedding, and Backfill.** Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation, Trenching and Backfilling," except where jacking,

boring, or tunneling methods are permitted. Jack, bore, or tunnel the pipe in accordance with Item 406, "Jacking, Boring, or Tunneling." If joints consist of materials other than mortar, immediate backfilling is permitted. Take special precautions in placing and compacting the backfill to avoid any movement of the pipe or damage to the joints. Unless otherwise shown on the plans or permitted in writing, 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 the Contractor at no expense to the City.

- B. Laying Pipe.** Unless otherwise authorized, 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. Where bell-and-spigot pipe is used, cut cross trenches in the foundation to allow the barrel of the pipe to rest firmly upon the bedding. Do not cut cross trenches 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. When elliptical pipe with circular reinforcing or circular pipe with elliptical reinforcing is used, lay the pipe in the trench so that the markings for the top or bottom are not more than 5° from the vertical plane through the longitudinal axis of the pipe. Remove and re-lay, without extra compensation, pipe that is not in alignment or that shows excessive settlement after laying.

Lay multiple lines of reinforced concrete pipe with the centerlines of the individual barrels parallel. Unless otherwise shown on the plans, use the clear distances between outer surfaces of adjacent pipes shown in Table 5. For arch pipe or horizontal elliptical pipe use the equivalent diameter from Table 2 or Table 3 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.

- C. Jointing.** Make available an appropriate rolling device similar to an automobile mechanic's "creeper" for conveyance through small-size pipe structures.
- 1. Joints Sealed with Hydraulic Cement Mortar.** Use mortar consisting of 1 part cement, 2 parts sand, and enough water to make a plastic mix. 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. After the pipes are tightly jointed, pack mortar into the joint from both inside and outside the pipe. Finish the inside smooth and flush with adjacent joints of pipe. For tongue-and-groove joints, form a bead of semicircular cross section over the joint outside the pipe, extending at least 1 in. on each side of the joint. For bell-and-spigot joints, form the mortar 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. When mortar joints are used, do not place fill or backfill until the jointing material has cured for at least 6 hr. Do not conduct jointing when the atmospheric temperature is at or below 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.

With approval, pipes that are large enough for a person to enter may be furnished with the groove between  $\frac{1}{2}$  in. and  $\frac{3}{4}$  in. longer than the tongue. Such pipe may be laid and backfilled without mortar joints. After the backfilling has been completed, 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.

2. **Joints Using Cold-Applied, Plastic Asphalt Sewer Joint Compound.** Ensure that both ends of the pipes are clean and dry. Trowel or otherwise place a  $\frac{1}{2}$ -in.-thick layer of the compound in the groove end of the pipe covering at least  $\frac{2}{3}$  of the joint face around the entire circumference. Next, shove home the tongue end of the next pipe with enough pressure to make a tight joint. After the joint is made, remove any excess mastic projecting into the pipe. Backfill after the joint has been inspected and approved.
  3. **Joints Using Rubber Gaskets.** Make the joint assembly according to the recommendations of the gasket manufacturer. When using rubber gaskets, make joints watertight. Backfill after the joint has been inspected and approved.
  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 that no dirt or other deleterious materials come in contact with the joint sealing material. Pull or push home the pipe with enough force to properly seal the joint. Remove any joint material pushed out into the interior of the pipe that would tend to obstruct the flow. When the atmospheric temperature is below 60°F, store pre-formed flexible joint sealants in an area warmed to above 70°F or artificially warm to this temperature in an approved manner. Apply flexible joint sealants to pipe joints immediately before placing pipe in trench, and then connect pipe to previously laid pipe. Backfill after the joint has been inspected and approved.
- D. Connections and Stub Ends.** Make connections of concrete pipe to existing pipes, pipe storm drains, or storm drain appurtenances as shown on the plans.

Mortar or concrete the bottom of existing structures if necessary to eliminate any drainage pockets created by the connections. Repair any damage to the existing structure resulting from making the connections.

Unless otherwise shown in the plans, make connections between concrete pipe and corrugated metal pipe with a suitable concrete collar having a minimum thickness of 4 in.

Finish stub ends for connections to future work not shown on the plans by installing watertight plugs into the free end of the pipe.

Fill lift holes with concrete, mortar, or precast concrete plugs after the pipe is in place.

**401.5. MEASUREMENT:** This Item will be measured by the foot. Measurement will be made between the ends of the pipe barrel along the flow line, not including safety end treatments. Safety end treatments, if used, will be measured in accordance with TxDOT Standard Specification Item 467, "Safety End Treatment." Pipe that will be jacked, bored, or tunneled will be measured in accordance with Item 406, "Jacking, Boring, or Tunneling." Measurement of spurs, branches, or new connecting pipe will be made from the intersection of the flow line with the outside surface of the pipe into which it connects. Where inlets, headwalls, catch basins, manholes, junction chambers, or other structures are included in lines of pipe, the length of pipe tying into the structure wall will be included for measurement, but no other portion of the structure length or width will be included. For multiple pipes, the measured length will be the sum of the lengths of the barrels.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by the Engineer. Additional measurements or calculations will be made if adjustments of quantities are required.

**401.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Reinforced Concrete Pipe," "Reinforced Concrete Pipe (Arch)," or "Reinforced Concrete Pipe (Elliptical)" of the size and D-load specified or of the size and class specified. This price is full compensation for constructing, furnishing, transporting, placing, and joining pipes; shaping the bed; cutting pipes on skew or slope; connecting to new or existing structures; breaking back, removing, and disposing of portions of the existing structure; replacing portions of the existing structure; cutting pipe ends on skew or slope; and equipment, labor, tools, and incidentals.

Protection methods for excavations greater than 5 ft. deep will be measured and paid for as required under Item 550, "Trench Excavation safety Protection," or Item 551, "Special Shoring." Excavation, shaping, bedding, and backfill will be paid for in accordance with Item 400, "Excavation, Trenching and Backfilling." When jacking, boring, or tunneling is used at the Contractor's option, payment will be made under this Item. When jacking, boring or tunneling is required, payment will be made under Item 406, "Jacking, Boring or Tunneling Pipe or Box."

**401.7. BID ITEM:**

Item 401.1 - Reinforced Concrete Pipe - per linear foot (Class \_) (\_ inches dia.)

Item 401.2 - Reinforced Concrete Pipe (Arch) - per linear foot (Design Size \_)

Item 401.3 - Reinforced Concrete Pipe (Elliptical) - per linear foot (Design Size \_)

Item 401.4 - Safety End Treatment (Type \_\_) - per barrel of each structure end

## ITEM

### 403 STORM SEWER JUNCTION BOXES AND INLETS

**403.1. DESCRIPTION:** *Construct junction boxes and inlets, complete in place or to the stage detailed, including excavation and backfilling; furnishing and installing frames, grates, rings and covers. Storm sewer (drainage) junction boxes are classified as junction boxes.*

**403.2. MATERIALS:** Furnish materials in accordance with the following:

- Item 300, “Concrete”
- Item 301, “Reinforcing Steel”
- Item 307, “Concrete Structures”
- Item 407, “Frames, Grates, Rings, and Covers.”

Precast junction boxes, inlets, risers, and appurtenances are acceptable unless otherwise shown. Alternate designs for precast items must be acceptable to the Engineer and not deviate from the functional dimensions given. Alternate designs are to be designed and sealed by a licensed professional engineer.

- A. Concrete.** Furnish Class A concrete for cast-in-place junction boxes and inlets unless otherwise shown on the plans. Furnish Class A concrete or concrete meeting ASTM C 478 for precast junction boxes and inlets. Air-entrained concrete will not be required in precast concrete members.
- B. Mortar.** Furnish mortar composed of 1 part hydraulic cement and 2 parts clean sand. Hydrated lime or lime putty may be added to the mix to a maximum of 10% by weight of the total dry mix.
- C. Bricks.** Furnish first-quality, sound, properly shaped bricks. Provide clay or shale bricks that are homogeneous and thoroughly and uniformly hard-burned and that meet ASTM C 32, Grade MS or MM. Provide concrete bricks meeting ASTM C 55, Type I (Grade S-I). The maximum allowable water absorption of completely dry bricks is 16% by weight when submerged in water for 24-hours.
- D. Concrete Blocks.** Provide concrete blocks that meet ASTM C 139.
- E. Cast Iron or Aluminum.** Provide supports and steps conforming to the shape and dimensions shown on the plans that meet the requirements of ASTM A 48, Class 35B, for gray iron castings or ASTM A 536, Grade 65-45-12, for ductile iron castings. Steps may also be aluminum meeting ASTM B 221, Alloy 6005-T5. Provide steps in accordance with ASTM C 478, Section 16, “Steps and Ladders.”
- F. Timber.** Provide sound timber for temporary covers when used with Stage I construction (see Section 403.3, “Construction”) that is a minimum of 3 inches nominal thickness and reasonably free of knots and warps.
- G. Other Materials.** Commercial-type hardware of other materials may be used with prior approval.

**403.3. CONSTRUCTION:**

- A. General.** All types of junction boxes and inlets may be built either in 1 stage or in 2 stages, described as Stage I and Stage II. Build junction boxes and inlets designed to match the final roadway surface in stages. Construct Stage II after the pavement structure is substantially complete unless otherwise approved by the Engineer.

Construct the Stage I portion of junction boxes and inlets as shown on the plans or as specified in this Item. Furnish and install a temporary cover as approved by the Engineer.

For Stage I construction of cast iron or steel inlet units, furnish and install the sewer pipe and a temporary plug for the exposed end of the sewer pipe from the storm sewer to a point below the top of curb indicated on the plans.

For Stage II, construct the remaining wall height and top of junction boxes or inlet and furnish and install any frames, grates, rings and covers, junction boxes steps, curb beams, or collecting basins required.

Construct precast junction boxes and inlets in accordance with Item 307, "Concrete Structures," or ASTM C 478. Construct cast-in-place junction boxes and inlets in accordance with Item 307. Forms will be required for all concrete walls. Multi-project fabrication plants (as defined in TxDOT Item 424, "Precast Concrete Structures (Fabrication)") that produce junction boxes and inlets will be approved by the TxDOT Construction Division in accordance with TxDOT DMS 7340, "Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Junction boxes and Inlets." The TxDOT Construction Division maintains a list of approved multi-project plants. Outside wall forms for cast-in-place concrete may be omitted with the approval of the Engineer if the surrounding material can be trimmed to a smooth vertical face. The outside form for concrete bases supporting brick walls may be omitted. Cast steps into the concrete walls when the concrete is placed, or drill and grout steps in place after concrete placement. Mortar steps into joints for brick walls. Use a full bed of mortar for brick work so the brick will thoroughly bond to the mortar. Construct full mortar joints no more than ½-inch wide for brick walls. Furnish a header course or bond course (laid perpendicular to the preceding courses) every fifth course of brick.

- B. Junction boxes and Inlets for Precast Concrete Pipe Sewers.** Construct junction boxes and inlets for precast concrete pipe sewers as soon as is practicable after sewer lines into or through the junction box or inlet locations are completed. Neatly cut all sewers at the inside face of the walls of the junction box or inlet and point up with mortar.
- C. Junction boxes and Inlets for Monolithic Pipe Sewers.** Construct bases for junction boxes and inlets on monolithic pipe sewers either monolithically with the sewer or after the sewer is constructed.
- D. Junction boxes for Box Sewers.** Cast bases for junction boxes for box sewers as an integral part of the sewer. Construct junction boxes before backfilling, or cover the junction box opening temporarily and backfill the sewer as a whole.
- E. Inverts.** Shape and route floor inverts passing out or through the junction box or inlet as shown on the plans. Shape by adding and shaping mortar or concrete after the base is cast or by placing the required additional material with the base.

- F. Finishing Complete Junction boxes and Inlets.** Complete junction boxes and inlets in accordance with the plans. Backfill to original ground elevation in accordance with Item 106, "Box Culvert Excavation and Backfilling."
- G. Finishing Stage I Construction.** Complete Stage I construction by constructing the walls to the elevations shown on the plans and backfilling to required elevations in accordance with Item 106, "Box Culvert Excavation and Backfilling."
- H. Stage II Construction.** Construct subgrade and base course or concrete pavement construction over Stage I junction box or inlet construction, unless otherwise approved by the Engineer. Excavate to expose the top of Stage I construction and complete the junction box or inlet in accordance with the plans and these Specifications, including backfill and cleaning of all debris from the bottom of the junction box or inlet.
- I. 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 plans. 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.
- 403.4. MEASUREMENT:** All junction boxes and inlets satisfactorily completed in accordance with the plans and specifications will be measured by each junction boxes or inlet, complete, or by each junction box or inlet completed to the stage of construction required by the plans. Extension to inlets will be measured by each extension separately from the inlet.
- 403.5. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for as follows:
- A. Complete Junction boxes.** Payment for complete junction boxes will be made at the unit price bid for "Junction Box (Complete)" of the type specified.
- B. Complete Inlets.** Payment for inlets will be made at the unit price bid for "Inlet (Complete)," of the type specified.
- C. Inlet Extensions.** Payment for inlet extensions will be made at the unit price bid for "Inlet Extension" of the type specified.

These price are full compensation for concrete, reinforcing steel, brick, mortar, aluminum and cast iron castings, frames, grates, rings and covers, excavation, and backfill and for all other materials, tools, equipment, labor, and incidentals.

**403.6. BID ITEMS:**

Item 403.1 - Junction Box (Complete) 4'x4'x4'

Item 403.2 - Junction Box (Complete) 5'x5'x5'

Item 403.3 - Junction Box (Complete) 6'x6'x6'

Item 403.4 - Junction Box (Complete) 7'x7'x7'

Item 403.5 - Junction Box (Complete) 8'x8'x8'

Item 403.6 - Special Junction Boxes (Complete)

Item 403.7 - Inlet (Complete) 5'

Item 403.8 - Inlet (Complete) 10'

Item 403.9 - Inlet (Complete) 15'

Item 403.10 - Inlet (Complete) 20'

Item 403.11 - Inlet (Complete) 25'

Item 403.12 - Inlet (Complete) 30'

Item 403.13 - Special Inlets (Complete)

Item 403.14 - Inlet Extensions

**DIVISION V - INCIDENTAL CONSTRUCTION****ITEM****500 CONCRETE CURB, GUTTER, AND CONCRETE CURB AND GUTTER**

**500.1. DESCRIPTION:** *Construct hydraulic cement concrete curb, gutter, and combined curb and gutter.*

**500.2. MATERIALS:** Furnish materials conforming to:

- A. **Concrete.** Item 300, "Concrete." Use Class A concrete or material specified in the plans. Use Grade 8 coarse aggregate for extruded Class A concrete. Use other grades if approved by the Engineer.
- B. **Reinforcing Steel.** Item 301, "Reinforcing Steel."
- C. **Expansion Joint Materials.** Item 304, "Expansion Joint Materials."
- D. **Membrane Curing Compound.** Item 305, "Membrane Curing."

**500.3. EQUIPMENT:**

- A. **General.** Provide machinery, tools, and equipment necessary for proper execution of the work.
- B. **Concrete Forms.** Forms shall be of metal and shall extend for the full depth of the concrete. Wooden forms may be used, when authorized by the Engineer, on short radius curves such as at street intersections and at such other locations for which curved metal forms may not be available. Wooden forms may be used in other situations when authorized by the Engineer.

All forms shall be free from warp and of sufficient strength to resist the pressure of the concrete without displacement. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal. All forms shall be cleaned and coated with an approved form release agent or form oil before concrete is placed. Divider plates shall be of metal. Forms shall conform to the specified radius when placed on curves.

- C. **Concrete Curbing Machine.** The curb, gutter, or curb and gutter may be constructed by the use of an automatic curb forming machine meeting the following requirements:
  - 1. The weight of the machine shall be such that required compaction is obtained without the machine riding above the bed on which curbing is constructed.
  - 2. The machine shall form curbing that is uniform in texture, shape and density.
  - 3. The forming tube of the extrusion machine or the form of the slipform machine must be easily adjustable vertically during the forward motion of the machine to provide variable heights necessary to conform to the established gradeline.

4. A pointer or gauge shall be attached to the machine so that a continual comparison can be made between the extruded or slipform work and the grade guideline. Other methods may be used when approved by the Engineer.

**500.4. CONSTRUCTION:** Curbs, gutters, or curb and gutter combinations may be placed using conventionally formed concrete placement or using a City approved self-propelled concrete curbing machine.

Provide finished work with a well-compacted mass and a surface free from voids and honeycomb, in the required shape, line, and grade. Round exposed edges with an edging tool of the radius shown on the plans. Mix, place, and cure concrete in accordance with Item 307, "Concrete Structures." Construct joints at locations shown on the plans. Cure for at least 72 hours unless approved by the Engineer.

Furnish and place reinforcing steel in accordance with Item 301, "Reinforcing Steel."

Set and maintain a guideline that conforms to alignment data shown on the plans, with an outline that conforms to the details shown on the plans.

**A. Formed Concrete.**

1. **Excavation and Foundation.** Excavate, shape and compact subgrade, foundation, or pavement surface to the line, grade, and cross section shown on the plans. Lightly sprinkle subgrade or foundation material immediately before concrete placement.

If the subgrade is undercut, or the natural ground is below "top of subgrade," the necessary backfill shall be made with an approved material and compacted with a mechanical tamper. Hand tamping will not be permitted.

2. **Placement.** Place concrete into forms, and strike off with a template  $\frac{1}{4}$  to  $\frac{3}{8}$  inch less than the dimensions of the finished curb unless otherwise approved. After initial set, plaster surface with mortar consisting of 1 part hydraulic cement and 2 parts fine aggregate. Brush exposed surfaces to a uniform texture.

Place curbs, gutters, and combined curb and gutters in 50 foot maximum sections unless otherwise approved.

The reinforcing steel, if required, shall be placed in position as shown on the typical section. Care shall be exercised to keep all steel in its proper location.

Expansion joint material shall be provided at intervals not to exceed 50 feet, and shall extend the full width and depth of the concrete. Templates for joints shall be of steel, not less than  $\frac{3}{16}$  of an inch in thickness and patterned to the shape of the curb. Templates shall be cleaned and oiled and spaced to cut the curb in sections 10 feet in length. The templates shall extend a distance of 8 inches into the curb from the top down.

Two round smooth dowel bars  $\frac{3}{8}$  of an inch in diameter and 18 inches in length shall be installed at each expansion joint. One 9 inch end of each dowel shall be thoroughly coated with hot oil asphalt so that it will not bond to the concrete; approved types of slip joints may be used in lieu of coating ends of dowels. The dowels shall be placed on the vertical centerline 3 inches from the top and bottom.



Immediately after finishing the curb, it shall be protected by a membrane-compound curing agent.

The curb shall be backfilled to the full height of the concrete, tamped and sloped as directed by the Inspector. The top 4 inches of fill shall be of clean top soil, free of stones and debris.

#### **B. Machine Laid Concrete.**

- 1. Foundation.** Hand-tamp and sprinkle subgrade or foundation material before concrete placement. Provide clean surfaces for concrete placement. If required, coat cleaned surfaces with approved adhesive or coating at the rate of application shown on the plans or as directed.
- 2. Placement.** The concrete shall be fed into the machine in such a manner and at such consistency that the finished curb will present a well compacted mass with a surface free from voids and honeycomb and true to established shape, line and grade.

Immediately following extrusion any voids between the trench walls and curb shall be filled with well compacted concrete and finished off flush with the surface of the base. Any additional surface finishing specified and/or required shall be performed immediately after the above void-filling operation. Joints shall be cut to a depth of  $\frac{1}{2}$  inch at 10 foot intervals or as directed by the Inspector.

Whenever the curb end abuts a concrete structure a  $\frac{1}{2}$  inch, pre-molded, expansion joint, conforming to the curb section, shall be placed between the two concrete surfaces.

Whenever extrusion is suspended long enough to produce a cold joint,  $\frac{3}{8}$  inch smooth dowel bars, 18 inches long, shall be embedded 9 inches into the completed curb, one-quarter ( $\frac{1}{4}$ ) curb height from top and bottom. The end of the curb at the point of suspension of extrusion shall be cut back until all remaining concrete is of a dense well compacted nature.

Any addition of concrete to the extruded curb is to be applied and finished before the extruded curb has achieved its initial set.

When finishing operations are completed the curb is to be coated with membrane curing compound.

When the curb has cured, it shall be backfilled to the full height of the concrete, tamped and sloped as directed by the Inspector. The top 4-inches of fill shall be clean top soil, free of stones and debris.

**500.5. MEASUREMENT:** Accepted work as prescribed by this item will be measured by the linear foot of concrete curb, complete in place.

**500.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Curb," "Concrete Curb (Mono)," "Concrete Gutter," or "Concrete Curb and Gutter" of the type specified. This price is full compensation for surface preparation of base, equipment, labor, materials, tools, and incidentals. Topsoil to be paid under Item 515, "Topsoil."

**500.7. BID ITEM:**

Item 500.1 - Concrete Curb - per linear foot

Item 500.2 - Concrete Curb (Mono) - per linear foot

Item 500.3 - Concrete Gutter - per linear foot

Item 500.4 - Concrete Curb and Gutter - per linear foot

**ITEM****502 CONCRETE SIDEWALKS**

**502.1. DESCRIPTION:** *Construct or repair hydraulic cement concrete sidewalks.*

**502.2. MATERIALS:** Furnish materials conforming to the following:

- A. Hydraulic Cement Concrete.** Item 300, "Concrete." Use Class A concrete or other concrete as specified. Use Grade 8 course aggregate for extruded Class A concrete. Use other grades if approved by the Engineer.
- B. Reinforcing Steel.** Item 301, "Reinforcing Steel."
- C. Wire Mesh.** Item 303, "Welded Wire Flat Sheets."
- D. Expansion Joint Material:** Item 304, "Expansion Joint Materials."
- E. Membrane Curing Compound:** Item 305, "Membrane Curing."
- F. Concrete Structures.** Item 307, "Concrete Structures."

**502.3. EQUIPMENT:** Furnish equipment as required and/or in accordance with the pertinent Items.

**502.4. CONSTRUCTION:** Routing and location of sidewalks shall be indicated by plans or as directed by the Engineer. Grading of sidewalks shall be a minimum of two feet wider than sidewalk width on straight sections and three feet wider than sidewalk at turns. Grading for sidewalks shall be in accordance with direction by the Engineer. Generally, where sidewalks occur on slopes, grading shall be performed so as to result in curved contours rather than abrupt banks. Fine grading shall prevent pocketing of water. Contractor shall complete final excavation and preparation of subgrade achieving slope, drainage and compaction.

Where a sidewalk crosses a concrete driveway, confirm that the sidewalk depth and reinforcement are not less than the driveway cross-sectional details shown on the plans.

**A. Trees and Roots.**

- 1. Tree Protection.** Trees that are near sidewalk construction shall be protected from construction equipment through the use of fencing or boarding in accordance with *City of San Antonio Tree Protection Details – Tree Preservation Standard Details 1.1.3, "Level II A Fence Protection," 1.1.4, "Level II B Fence Protection,"* or as shown on the plans. Whenever possible, the entire drip line of the tree should be protected from construction activities in accordance with *Tree Preservation Standard Details 1.1.2, "Level I & Fence Protection."*
- 2. Root Barriers.** When shown on the plans, install root barriers near the edge of the sidewalk to reduce potential future damage to the sidewalk in accordance with the locations and depths shown on the plans. Unless otherwise shown on the plans, the root barrier shall be thermoplastic panels or sheets.
- 3. Root Damage to Existing Sidewalks.** When roots have damaged the sidewalk and repairs are undertaken, the tree roots causing the damage shall be removed. Unless

otherwise shown on the plans, retain the City Arborist to review the trees affected before sidewalk reconstruction begins. The City Arborist will identify roots to be removed and branches to be pruned, if required. Utilize equipment that will provide a sharp clean cut to minimize damage to the tree roots and branches. Prune the tree in accordance with the City Arborist's requirements.

- B. **Removal of Existing Sidewalk.** If an existing sidewalk is to be reconstructed or repaired, remove existing sidewalk to the depths and limits shown on the plans or identified by the Engineer. All concrete sidewalks to be repaired shall be cut with a concrete saw or other equipment approved by the Engineer from existing sidewalks, driveways or other concrete structures. If necessary, remove adjacent soil and vegetation to prevent contamination of the sidewalk area, and place it in a windrow or stockpile. Do not damage adjacent sidewalk or other structures during removal and reconstruction operations. Remove and dispose of existing concrete and other materials from the work area.
- C. **Subgrade Preparation.** Shape and compact subgrade to the line, grade, and cross-section shown on the plans. Mechanically tamp and sprinkle foundation when placement is directly on subgrade.
- D. **Subbase Placement.** A cushion, 2 inch minimum thickness, of crusher screenings, gravel, crushed rock or flexible base material shall be spread, wetted thoroughly, tamped and leveled. The cushion shall be moist at the time the concrete is placed. Where the subgrade is rock or gravel, 70% of which is rock, the 2 inch cushion need not be used. The Engineer will determine if the subgrade meets the above requirement.

If the subgrade is undercut, or the natural ground is below "top of subgrade," the necessary backfill shall be made with an approved material and compacted with a mechanical tamper. Hand tamping will not be permitted.

The foundation shall be level and uniformly compacted to prevent future settlement.

- E. **Reinforcement.** Concrete sidewalks shall be reinforced as shown in the plans. Concrete reinforcement for sidewalks may consist of longitudinal reinforcing steel without traverse reinforcement or as specified by the manufacturer or the Engineer. Steel reinforcement may be omitted if approved by the Engineer.

An alternate method of reinforcing using nylon or polypropylene fibers may be used if approved by Engineer or slip-form paver equipment manufacturer. Nylon fibers shall be used at a rate of one pound (1 lb) per cubic yard or polypropylene fibers at one and a half pounds (1.5 lbs) per cubic yard, unless otherwise specified by the Engineer or slip-form paver manufacturer.

- F. **Joints.** Unless otherwise specified on plans or as agreed to by Engineer, tooled joints with rounded edges will be placed every ten feet (10') and will be opened with one-half inch ( $\frac{1}{2}$ " ) radius by one and one-half inch ( $1 \frac{1}{2}$ " ) depth and closed by one-half inch ( $\frac{1}{2}$ " ) radius by one-inch (1" ) depth.
  - 1. **Expansion Joints.** Provide sidewalk sections separated by pre-molded or board joint  $\frac{1}{2}$  inch thick, or as shown on the plans, in lengths greater than 8 feet but less than 50 feet, unless otherwise directed. Terminate workday production at an expansion joint. Expansion joint material shall also be placed where the new construction abuts the existing curbs or driveways if the Engineer deems it necessary. The expansion joint

material shall be placed vertically and shall extend the full depth and width of the concrete.

2. **Expansion Joint Dowels.** Unless otherwise shown on the plans, a minimum of two (2) round smooth dowel bars  $\frac{3}{8}$  inch in diameter and 18 inches in length shall be spaced 18 inches apart at each expansion joint. Nine inches (9") of each dowel shall be thoroughly coated with hot oil asphalt or greased, so that it will not bond to the concrete. Approved types of slip joints may be used in lieu of coating ends of dowels.
  3. **Transverse Joints.** Sidewalks shall be marked with transverse "dummy" joints as shown on detail sheets, by the use of City approved jointing tools.
- G. Curb Ramps.** Curb ramps must include a detectable warning surface and conform to details shown on the plans. Confirm that abrupt changes in sidewalk elevation do not exceed  $\frac{1}{4}$  inch, sidewalk cross slope does not exceed 2%, curb ramp grade does not exceed 8.3%, and flares adjacent to the ramp do not exceed 10% slope.
- H. Concrete Placement.** Provide a smooth, uniform surface free of debris and loose foundation material for concrete placement. Lightly sprinkle subgrade or foundation material immediately before concrete placement. Mix and place concrete in accordance with the pertinent Items. Hand-finishing is allowed for any method of construction. Finish exposed surfaces to a uniform transverse broom finish surface.
1. **Conventionally Formed Concrete.** Forms shall be of metal or wood and shall extend for the full depth of the concrete. All forms shall be free from warp and of sufficient strength to resist the pressure of the concrete without displacement. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal. All forms shall be cleaned and coated with an approved form release agent or form oil before concrete is placed. Divider plates shall be of metal. Forms shall conform to the specified radius when placed on curves.
  2. **Extruded or Slip-Formed Concrete.** A slip form paver approved by the Engineer shall lay the sidewalk. Contractor shall set guidelines or guide-rails from survey marks established by the Engineer. Guidelines shall be set to avoid obstacles in the path that may interfere with operation of equipment and overall quality of sidewalk. Sidewalk outline shall strictly conform to the details shown on the plans or as set by Engineer. Slip form equipment shall be operated according to machine specifications and manual for paving accuracy. Slip form equipment shall spread, consolidate and finish the concrete to produce a dense homogeneous concrete true to grade and cross section. Concrete shall be consolidated by the use of internal vibrators. The concrete shall be of such consistency that it will maintain the shape of the sidewalk section without support.

Where forms are required for transitional zones the forms shall conform to 502.4.G.2. "Conventionally Formed Concrete."

- I. Finish and Curing.** Provide finished work with a well-compacted mass, a surface free from voids and honeycomb, and the required true-to-line shape and grade. After finishing each portion of the sidewalk, the surface shall be textured with heavy broom finish. Within twenty minutes of broom finish, a curing compound shall be used to protect the sidewalk. The curing compound shall be of a high solid content, greater than thirty percent (+30%). All edges shall be tooled to have slight radius. Surface water retention is not acceptable. Finished surface of

sidewalks shall generally be one-half inch ( $\frac{1}{2}$  inch) to one inch (1 inch) above existing grade. Concrete must be cured and protected from freezing temperatures for at least three (3) days.

- J. Exposed Aggregate Surface.** For exposed Aggregate finished sidewalks, wash concrete surface after initial set with stiff bristle brush and water to remove matrix and clean each piece of exposed coarse aggregate. Unless otherwise acceptable to the Engineer, perform washing and brushing 3 - 4 hours after casting. Care shall be taken to uniformly expose about a third of each piece of coarse aggregate, removing no more of the matrix than necessary across the panel surface and as required to achieve appearance similar to adjacent existing work. After seven days, follow with a final cleaning with a mild acid solution and final rinsing with clear water.
- K. Backfilling.** Once sidewalk has cured, sidewalk will need to be backfilled to the full height of the sidewalk with material approved by the Engineer. The top 4 inches of fill shall be tamped and sloped using clean topsoil. Heavy equipment must remain off sidewalks at all times.

All necessary excavation for the sidewalk section, will be considered incidental work pertaining to this item, and will not be paid for directly. The adjacent excavation and grading of the slopes shall be done in a manner acceptable to the Engineer.

**502.5. MEASUREMENT:** Sidewalks will be measured by the square yard of surface area at the depth specified. Curb ramps will be measured by the square yard of surface area or by each unit. The unit will consist of the curb ramp, landing, adjacent flares or side curb, and detectable warning surface as shown on the plans.

**502.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per square yard for "Concrete Sidewalks - Conventionally Formed" or "Concrete Sidewalks - Machine Laid" and includes curb ramps where applicable. This price is full compensation for surface preparation of base; materials; removal and disposal of existing concrete; excavation, hauling and disposal of excavated material; drilling and doweling into existing concrete curb, sidewalk, and pavement; repair of adjacent street or pavement structure damaged by these operations; and equipment, labor, materials, tools, and incidentals.

Sidewalks that cross and connect to concrete driveways will be measured and paid for in accordance with Item 503, "Asphaltic Concrete, Portland Cement Concrete, and Gravel Driveways."

**502.7. BID ITEM:**

Item 502.1 - Concrete Sidewalks - Conventionally Formed - per square yard

Item 502.2 - Concrete Sidewalks - Machine Laid - per square yard

**ITEM****503 ASPHALTIC CONCRETE, PORTLAND CEMENT CONCRETE, AND GRAVEL DRIVEWAYS**

**503.1. DESCRIPTION:** *Construct and pave driveways. Reconstruct existing driveways.*

**503.2. MATERIALS:** Furnish materials in accordance with the requirements herein unless otherwise shown on the plans. Provide materials of the type and grade as shown on the plans or directed by the Engineer and in accordance with the pertinent Items listed below:

- A. Embankment. Item 107, "Embankment."
- B. Lime Treated Subgrade. Item 108, "Lime Treated Subgrade."
- C. Cement Treated Subgrade. Item 109, "Cement Treated Subgrade."
- D. Flexible Base. Item 200, "Flexible Base."
- E. Cement Treated Base. Item 201, "Cement Treated Base."
- F. Prime Coat. Item 202, "Prime Coat."
- G. Tack Coat. Item 203, "Tack Coat."
- H. Surface Treatments. Item 204, "Surface Treatments."
- I. Hot Mix Asphaltic Concrete Pavement. Item 205, "Hot Mixed Asphaltic Concrete Pavement."
- J. Asphalt Treated Base. Item 206, "Asphalt Treated Base."
- K. Concrete Pavement. Item 209, "Concrete Pavements."
- L. Concrete. Item 300, "Concrete."
- M. Reinforcing Steel. Item 301, "Reinforcing Steel."
- N. Welded Wire Reinforcement. Item 303, "Welded Wire Flat Sheets."
- O. Epoxy. TxDOT DMS 6100, "Epoxies and Adhesives."

**503.3. EQUIPMENT:** Furnish equipment as required and/or in accordance with the pertinent Items. Use of a motor grader will be permitted for asphalt concrete pavement unless otherwise shown on the plans.

**503.4. CONSTRUCTION:**

- A. Removal of Existing Driveway or Curbs. If an existing driveway is to be reconstructed, remove existing driveway pavement to the depths and limits shown on the plans or identified by the Engineer using the methods described herein. All concrete and asphaltic concrete driveway pavements shall be cut with a concrete saw or other equipment approved by the

- Engineer from existing pavement lanes and/or parking areas. Existing gravel driveways shall be removed with appropriate excavation equipment as shown on the plans or approved by the Engineer. If necessary, remove adjacent soil and vegetation to prevent contamination of the driveway area, and place it in a windrow or stockpile. Do not damage adjacent pavement structure during removal and reconstruction operations.
1. **Existing Asphaltic Concrete Driveway.** Unless otherwise shown on the plans or directed by the Engineer, saw-cut the existing driveway from existing pavement lanes and/or parking areas. The depth of the cut shall be such that upon removal of asphaltic concrete, the sides of the cut will be straight and square. Where existing base materials are to remain, driveway pavements shall be removed to their full depth up to the top of the base material. Care shall be taken not to damage the existing base. Remove or repair loose or damaged base material if present, and replace or repair it with approved base material to the original top of base grade. If subgrade work is required, remove flexible pavement structure layers to the top of subgrade and remove material from work area.
  2. **Existing Portland Cement Concrete Driveway.** If required, saw-cut full depth through the concrete around the perimeter of the existing driveway before removal. Do not spall or fracture concrete adjacent to the repair area. Remove or repair loose or damaged base material if present, and replace or repair it with approved base material to the original top of base grade. Allow treated materials used as base material to attain sufficient strength to prevent displacement when placing concrete pavement. If subgrade work is required, remove the entire pavement structure to the top of subgrade and remove material from work area.
  3. **Curb Cuts.** If required, saw-cut full depth through the concrete curb before removal. Do not spall or fracture concrete adjacent to the repair area. Remove or repair loose or damaged base material if present, and replace or repair it with approved base material to the original top of base grade. Allow treated materials used as base material to attain sufficient strength to prevent displacement when placing concrete pavement.
- B. Preparing Subgrade.** For construction of new driveways or vertical and/or horizontal realignment of existing driveways, the subgrade shall be excavated to the depth below the finished grade of the driveway as shown on the plans or directed by the Engineer. For new construction, or reconstruction where the subgrade has been exposed, scarify the top 6 inches of the subgrade, recompact, and shape to the proper line and cross-section as shown on the plans or as directed by the Engineer. Compaction shall be controlled by “Ordinary Compaction” unless “Density Control” is shown in the plans or required by the Engineer.
1. **Ordinary Compaction.** Use approved equipment to compact the subgrade layer. The plans or the Engineer may require specific equipment. Before and during compaction, bring the scarified layer to the moisture content directed. Compact until there is no evidence of further consolidation. Maintain a level layer to ensure uniform compaction. If the required stability or finish is lost for any reason, recompact and refinish the subgrade at no additional expense to the City.
  2. **Density Control.** Wet the subgrade to optimum moisture content but not exceeding 3% above the optimum moisture content ( $W_{opt}$ ) and compact to at least 95% of the maximum dry density ( $D_a$ ) determined using TxDOT standard laboratory test procedure Tex-114-E. Density of the completed subgrade will be measured in the field in accordance with TxDOT standard test procedure Tex-115-E.



If the subgrade is undercut, or the natural ground is below “top of subgrade,” the necessary backfill shall be made with flexible base, or approved material as directed by the Engineer and the applicable item.

- C. Placing Base Material.** When shown on the plans, place, spread, and compact material in accordance with the applicable Item to the required or directed depth.
- 1. Flexible Base.** Place or repair flexible base as required in accordance with Item 200, “Flexible Base,” and details shown on the plans to achieve required section.
  - 2. Cement-Treated Base.** Use existing base, add flexible base if required, and stabilize with a minimum cement content of 3% by weight of the total mixture. Construct in accordance with details shown on the plans and Item 201, “Cement Treated Base,” to achieve required section.
  - 3. Asphalt-Treated Base or Asphaltic Concrete Base.** Place asphalt-treated base in accordance with details shown on the plans and Item 206, “Asphalt Treated Base,” or Item 205, “Hot Mix Asphaltic Concrete Pavement,” to achieve required section.
- D. Curing Base.** Cure in accordance with the appropriate Item unless otherwise directed or approved by the Engineer. Maintain completed base sections until surfacing.
- E. Surfacing.** Apply surfacing with materials as shown on the plans to the completed base section.
- 1. Gravel Driveway.** A gravel driveway is defined as a driveway consisting entirely of flexible base material without an asphaltic concrete, Portland cement concrete, or surface treatment layer. The surface of the compacted base shall be smooth and in conformity with typical sections and to the established lines and grades. Prime coat the surface if shown on the plans or directed.
  - 2. Prime Coat.** Protect the compacted, finished, and cured flexible or cement-treated base mixtures with a prime coat. Unless otherwise shown on the plans, apply prime coat with an approved sprayer at a rate not to exceed 0.20 gallons per square yard of surface. The type and grade shall be shown on the plans or directed by the Engineer.
  - 3. Surface Treatments.** If shown on the plans, apply surface treatment with the type and grade of asphalt and aggregate as shown on the plans in accordance with Item 204, “Surface Treatments.”
  - 4. Asphalt Concrete Pavement.** Unless otherwise shown on the plans, apply tack coat at a rate not to exceed 0.10 gallons per square yard. The type and grade shall be shown on the plans or directed by the Engineer. Place asphaltic concrete in accordance with Item 205, “Hot Mixed Asphaltic Concrete Pavement,” to achieve required section. Testing requirements may be altered or waived by the Engineer.
  - 5. Portland Cement Concrete Pavement.** If shown on the plans, tie the concrete driveway to concrete pavement or concrete parking lot pavement. Use only drilling operations that do not damage the surrounding operations when drilling holes for replacement steel. Unless otherwise shown on the plans, reinforcement shall consist of either one layer of 6” x 6” - W5 x W5 welded wire flat sheet or No. 3 ( $\frac{3}{8}$ ”) reinforcing steel placed not more than 12 inches on centers both directions. All reinforcement shall be placed equidistant

from the top and bottom of the concrete. Care shall be exercised to keep all steel in its proper position during the depositing of concrete. Splices in wire fabric shall conform to the requirements set forth in Item 303, "Welded Wire Flat Sheets." Splices in the No. 3 bars shall have a minimum lap of 12 inches. For existing driveways with existing steel, place new deformed reinforcing steel bars of the same size and spacing as the bars removed or as shown on the plans. Lap all reinforcing steel splices in accordance with Item 301, "Reinforcing Steel." Epoxy-grout all tiebars for at least a 12 inch embedment into existing concrete. Completely fill the tiebar hole with Type III, Class A or Class C epoxy before inserting the tiebar into the hole. Provide grout retention disks for all tiebar holes. Provide and place approved supports to firmly hold the new reinforcing steel, tiebars, and dowel bars in place.

Place a polyethylene sheet at least 4 mils thick as a bond breaker at the interface of the base or subgrade and new driveway pavement. Provide Class P concrete conforming to Item 209, "Concrete Pavement." Mix, place, and cure concrete to the requirements of Item 209, "Concrete Pavement," and Item 300, "Concrete," unless otherwise shown on the plans. Hand placement of concrete is allowed. The Engineer may waive testing requirements.

If the time frame designated for opening to traffic is less than 72 hours after concrete placement, provide Class HES concrete designed to attain a minimum average flexural strength of 255 psi or a minimum average compressive strength of 1,800 psi within the designated time frame. Type III cement is permitted for Class HES concrete. For driveways that are to be opened to traffic before 72 hours, use curing mats to maintain a minimum concrete surface temperature of 70°F when air temperature is less than 70°F.

Match the grade and alignment of existing concrete pavement. Broom-finish the concrete surface unless otherwise shown on the plans. Saw and seal contraction joints, if shown on the plans or directed by the Engineer, in accordance with Item 209, "Concrete Pavement."

- a. **Commercial Driveways.** Reinforcing for commercial driveways shall consist of either one (1) layer of 6" x 6" - W10 x W10 welded wire flat sheets or No. 4 (½") reinforcing steel placed not more than 12 inches on center both directions. The concrete slab shall be a minimum of 6 inches thick or as shown on the plans.
- b. **Exposed Aggregate Surface.** For exposed Aggregate finished driveways, wash concrete surface after initial set with staff bristle brush and water to remove matrix and clean each piece of exposed coarse aggregate. Unless otherwise acceptable to the Engineer, perform washing and brushing 3 - 4 hours after casting. Care shall be taken to uniformly expose about a third of each piece of coarse aggregate, removing no more of the matrix than necessary across the panel surface and as required to achieve appearance similar to adjacent existing work. After seven days, follow with a final cleaning with a mild acid solution and final rinsing with clear water.

**503.5. MEASUREMENT:** No separate measurement of excavation, base material, prime coat, tack coat, Portland cement concrete, or asphalt surfacing will be made. Accepted work as prescribed by this item will be measured by the square yard of Portland cement concrete driveway, asphaltic concrete driveway or gravel driveway.

**503.6. PAYMENT:** The work performed as prescribed by this item will be paid for at the contract unit price bid per square yard for "Portland Cement Concrete Driveway," "Portland Cement Concrete

Driveway - Commercial," "Asphaltic Concrete Driveway," or "Gravel Driveway," which price shall be full compensation for removal of existing driveway (if required), preparing the subgrade, for furnishing and placing all materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

**503.7. BID ITEM:**

Item 503.1 - Portland Cement Concrete Driveway - per square yard

Item 503.2 - Portland Cement Concrete Driveway - Commercial - per square yard

Item 503.3 - Exposed Aggregate Driveway - per square yard

Item 503.4 - Asphaltic Concrete Driveway - per square yard

Item 503.5 - Gravel Driveway - per square yard

**ITEM****507 CHAIN LINK WIRE FENCE**

**507.1. DESCRIPTION:** *This item shall govern for chain link fabric supported on posts and with bracing and accessories as shown in the plans or as specified herein, erected complete in place as shown in the plans or as directed by the inspector.*

**507.2. MATERIALS:** Before installation of the chain link fence, furnish certification from the fence materials manufacturer stating that all fencing materials comply with the requirements of this Item. Use only new materials.

**A. General.** Furnish materials in accordance with the following:

1. Concrete. Item 300, "Concrete," Class "B."
2. Galvanizing. Texas Department of Transportation Item 445, "Galvanizing."

**B. Fabric.** Provide wire fabric with:

1. Nine (9) gauge (0.148 in. diameter) steel wire with a minimum breaking strength of 1,290 lb. meeting ASTM A 392 Class I or ASTM A 491;
2. mesh size of 2 in.  $\pm$  1/8 in. between parallel wires with at least 7 meshes in a vertical dimension of 23 in. along the diagonals of the openings; and
3. knuckled selvages at the top and bottom edge of the fabric, unless otherwise shown on the plans.

**C. Posts.** Provide posts of the size and weight shown on the plans. Do not provide rerolled or open-seam posts. Use material meeting ASTM F 1083 for all posts. When specified, furnish thin-wall, high-strength pipe posts manufactured by cold rolling using steel strip conforming to ASTM A 1011, CS (Commercial Steel).

**D. Post Caps.** Provide malleable iron post caps designed to exclude all moisture. If barbed wire is shown on the plans, furnish barbed wire support arms integral with the post caps. If top rail is shown on the plans, furnish post caps with an opening for the top rail. Post caps must have a 2-in. skirt.

**E. Gates.** Provide gates fabricated from round sections of pipe of the size and weight shown on the plans. Use material meeting ASTM F 1083 for all gate pipes. For each gate, include:

1. corner and tee fittings of malleable iron or pressed steel with means for attaching diagonal bracing members;
2. hinges of malleable iron allowing a full 180° swing, easily operated by one person;
3. ball-and-socket-type bottom hinges that do not twist or turn from the action of the gate and prevent the closed gate from being lifted off the hinges;
4. a positive stop that prevents any portion of the gate from swinging over an adjacent traffic lane;

5. malleable iron pulley systems for roll type gate (only when required);
  6. diagonal braces consisting of  $\frac{3}{8}$ -in.-diameter cable with turnbuckles, 2 to each gate frame, and, for vehicle gates, a vertical pipe brace of the size and weight shown on the plans at the center of each gate leaf;
  7. latches of malleable iron or steel for single gates with a single-fork latch and padlock eye that will keep the gate closed;
  8. two fork latches mounted on a center plunger rod with a padlock eye for double-leaf gates;
  9. holdbacks for each leaf of vehicular gates, with a semi-automatic holdback catch anchored at least 12 in. into a 12 in.-diameter by 24 in.-deep concrete footing; and
  10. a malleable iron center rest, designed to receive the plunger rod anchored as shown on the plans for all double-leaf gates.
- F. Top Rail.** When shown on the plans, provide top rail manufactured from 1.660 in. OD standard weight (Schedule 40) steel pipe weighing 2.27 lb. per foot or high-strength pipe weighing 1.82 lb. per foot. Use material meeting ASTM F 1083 for all top rail pipes. Provide pipe in sections at least 18 ft. long joined with outside steel sleeve couplings at least 6 in. long with a minimum wall thickness of 0.70 in. Use couplings designed to allow for expansion of the top rail.
- G. Tension Wire.** Unless shown on the plans, use 7 gauge (0.177-in.) carbon steel wire with a minimum breaking strength of 1,950 lb. for the bottom edge of all fence fabric, and for the top edge of fence fabric when a top rail is not specified.
- H. Truss Bracing.** Provide truss bracing as shown on the plans.
- I. Stretcher Bars.** Provide stretcher bars made of flat steel at least  $\frac{3}{16}$  in. by  $\frac{3}{4}$  in. and not more than 2 in. shorter than the fabric height. Provide 1 stretcher bar for each gate and end post and 2 stretcher bars for each corner and pull post.
- J. Grounds.** Provide copper-clad steel rods 8 ft. long with a minimum diameter of  $\frac{5}{8}$  in., or other UL-listed ground rods.
- K. Tie Wire.** Wire for attaching fabric to tension wire and to top rail shall be not less than No. 12 gauge galvanized wire, or fastenings in accordance with the manufacturer's standard design. Sufficient fastening material shall be furnished to provide for attaching the fabric to the tension wire and to the top rail and posts at the spacing shown on the plans.
- L. Braces and Cables.** Braces or cables shall be installed at all corner, tension, terminal and gate posts and shall be extended to adjacent line posts, in accordance with the plans. Braces and trussing material shall be high carbon steel of good commercial quality and shall meet the dimensions and other requirements on the plans. Brace rods shall be  $\frac{3}{8}$  inch diameter and be equipped with turnbuckles. Cables shall be  $\frac{3}{8}$  inch diameter and shall be composed of seven wires. Cables shall be installed as shown on the plans, and shall include the use of  $\frac{3}{8}$  inch drop-forged eye-and-eye, or eye-and-clevis turnbuckles.

- M. Steel Pipe.** All steel pipe, except for thin-wall, high strength pipe, used for top rails, line posts, corner, tension, terminal or gate posts, braces or gate frames shall conform to the requirements of ASTM A 120. Thin-wall, high strength pipe shall be manufactured by cold rolling using steel strip conforming to ASTM A 569.
- N. Galvanizing and Aluminum Coating.** Unless specified on the plans, hot-dip galvanize all materials. Fabric and tension wire may be aluminum coated or alloy-coated if approved. When shown on the plans, additionally coat all material except bolts, nuts, and washers with thermally fused polyvinyl chloride (PVC) in accordance with ASTM F 668, Class 2B, meeting the specified color.
- 1. Fabric.**
    - a. Galvanizing.** Hot-dip galvanize in accordance with ASTM A 392, Class I.
    - b. Aluminum Coating.** Aluminum-coat in accordance with ASTM A 491.
    - c. Alloy Coating.** Coat with zinc-5% aluminum-mischmetal alloy (Zn-5A1-MM) in accordance with ASTM F 1345, Class I.
  - 2. Posts.**
    - a. Inside and Outside Galvanizing.** Hot-dip galvanize inside and outside in conformance with ASTM F 1083.
    - b. Alloy Coating.** Coat inside and outside with Zn-5A1-MM in accordance with ASTM F 1043, Class C.
  - 3. Braces and Gates.**
    - a. Galvanizing.** Hot-dip galvanize braces and gates inside and out in conformance with ASTM F 1083.
    - b. Alloy Coating.** Coat inside and out with (Zn-5A1-MM) in accordance with ASTM F 1043, Class C.
  - 4. Fittings, Bolts, and Other Miscellaneous Hardware.** Galvanize all fittings, bolts and miscellaneous hardware in conformance with TxDOT Item 445, "Galvanizing."
  - 5. Tension Wire.** Zinc-coat tension wire with a minimum coating of 0.80 oz./sq. ft. or aluminum-coat with a minimum coating of 0.30 oz./sq. ft.
  - 6. Barbed Wire.** Zinc-coat barbed wire in accordance with ASTM A 121 (0.80 oz./sq. ft.) or aluminum-coat in accordance with ASTM A 585 (0.30 oz./sq. ft.).
  - 7. Pull Cable.** Zinc-coat pull cable with a minimum coating of 0.80 oz./sq. ft. of individual-wire surface when tested in conformance with ASTM A 116.
- O. Sampling.** If there is reason to confirm the Certification provided in 507.2, "Materials," the Contractor shall furnish, upon request of the Engineer, samples of each component part of the fence, including fittings. These samples shall be subjected to the galvanizing, weight and, where applicable, strength tests. A sample may be taken from each shipment and all samples shall be furnished to the City without cost. If a sample or specimen fails to meet the

- requirements of this specification, two additional samples or specimens shall be taken from the same shipment and tested, either samples or specimens so tested shall meet the requirements in every respect, or the lot represented by the samples may be rejected.
- 507.3. EQUIPMENT:** Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.
- 507.4. CONSTRUCTION:** Erect the chain link fence to the lines and grades established on the plans. Overall height of the fence when erected is the height above the grade shown.
- A. Clearing and Grading.** Clear all brush, rocks, and debris necessary for the installation of this fencing. Unless otherwise shown on the plans, stake the locations for corner posts and terminal posts. Follow the finished ground elevations for fencing panels between corner and terminal posts. Level off minor irregularities in the path of the fencing.
- B. Erection of Posts.** Install posts as shown on the plans. Plumb and permanently position posts with anchorages firmly set before fabric is placed. Brace corner and pull posts as shown on the plans.
- 1. Post Spacing.** Space posts as shown in Table 1.

**Table 1**  
**Post Spacing and Placement**

<b>Post Type</b>	<b>Required Spacing of Placement</b>
Line Posts	at most 10 ft. apart
Tension Posts	at most 330 ft. apart and at each change in direction exceeding 20° vertically
Corner Posts	at each horizontal angle point

Install cables on all terminal posts and extend to adjacent posts. Install cables on each side of corner and pull posts with a  $\frac{3}{8}$ -in. drop-forged eye-and-eye or eye-and-clevis turnbuckle, unless otherwise shown on the plans.

- 2. Postholes.** Drill holes for concrete footings for all posts to provide footings of the dimensions shown on the plans.

Where solid rock is encountered before reaching plan depth, penetrate the solid rock by at least 12 in. (18 in. for end, corner, gate, and pull posts) or to plan depth. Drill holes in the solid rock with a diameter at least 1 in. greater than the outside diameter of the post.

After the posts are set and plumbed, fill the hole in the solid rock with grout consisting of 1 part hydraulic cement and 3 parts clean, well-graded sand. Other grouting materials may be used if approved. Thoroughly work the grout into the hole, leaving no voids. Construct concrete footings from the solid rock to the top of the ground.

- 3. Gate Posts.** Align the tops of all gate frames with the fencing top tension wire or top rail. If curbs are shown on the plans, provide vehicular gates that are greater in overall height than the adjacent fencing by the height necessary to extend to within 2 in. of the pavement between the curbs.

- 4. Concrete Footings.** Center posts in their footings. Place concrete and compact by tamping or other approved methods. Machine mix all batches of concrete over  $\frac{1}{2}$  cu. yd. Hand mixing concrete is allowed on batches under  $\frac{1}{2}$  cu. yd.

Use forms for footings where the ground cannot be satisfactorily excavated to neat lines. Crown the concrete or grout (for solid rock) to carry water from the post. Keep the forms in place for at least 24 hr. Backfill the footing with moistened material as soon as each form is removed, and thoroughly tamp. Cover concrete with at least 4 in. of loose moist material, free of clods and gravel, immediately after placing concrete. No other curing is required.

Spread all excess excavated and loose material used for curing neatly and uniformly. Remove excess concrete and other construction debris from the site.

- C. Erection of Fabric.** After all posts have been permanently positioned and anchorages firmly set, place the fabric with the cables drawn taut with the turnbuckles. Secure one end and apply enough tension to the other end to remove all slack before making attachments. Unless otherwise shown on the plans, cut the fabric and independently attach each span at all corner posts and pull posts.

Follow the finished contour of the site with the bottom edge of fabric located approximately 2 in. above the grade. Grade uneven areas so the maximum distance between the bottom of fabric and ground is 6 in. or less. Fasten fabric at 12 in. intervals to the top and bottom tension wires between posts. When top rail is shown on the plans, fasten the fabric in the same manner. On gate frames, fasten the fabric to the top and bottom of the gate frame at 12 in. intervals. Use steel wire fabric ties of 9 gauge steel or larger.

Fasten fabric to terminal posts by steel stretcher bars and stretcher bar bands fitted with carriage bolts and nuts of the size and spacing shown on the plans. Use stretcher bars to fasten endposts, pull posts, corner posts, and gateposts with stretcher bar bands at intervals of at most 15 in. Attach stretcher bars to terminal posts with 1 in.  $\times$   $\frac{1}{8}$  in. flat steel bands with  $\frac{3}{8}$ -in. carriage bolts at intervals up to 15 in.

- D. Electrical Grounds.** Provide at least 1 electrical ground for each 1,000 ft. of fence, located near the center of the run. Provide additional grounds directly under the point where power lines pass over the fence. Vertically drive or drill in the grounding rod until the top of the rod is approximately 6 in. below the top of the ground. Connect a No. 6 solid copper conductor to the rod and to the fence by a UL-listed method so that each element of the fence is grounded.

- E. Repair of Coatings.** Repair damaged zinc coating in accordance with TxDOT Item 445, Section 445.3.D, "Repairs."

- 507.5. MEASUREMENT:** "Chain Link Wire Fence," of the height specified, will be measured by the linear foot of fence at the bottom of the fabric along the center line of the fence from center to center of end posts, exclusive of gates. "Chain Link Wire Fence" shall include all end posts, angle and corner posts, and tension posts, complete in place with all bracing and accessories.

Gates will be measured per each gate of each type, complete in place with gate posts, all bracing and all accessories.

- 507.6. PAYMENT:** "Chain Link Wire Fence" measured as prescribed above, will be paid for at the contract unit price bid per linear foot for "Chain Link Wire Fence" of the height specified, which



price shall be full compensation for furnishing and installing all fencing materials, end posts, angle and corner posts, tension posts, line posts, caps, tension wires, top rail, and connection fittings; digging post holes or setting into retaining wall and structures; furnishing and placing concrete for setting posts; all hauling and hauling charges; and for all manipulation, labor, tools, equipment, and incidentals necessary to complete the work.

Gates measured as prescribed above will be paid for at the contract unit price bid for each "Gate, Pedestrian" or "Gate, Vehicular" of each size called for, which price shall be full compensation for furnishing all materials; fabrication, preparation, hauling, handling charges, and erecting; including gate and gate posts, posts caps, braces, miscellaneous fitting and fastenings, latches, hinges, stops and holding devices; and for all manipulation, labor, tools, concrete for setting posts, equipment and incidentals necessary complete installation.

**507.7. BID ITEM:**

Item 507.1 - Chain Link Wire Fence - (4 ft. high) - per linear foot

Item 507.2 - Chain Link Wire Fence - (6 ft. high) - per linear foot

Item 507.3 - Chain Link Wire Fence - (8 ft. high) - per linear foot

Item 507.4 - Gates - Pedestrian - per each

Item 507.5 - Gates - Vehicular - per opening

**ITEM****511 CUTTING AND REPLACING PAVEMENTS (TRENCH REPAIR)**

- 511.1. DESCRIPTION:** *Cut pavements, remove base, and replace base material and pavements on cuts up to six (6) feet in width.*
- 511.2. MATERIALS:** Furnish materials conforming to the following:
- A. Tack Coat.** Item 203, "Tack Coat."
  - B. Surface Treatments.** Item 204, "Surface Treatments."
  - C. Hot Mixed Asphaltic Concrete Pavement.** Item 205, "Hot Mixed Asphaltic Concrete Pavement."
  - D. Asphalt Treated Base.** Item 206, "Asphalt Treated Base."
  - E. Hydraulic Cement Concrete.** Item 300, "Concrete."
  - F. Reinforcing Steel.** Item 301, "Reinforcing Steel."
  - G. Membrane Curing Compound:** Item 305, "Membrane Curing."
- 511.3. EQUIPMENT:** Furnish equipment in accordance with the pertinent Items. Use of a motor grader will be permitted for placement of asphalt concrete pavement unless otherwise shown on the plans.
- 511.4. CONSTRUCTION:** Repair using one or more of the following operations as shown on the plans. Cut neat vertical faces around the perimeter of the work area when removing pavement structure layers. Removed materials are the property of the Contractor unless otherwise shown on the plans. Dispose of removed material in accordance with federal, state, and local regulations. Provide a smooth line and grade conforming to the adjacent pavement.
- A. Removing Upper Pavement Layers.** All concrete and asphaltic concrete pavements shall be cut with a concrete saw or other approved equally capable equipment. If necessary, remove adjacent soil and vegetation to prevent contamination of the repair area, and place it in a windrow. Do not damage adjacent pavement structure during repair operations.
    - 1. Cutting Existing Asphaltic Concrete Layers.** The depth of the cut shall be such that upon removal of asphaltic concrete, the sides of the cut will be straight and square. Where existing base materials are to remain, pavements shall be removed to their full depth up to the top of the base material. Care shall be taken not to damage the existing base. If subgrade work is required, remove flexible pavement structure layers from work area.
    - 2. Cutting Existing Portland Cement Concrete Layers.** Remove areas identified by the Engineer. Saw-cut and remove existing asphalt concrete overlay over the repair area and at least 6 inches outside each end of the repair area. Saw-cut full depth through the concrete around the perimeter of the repair area before removal. Do not spall or fracture concrete adjacent to the repair area. Care shall be taken, when cutting concrete pavement, not to cut transverse reinforcing steel.

3. **Cutting Surface Treatments.** Asphalt surface treatments shall be cut by means of sharp axes or hand held pneumatic tools with wedge bits, or other approved equipment.

**B. Removal of Underlying Layers (Bases).**

1. **Concrete and Cement Stabilized Bases:** Remove by means of hand held pneumatic pavement breakers with approved cutting bits. It is the intent of this specification that the base shall be removed in a manner that will leave the sides of the cut straight and square.

Where reinforcement is encountered in concrete bases, a minimum of 1 foot shall be cleaned of all old concrete and left in place to tie to new reinforcement in the new concrete base.

2. **Flexible Bases.** Remove by normal trenching operations.

**C. Replacement of Underlying Layers (Bases).**

1. **Concrete Base.** Replace concrete bases with Class "A" concrete conforming to the provisions of Item 300, "Concrete." If existing concrete is steel reinforced, the reinforcing steel shall be replaced in accordance with Item No. 301, "Reinforcing Steel." The concrete shall have a slump of not more than 3 inches and shall be spaded, tamped and finished to the satisfaction of the Engineer. Immediately following finishing operations, the surface shall be cured in accordance with the provisions of Item 305, "Membrane Curing." The concrete shall be protected from traffic for seventy-two (72) hours.
2. **Stabilized or Flexible Base.** Unless otherwise shown on the plans, replace cement stabilized, asphalt treated, asphaltic concrete, or flexible bases with Type B asphaltic concrete base in accordance with Item 205, "Hot Mix Asphaltic Concrete Pavement" or other materials approved by the Engineer.

**D. Replacement of Upper Pavement Layers.** Pavement layers shall be replaced under this item in the thickness and type shown on the plans or as directed by the Engineer.

1. **Asphaltic Concrete.** Hot mix asphaltic concrete shall be furnished and placed in accordance with Item 205, "Hot Mix Asphaltic Concrete Pavement." All concrete bases shall receive a tack coat of asphalt or emulsion in accordance with the provisions of Item 203, "Tack Coat" prior to placement of hot mix asphaltic concrete.
2. **Portland Cement Concrete.** When Portland cement concrete pavement is indicated on the plans as the replacement pavement, "Class A" concrete in accordance with Item 300, "Concrete," shall be placed conforming to the methods described in 511.4.C.1. "Concrete Bases." The concrete shall be placed, spaded, tamped and finished to the line, grade and texture of the surrounding concrete pavement.
3. **Surface Treatments.** Where the existing pavement is shown to be a single or double surface treatment on the plans, the replacement surface pavement will not be constructed under this item. Such surface treatments will be constructed to the widths and details shown on the plans and measured and paid under Item 204, "Surface Treatments" or other items as directed by the Engineer.

**511.5. MEASUREMENT:** Cutting and replacing pavements will be measured by the square yard of pavement so cut and replaced, of the type and depth indicated in the plans and bid proposal and of the limits shown in the plans. Materials used in replacing bases and pavements such as flexible base, cement stabilized base, concrete, reinforcing steel, prime coat, tack coat and asphaltic concrete pavement will not be measured directly for payment. Depth will be measured from the top of pavement to the bottom of new base material.

**511.6. PAYMENT:** Payment for cutting and replacing pavements will be made at the contract unit price bid per square yard for "Cutting and Replacing Pavements" of the type and depth classification shown on the plans. Where the depth of replaced base and pavement differs from that shown on the plans and bid proposal, the contract unit price bid per square yard shall be adjusted by the ratio of the actual depth of pavement and base replaced to the depth shown on the plans and in the bid proposal. Such variations in depth shall be subject to approval of the Engineer in writing.

The contract unit price bid for "Cutting and Replacing Pavements" shall be considered as full compensation for cutting pavements, removing bases, replacing bases and pavements, removing and disposing of all surplus materials, furnishing and placing all new materials, and for all manipulations, work, tools, equipment, labor and incidentals necessary to complete the work.

**511.7. BID ITEMS:**

Item 511.1 - Replacing with Flexible Base and Pavement - \_\_inches compacted depth - per square yard

Item 511.2 - Replacing with Cement Stabilized Base and Pavement \_\_inches depth - per square yard

Item 511.3 - Replacing with Hot Mix Asphaltic Concrete Pavement - Type B \_\_inches compacted depth - per square yard

Item 511.4 - Replacing with Portland Cement Concrete Pavement - \_\_inches depth - per square yard

Item 511.5 - Replacing with Flexible Base and Surface Treatment - \_\_inches compacted depth - per square yard

**ITEM****533 CLEANING AND REMOVAL OF PAVEMENT MARKINGS AND MARKERS**

**533.1. DESCRIPTION:** *Clean both concrete and asphaltic surfaces prior to the placement of pavement markings/markers and/or for removal of existing pavement markings and raised pavement markers.*

**533.2. MATERIALS:** The blasting medium shall be a quality commercial product capable of producing the specified surface cleanliness without the deposition of deleterious materials on the cleaned surface.

**533.3. EQUIPMENT:** All equipment shall be of sufficient capacity to efficiently and economically clean the roadway surface to the specified cleanliness. Equipment shall be power driven and in good operating condition. Equipment shall utilize moisture and oil traps, in working order, of sufficient capacity to remove contaminants from the air and prevent deposition of moisture, oil or other contaminants on the roadway surface.

**533.4. CONSTRUCTION:** Unless otherwise shown on the plans, acceptable methods of removal for asphaltic pavements include heat scarification, blasting, and mechanical methods. Grinding is not an acceptable mechanical method unless otherwise approved by the Engineer. Blasting is the only acceptable method for removal or cleaning of a portland cement concrete surfaced pavement.

**A. Removal of Existing Pavement Markings/Markers.**

1. Existing markings or markers to be removed shall be removed to the extent that the pavement marking or marker and its adhesive compound is/are either completely removed or obliterated.
2. Widths, lengths, and shapes of the cleaned surface shall be of sufficient size to include the full area of the specified pavement marking to be placed or removed.
3. Avoid damage to the pavement surface during the removal of markings or markers. Repair damaged areas on asphaltic surfaces in excess of ¼ inch in depth using approved patching materials.
4. Blasting on portland cement concrete surfaces shall be sufficient to remove old pavement markings and all other contaminants. Over-blasting to the extent of damage to the roadway surface shall be avoided.
5. Very small particles of tightly adhering existing markings may remain in place if complete removal of the small particles will result in pavement damage.

**B. Cleaning.**

1. Pavement surfaces where existing pavement markings will remain in place shall be cleaned with high pressure air or water to remove dust, sand, and other objectionable material prior to application of new markings. If water is used, the area to be cleaned shall be sufficiently dry, as defined in Item 535.4.A.1, for application of the marking material.

2. All surfaces other than portland cement concrete surfaces required to be cleaned shall be cleaned sufficiently to remove loose and flaking conditions or markings of the road surface. Surface cleaning shall be completed on all existing pavements where the inlaid plastic material or raised pavement marker is not being used with new pavement.
  3. Where blasting is used for the removal of pavement markings, adhesives, or for removal of objectionable material, remove the residue, including dust and water, immediately after contact with the surface being treated. Remove by a vacuum attachment operating concurrently with the blasting operation.
  4. Where grinding is allowed by the Engineer to remove pavement markings on asphaltic concrete pavements, remove the residue by means of a vacuum attachment to the grinding machine. Do not allow the residue to flow across or be left on the pavement.
- 533.5. MEASUREMENT AND PAYMENT:** Cleaning or removal of existing or incorrectly installed pavement markings and/or markers shall not be paid for directly, but shall be considered subsidiary to the pavement marking or marker items or Mobilization if no pavement marking pay items are used.
- 533.6. BID ITEM:** This specification is included solely as a technical guide as to how cleaning or removal of markings and/or markers shall be performed and does not constitute a separate bid item.

## ITEM

### 535 HOT APPLIED THERMOPLASTIC PAVEMENT MARKINGS

- 535.1. DESCRIPTION:** *Apply thermoplastic pavement markings, in conformance with the minimum optical and physical properties required for a thermoplastic road marking compound described herein, in a molten state, onto a pavement surface.*
- 535.2. MATERIALS:** All materials shall conform to the requirements of TxDOT DMS-8220 "Hot Applied Thermoplastic." Thermoplastic materials shall be stored in a dry environment to minimize the amount of moisture retained during storage.
- 535.3. EQUIPMENT:** Provide the necessary equipment to conduct the work specified herein. All equipment shall be maintained in good working order such that neat and clean thermoplastic markings are applied at the proper thicknesses and glass beads are placed at the correct rate. Equipment that is deemed deficient by the Engineer shall be replaced immediately.
- 535.4. CONSTRUCTION:** The appearance of the finished markings shall have a uniform surface, crisp edges with a minimum over-spray, clean cut-off, meet straightness requirements and conform to the design drawings and/or engineer instructions.

The contractor shall provide the Engineer with certification from the marking manufacturer that contractor has been adequately trained and certified to apply the manufacturer's material. This certification shall be considered current if the certification date provided by the manufacturer is within two years of the date of marking application.

All striping and pavement markings shall be placed in accordance with the requirements of this specification, the detailed plans, and the current edition of the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD). The Contractor shall provide all other engineering services necessary for pre-marking of all proposed stripe within the limits of the designated work.

Unless authorized otherwise in writing by the Engineer, striping shall be accomplished during daylight hours. Approved lighting arrangements will be required for night time operations when allowed.

The Contractor may be required to place markings over existing markings, as determined by the Engineer. The contractor shall adjust the operation of the thermoplastic screed shoe to match the previous lengths of stripes and skips, when necessary.

Failure of the striping material to adhere to the pavement surface during the life of the contract shall be prima facie evidence that the materials, even though complying with these specifications, or the application thereof, was inconsistent with the intent of the requirements for the work under the latest City specifications and shall be cause for ordering corrective action or replacement of the marking without additional cost to the City.

Unless otherwise approved by the Engineer, permanent pavement markings on newly constructed pavements surfaced with asphaltic concrete or bituminous seals shall not be applied for a minimum of 14 days or a maximum 35 days. Temporary pavement marking shall be provided during the 14 to 35 day period.

**A. Surface Preparation.**

1. **Moisture.** All surfaces shall be inspected for moisture content prior to application of thermoplastic. Approximately two square feet of a clear plastic or tar paper shall be laid on the road surface and held in place for 15 to 20 minutes. The underside of the plastic or tar paper shall then be inspected for a buildup of condensed moisture from the road surface. Pavement is considered dry if there is no condensation on the underside of the plastic or tarpaper. In the event of moisture, this test shall be repeated until there is no moisture on the underside of the plastic or tar paper.
2. **Cleaning.** All surfaces shall be clean and dry, as defined in Section 535.4.A.1, before thermoplastic can be applied. Loose dirt and debris shall be removed by thoroughly blowing compressed air over the area to be striped. If the thermoplastic is to be applied over existing paint lines, the paint line shall be swept with a mechanical sweeper or wire brush to remove poorly adhered paint and dirt that would interfere with the proper bonding or the thermoplastic. Additional cleaning through the use of compressed air may be required to remove embedded dirt and debris after sweeping. Latence and curing compound shall be removed from all new portland cement concrete surfaces in accordance with Item 533, "Removal of Pavement Markings and Markers."
3. **Layout.** The pavement markings shall be placed in proper alignment with guidelines established on the roadway. Deviation from the alignment established shall not exceed 2 inches and, in addition, the deviation in alignment of the marking being placed shall not exceed 1 inch per 200 feet of roadway nor shall any deviation be abrupt.

No striping material shall be applied over a guide cord; only longitudinal joints, existing stripes, primer, or other approved type guides will be permitted. In the absence of a longitudinal joint or existing stripe, the Contractor shall mark the points necessary for the placing of the proposed stripe. Edge striping shall be adjusted as necessary so that the edge stripe will be parallel to the centerline and shall not be placed off the edge of the pavement.

Longitudinal markings shall be offset at least 2-inches from construction joints of portland cement concrete surfaces and joints and shoulder breaks of asphalt surfaces.

4. **Primer Sealer.** Primer sealer shall be used on all portland cement concrete surfaces. A primer sealer shall be used on asphalt surfaces that are over two years old and/or on asphalt surfaces that are worn or oxidized to a condition where 50 percent or more of the wearing surface is exposed aggregate. Existing pavement markings may act as the primer sealer if, after cleaning, more than 70 percent of the existing pavement marking is still properly bonded to the asphalt surface (see coverage check procedure in Appendix A to estimate percent of marking remaining).
5. **Primer Sealer Application.** When required as described, the primer-sealer shall be applied to the road surface in a continuous film at a minimum thickness of 3 to 5 mils. Before the Thermoplastic is applied, the primer-sealer shall be allowed to dry to a tacky state. The thermoplastic shall be applied within 4 hours after the primer application.

**B. Temperature Requirements.**

1. **Ambient Conditions.** The ambient air and road surface shall be 55°F and rising before application of thermoplastic can begin.



2. **Material Requirements.** Unless otherwise specified by the material manufacturer, the thermoplastic compound shall be heated from 400°F to 450°F and shall be a minimum of 400°F as it makes contact with road surface during application. An infrared temperature gun shall be used to determine the temperature of the thermoplastic as it is being applied to the road surface.

**C. Drop-on Glass Sphere Application.**

1. **Application Rate.** Retro-reflective glass spheres shall be applied at the rate of 10 pounds per 100 square feet of applied markings. This application rate shall be determined by confirming the following consumption rates:
  - a. 200 pounds of drop on glass spheres per ton of applied thermoplastic when the thermoplastic is being applied at 0.090 inch film thickness.
  - b. 150 pounds of drop on glass spheres per ton of applied thermoplastic when the thermoplastic is being applied at 0.125 inch thickness.
2. **Application Method.** Retro-reflective glass spheres shall be applied by a mechanical dispenser properly calibrated and adjusted to provide proper application rates and uniform distribution of the spheres across the cross section of the entire width of the line. To enable the spheres to embed themselves into the hot thermoplastic, the sphere dispenser shall be positioned immediately behind the thermoplastic application device. This insures that the spheres are applied to the thermoplastic material while it is still in the molten state.

**D. Application Thickness.**

1. **Longitudinal and Transverse Markings.** On previously unmarked pavements or pavements where markings have been effectively removed, all lane lines, center lines, transverse markings and pavement markings in traffic areas with  $\leq 1,000$  vehicles per day per lane shall have a minimum film thickness of 0.090 inch at the edges and a maximum of 0.145 inch at the center. A minimum average film thickness of 0.090 inch shall be maintained. On pavements with existing markings, meeting the traffic requirements stated above, all lane lines, center lines, transverse markings and pavement markings shall have a minimum film thickness of 0.060 inch for re-application over existing strip line.
2. **High Wear Longitudinal and Transverse Marking.** On previously unmarked pavements or pavements where markings have been effectively removed, all lane lines, center lines, transverse markings and pavement markings in high traffic areas ( $>1,000$  vehicles per day per lane) shall have a minimum film thickness of 0.125 inch at the edges and a maximum of 0.188 inch at the center. A minimum average film thickness of 0.125 inch shall be maintained. On pavements with existing markings, meeting the traffic requirements stated above, all lane lines, center lines, transverse markings and pavement markings shall have a minimum film thickness of 0.090 inch for re-application over existing strip line.

**E. Packaging.**

1. **Containers.** The thermoplastic material shall be delivered in 50 pound containers or bags of sufficient strength to permit normal handling during shipment and handling on the job without loss of material.
2. **Labeling.** Each container shall be clearly marked to indicate the color of the material, the process batch number and/or manufacturer's formulation number, the manufacturer's name and address and the date of manufacture.

**F. Acceptance.**

1. **Sampling Procedure.** Random samples may be taken at the job site at the discretion of the City Engineer for quality assurance. The City reserves the right to conduct the tests deemed necessary to identify component materials and verify results of specific tests indicated in conjunction with the specification requirements.

The sample(s) shall be labeled as to the shipment number, lot number, date, quantity, and any other pertinent information. At least three randomly selected bags shall be obtained from each lot. A 10 pound sample from the three bags shall be submitted for testing and acceptance. The lot size shall be approximately 44,000 pounds unless the total order is less than this amount.

2. **Manufacturer's Responsibility.**

- a. **Sampling and Testing.** The manufacturer shall submit test results from an approved independent laboratory. All material samples shall be obtained 20 days in advance of the pavement marking operations. The cost of testing shall be included in the price of thermoplastic material. The approved independent laboratory's test results shall be submitted to the City Traffic Engineer in the form of a certified test report.
- b. **Bill of Lading.** The manufacturer shall furnish the Material and Tests Laboratory with copies of Bills of Lading for all materials inspected. Bill of lading shall indicate the consignee and the destination, date of shipment, lot numbers, quantity, type of material, and location of source.
- c. **Material Acceptance.** Final acceptance of a particular lot of thermoplastic will be based on the following.
  - (1) Compliance with the specification for material composition requirements verified by approved independent laboratory with tests results.
  - (2) Compliance with the specification for the physical properties required and verified by an approved independent laboratory with test results.
  - (3) Manufacturer's test results for each lot thermoplastic have been received.
  - (4) Identification requirements are satisfactory.

3. **Contractor's Responsibility.**

- a. **Notification.** The contractor shall notify the Construction Inspector 72 hours prior to the placement of the thermoplastic markings to enable the inspector to be present during the application operation. At the time of notification, the Contractor shall indicate the manufacturer and the lot numbers of the thermoplastic that will be used.

A check should be made by the contractor to insure that the approved lot numbers appear on the material package. Failure to do so is cause for rejection.

- b. **Warranty or Guarantee.** If the normal trade practice for manufacturers is to furnish warranties or guarantees for the materials and equipment specified herein, the Contractor shall turn the guarantees and warranties over to the Engineer for potential dealing with the manufactures. The extent of such warranties or guarantees will not be a factor in selecting the successful bidder.

**535.5. MEASUREMENT:** Measurement shall be based on the length of satisfactorily installed line, in feet, or as appropriate, the number of symbols or words which are satisfactorily installed on the roadway surface by the contractor.

**535.6. PAYMENT:** Payment shall be according to the quantities measured for each bid item.

**535.7. BID ITEM:**

Item 535.1 - 4 inch wide yellow line

Item 535.2 - 4 inch wide white line

Item 535.3 - 8 inch wide yellow line

Item 535.4 - 8 inch wide white line

Item 535.5 - 12 inch wide white line

Item 535.6 - 16 inch wide white line

Item 535.7 - 24 inch wide white line

Item 535.8 - Right White Arrow (per each)

Item 535.9 - Left White Arrow (per each)

Item 535.10 - Combination Thru/Right White Arrow (per each)

Item 535.11 - Combination Thru/Left White Arrow (per each)

Item 535.12 - Word "ONLY" (per word)

Item 535.13 - Straight White Arrow (per each)

Item 535.14 - Railroad Crossing Symbol, including two R's, crossbuck and 3 transverse bars (per each)

Item 535.15 - White Diamond (per each)

Item 535.16 - Straight White Arrow Bicycle Facility (per each)

Item 535.17 - Bicycle Rider Symbol (per each)

Item 535.18 - Solid White Yield Lines (6" x 9") (per each)

Item 535.19 - Word "STOP" (per word)

Item 535.20 - Word "YIELD" (per word)

Item 535.21 - Word "BUS" (per word)

### APPENDIX A: Method for Estimating Amount of Marking Bonded to Pavement

This inspection will ensure uniformity of coverage of the entire line, such as paint cracking, peeling, and whether or not the marking has adequate coverage. One-square-inch sections of transparent material inscribed within a grid of 100 equal squares shall be used as a tool for quantitative measure of specified percentage of coverage. The grid concept was taken from the Air Force who used it for measuring rubber coverage on pavement. For a 4-inch line, it is suggested that a grid of 4 x 25 inches be used, and for a 12-inch (or larger) line, a grid of 10 x 10 inches. Count the squares that have no paint, e.g., 3 out of 100 squares equal 3% of the paint gone or 97% coverage.

Follow the steps below to take the readings of the pavement markings:

1. Using either the 10- x 10-inch grid or the 4- x 25-inch grid, place the grid on the line to be evaluated.
2. Count the squares that have no paint.
3. The number of squares without paint will be the percentage of paint gone. In other words, if there are 30 out of 100 squares that have no paint, then 30% of the paint is gone.



Cyrus, Holly M., "Development of Methods for Determining Airport Pavement Marking Effectiveness," DOT/FAA/AR-TN03/22, Federal Aviation Administration, March 2003.

**ITEM****540 TEMPORARY EROSION, SEDIMENTATION AND WATER POLLUTION PREVENTION AND CONTROL**

**540.1. DESCRIPTION:** *This item shall govern the control measures necessary to prevent and control soil erosion, sedimentation and water pollution which may degrade receiving waters including rivers, streams, lakes, reservoirs, tidal water, groundwater and wetlands.*

Note: The control measures contained herein shall be installed and maintained throughout the construction contract and coordinated with the permanent or existing temporary pollution control features specified elsewhere on the plans and in the specifications to assure effective and continuous water pollution control throughout the construction and post construction period. These control measures shall not be used as a substitute for the permanent pollution control measures unless otherwise directed by the Engineer in writing. The controls may include sediment control fences, inlet protection, baled hay, rock filter dams, dikes, swales, sediment traps and basins, pipe slope drains, paved flumes, construction exits, temporary seeding, sodding, mulching, soil retention blankets or other structural or non-structural water pollution controls. This item does not apply to commercial operations.

**540.2. MATERIALS:** The items, estimated quantities and locations of the control measures are shown on the plans; however, the Engineer may increase or decrease the quantity of these items as the need arises. The materials will be shown on the plans and in this specification. The Engineer may allow other materials and work as the need arises and as approved in writing. Pollution control measures may be applicable to contractor operations outside the right of way where such work is necessary as a result of roadway related construction such as construction and haul roads, field offices, equipment and supply areas, and materials sources.

Unless otherwise shown on the plans, provide materials that meet the following requirements:

**A. Rock Filter Dams.**

1. **Aggregate.** Furnish aggregate with hardness, durability, cleanliness, and resistance to crumbling, flaking, and eroding acceptable to the Engineer. Provide the following:
  - **Types 1, 2, and 4 Rock Filter Dams.** Use 3 to 6 in. aggregate.
  - **Type 3 Rock Filter Dams.** Use 4 to 8 in. aggregate.
2. **Wire.** Provide minimum 20 gauge galvanized wire for the steel wire mesh and tie wires for Types 2 and 3 rock filter dams. Type 4 dams require:
  - a double-twisted, hexagonal weave with a nominal mesh opening of 2½ in. x 3¼ in.;
  - minimum 0.0866 in. steel wire for netting;
  - minimum 0.1063 in. steel wire for selvages and corners; and
  - minimum 0.0866 in. for binding or tie wire.
3. **Sandbag Material.** Furnish sandbags meeting Section 540.2.I, "Sandbags," except that any gradation of aggregate may be used to fill the sandbags.

- B. Temporary Pipe Slope Drains.** Provide corrugated metal pipe, polyvinyl chloride (PVC) pipe, flexible tubing, watertight connection bands, grommet materials, prefabricated fittings, and flared entrance sections that conform to the plans. Recycled and other materials meeting these requirements are allowed if approved. Furnish concrete in accordance with Item 505, "Concrete Riprap."
- C. Baled Hay.** Provide hay bales weighing at least 50 lb., composed entirely of vegetable matter, measuring 30 in. or longer, and bound with wire, nylon, or polypropylene string.
- D. Temporary Paved Flumes.** Furnish asphalt concrete, hydraulic cement concrete, or other comparable non-erodible material that conforms to the plans. Provide rock or rubble with a minimum diameter of 6 in. and a maximum volume of  $\frac{1}{2}$  cu. ft. for the construction of energy dissipaters.
- E. Construction Exits.** Provide materials that meet the details shown on the plans and this Section.
- 1. Rock Construction Exit.** Provide crushed aggregate for long and short-term construction exits. Furnish aggregates that are clean, hard, durable, and free from adherent coatings such as salt, alkali, dirt, clay, loam, shale, soft, or flaky materials and organic and injurious matter. Use 4- to 8- in. rock for Type 1 and 2- to 4- in. rock for Type 3. Unless otherwise shown on the plans, provide a light weight (4 oz.) non-woven filter fabric below the ballast to prevent mud and sediment migration.
  - 2. Timber Construction Exit.** Furnish No. 2 quality or better railroad ties and timbers for long-term construction exits, free of large and loose knots and treated to control rot. Fasten timbers with nuts and bolts or lag bolts, of at least  $\frac{1}{2}$  in. diameter, unless otherwise shown on the plans or allowed. For short-term exits, provide plywood or pressed wafer board at least  $\frac{1}{2}$  in. thick.
  - 3. Foundation Course.** Provide a foundation course consisting of flexible base, bituminous concrete, hydraulic cement concrete, or other materials as shown on the plans or directed.
- F. Embankment for Erosion Control.** Provide rock, loam, clay, topsoil, or other earth materials that will form a stable embankment to meet the intended use.
- G. Pipe.** Provide pipe outlet material in accordance with TxDOT Standard Specification Item 556, "Pipe Underdrains," and details shown on the plans.
- H. Construction Perimeter Fence.**
- 1. Posts.** Provide essentially straight wood or steel posts that are at least 60 in. long. Furnish soft wood posts with a minimum diameter of 3 in. or use 2 x 4 boards. Furnish hardwood posts with a minimum cross-section of  $1\frac{1}{2}$  x  $1\frac{1}{5}$  in. Furnish T- or L-shaped steel posts with a minimum weight of 0.95 lb. per foot.
  - 2. Fence.** Provide orange construction fencing as approved by the Engineer.
  - 3. Fence Wire.** Provide 14 gauge or larger galvanized smooth or twisted wire. Provide 16 gauge or larger tie wire.

4. **Flagging.** Provide brightly-colored flagging that is fade-resistant and at least  $\frac{3}{4}$  in. wide to provide maximum visibility both day and night.
  5. **Staples.** Provide staples with a crown at least  $\frac{1}{2}$  in. wide and legs at least  $\frac{1}{2}$  in. long.
  6. **Used Materials.** Previously used materials meeting the applicable requirements may be used if accepted by the Engineer.
- I. Sandbags.** Provide sandbag material of polypropylene, polyethylene, or polyamide woven fabric with a minimum unit weight of 4 oz. per square yard, a Mullen burst-strength exceeding 300 psi, and an ultraviolet stability exceeding 70%. Use natural coarse sand or manufactured sand meeting the gradation given in Table 1 to fill sandbags. Filled sandbags must be 24 to 30 in. long, 16 to 18 in. wide, and 6 to 8 in. thick.

**Table 1**  
**Sand Gradation**

Sieve #	Maximum Retained (% by Weight)
4	3%
100	80%
200	95%

- J. Temporary Sediment Control Fence.** Provide a net-reinforced fence using woven geotextile fabric. Logos visible to the traveling public will not be allowed.
1. **Fabric.** Provide fabric materials in accordance with TxDOT DMS-6230, "Temporary Sediment Control Fence Fabric."
  2. **Posts.** Provide essentially straight wood or steel posts with a minimum length of 48 in., unless otherwise shown on the plans. Soft wood posts must be at least 3 in. in diameter or nominal 2 x 4 in. Hardwood posts must have a minimum cross-section of  $1\frac{1}{2}$  x  $1\frac{1}{2}$  in. T- or L-shaped steel posts must have a minimum weight of 0.95 lb. per foot.
  3. **Net Reinforcement.** Provide net reinforcement of at least 14 gauge galvanized welded wire mesh, with a maximum opening size of 2 x 4 in., at least 24 in. wide, unless otherwise shown on the plans.
  4. **Staples.** Provide staples with a crown at least  $\frac{3}{4}$  in. wide and legs  $\frac{1}{2}$  in. long.
  5. **Used Materials.** Use recycled material meeting the applicable requirements if accepted by the Engineer.
- K. Curb Inlet Gravel Filters.**
1. **Gravel Filter Bags.** Furnish gravel filter bags meeting Section 540.2.I, "Sandbags." Gravel bags shall be filled with  $\frac{3}{4}$  inch gravel.
  2. **Concrete Masonry Units.** Hollow, Non-Load-Bearing Concrete blocks of 1500-2000 psi, 28-day compressive strength concrete shall be used with dimensions of 8" x 6" x 6" width, height, and length, respectively.
  3. **Wood Blocks.** Wolmanized treated 2" x 4" lumber with the length as per inlet size.



**540.3. EQUIPMENT.** Provide a backhoe, front end loader, blade, scraper, bulldozer, or other equipment as required when "Earthwork for Erosion Control" is specified on the plans as a bid item.

**540.4. CONSTRUCTION:** The contractor shall provide control measures to prevent or minimize the impact to receiving waters as required by the plans and/or as directed by the Engineer in writing.

**A. Contractor Responsibilities.**

1. **SW3P.** Implement the City's Storm Water Pollution Prevention Plan (SWP3) for the project site in accordance with the specific or general storm water permit requirements. Prevent water pollution from storm water associated with construction activity from entering any surface water or private property on or adjacent to the project site. The Contractor shall effectively prevent and control erosion and sedimentation on the site at the earliest practicable time as outlined in the approved schedule. Control measures, where applicable, will be implemented prior to the commencement of each construction operation or immediately after the area has been disturbed.

2. **Preconstruction Submittals.**

a. **Operations on Right of Way.** Prior to the start of construction, the Contractor shall submit to the Engineer, for approval, schedules for accomplishment of the pollution control measures in accordance with the Storm Water Pollution Prevention Plan (SW3P). A plan for the disposal of waste materials generated on the project site must be submitted for approval, also. The Contractor shall submit to the Engineer, for approval, the proposed SW3P for the industrial activities (such as hot mix plants, concrete batch plants, or material handling areas) on the right of way.

b. **Operations off Right of Way.** The Contractor shall provide the Engineer, for information purposes only, proposed methods of pollution control for Contractor operations in areas which are outside the right of way (such as construction and haul roads, field offices, equipment and supply areas, and material sources).

Pollution control measures for the Contractor's facilities off the right of way are not covered by the City's Environmental Protection Agency (EPA) NPDES general permit. The Contractor shall obtain his own Notice of Intent for the off-site operations. These pollution controls will not be measured for payment but shall be performed at the Contractor's expense.

**B. General.**

1. **Phasing.** Implement control measures in the area to be disturbed before beginning construction, or as directed. Limit the disturbance to the area shown on the plans or as directed. If, in the opinion of the Engineer, the Contractor cannot control soil erosion and sedimentation resulting from construction operations, the Engineer will limit the disturbed area to that which the Contractor is able to control. Minimize disturbance to vegetation.

2. **Rainfall Events.** A rain gauge shall be provided by the Contractor and located at the project site. Within 24 hours of a rainfall event of ½ inch or more as measured by the project rain gauge, the Contractor and Inspector will inspect the entire project to

determine the condition of the control measures. Maintain control measures in accordance with Item 540.4.B.3, "Maintenance."

3. **Maintenance.** Correct ineffective control measures in accordance with this section. Implement additional controls as directed. Remove excavated material within the time requirements specified in the applicable storm water permit.

Following a rain event as described in Item 540.4.B.2, Rainfall Event," sediment will be removed and devices repaired as soon as practicable but no later than 7 days after the surrounding exposed ground has dried sufficiently to prevent further damage from equipment needed for repair of control measures.

In the event of continuous rainfall over a 24-hour period, or other circumstances that preclude equipment operation in the area, the Contractor will hand carry and install additional backup devices as determined by the Engineer. The Contractor will remove silt accumulations and deposit the spoils in an area approved by the Engineer as soon as practical. Any corrective action needed for the control measures will be accomplished in the sequence directed by the Engineer; however, areas adjacent to waterbodies shall generally have priority followed by devices protecting storm sewer inlets.

4. **Stabilization.** Stabilize disturbed areas where construction activities will be temporarily stopped, or construction becomes inactive, in accordance with the applicable storm water permit. Inactive construction areas are defined as areas in which no construction activity will occur for a period of 30 days or longer. Inactive construction areas which have been disturbed will require stabilization through the use of vegetation, mulch, erosion control matting or structural methods within 7 calendar days from the last construction activity in the area. At all times prior to stabilization, inactive construction areas shall be considered as active, disturbed construction area, contributing to the sediment loading at the site control systems. After stabilization, inactive construction areas will be considered undisturbed areas, eliminating the contribution of sediment to the erosion control devices.
5. **Finished Work.** Upon acceptance of vegetative cover, remove and dispose of all temporary control measures, temporary embankments, bridges, matting, falsework, piling, debris, or other obstructions placed during construction that are not a part of the finished work, or as directed. Soil retention blankets shall be removed only when, in the opinion of the Engineer, final permanent perennial seeding would be adversely affected by the presence of an existing soil retention blanket.

The project will not be accepted until a 70% density of existing adjacent undisturbed areas is obtained, unless otherwise shown on the plans. When shown on the plans, the Engineer may accept the project when adequate controls are in place that will control erosion, sedimentation, and water pollution until sufficient vegetative cover can be established.

6. **Restricted Activities.** Do not locate disposal areas, stockpiles, or haul roads in any wetland, water body, or streambed. Do not install temporary construction crossings in or across any water body without the prior approval of the appropriate resource agency and the Engineer. Restrict construction operations in any water body to the necessary areas as shown on the plans or applicable permit, or as directed. Use temporary bridges, timber mats, or other structurally sound and non-eroding material for stream crossings.

Provide protected storage area for paints, chemicals, solvents, and fertilizers at an approved location. Keep paints, chemicals, solvents, and fertilizers off bare ground and provide shelter for stored chemicals.

- C. Installation, Maintenance, and Removal Work.** Perform work in accordance with the specific or general storm water permit. Install and maintain the integrity of temporary erosion and sedimentation control devices to accumulate silt and debris until earthwork construction and permanent erosion control features are in place or the disturbed area has been adequately stabilized as determined by the Engineer. If a device ceases to function as intended, repair or replace the device or portions thereof as necessary. Remove sediment, debris, and litter. When approved, sediments may be disposed of within embankments, or in the right of way in areas where the material will not contribute to further siltation. Dispose of removed material in accordance with federal, state, and local regulations. Remove devices upon approval or when directed. Upon removal, finish-grade and dress the area. Stabilize disturbed areas in accordance with the permit, and as shown on the plans or directed. The Contractor retains ownership of stockpiled material and must remove it from the project when new installations or replacements are no longer required.
- 1. Rock Filter Dams for Erosion Control.** Remove trees, brush, stumps, and other objectionable material that may interfere with the construction of rock filter dams. Place sandbags as a foundation when required or at the Contractor's option. For Types 1, 2, 3, and 5, place the aggregate to the lines, height, and slopes specified, without undue voids. For Types 2 and 3, place the aggregate on the mesh and then fold the mesh at the upstream side over the aggregate and secure it to itself on the downstream side with wire ties, or hog rings, or as directed. Place rock filter dams perpendicular to the flow of the stream or channel unless otherwise directed. Construct filter dams according to the following criteria, unless otherwise shown on the plans:
- a. Type 1 (Non-reinforced).**
    - (1) **Height.** At least 18 in. measured vertically from existing ground to top of filter dam.
    - (2) **Top Width.** At least 2 ft.
    - (3) **Slopes.** At most 2:1.
  - b. Type 2 (Reinforced).**
    - (1) **Height.** At least 18 in. measured vertically from existing ground to top of filter dam.
    - (2) **Top Width.** At least 2 ft.
    - (3) **Slopes.** At most 2:1.
  - c. Type 3 (Reinforced).**
    - (1) **Height.** At least 36 in. measured vertically from existing ground to top of filter dam.
    - (2) **Top Width.** At least 2 ft.

- (3) Slopes. At most 2:1.
- d. **Type 4 (Sack Gabions).** Unfold sack gabions and smooth out kinks and bends. For vertical filling, connect the sides by lacing in a single loop–double loop pattern on 4- to 5-in. spacing. At one end, pull the end lacing rod until tight, wrap around the end, and twist 4 times. At the filling end, fill with stone, pull the rod tight, cut the wire with approximately 6 in. remaining, and twist wires 4 times. For horizontal filling, place sack flat in a filling trough, fill with stone, and connect sides and secure ends as described above. Lift and place without damaging the gabion. Shape sack gabions to existing contours.
  - e. **Type 5.** Provide rock filter dams as shown on the plans.
2. **Temporary Pipe Slope Drains.** Install pipe with a slope as shown on the plans or as directed. Construct embankment for the drainage system in 8-in. lifts to the required elevations. Hand-tamp the soil around and under the entrance section to the top of the embankment as shown on the plans or as directed. Form the top of the embankment or earth dike over the pipe slope drain at least 1 ft. higher than the top of the inlet pipe at all points. Secure the pipe with hold-downs or hold-down grommets spaced a maximum of 10 ft. on center. Construct the energy dissipaters or sediment traps as shown on the plans or as directed. Construct the sediment trap using concrete in accordance with Item 505, “Concrete Riprap,” when designated on the plans. Rubble riprap in accordance with TxDOT Standard Specification Item 432, “Riprap” may also be used when designated on the plans or as directed by the Engineer.
  3. **Baled Hay for Erosion and Sedimentation Control.** Install hay bales at locations shown on the plans by embedding in the soil at least 4 in. and, where possible, approximately  $\frac{1}{2}$  the height of the bale, or as directed. Fill gaps between bales with hay.
  4. **Temporary Paved Flumes.** Construct paved flumes as shown on the plans or as directed. Provide excavation and embankment (including compaction of the subgrade) of material to the dimensions shown on the plans, unless otherwise indicated. Install a rock or rubble riprap energy dissipater, constructed from the materials specified above to a minimum depth of 9 in. at the flume outlet to the limits shown on the plans or as directed.
  5. **Construction Exits.** When tracking conditions exist, prevent traffic from crossing or exiting the construction site or moving directly onto a public roadway, alley, sidewalk, parking area, or other right of way areas other than at the location of construction exits. Construct exits for either long or short-term use.
    - a. **Long-Term.** Place the exit over a foundation course, if necessary. Grade the foundation course or compacted subgrade to direct runoff from the construction exits to a sediment trap as shown on the plans or as directed. Construct exits with a width of at least 14 ft. for one-way and 20 ft. for two-way traffic for the full width of the exit, or as directed.
      - (1) **Type 1.** Construct to a depth of at least 8 in. using crushed aggregate as shown on the plans or as directed.
      - (2) **Type 2.** Construct using railroad ties and timbers as shown on the plans or as directed.

- b. Short-Term.**
    - (1) **Type 3.** Construct using crushed aggregate, plywood, or wafer board. This type of exit may be used for daily operations where long-term exits are not practical.
    - (2) **Type 4.** Construct as shown on the plans or as directed.
- 6. Earthwork for Erosion and Sediment Control.** Perform excavation and embankment operations to minimize erosion and to remove collected sediments from other erosion control devices.
  - a. Excavation and Embankment for Erosion Control Features.** Place earth dikes, swales or combinations of both along the low crown of daily lift placement, or as directed, to prevent runoff spillover. Place swales and dikes at other locations as shown on the plans or as directed to prevent runoff spillover or to divert runoff. Construct cuts with the low end blocked with undisturbed earth to prevent erosion of hillsides. Construct sediment traps at drainage structures in conjunction with other erosion control measures as shown on the plans or as directed. Where required, create a sediment basin providing 3,600 cu. ft. of storage per acre drained, or equivalent control measures for drainage locations that serve an area with 10 or more disturbed acres at one time, not including offsite areas.
  - b. Excavation of Sediment and Debris.** Remove sediment and debris when accumulation affects the performance of the devices, after a rain, and when directed.
- 7. Construction Perimeter Fence.** Construct, align, and locate fencing as shown on the plans or as directed.
  - a. Installation of Posts.** Embed posts 18 in. deep or adequately anchor in rock, with a spacing of 8 to 10 ft.
  - b. Wire Attachment.** Attach the top wire to the posts at least 3 ft. from the ground. Attach the lower wire midway between the ground and the top wire.
  - c. Flag Attachment.** Attach flagging to both wire strands midway between each post. Use flagging at least 18 in. long. Tie flagging to the wire using a square knot.
- 8. Sandbags for Erosion Control.** Construct a berm or dam of sandbags that will intercept sediment-laden storm water runoff from disturbed areas, create a retention pond, detain sediment, and release water in sheet flow. Fill each bag with sand so that at least the top 6 in. of the bag is unfilled to allow for proper tying of the open end. Place the sandbags with their tied ends in the same direction. Offset subsequent rows of sandbags  $\frac{1}{2}$  the length of the preceding row. Place a single layer of sandbags downstream as a secondary debris trap. Place additional sandbags as necessary or as directed for supplementary support to berms or dams of sandbags or earth.
- 9. Temporary Sediment-Control Fence.** Provide temporary sediment-control fence near the downstream perimeter of a disturbed area to intercept sediment from sheet flow. Incorporate the fence into erosion-control measures used to control sediment in areas of higher flow. Install the fence as shown on the plans, as specified in this Section, or as directed.

- a. **Installation of Posts.** Embed posts at least 18 in. deep, or adequately anchor, if in rock, with a spacing of 6 to 8 ft. and install on a slight angle toward the run-off source.
- b. **Fabric Anchoring.** Dig trenches along the uphill side of the fence to anchor 6 to 8 in. of fabric. Provide a minimum trench cross-section of 6 x 6 in. Place the fabric against the side of the trench and align approximately 2 in of fabric along the bottom in the upstream direction. Backfill the trench, then hand-tamp.
- c. **Fabric and Net Reinforcement Attachment.** Unless otherwise shown under the plans, attach the reinforcement to wooden posts with staples, or to steel posts with T-clips, in at least 4 places equally spaced. Sewn vertical pockets may be used to attach reinforcement to end posts. Fasten the fabric to the top strand of reinforcement by hog rings or cord every 15 in. or less.
- d. **Fabric and Net Splices.** Locate splices at a fence post with a minimum lap of 6 in. attached in at least 6 places equally spaced, unless otherwise shown under the plans. Do not locate splices in concentrated flow areas. Requirements for installation of used temporary sediment control fence include the following:
  - fabric with minimal or no visible signs of biodegradation (weak fibers),
  - fabric without excessive patching (more than 1 patch every 15 to 20 ft.),
  - posts without bends, and
  - backing without holes.

#### 10. Curb Inlet Gravel Filter.

- a. **Installation.** Install the curb inlet gravel filters in the following manner:
  - (1) Place the 2" x 4" treated lumber in front of and parallel with the opening of the inlet.
  - (2) Place the Concrete Masonry Units (CMUs) around the inlet, to be protected, in front of the 2" x 4" lumber, with the openings of the CMUs facing the inlet.
  - (3) Surround the CMUs with gravel bags, making certain that there are no gaps are evident between the gravel bags.
- b. **Sediment Control.** When the accumulated sediment deposit reaches a depth of approximately 6 inches, it shall be removed and disposed of at approved sites in a manner that will not contribute to additional siltation. If the structure ceases to function as intended, the Engineer may direct that the Filter bag be replaced. Such replacement will not be measured for payment. Torn or punctured bags shall be replaced with a new Filter bag.

**540.5. MEASUREMENT:** If the Contractor is required to install temporary erosion, sediment and water pollution control measures due to his negligence, carelessness, lack of maintenance, or failure to install permanent controls as a part of the work as scheduled, and measures are ordered in writing by the Engineer, such work shall not be measured for payment, but shall be performed at the Contractor's expense.

In case of failure on the part of the Contractor to prevent and control soil erosion, sedimentation and water pollution which may degrade receiving water, the Engineer reserves the right to employ outside assistance or to use City forces to provide the necessary corrective measures. All costs including engineering costs will be deducted from any moneys due or to become due to the Contractor.

When the need for control measures can not be attributed to the contractor's negligence, carelessness, lack of maintenance or failure to install permanent water pollution control measures and these measures are shown on the plans and/or directed by the Engineer, these measures shall be measured and paid for in accordance with contract bid items shown under this section.

- A. Rock Filter Dams.** Installation or removal of rock filter dams will be measured by the foot or by the cubic yard. The measured volume will include sandbags, when used.
  - 1. Linear Measurement.** When rock filter dams are measured by the foot, measurement will be along the centerline of the top of the dam.
  - 2. Volume Measurement.** When rock filter dams are measured by the cubic yard, measurement will be based on the volume of rock computed by the method of average end areas.
    - a. Installation.** Measurement will be made in final position.
    - b. Removal.** Measurement will be made at the point of removal.
- B. Temporary Pipe Slope Drains.** Temporary pipe slope drains will be measured by the foot.
- C. Baled Hay.** Baled hay will be measured by each bale.
- D. Temporary Paved Flumes.** Temporary paved flumes will be measured by the square yard of surface area. The measured area will include the energy dissipater at the flume outlet.
- E. Construction Exits.** Construction exits will be measured by the square yard of surface area.
- F. Earthwork for Erosion and Sediment Control.** Earthwork for erosion and sediment control will not be measured directly but will be considered subsidiary to this or other pertinent items.
- G. Construction Perimeter Fence.** Construction perimeter fence will be measured by the foot.
- H. Sandbags for Erosion Control.** Sandbags will be measured as each sandbag or by the foot along the top of sandbag berms or dams.
- I. Temporary Sediment-Control Fence.** Temporary sediment-control fence will be measured by the foot.
- J. Curb Inlet Gravel Filter.** Curb inlet gravel filter will be measured by the linear foot, as measured on the centerline of the gravel bags installed.

**540.6. PAYMENT:** The following will not be paid for directly but are subsidiary to pertinent Items:

- erosion-control measures for Contractor project-specific locations (PSLs) inside and outside the right of way (such as construction and haul roads, field offices, equipment and supply areas, plants, and material sources);
- removal of litter;
- repair to devices and features damaged by Contractor operations;
- added measures and maintenance needed due to negligence, carelessness, lack of maintenance, and failure to install permanent controls;
- removal and reinstallation of devices and features needed for the convenience of the Contractor;
- finish grading and dressing upon removal of the device; and
- minor adjustments including but not limited to plumbing posts, reattaching fabric, minor grading to maintain slopes on an erosion embankment feature, or moving small numbers of sandbags.

The Contractor will be reimbursed for maintenance, repair, or reinstallation of devices and features when the need for additional control measures cannot be attributed to the above, as determined by the Engineer. Stabilization of disturbed areas will be paid for under pertinent Items. Furnishing and installing pipe for outfalls associated with sediment traps and ponds will not be paid for directly but is subsidiary to the excavation and embankment under this Item.

Pollution control measures outside the right of way will not be measured for payment but shall be performed at the Contractor's expense.

Control measures as shown on the plans will be paid for in accordance with applicable bid items as shown below:

- A. Rock Filter Dams.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid as follows:
1. **Installation.** Installation will be paid for as "Rock Filter Dams (Install)" of the type specified. This price is full compensation for furnishing and operating equipment, finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals.
  2. **Removal.** Removal will be paid for as "Rock Filter Dams (Remove)." This price is full compensation for furnishing and operating equipment, proper disposal, labor, materials, tools, and incidentals.

When the Engineer directs that the rock filter dam installation or portions thereof be replaced, payment will be made at the unit price bid for "Rock Filter Dams (Remove)" and for "Rock Filter Dams (Install)" of the type specified. This price is full compensation for furnishing and operating equipment, finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals

- B. Temporary Pipe Slope Drains.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Pipe Slope Drains" of the size specified. This price is full



compensation for furnishing materials, removal and disposal, furnishing and operating equipment, labor, tools, and incidentals.

Removal of temporary pipe slope drains will not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the pipe slope drain installation or portions thereof be replaced, payment will be made at the unit price bid for "Temporary Pipe Slope Drains" of the size specified, which is full compensation for the removal and reinstallation of the pipe drain.

Earthwork required for the pipe slope drain installation, including construction of the sediment trap, will be measured and paid for under Section 540.5.F, "Earthwork for Erosion and Sediment Control." Riprap concrete or stone, when used as an energy dissipater or as a stabilized sediment trap, will be measured and paid for in accordance with Item 505, "Concrete Riprap" or TxDOT Item 432, "Riprap," respectively.

- C. **Baled Hay.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Baled Hay." This price is full compensation for furnishing and placing bales, excavating trenches, removal and disposal, equipment, labor, tools, and incidentals.

When the Engineer directs that the baled hay installation (or portions thereof) be replaced, payment will be made at the unit price bid for "Baled Hay," which is full compensation for removal and reinstallation of the baled hay.

- D. **Temporary Paved Flumes.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Paved Flume (Install)" or "Temporary Paved Flume (Remove)." This price is full compensation for furnishing and placing materials, removal and disposal, equipment, labor, tools, and incidentals.

When the Engineer directs that the paved flume installation or portions thereof be replaced, payment will be made at the unit prices bid for "Temporary Paved Flume (Remove)" and "Temporary Paved Flume (Install)." These prices are full compensation for the removal and replacement of the paved flume and for equipment, labor, tools, and incidentals.

Earthwork required for the paved flume installation, including construction of a sediment trap will be considered subsidiary to this item and will not be measured or paid for directly.

- E. **Construction Exits.** Contractor-required construction exits from off right-of-way locations or on-right of way PSLs will not be paid for directly but are subsidiary to pertinent Items.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" for construction exits needed on right-of-way access to work areas required by the Department will be paid for at the unit price bid for "Construction Exits (Install)" of the type specified or "Construction Exits (Remove)." This price is full compensation for furnishing and placing materials, excavating, removal and disposal, cleaning vehicles, labor, tools, and incidentals.

When the Engineer directs that a construction exit or portion thereof be removed and replaced, payment will be made at the unit prices bid for "Construction Exit (Remove)" and "Construction Exit (Install)" of the type specified. These prices are full compensation for the

removal and replacement of the construction exit and for equipment, labor, tools, and incidentals.

Construction of sediment traps used in conjunction with the construction exit will be considered subsidiary to this item and will not be measured or paid for directly.

- F. Earthwork for Erosion and Sediment Control.** The work performed and materials furnished in accordance with this Item will not be paid for directly but is subsidiary to pertinent Items unless otherwise shown on the plans.

Sprinkling and rolling required by this Item will not be paid for directly, but will be subsidiary to this Item.

- G. Construction Perimeter Fence.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Construction Perimeter Fence." This price is full compensation for furnishing and placing the fence; digging, fence posts, wire, and flagging; removal and disposal; and materials, equipment, labor, tools, and incidentals.

Removal of construction perimeter fence will be not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the perimeter fence installation or portions thereof be removed and replaced, payment will be made at the unit price bid for "Construction Perimeter Fence," which is full compensation for the removal and reinstallation of the construction perimeter fence.

- H. Sandbags for Erosion Control.** Sandbags will be paid for at the unit price bid for "Sandbags for Erosion Control" (of the height specified when measurement is by the foot). This price is full compensation for materials, placing sandbags, removal and disposal, equipment, labor, tools, and incidentals.

Removal of sandbags will not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the sandbag installation or portions thereof be replaced, payment will be made at the unit price bid for "Sandbags for Erosion Control," which is full compensation for the reinstallation of the sandbags.

- I. Temporary Sediment-Control Fence.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Sediment-Control Fence." This price is full compensation for furnishing and placing the fence; trenching, fence posts, fabric and backfill; removal and disposal; and equipment, labor, tools, and incidentals.

Removal of temporary sediment-control fence will not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the temporary sedimentation control fence installation or portions thereof be replaced, payment will be made at the unit price bid for "Temporary Sediment-Control Fence," which is full compensation for the removal and reinstallation of the temporary sediment-control fence.

- J. Curb Inlet Gravel Filter.** The work performed and the materials furnished as specified herein, measured as provided under "Measurement" will be paid for at the unit price bid per linear foot for "Curb Inlet Gravel Filter," which payment shall be full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the work as specified, including maintaining and replacing the gravel bags as required by these

specifications, removal of accumulated silt, and removal and proper disposal of the “Curb Inlet Gravel Filter” upon completion of site stabilization.

**540.7. BID ITEM:**

- Item 540.1 - Rock Filter Dams (Install/Remove) - per linear foot (Type \_)
- Item 540.2 - Rock Filter Dams (Install/Remove) - per cubic yard (Type \_)
- Item 540.3 - Temporary Pipe Slope Drains - per foot (\_ inches in diameter)
- Item 540.4 - Baled Hay - per bale
- Item 540.5 - Temporary Paved Flume (Install/Remove) - per square yard
- Item 540.6 - Construction Exits (Install/Remove) - per square yard
- Item 540.7 - Construction Perimeter Fence - per foot
- Item 540.8 - Sandbags for Erosion Control - per foot (\_ inches high)
- Item 540.9 - Temporary Sediment-Control Fence - per foot
- Item 540.10 - Curb Inlet Gravel Filters - per linear foot

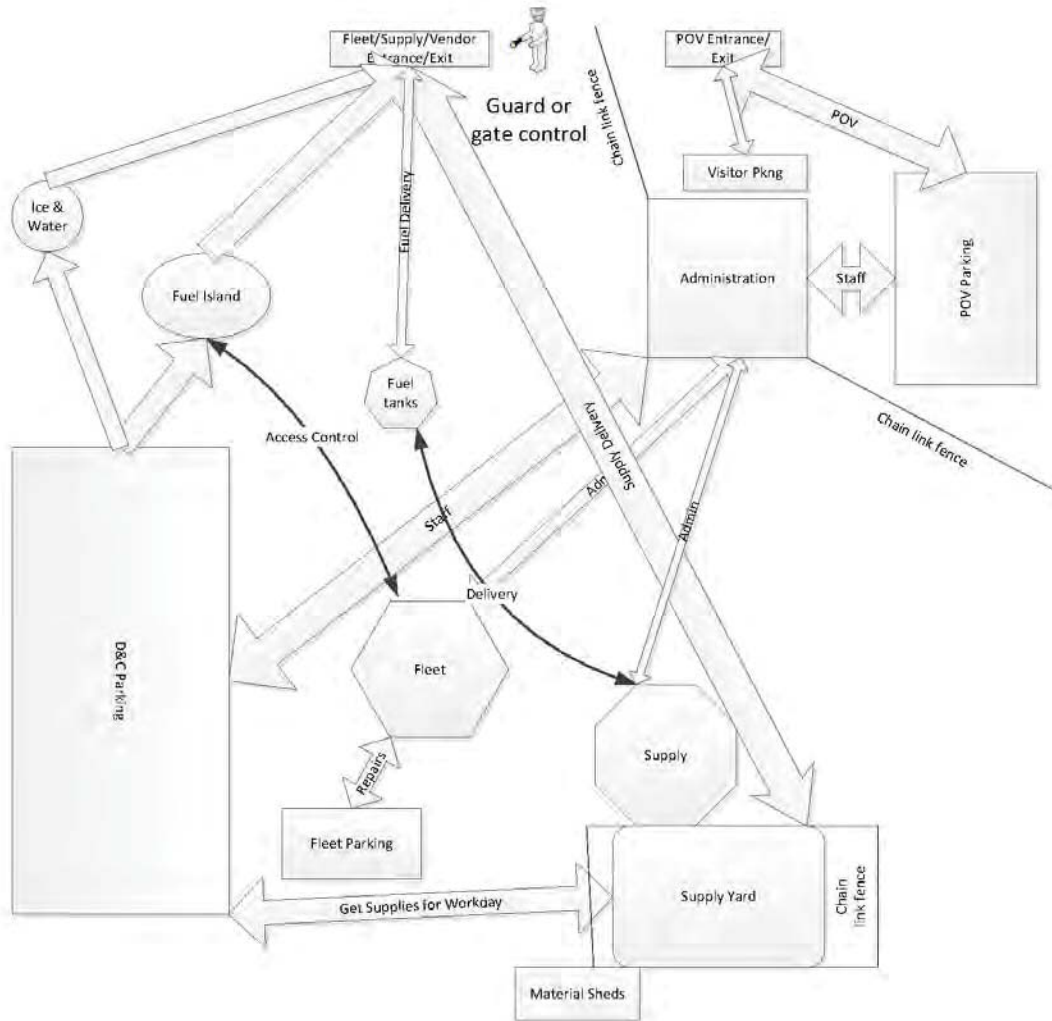
## IV SITE LAYOUT

- A. NORTHEAST OPERATIONS CENTER AERIAL IMAGE (NEW FACILITY)
- B. NORTHEAST OPERATIONS CENTER AFFINITY DIAGRAM (NEW FACILITY)
- C. NORTHEAST OPERATIONS CENTER BUBBLE DIAGRAM (NEW FACILITY)
- D. NACO PUMP STATION AERIAL IMAGE (EXISTING NESC SITE)

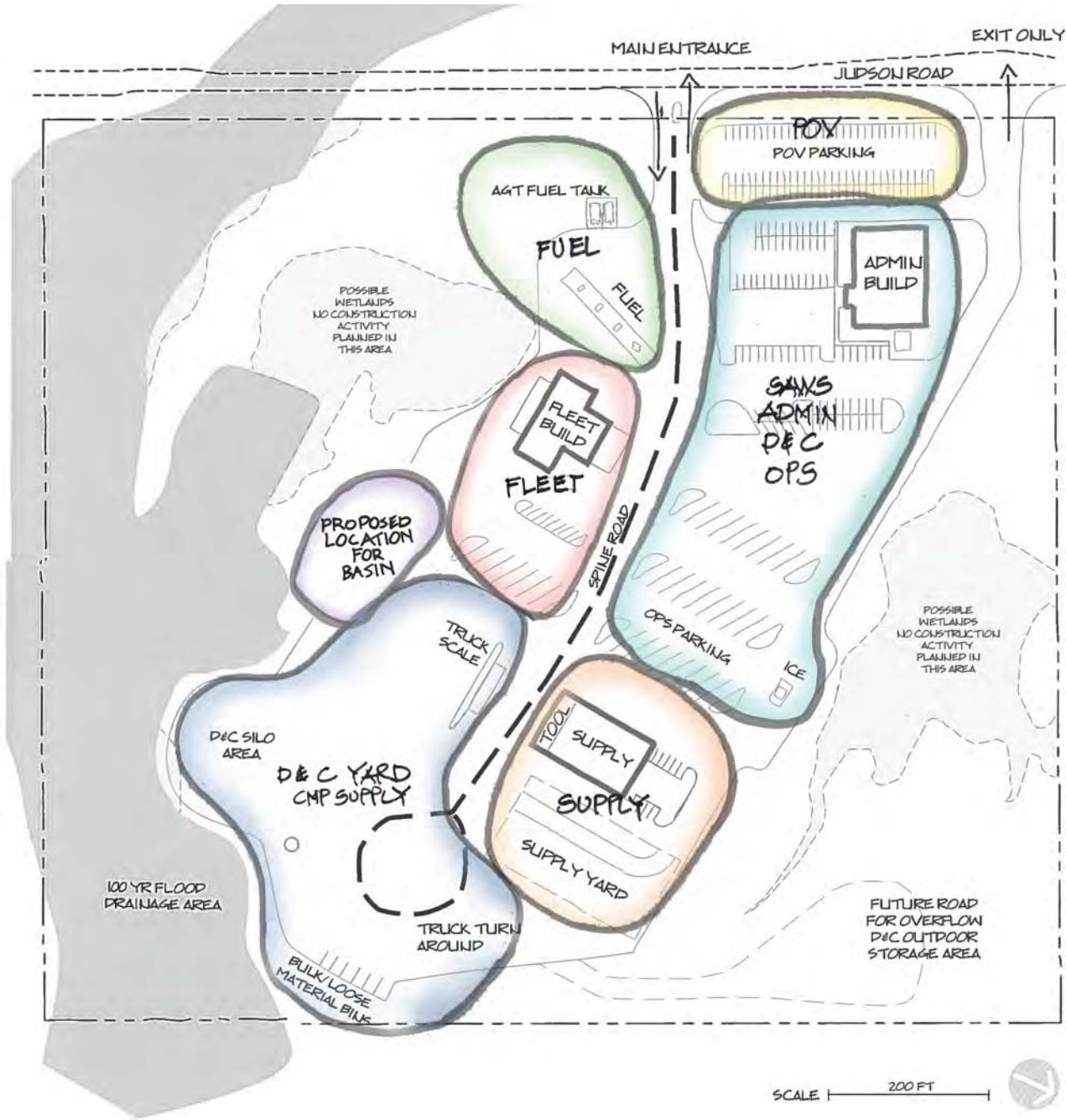
## NEOC - AERIAL VIEW OF SITE



NEOC – AFFINITY DIAGRAM

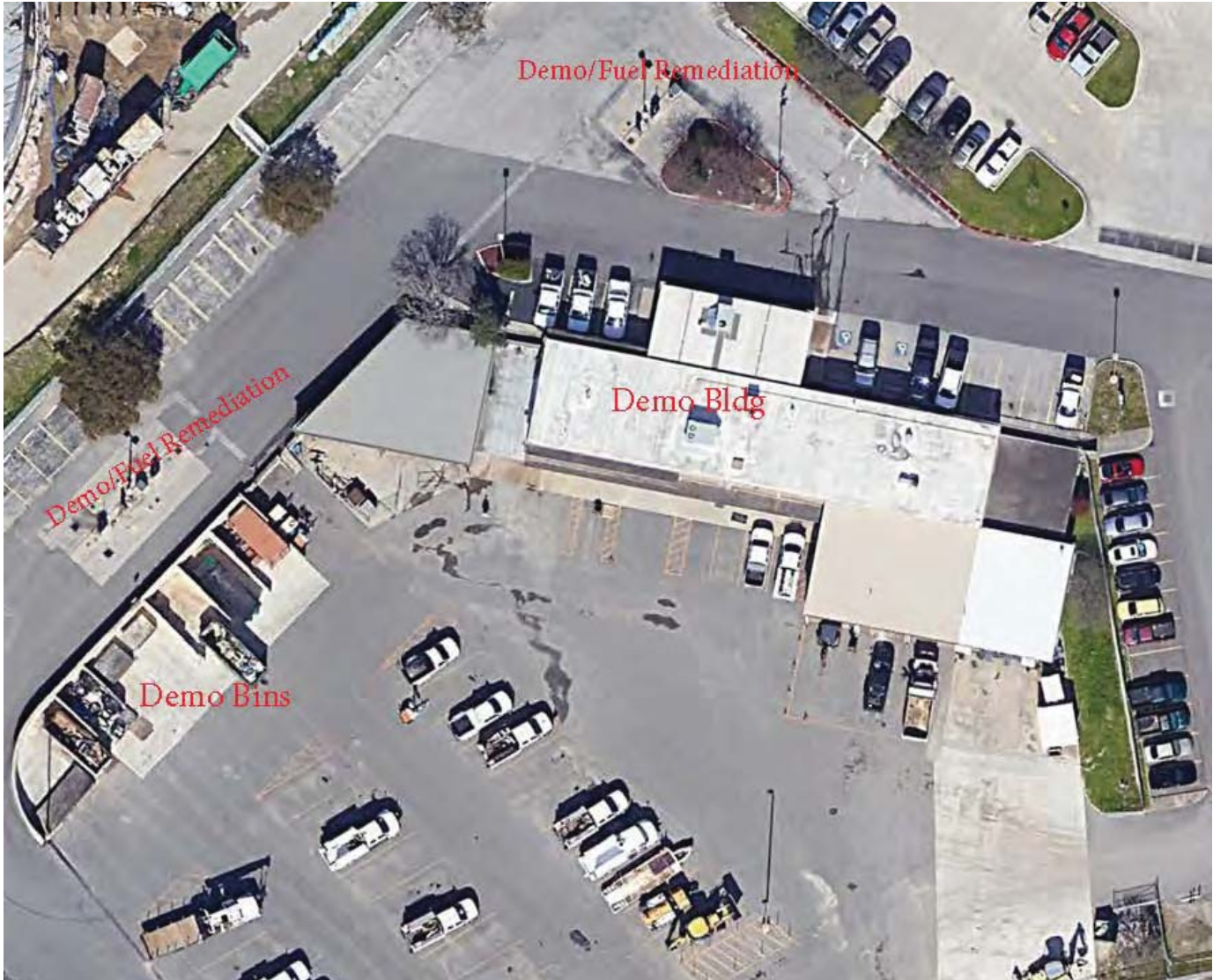


### NEOC – BUBBLE DIAGRAM



The DB firm is free to arrange the buildings, drives, and site features subject to review meetings and Approval by SAWS and change the building massing or flow patterns as per their professional practice. Any deviations shall be done with consideration and with adherence to the adjacencies as represented on this bubble diagram. However, the Operations Center must stay within the Approved scope, Project Schedule, and GMP. SAWS will not allow an overrun of the GMP, in accordance with the Design-Build Services Agreement.

## NACO PUMP STATION (NESC) AERIAL IMAGE





## V. BUDGET LIMIT

SAWS has established a budget limit range of \$27,500,000 to \$29,200,000 for this project.

## VI. SUPPORTING DATA

### A. NEOC PROGRAM OF SPACES

**SAWS Operation Center - NEOC Administration Building Program of Spaces**

Department/Space	Room Code	No. Rms	Assigned Square Footage
<b>ADMIN BUILDING - NEW BUILDING</b>			
<b>SHARED SPACES</b>			<b>Orig</b>
Vestibule/Lobby	A-01	1	280
Large Mutli-Purpose Room A/B 90 Persons	A-02	1	1,786
Furniture/AV Equip Storage	A-03	1	237
Small Multipurpose Room - 16 Persons	A-04	1	224
Crew Quarters	A-05	1	577
Food Service - Located in Breakroom	A-06	1	-
Food Service Storage	A-07	1	52
Breakroom/Vending	A-08	1	567
Restrooms	A-09	2	782
Fitness Room	A-10	1	244
Work Room	A-11	2	71
Work Counter - Niche in Corridor	A-12	1	45
Kronos Niche - in Corridors	A-13	2	-
Storage	A-14	1	92
Lockers - In Corridors	A-15	-	-
Laptop Storage - in Foreman's Rooms.	A-16	-	-
<b>Shared Space Subtotal</b>			<b>4,957</b>
<b>D&amp;C/CMP DEPARTMENTS</b>			
<b>D&amp;C Dept.</b>			
D&C Directors Flex Office	A-17	1	209
D&C Manager Office	A-18	2	462
D&C Superintendent Offices	A-19	7	823
D&C Foreman's Room	A-20	1	377
D&C Admin Station (Cubicle)	A-21	1	81
<b>D&amp;C Crew Subtotal</b>			<b>1,952</b>
<b>CMP Dept.</b>			
CMP Superintendent Offices	A-22	2	226
CMP Foreman's Room	A-23	1	250
CMP Admin Station (Cubicle)	A-24	1	81
<b>CMP Crew Subtotal</b>			<b>557</b>
<b>Flex Office</b>			
Flex Office	A-25	1	109
<b>Flex Office Subtotal</b>			<b>109</b>
<b>TOTAL D&amp;C/CMP ASF</b>			<b>7,574</b>
<b>Building Support Spaces</b>			
MDF Room	A-26	1	97
Electrical Room	A-27	1	80
Mechanical Room	A-28	1	226
Janitor Closet	A-29	1	14
Janitor Office	A-30	1	80
Fire Riser Room	A-31	1	47
Circulation			1,596
<b>Building Support Spaces Subtotal</b>			<b>2,140</b>
<b>SAWS Admin Building Total ASF</b>			<b>9,714</b>
<b>SAWS Admin Bldg. Total GSF Per Floor Plan</b>			<b>10,640</b>

## SAWS Operation Center - NEOC Supply Building Program of Spaces

Department/Space	Room Code	No. Rms	Assigned Square Footage
<b>SUPPLY BUILDING - NEW BUILDING</b>			
<b>Warehouse</b>			
Receiving	S-01	1	393
Warehouse	S-02	1	2438
Storage - Conditioned Space	S-03	1	136
<b>Warehouse Subtotal</b>			<b>2967</b>
<b>Supply Administrative Office Areas</b>			
Service Counter	S-04	1	114
Work Stations/Break Room	S-05	1	333
<b>Warehouse Administrative Subtotal</b>			<b>447</b>
<b>Supply Building Support</b>			
Kitchenette Niche in Corridor	S-06	1	33
Janitor Closet	S-07	1	39
Toilets	S-08	2	96
MDF	S-09	1	52
Fire Riser Room	S-10	1	30
Electrical	S-11	1	52
Circulation			244
<b>Supply Building Support Subtotal</b>			<b>546</b>
<b>D &amp; C Tool Room</b>			
Tool Room (Including caged vestibule)	S-12	1	1138
Tool Workroom/Office	S-13	1	328
Covered Outdoor Yard	S-14	1	-
<b>D&amp;C Tool Room Subtotal</b>			<b>1,466</b>
25,000 SF Fenced Outdoor Supply Yard w/Vehicle/Man Gates		-	-
<b>SAWS Supply Bldg. Total ASF</b>			<b>5,426</b>
<b>SAWS Supply Bldg. Total GSF per Floor Plan</b>			<b>6,088</b>

## SAWS Operation Center - NEOC Fleet Building Program of Spaces

Department/Space	Room Code	No. Rms	Assigned Square Footage
<b>FLEET BUILDING - NEW BUILDING</b>			
<b>Service Bay</b>			
Large Vehicle Size Service Bay (2 stall per bay)	F-01	2	3,786
Supply	F-02	1	698
Battery Storage	F-03	1	85
Tool Storage	F-04	1	102
<b>Service Bay Subtotal</b>			<b>4,671</b>
<b>Fleet Administrative Office Areas</b>			
Drop Off lobby	F-05	1	130
Manager Office	F-06	1	145
Workstations/Break/Kitchenette	F-07	1	491
<b>Fleet Administrative Subtotal</b>			<b>766</b>
<b>Fleet Building Support Spaces</b>			
Lockers	F-08	-	-
Toilet Rooms	F-09	2	212
Janitor Closet	F-10	1	30
Outdoor Yard	F-11	1	-
Wash Bay	F-12	1	-
Wash Equipment Room	F-13	1	22
Inspection Room	F-14	1	11
MDF Room	F-15	1	59
Fire Riser Room	F-16	1	33
Electrical Room	F-17	1	53
Circulation	-	-	282
<b>Fleet Building Support Spaces Subtotal</b>			<b>702</b>
<b>SAWS Fleet Building Total ASF</b>			<b>6,139</b>
<b>SAWS Fleet Bldg. Total GSF per Floor Plan</b>			<b>6,862</b>
<b>MISCELLANEOUS NEOC SITE</b>			
Fuel - Covered Fuel Island		1	-
Diesel - Above Ground Storage Tank		1	-
Gasoline - Above Ground Storage Tank		1	-
Water Fill Dispenser Reels		1	-
Grease Dispenser Reels		1	-
Air Dispenser Reels		1	-
DEF Tank/Dispenser		1	-
Access Control Gates - Chain Link 6ft high		2	-
Ice/Water Station - CMU Wall, Metal Canopy, Sink		1	-
Dumpster Pads		2	-
Bulk Bins 15ft wide x 18ft deep, plus 20 wide concrete apron		6	-
Bulk Bins 30ft wide x 18ft deep, plus 20 wide concrete apron		2	-
Recycle Bin Pads		5	-
Truck Scale		1	-
<b>NEOC NEW BUILDING STRATEGY</b>			
<b>ADMIN BUILDING - GSF</b>			<b>10,640</b>
<b>SUPPLY BUILDING - GSF</b>			<b>6,088</b>
<b>FLEET BUILDING - GSF</b>			<b>6,862</b>
<b>NEOC TOTAL NEW BUILDING GSF</b>			<b>23,590</b>



B. NEOC ROOM DATA SHEETS



# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	LOBBY	A - 01

## ROOM DESCRIPTION

This space is the main entry to the building and also serves as the control point where public could arrive. The lobby should be adjacent to a staff space where there is visual access to monitor entry doors.

## ROOM DATA

Number of Occupants NA

## ROOM ENTRY

Double Door See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	<u>Polished Concrete</u>
Base	<u>4" Rubber Base</u>
Walls	<u>Ptd Gyp Bd/Wood - See Note 3</u>
Ceiling	<u>See Note 4</u>
Ceiling Height	<u>12" - 0" Min.</u>
Remarks	<u>Chair Rail/Corner Guards Typ</u>

### MECHANICAL / PLUMBING

HVAC	<u>72 Degrees / 50% RH</u>
Air Changes	<u>Min per Code</u>

### ELECTRICAL

Power	<u>Duplex 110v - See Note 2</u>
Lighting	<u>See Note 5</u>

### COMMUNICATIONS

Wi-Fi Coverage

### FIXED EQUIPMENT

1 Building Directory	<u>OFOI</u>
1 Walk Off Mat	<u>CFCI</u>
1 Exterior Bldg Plaque	<u>CFCI</u>

### MOVEABLE / FFE

.....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....

## NOTES

- 1 Provide pair of 3ft x 7ft glass entry doors with access control. A vestibule should be provided w/ cover or recess in building. Access to comply with ADA/TDLR requirements also provide push button HC door controls to control both sets of automatic doors from same control button. Exterior side of vestibule doors to have intercom system with surveillance camera .
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals. Power/data to be coordinated with systems furniture.
- 3 Walls at doors to be storefront. Accent wall in Lobby, behind Admin Stations, to have 3'x7' wood veneer door panels and SAWS logo/signage to match Phase I theme.
- 4 Gyp Bd at Vestibule, slopped ceiling w/metal soffit panel at Lobby
- 5 Light fixtures to be cable suspended pendants in Vestibule and Lobby.

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	LARGE MULTI-PURPOSE ROOM	A - 02

## ROOM DESCRIPTION

The Large Multi-Purpose room will serve as training room spaces. A folding wall which will be able to subdivide the room to allow for different configurations and uses. It will also open up to the adjacent Crew quarters for all hands meetings

## ROOM DATA

Number of Occupants ..... 90 Persons

## ROOM ENTRY

Exterior Door ..... See Note 1  
 Interior Door w/View Planal ..... See Note 2

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Polished Concrete
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Susp Lay-In/Gyp Bd Soffit
Ceiling Height	12'-0"
Remarks	Provide chair rail/corner guards typ.

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

### ELECTRICAL

Power	See Notes 3, 4, & 5
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	See Notes 3, 4, & 5
Phone	VOIP - OFOI
Ceiling Speakers	w/ sound reinforcement

### FIXED EQUIPMENT

2 Dry Erase Boards	8' x 4' - Located behind screens - CFCI
1 Folding Wall	CFCI - See Note 8
2 Ceiling Proj. Screen	CFCI - See Note 5
2 Ceiling Projector	OFOI - See Note 3

### MOVEABLE / FFE

90 Chairs	OFOI
45 Tables -24" x 60"	OFOI
2 Podiums	OFOI

## NOTES

- 1 Provide exterior 3ft x 7ft door for emergency exit access only w/push bar and local alarm. No access from the exterior.
- 2 Provide 3ft x 7ft door with keyed lock and view panel
- 3 Convenience duplex outlets are to be provided along perimeter wall at regular intervals.
- 4 Provide ceiling mounted brackets, power, and data. Projector will be OFOI. Tie into A/V system. Coordinate exact location w/screen and Owner.
- 5 Provide metal combo floor boxes, flush w/finish floor for power and data. Tie into A/V system. A/V system touch screen Creston control panel to be mounted on wall behind screens.
- 6 Provide recessed, ceiling mounted, electric powered projector screens sized for space and coordinated w/Owner FF&E.
- 7 Provide roller shades at all windows.
- 8 Operable panel partition to have wood veneer finish similar to the SAWS NSOC facility.



# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	FURNITURE STORAGE	A - 03

## ROOM DESCRIPTION

The Furniture storage room will contain bulk storage of tables, chairs, podium, portable marker boards to allow for different seating configurations of Multi-Purpose rooms and Crew Quarters.

## ROOM DATA

Number of Occupants ..... NA

## ROOM ENTRY

Double Door ..... See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Polished Concrete
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Open to Painted Structure
Ceiling Height	Open to Structure
Remarks	

## NOTES

- 1 Provide pair of 3ft x 7ft doors with keyed lock.
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals.
- 3 A/V equipment rack for Multi-Purpose Room and crew Quarters shall be located in this room. Rack shall be wall mounted. Specifications by DPOR.

## MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

## ELECTRICAL

Power	Duplex 110v - See Note 2
Lighting	General Room Lighting - LED

## COMMUNICATIONS

Data ..... On opposite walls and at AV Rack - See Note 3

## FIXED EQUIPMENT

AV Rack and Equip ..... CFCI

## MOVEABLE / FFE

Cart for Chairs ..... OFOI

Shelving ..... OFOI

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	SMALL MULTI-PURPOSE	A - 04

## ROOM DESCRIPTION

This room will serve as conference space and provide teleconferencing capabilities.

## ROOM DATA

Number of Occupants ..... 16 Persons

## ROOM ENTRY

Single Door ..... See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Carpet Tile
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Susp Lay-In
Ceiling Height	12' - 0"
Remarks	

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

### ELECTRICAL

Power	See Notes 2, 3, 4, & 5
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	Dual Port - See Note 3, 4, & 5
Phone	VOIP - OFOI
1 Flat Panel Display	OFOI - See Notes 3, 4, & 5

### FIXED EQUIPMENT

1 Marker Board	4ft x 8ft - CFCI
----------------	------------------

### MOVEABLE / FFE

16 Chairs	OFOI
1 Conf Table 3ft x 10ft	OFOI See Note 6

## NOTES

- 1 Provide 3ft x 7ft door with passage lock and 2' sidelite.
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals.
- 3 Provide wall outlet for wall mounted Flat Panel Display.
- 4 Provide combo floor box for power and data. Tie into A/V system and OFOI conference table.
- 5 Wall and floor boxes to have 110v, HDMI, VGA, USB, and data
- 6 "Pop Up" cable cubby to be CFCI in Owner provided conference table.

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	CREW QUARTERS	A - 05

## ROOM DESCRIPTION

The Crew Quarters is the main gathering space in mornings and allows for crew to review tasks for the day at workstations along perimeter of the room. Folding wall which will be able to separate this room from the adjacent Multi-Purpose Room.

## ROOM DATA

Number of Occupants ..... 42 Persons

## ROOM ENTRY

Single Doors ..... See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Polished Concrete
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Susp Lay-In/Gyp Bd Soffits
Ceiling Height	12' - 0"
Remarks	Provide chair rail/corner guards typ.

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

### ELECTRICAL

Power	Duplex 110v-See Note 2, 3, 4, & 6
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	See Notes 4 & 6
Phone	See Note 4
Ceiling Speakers	w/ sound reinforcement
1 Flat Panel Displays	OFOI - See Note 5

### FIXED EQUIPMENT

1 Dry Erase Board	48" x 36" - CFCI
1 Folding Wall	CFCI - See Note 7

### MOVEABLE / FFE

Tables	OFOI
Chairs	OFOI
1 Printer Station	OFOI

## NOTES

- 1 Provide 3ft x 7ft door with keyed lock from corridor. Provide exterior 3ft x 7ft door with access controls. Both doors to have view panel.
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals.
- 3 Workstations require one 110v duplex outlet per two stations coordinated w/Owner's systems furniture and FF&E plans.
- 4 Workstations require one duplex data/phone connection per two stations coordinated w/Owner's systems furniture and FF&E plans.
- 5 Provide power/data/VGA/HDMI/USB/Data for wall mounted Flat Panel Display, coordinate locations.
- 6 Provide heavy duty (no plastic) combo floor boxes for power and data. Tie into A/V system.
- 7 Operable panel partition to have wood veneer finish similar to the SAWS NSOC facility.

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	FOOD SERVICE	A - 06

## ROOM DESCRIPTION

The Food Service area will allow for pre-prepared food items to be served.

## ROOM DATA

Number of Occupants

N/A

## ROOM ENTRY

See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Polished Concrete
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Susp Lay-In Vinyl Faced/Gyp Bd Soffit - See Note 1
Ceiling Height	9' - 0"
Remarks	

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code
Plumbing	See Note 3
Floor Drain	

### ELECTRICAL

Power	Duplex 110v - See Note 2
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	See Note 2
Phone	VOIP - OFOI

### FIXED EQUIPMENT

1 2 Compartment Sink	CFCI
1 Disposal	CFCI
Base/Wall Cabinets	CFCI - See Note 3
1 Ice Maker	CFCI
1 Dishwasher	CFCI

### MOVEABLE / FFE

1 Refrigerator/Freezer	OFOI - See Note 4
1 Microwave	OFOI
1 Coffee Maker	OFOI - See Note 4

## NOTES

- 1 Room to be open directly to Breakroom. Change in ceiling height between the two rooms with a gyp. Bd. Soffit separation. Soffit to follow line of counter below.
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals. Convenience outlets along counter backsplash to occur at 4'-0 O.C.
- 3 Provide base cabinets (drawers and doors) and wall cabinets (doors w/ locks and adj shelves). Counter at wall to have single compartment, undermount, sink with hot and cold water. "L" shaped counter separating Food Service from the Breakroom to be 42" tall. Counter tops to be solid surface material. Include wall shelf for microwave.
- 4 Water supply to be CFCI. Locations to be coordinated with OFOI equipment.

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	FOOD SERVICE-DRY STORAGE	A - 07

## ROOM DESCRIPTION

The Dry Storage room shall be located adjacent to Food Service area and serve as a secure support space for supplies.

## ROOM DATA

Number of Occupants ..... NA

## ROOM ENTRY

Single Door ..... See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Sealed Concrete
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Susp Lay-In Vinyl Faced
Ceiling Height	9' - 0"
Remarks	

## NOTES

- 1 Provide 3ft x 7ft door with keyed lock.
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals.
- 3 24" deep, adjustable shelves, full height to 7' continuous on three walls.

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code
Plumbing Fixtures	

### ELECTRICAL

Power	Duplex 110v - See Note 2
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	See Note 2

### FIXED EQUIPMENT

Shelving	CFCI - See Note 3

### MOVEABLE / FFE


# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	BREAKROOM/VENDING	A - 08

## ROOM DESCRIPTION

The Breakroom shall be located adjacent to the Crew Quarters. There shall be an alcove for vending machines.

## ROOM DATA

Number of Occupants ..... 25

## ROOM ENTRY

Cased Opening ..... See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor ..... Polished Concrete  
 Base ..... 4" Rubber Base  
 Walls ..... Ptd Gyp Bd/Tile - See Notes 4 & 5  
 Ceiling ..... Susp Lay-In/Gyp Bd Soffit  
 Ceiling Height ..... 12' - 0"  
 Remarks .....

## NOTES

- 1 Provide 6ft x 7ft cased opening.
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals.
- 3 Provide power/data/video/in-wall bracing for wall mounted TV, coordinate locations.
- 4 Coordinate power with Owner's Vending Machine Vendor and size of alcove for Vending Machines and OFOI trash receptacles.
- 5 Coordinate wall space to allow for OFOI Bulletin Board, First Aid Kit, and Defibrillator.

### MECHANICAL / PLUMBING

HVAC ..... 72 Degrees / 50% RH  
 Air Changes ..... Min per Code  
 Plumbing .....

### ELECTRICAL

Power ..... See Notes 2, 3, & 4  
 Lighting ..... General Room Lighting - LED

### COMMUNICATIONS

Data ..... See Notes 2 & 3  
 Video ..... See Notes 2 & 3

### FIXED EQUIPMENT

1 Sink ..... CFCI - See Note 6 & 7  
 1 Disposal ..... CFCI  
 Base/Wall Cabinets ..... CFCI - See Note 6 & 7

### MOVEABLE / FFE

6 Tables ..... OFOI  
 28 Chairs ..... OFOI  
 1 TV ..... OFOI - See note 3  
 Vending Machines ..... OFOI - See note 4

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	RESTROOMS	A - 09

## ROOM DESCRIPTION

The restrooms will support the Administration Building's staff. Men's and Women's per Code.

## ROOM DATA

Number of Occupants  
 .....  
 Fixture count per Owners staff count  
 .....

## ROOM ENTRY

3ft x 7ft door interior  
 Push Plate with Keyed Bolt Above

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor Ceramic Tile - See Note 6  
 .....  
 Base Coved Tile  
 .....  
 Walls See Note 4  
 .....  
 Ceiling Painted gyp bd/soffit (at LAV)  
 .....  
 Ceiling Height 9ft  
 .....  
 Remarks See Note 3  
 .....

### MECHANICAL / PLUMBING

HVAC 72 Degrees / 50% RH  
 .....  
 Air Changes Min per Code  
 .....  
 Plumbing Fixtures See Notes 7 & 8  
 .....  
 Floor Drain With a trap primer - Note 6  
 .....  
 Lavatory Hot and Cold Water  
 .....  
 Hose Bibb For maintenance  
 .....

### ELECTRICAL

Power 110v convenience outlets  
 .....  
 See Note 2  
 .....  
 Lighting LED fixtures/Wall Scones  
 .....  
 Sealed fixture at showers  
 .....

### COMMUNICATIONS

Data NA  
 .....

### FIXED EQUIPMENT

Signage CFCI - See Note 11  
 .....  
 Shelf CFCI - See Note 10  
 .....  
 Toilet Accessories CFCI  
 .....  
 Mirror CFCI  
 .....  
 Countertop CFCI - Solid Surface  
 .....  
 Changing Benches CFCI - Wood Finish  
 .....  
 Toilet Partitions CFCI - Solid Surface  
 .....  
 Lockers CFCI - See Note 12  
 .....

### MOVEABLE / FFE

Shower Curtain CFCI  
 .....  
 Bench CFCI  
 .....

## NOTES

- The toilet room area will include roll-in showers and changing areas. Access to be off main circulation corridor near Training and Admin spaces. Toilet accessories to be per SAWS spec and be recessed.
- GFI Convenience duplex outlets are to be provided at counter and regular intervals for maintenance.
- Toilet/Lockers and Shower rooms are to be ADA compliant.
- Tile Wainscot 4ft aff and painted CMU above. At wet walls, shower and changing areas tile is to be full height. Ceiling at shower to be tile.
- Slope floor to drains at showers and in front of LAVs/Urinals
- All sinks to be undermount. Toilets to be wall mount capable to support 300#. All fixtures to be vitreous china.
- Shower stall shall be ADA "roll in" six so fold down bench is not required. Shower heads to be stainless steel and adjustable.
- Accent walls/soffit at LAVS. Paint with accent color.
- Built-in solid surface shelf to match countertops. 6" min wide.
- 
- Provide single tier lockers w/sloped top, 7 in Men's/5 in Women's. 12"Wx18"Dx66"H. Locker shall be secured with a recessed hasp with a resettable combination lock and master key.

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	FITNESS ROOM	A - 10

## ROOM DESCRIPTION

The Fitness Room will provide a space for fitness equipment and exercising. Located on the first floor.

## ROOM DATA

Number of Occupants ..... NA

## ROOM ENTRY

Single Door ..... See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Carpet Tile
Base	Carpet Tile
Walls	Ptd Gyp Bd - See Note 3
Ceiling	Susp Lay-In
Ceiling Height	12' - 0"
Remarks	Provide impact resistant wainscot and corner guards.

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH See Note 4
Air Changes	Min per Code
Plumbing	Drinking Fountains

### ELECTRICAL

Power	Duplex 110v - See Notes 2, 6, & 7
Lighting	General Room Lighting - LED

### COMMUNICATIONS

1 Data	See Notes 2 and 7
	VOIP - OFOI

### FIXED EQUIPMENT

Mirrors	See Note 5
---------	------------

### MOVEABLE / FFE

Fitness Equipment	OFOI
TV	OFOI - See Note 7

## NOTES

- 1 Provide a 3ft x 7ft door with vision panel.
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals and one data/power outlet at exercise stations.
- 3 Walls to deck and are to be soundproof.
- 4 Ensure HVAC is adequate for the intended use of this space and there is direct exhaust to the exterior.
- 5 Full height fixed mirrors on a least one wall.
- 6 J-box for future ceiling fan.
- 7 Provide power/data/cable TV/in-wall bracing for OFOI TV. Coordinate location w/Owner.



# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	WORKROOM /COPY CENTER	A - 11

## ROOM DESCRIPTION

Workroom will serve as copy center for the offices.

## ROOM DATA

Number of Occupants

NA

## ROOM ENTRY

Open to Corridor

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Polished Concrete
Base	4" Rubber Base
Walls	Ptd Gyp Bd - See Note 5
Ceiling	Susp Lay-In
Ceiling Height	10'- 0"
Remarks	

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

### ELECTRICAL

Power	Duplex 110v-See Note 1, 2, & 3
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	See Note 3

### FIXED EQUIPMENT

Base/Wall Cabinets	CFCI - See Note 4
1 Tack Board	36" x 48" - CFCI

### MOVEABLE / FFE

Copier	OFOI
Printers	OFOI
TBD	OFOI

## NOTES

- 1 Convenience duplex outlets are to be provided along perimeter wall at regular intervals.
- 2 Convenience outlets along counter backsplash to occur at 4'-0 O.C.
- 3 Provide Data outlets along counter backsplash for printers. One dedicated power/data receptacle to be for the copy machine.
- 4 Provide base cabinets (drawers and doors) and wall cabinets (with adj shelves). Countertops and backsplash to be solid surface material.

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	WORK COUNTER	A - 12

## ROOM DESCRIPTION

There shall be a Work Counter niche, recessed at least 4', located in the corridor, next to the MDF Room.

## ROOM DATA

Number of Occupants NA

## ROOM ENTRY

Open to Corridor

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor Same as surrounding area.  
 Base Same as surrounding area.  
 Walls Same as surrounding area.  
 Ceiling Same as surrounding area.  
 Ceiling Height Same as surrounding area.  
 Remarks

### MECHANICAL / PLUMBING

HVAC Same as surrounding area.  
 Air Changes Same as surrounding area.

### ELECTRICAL

Power Duplex 110v-See Notes 1, 2, & 3  
 Lighting Same as surrounding area.

### COMMUNICATIONS

Data See Note 2  
 Phone

### FIXED EQUIPMENT

### MOVEABLE / FFE

Copier OFOI - See Notes 3 & 5  
 Printers OFOI - See Notes 3 & 5  
 Plotter OFOI - See Notes 3 & 5

## NOTES

- 1 Convenience duplex outlets are to be provided along perimeter wall at regular intervals.
- 2 Convenience outlets along countertop backsplash to occur at 4'-0 O.C.
- 3 Provide 2 duplex Data outlets along counter backsplash for printers. Provide 2 duplex dedicated Power/Data outlets at wall for copier/plotter.
- 4 Provide base cabinets (lockable drawers and doors) and wall cabinets (lockable doors and adj shelves). Countertops and backsplash to be solid surface material, min. 6' L.
- 5 Coordinate room size/layout with Equipment. Plotter requires 60" W and 48" D min and copier 48" W and 36" D min.

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	KRONOS Niche	A - 13

## ROOM DESCRIPTION

There shall be two Kronos Clock Niches, recessed at least 2', located in the corridors, near the Lobby and exit adjacent to the Fire Riser Room.

## ROOM DATA

Number of Occupants ..... NA .....

## ROOM ENTRY

Open to Corridor .....

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor ..... Same as surrounding area.  
 Base ..... Same as surrounding area.  
 Walls ..... Same as surrounding area.  
 Ceiling ..... Same as surrounding area.  
 Ceiling Height ..... Same as surrounding area.  
 Remarks .....

## NOTES

- 1 Provide power/data for OFOI Kronos Clock. Coordinate mounting height/in-wall backing with Owner.
- 2 Provide power/data for OFOI Flat Panel Display. Coordinate mounting height/in-wall backing with Owner.

### MECHANICAL / PLUMBING

HVAC ..... Same as surrounding area.  
 Air Changes ..... Same as surrounding area.

### ELECTRICAL

Power ..... Notes 1 & 2 .....

Lighting ..... Same as surrounding area. ....

### COMMUNICATIONS

Data ..... See Note 1 & 2 .....

Phone .....

### FIXED EQUIPMENT

Kronos Clock ..... OFOI - See Notes 1 & 2 .....

Flat Panel Display ..... OFOI - See Notes 1 & 2 .....

### MOVEABLE / FFE

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# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	ADMIN STORAGE	A - 14

## ROOM DESCRIPTION

The storage room will serve as a secure area for supplies within the Administration suite.

## ROOM DATA

Number of Occupants ..... NA .....

## ROOM ENTRY

Single Door ..... See Note 1 .....

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Sealed Concrete .....
Base	4" Rubber Base .....
Walls	Ptd Gyp Bd .....
Ceiling	Susp Lay-In .....
Ceiling Height	8' - 0" min .....
Remarks	.....

## NOTES

- 1 Provide 3ft x 7ft door with keyed lock.
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals.
- 3 18" deep, adjustable shelves, full height to 7' continuous on three walls.

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH .....
Air Changes	Min per Code .....

### ELECTRICAL

Power	Duplex 110v - See Note 2 .....
Lighting	General Room Lighting - LED .....

### COMMUNICATIONS

Data	See Note 2 .....
------	------------------

### FIXED EQUIPMENT

Shelving	CFCl - See Note 3 .....
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### MOVEABLE / FFE

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# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	LOCKERS	A - 15

## ROOM DESCRIPTION

Lockers will be for storage of employees personal items. The lockers may be located along corridor walls recessed into walls w/soffit above.

## ROOM DATA

Number of Occupants ..... NA

## ROOM ENTRY

Corridor .....

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor .....  
 Base .....  
 Walls .....  
 Ceiling .....  
 Ceiling Height .....  
 Remarks .....

### MECHANICAL / PLUMBING

HVAC .....  
 Air Changes .....

### ELECTRICAL

Power .....  
 Lighting .....

### COMMUNICATIONS

Data .....  
 .....  
 .....

### FIXED EQUIPMENT

Lockers CFCI - See Notes 1, 2, & 3 .....  
 .....

### MOVEABLE / FFE

.....  
 .....  
 .....  
 .....

## NOTES

- 1 Provide 60 vented double tier metal lockers. Size to be 12'W x 18"D x 66" H. Locker shall be secured with a recessed hasp to receive Owner provided padlock.
- 2 Lockers shall be set into corridor walls, min 1 1/2" recess from front of locker to wall. 8" locker bases. Top of locker shall be 6'-2" AFF.
- 3 All lockers to have shelves, coordinate height w/Owner, and coat hook.

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C/CMP	LAPTOP STORAGE	A - 16

## ROOM DESCRIPTION

Locker storage for laptops will allow for overnight charging and a secure place for employees to leave their laptop overnight. Laptop Lockers shall be included both the D&C and CMP Foreman Rooms and be recessed into walls w/soffit above

## ROOM DATA

Number of Occupants

NA

## ROOM ENTRY

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor .....  
 Base .....  
 Walls .....  
 Ceiling .....  
 Ceiling Height .....  
 Remarks .....

## NOTES

- 1 Provide 15 double tier large metal vented lockers. Size to be 15"W x 18"D x 66" H with an intermediate shelf. Locker shall be secured with a recessed hasp to receive Owner provided padlock.
- 2 Each locker is to have power and data receptacle for overnight charging

### MECHANICAL / PLUMBING

HVAC .....  
 Air Changes .....

### ELECTRICAL

Power See Note 2 .....  
 Lighting .....

### COMMUNICATIONS

Data See Note 2 .....  
 .....  
 .....

### FIXED EQUIPMENT

Lockers CFCI - see Note 1 .....  
 .....

### MOVEABLE / FFE

.....  
 .....  
 .....  
 .....

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	DIRECTOR OFFICE	A - 17

## ROOM DESCRIPTION

There shall be one Director's Office. A window with view to exterior is required.

## ROOM DATA

Number of Occupants ..... 2 Persons

## ROOM ENTRY

Single Door ..... See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Carpet Tile
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Susp Lay-In
Ceiling Height	10 - 0"
Remarks	

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

### ELECTRICAL

Power	Duplex 110v - See Note 2 & 4
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	See Note 2 & 4
Phone	VOIP - OFOI

### FIXED EQUIPMENT

1 Dry Erase Board	48" x 36" - CFCI - See Note 3
1 Tack Board	48" x 36" - CFCI - See Note 3

### MOVEABLE / FFE

1 Exec Desk Chair	OFOI - See Note 4
1 Lateral File	OFOI
2 Side Chair	OFOI
1 Bookshelf	OFOI
1 Credenza	OFOI
1 Round Table	OFOI

## NOTES

- 1 Provide 3ft x 7ft door with keyed lock with vision lite and 2' sidelight .
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals. Provide one quad outlet adjacent to each data outlet. Coordinate with furniture layout.
- 3 In-wall bracing for CFCI dry erase and tack boards.
- 4 All OFOI furniture in this office is freestanding (not a modular furniture system). Perimeter data/power to be coordinated w/Owner prior to construction.
- 5 Coat hook on back of door.

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	MANAGER OFFICE	A - 18

## ROOM DESCRIPTION

There shall be two Manager Offices. A window with view to exterior is required. Office width to be a minimum of 10'.

## ROOM DATA

Number of Occupants ..... 2 Persons

## ROOM ENTRY

Single Door ..... See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Carpet Tile
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Susp Lay-In
Ceiling Height	10 - 0"
Remarks	

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

### ELECTRICAL

Power	Duplex 110v - See Note 2 & 4
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	See Note 2 & 4
Phone	VOIP - OFOI

### FIXED EQUIPMENT

1 Dry Erase Board	48" x 36" - CFCI - See Note 3
1 Tack Board	48" x 36" - CFCI - See Note 3

### MOVEABLE / FFE

1 Exec Desk Chair	OFOI - See Note 4
1 Lateral File	OFOI
2 Side Chair	OFOI
1 Bookshelf	OFOI
1 Credenza	OFOI

## NOTES

- 1 Provide 3ft x 7ft door with keyed lock with vision lite and 2' sidelight .
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals. Provide one quad outlet adjacent to each data outlet. Coordinate with furniture layout.
- 3 In-wall bracing for CFCI dry erase and tack boards.
- 4 All OFOI furniture in this office is freestanding (not a modular furniture system). Perimeter data/power to be coordinated w/Owner prior to construction.
- 5 Coat hook on back of door.



# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	SUPERINTENDENT OFFICE	A - 19

## ROOM DESCRIPTION

There shall be seven Superintendent Offices. A window with view to exterior is required. Office width to be a minimum of 9'-6".

## ROOM DATA

Number of Occupants ..... NA

## ROOM ENTRY

Single Door ..... See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Carpet Tile
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Susp Lay-In
Ceiling Height	10 - 0"
Remarks	

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

### ELECTRICAL

Power	Duplex 110v - See Note 2 & 4
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	See Note 2 & 4
Phone	VOIP - OFOI

### FIXED EQUIPMENT

1 Dry Erase Board	48" x 36" - CFCI - See Note 3
1 Tack Board	48" x 36" - CFCI - See Note 3

### MOVEABLE / FFE

1 Exec Desk Chair	OFOI - See Note 4
1 Lateral File	OFOI
2 Side Chair	OFOI
1 Bookshelf	OFOI
1 Credenza	OFOI

## NOTES

- 1 Provide 3ft x 7ft door with keyed lock with vision lite and 2' sidelight .
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals. Provide one quad outlet adjacent to each data outlet. Coordinate with furniture layout.
- 3 In-wall bracing for CFCI dry erase and tack boards.
- 4 All OFOI furniture in this office is freestanding (not a modular furniture system). Perimeter data/power to be coordinated w/Owner prior to construction.
- 5 Coat hook on back of door.

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	D&C FOREMANS ROOM	A - 20

## ROOM DESCRIPTION

The D&C Foremen's Room is the main work space in mornings for the foreman to plan/review tasks for the day. 10 Workstations (4' wide) along perimeter of the room. 6' long work table. Access will be from the corridor. 6' wide view window into corridor.

## ROOM DATA

Number of Occupants ..... 10 Persons

## ROOM ENTRY

Single Door ..... See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Polished Concrete
Base	4" Rubber Base
Walls	Ptd Gyp Bd - See Note 6
Ceiling	Susp Lay-In
Ceiling Height	12' - 0"
Remarks	Provide corner guards typ.

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

### ELECTRICAL

Power	Duplex 110v - See Notes 2, 3, 4, 5, 7, & 8
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	See Notes 2, 3, 4, 5, 7, & 8
Phone	VOIP - OFOI

### FIXED EQUIPMENT

1 Dry Erase Board	60" x 48" - CFCI
Lockers	CFCI - see Notes 4 & 5
1 Tackboard	48" x 36" - CFCI

### MOVEABLE / FFE

15 Workstations 4' w	OFOI
2 Tables -24" x 60"	OFOI
20 Chairs	OFOI
1 Printer Station	OFOI
1 Copier	OFOI

## NOTES

- 1 Provide 3ft x 7ft door with keyed lock, vision lite, and 2' sidelight .
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals. Provide J-box and whips and coordinate w/OFOI systems furniture.
- 3 Workstations require one 110v duplex outlet and one dual data outlet per two stations. Separate data outlet for printer.
- 4 Provide 10 double tier large metal vented laptop lockers with charging stations. Refer to Room Data Sheet A-16.
- 5 Provide one data/power connection at each locker. Refer to Room Data Sheet A-16.
- 6 Provide 6' W view window into corridor.
- 7 Provide metal floor box with
- 8 Coordinate area for OFOI copier and provide power/data

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
CMP	D&C ADMIN STATION	A - 21

## ROOM DESCRIPTION

This space is a modular cubicle workstation located in an open space adjacent to the Lobby.

## ROOM DATA

Number of Occupants ..... 1 Person

## ROOM ENTRY

Access from within CMP Suite .....

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Carpet Tile
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Susp Lay-In
Ceiling Height	9" - 0"
Remarks	

## NOTES

- 1 Data / Phone to be coordinated with systems furniture
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals. Coordinate with systems furniture requirements.

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

### ELECTRICAL

Power	Duplex 110v - See Note 2
Lighting	General Room Lighting

### COMMUNICATIONS

Data	2 - Dual port - See Note 1
Phone	1 - Location - See Note 1

### FIXED EQUIPMENT

### MOVEABLE / FFE

1 Modular Setup	OFOI
1 Desk Chair	OFOI
1 Lateral File	OFOI

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
CMP	CMP SUPERINTENDENT OFFICE	A - 22

## ROOM DESCRIPTION

There shall be two CMP Superintendent Offices. A window with view to exterior is desirable. Office width to be a minimum of 9'-6".

## ROOM DATA

Number of Occupants ..... NA

## ROOM ENTRY

Single Door ..... See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Carpet Tile
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Susp Lay-In
Ceiling Height	10 - 0"
Remarks	

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

### ELECTRICAL

Power	Duplex 110v - See Note 2 & 4
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	See Note 2 & 4
Phone	VOIP - OFOI

### FIXED EQUIPMENT

1 Dry Erase Board	48" x 36" - CFCI - See Note 3
1 Tack Board	48" x 36" - CFCI - See Note 3

### MOVEABLE / FFE

1 Exec Desk Chair	OFOI - See Note 4
1 Lateral File	OFOI
2 Side Chair	OFOI
1 Bookshelf	OFOI
1 Credenza	OFOI

## NOTES

- 1 Provide 3ft x 7ft door with keyed lock with vision lite and 2' sidelight .
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals. Provide one quad outlet adjacent to each data outlet. Coordinate with furniture layout.
- 3 In-wall bracing for CFCI dry erase and tack boards.
- 4 All OFOI furniture in this office is freestanding (not a modular furniture system). Perimeter data/power to be coordinated w/Owner prior to construction.
- 5 Coat hook on back of door.

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
D&C	CMP FOREMANS ROOM	A - 23

## ROOM DESCRIPTION

The CMP Foremen's Room is the main work space in mornings for the foreman to plan/review tasks for the day. 6 Workstations (4' wide) along perimeter of the room. 6' long work table. Access will be from the corridor. 6' wide view window into corridor.

## ROOM DATA

Number of Occupants ..... 10 Persons

## ROOM ENTRY

Single Door ..... See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Polished Concrete
Base	4" Rubber Base
Walls	Ptd Gyp Bd - See Note 6
Ceiling	Susp Lay-In
Ceiling Height	12' - 0"
Remarks	Provide corner guards typ.

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

### ELECTRICAL

Power	Duplex 110v - See Notes 2, 3, 4, 5, 7, & 8
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	See Notes 2, 3, 4, 5, 7, & 8
Phone	VOIP - OFOI

### FIXED EQUIPMENT

1 Dry Erase Board	60" x 48" - CFCI
Lockers	CFCI - see Notes 4 & 5
1 Tackboard	48" x 36" - CFCI

### MOVEABLE / FFE

15 Workstations 4' w	OFOI
2 Tables -24" x 60"	OFOI
20 Chairs	OFOI
1 Printer Station	OFOI
1 Copier	OFOI

## NOTES

- 1 Provide 3ft x 7ft door with keyed lock, vision lite, and 2' sidelight .
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals. Provide J-box and whips and coordinate w/OFOI systems furniture.
- 3 Workstations require one 110v duplex outlet and one dual data outlet per two stations. Separate data outlet for printer.
- 4 Provide 7 double tier large metal vented laptop lockers with charging stations. Refer to Room Data Sheet A-164.
- 5 Provide one data/power connection at each locker. Refer to Room Data Sheet A-16.
- 6 Provide 6' W view window into corridor.
- 7 Provide metal floor box with power/data.
- 8 Coordinate area for OFOI copier and provide power/data

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
CMP	CMP ADMIN STATION	A - 24

## ROOM DESCRIPTION

This space is a modular cubicle workstation located in an open space adjacent to the Lobby.

## ROOM DATA

Number of Occupants ..... 1 Person

## ROOM ENTRY

Access from within CMP Suite .....

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Carpet Tile
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Susp Lay-In
Ceiling Height	9" - 0"
Remarks	

## NOTES

- 1 Data / Phone to be coordinated with systems furniture
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals. Coordinate with systems furniture requirements.

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

### ELECTRICAL

Power	Duplex 110v - See Note 2
Lighting	General Room Lighting

### COMMUNICATIONS

Data	2 - Dual port - See Note 1
Phone	1 - Location - See Note 1

### FIXED EQUIPMENT

### MOVEABLE / FFE

1 Modular Setup	OFOI
1 Desk Chair	OFOI
1 Lateral File	OFOI

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
Flex Office	Flex Office	A - 25

## ROOM DESCRIPTION

This office will provide a shared flex space for visiting SAWS personnel.

## ROOM DATA

Number of Occupants ..... 2 Persons

## ROOM ENTRY

Single Door ..... See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Carpet Tile
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Susp Lay-In
Ceiling Height	10 - 0"
Remarks	

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH
Air Changes	Min per Code

### ELECTRICAL

Power	Duplex 110v - See Note 2 & 4
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	See Note 2 & 4
Phone	VOIP - OFOI

### FIXED EQUIPMENT

1 Dry Erase Board	48" x 36" - CFCI - See Note 3
1 Tack Board	48" x 36" - CFCI - See Note 3

### MOVEABLE / FFE

1 Exec Desk Chair	OFOI - See Note 4
1 Lateral File	OFOI
2 Side Chair	OFOI
1 Bookshelf	OFOI
1 Credenza	OFOI
1 Bookshelf	OFOI

## NOTES

- 1 Provide 3ft x 7ft door with keyed lock with vision lite and 2' sidelight .
- 2 Convenience duplex outlets are to be provided along perimeter wall at regular intervals. Provide one quad outlet adjacent to each data outlet. Coordinate with furniture layout.
- 3 In-wall bracing for CFCI dry erase and tack boards.
- 4 All OFOI furniture in this office is freestanding (not a modular furniture system). Perimeter data/power to be coordinated w/Owner prior to construction.
- 5 Coat hook on back of door.

# ADMINISTRATION BUILDING - NEOC

DEPARTMENT	ROOM NAME	ROOM CODE
IT	MAIN IT ROOM - MDF	A - 26

## ROOM DESCRIPTION

This room serves as the Main Entry for IT/Telecommunications on the site. All other buildings are to have their IDF rooms connected directed back to this location.

## ROOM DATA

Number of Occupants

NA

## ROOM ENTRY

Single Door

See Note 1

## TECHNICAL REQUIREMENTS

### ARCHITECTURAL

Floor	Anti-Static Coating
Base	4" Rubber Base
Walls	Ptd Gyp Bd
Ceiling	Open to Structure - See Note 8
Ceiling Height	Open to Structure
Remarks	Walls extend to structure

### MECHANICAL / PLUMBING

HVAC	72 Degrees / 50% RH - See Note 5
Air Changes	Min per Code

### ELECTRICAL

Power	See Note 2 & 4
Lighting	General Room Lighting - LED

### COMMUNICATIONS

Data	See Notes 2 & 7
Phone	Main Fiber Backbone

### FIXED EQUIPMENT

Equipment Racks	CFCI - See Note 6
Network Switches	CFCI
Cable Tray	CFCI
UPS	OFOI

## NOTES

- 1 Provide 3ft x 7ft door with access control.
- 2 Dedicated circuit for each convenience duplex outlets (110v - 30 amp) are to be provided along perimeter wall at regular intervals, coordinate with equipment racks/switch locations. Minimum 6 locations
- 3 Provide 3ft x 5ft plywood panels on 3 walls. Coordinate with IT equipment layout.
- 4 Provide 220 volt outlets, coordinate location with equipment.
- 5 Dedicated CRAC unit.
- 6 Center racks in room with 360 degree access.
- 7 Label all conduits with "to/from".
- 8 Assure roof penetration for OFOI Wi-Fi radio antenna, 2" steel, pipe mount is properly sealed and flashed.