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DIVISION 01
GENERAL REQUIREMENTS



SECTION 01 02 00

TPDES REQUIREMENTS

PART 1 GENERAL

1.01 GENERAL

- A. The Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit No. TXR 150000, was re-issued March 5, 2008 (Construction General Permit). The Construction General Permit allows operators to obtain permit coverage for storm water conveyance from Small and Large Construction Activities. The TPDES program implements the federal National Pollutant Discharge Elimination System (NPDES) program in the state of Texas, which requires that operators of Small or Large Construction Activities to obtain permit coverage prior to the commencement of construction activities.
- B. The Engineer has estimated that the project will disturb approximately 3.62 acres of land.

1.02 SECTION INCLUDES

- A. Documentation to be prepared and signed by Contractor before conducting construction operations, in accordance with the Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit Number TXR 150000, issued on March 5, 2008 (Construction General Permit).
- B. Contractor is responsible for the implementation, maintenance inspection, and termination of storm water pollution prevention control measures including, but not limited to, erosion and sediment controls, storm water management plans, waste collection and disposal, and other applicable SW3P practices.

1.03 DEFINITIONS

- A. Commencement of Construction Activities: The exposure of soil resulting from activities such as clearing, grading, and excavating.
- B. Large Construction Activity is defined as a project that:
 - 1. Disturbs five acres or more, or
 - 2. Disturbs less than five acres but is part of a large common plan of development that will disturb five acres or more of land.
- C. Small Construction Activity is defined as a project that:
 - 1. Disturbs one or more acres but less than five acres, or
 - 2. Disturbs less than one acres but is part of a larger common plan of development that will ultimately disturb one or more acres but less than five acres.



- D. Operator is a person or persons who have day-to-day operational control of the construction activities, which are necessary to ensure compliance with the SW3P for the site.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 STORM WATER POLLUTION PREVENTION PLAN (SWP3)

- A. The Engineer has completed an SW3P and the Contractor is responsible for implementing the SW3P in accordance with Part III of the Construction General Permit for Small Construction Activities.
- B. Other items that must be incorporated into the SW3P to be determined and provided by the Contractor upon commencement of construction activities and coordination with the County of El Paso, include but are not limited to:
1. Equipment Staging Areas
 2. Material Storage yards
 3. Material Borrow areas
 4. Excavated material disposal areas
 5. Concrete batch plants
 6. Asphalt batch plants

Refer to Part II, Section A of the Construction General Permit for a description of Discharges Eligible for Authorization under the Construction General Permit.

- C. The SW3P will be updated as needed during construction following Part III, Section E of the Construction General Permit.
- D. The SW3P shall be implemented prior to commencement of construction activities and maintained through the duration of construction.

PROVISIONAL COVERAGE

Provisional coverage under this general permit begins:

- Seven days after the completed NOI is postmarked for delivery to the Texas Commission on Environmental Quality (TCEQ) or,
- Immediately if the completed NOI is submitted electronically using STEERS.

AFTER TCEQ REVIEW

After TCEQ review, you will receive one of the following:

- an Acknowledgment Certificate acknowledging your coverage under this general permit.
- a Notice of Deficiency if there is insufficient information in your application, in which case you will have 30 days to respond.



- a Denial Letter informing you that coverage has been denied (usually the result of information requested in a Notice of Deficiency letter not being fully provided).

STEPS TO TAKE AFTER OBTAINING COVERAGE

After obtaining coverage under this permit:

1. Adhere to the requirements of General Permit TXR150000.
2. Submit a Notice of Termination (NOT) within 30 days after one or more of the following occurs:
 - final stabilization has occurred
 - another permitted operator has assumed control over all areas of the site that have not been finally stabilized and all silt fences and other temporary erosion control measures have either been removed, scheduled for removal, or transferred to a new operator as described in the Storm Water Pollution Prevention Plan
 - authorization was granted under an individual permit
3. If the operator changes, the new operator must submit a Notice of Intent (NOI) and then the existing operator must submit a Notice of Termination (NOT). The NOT and NOI must be submitted at least 10 days before the change.
4. If you are discharging to gutters, streets, channels, ditches or any other Municipal Separate Storm Water Sewer System (MS4) - which includes anything designed or used to collect or transport storm water - you must submit a copy of each of these items to the operator of that system at the same time you submit that item to the TCEQ:
 - Notice of Intent
 - Notice of Change, which is used if the operator becomes aware of failing to submit any relevant information or submitting incorrect information.
 - Notice of Termination

Even if the general permit described above applies to your situation, you may opt to request coverage under an individual permit.

You can view some of the relevant Rules for Storm Water Discharges from Construction Activities.

NOTICE OF CHANGE

A Notice of Change is required to be submitted for making updates, changes, or corrections to an NOI or Waiver as required in the general permit.

NOTICE OF TERMINATION

Notice of Termination can be submitted in one of the following ways:

- Electronic (STEERS) NOT - even if the NOI was submitted via paper
- Paper NOT



3.02 SMALL CONSTRUCTION ACTIVITY

A. CONSTRUCTION SITE NOTICE

1. Fill out, sign, and date the Construction Site Notice, included at the end of this technical specification. Submit the signed copy of the Construction Site Notice to the Engineer at least two days before commencement of construction activities.
2. Post a signed copy of the Construction Site Notice near the main entrance of a construction site in a prominent place for viewing by the general public and local, state, and federal authorities prior to commencing construction activities, and maintain it in that location until completion of the construction. Post name and telephone number of Contractor's local contact person, brief project description and location of SW3P.
If Project is a linear construction project (e.g.: road, utilities, etc), post notice in a publicly accessible location near active construction. Move notice as necessary.
3. The Contractor shall submit a signed copy of the Construction Site Notice to the County of El Paso.

B. STORM WATER POLLUTION PREVENTION PLAN APPLICATION

1. Fill out and sign a Storm Water Pollution Prevention Plan Application with the County of El Paso.
2. Provide the Engineer with a copy of the signed application 10 days prior to commencing construction activities.
3. Submit the original signed application along with fee and two copies of the SW3P to Municipal Services for review and approval seven (7) days prior to commencing construction activities.
4. Provide copies of the approved SW3P to the Engineer and the County of El Paso.

3.03 CERTIFICATION REQUIREMENTS

- A. Fill out Pollution Prevention Plan Certification Form to include the Operator's signature, name, title and organization.
- B. Contractor and Subcontractors shall sign and date Contractor's/Subcontractor's Certification for TPDES Permitting included at the end of this technical specification to include Contractor's name, address, and telephone number, and the names of persons or firms responsible for maintenance and inspection of erosion and sediment control measures. Use multiple copies as required to document full information. Include this certification with other Project certification forms.
- C. Submit properly completed certification forms to the engineer for review before commencing construction.
- D. Conduct inspections in accordance with TCEQ requirements. Ensure persons or firms responsible for maintenance and inspection of erosion and sediment control measure



read, fill out, sign, and date the Erosion Control Contractor's Certification for Inspection and Maintenance. Controls must be inspected once every fourteen (14) calendar days and within twenty-four (24) hours of the end of a storm event of 0.5 inches or greater, in accordance with Part III, Section F, of the Construction General Permit.

3.04 RETENTION OF RECORDS

- A. Keep a copy of this document and the SW3P Permit in a readily accessible location at the construction site from Commencement of Construction Activity and maintain it in that location until completion of the construction. Contractors with day-to-day operational control over SW3P implementation shall have a copy of the SW3P available at a central location, on-site, for the use of all operators and those identified as having responsibilities under the SW3P.

3.05 ON-SITE WASTE MATERIAL STORAGE

- A. On-site waste material storage shall be self-contained and shall satisfy appropriate local, state, and federal rules and regulations.
- B. Prepare list of waste material to be stored on-site. Update list as necessary to include up-to-date information. Keep a copy of the updated list with the SW3P.
- C. Prepare description of controls to reduce pollutants generated from on-site storage. Include storage practices necessary to minimize exposure of materials to storm water, and spill prevention and response measures consistent with best management practices. Keep a copy of the description with the SW3P.

END OF SECTION



SECTION 01 10 00

SUMMARY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Contract description.
- B. Contractor's use of site and premises.
- C. License agreement for Construction Access.
- D. Damage to Private Property.
- E. Contractor's Superintendence.
- F. Emergency Communication.
- G. Video Taping.
- H. Geotechnical Engineering Report.

1.2 CONTRACT DESCRIPTION

- A. The project consists of providing drainage improvements. The purpose of this project is to provide for improved drainage and safety. The following is a summary of the proposed improvements.
- B. The contractor shall furnish all labor, materials, equipment, tools and incidentals and completely construct the work, so it is ready to use as shown on the Drawings and as described in the Specifications.
- C. The Celeste Drive Drainage Improvements project consist of the following:
 - Site clearing and grubbing.
 - Implementation of traffic control plan.
 - Repair and improvement of the existing drainage crossing under Celeste Drive.
 - Excavation of unclassified material: cut to waste and cut to fill.
 - Installation of drainage improvements including gabion baskets, reinforced concrete drainage structures, loose rock riprap, headwalls, cast-in-place concrete, reinforced concrete flumes, and concrete energy dissipation structures.
 - Installation of site improvements including concrete curbs and gutters, rock walls, wrought iron fences and gates, pedestrian ramps, and landscaping improvements.

The project description, as shown above, is only a general overview of the project. Contractor shall refer to the project plans, contract documents and technical specifications for further information.



1.3 CONTRACTOR'S USE OF SITE AND PREMISES

- A. Confine operations to areas within Contract limits indicated. The area beyond the construction limits shall be kept undisturbed. Areas disturbed beyond the construction limits will be repaired and restored to original or better condition at Contractor's expense.
- B. The Contractor shall keep the construction disturbances to a minimum.
- C. Always keep all driveways and entrances serving the premises clear and available. These areas are not to be used for the storage of materials, stockpile or parking. Contractor shall coordinate with the County of El Paso to provide vehicular and pedestrian access at all times during construction.
- D. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on site.
- E. Contractor shall be responsible for obtaining an area to be used for staging. Contractor shall coordinate with the County of El Paso for possible locations near the project site.
- F. The project area shall be swept within 24-hrs of completion of a rain event.
- G. It will be the responsibility of the Contractor to schedule and perform the work to provide proper passage of any storm water during the course of the operations. All labor, tools, equipment and supervision required to assure such proper passage of runoff water and any removal or handling of water in order to maintain dry conditions shall be considered as incidental to the remainder of the work and shall be at the expense of the Contractor.
- H. The Contractor shall coordinate the work with all utility companies having facilities within the area of work. Therefore, any work associated with the protection, relocation or by-passing of existing utility lines shall be reflected in the Contractor's project schedule so the work may be completed without delay to the project. All the requirements of the contract documents also apply to any subcontractors.

1.4 DAMAGE TO PRIVATE PROPERTY

- A. The Contractor shall be responsible for any damage to private property caused by the construction project. The Contractor, upon receipt of a complaint of damage, shall within 5-days respond in writing with a proposal to repair said damage or a letter with reasons explaining why the damage was not caused by the construction. The damage shall be repaired completely within 7-days of the complaint.

1.5 CONTRACTOR'S SUPERINTENDENCE

- A. Contractor shall always keep a qualified competent Project Superintendent, satisfactory to the Engineer. The Project Superintendent shall have the responsibility to coordinate all subcontractors and be capable of communicating with the Public, the Engineer, and the County of El Paso. The Project Superintendent shall be responsible for and shall coordinate all activities of the various crews, subcontractors and suppliers.



- B. The Project Superintendent shall be cooperative and authorized to receive orders to act for the Contractor. In the event a competent Superintendent is not available the County of El Paso may suspend work until one is available. Changes of Superintendent require prior written approval by the Engineer and the County of El Paso.
- C. All workers employed by the Contractor shall have such skill and experience as will enable them to properly perform the duties assigned. Any person employed by the Contractor or a subcontractor who, in the opinion of the Engineer, does not perform their work in a proper and skillful manner, or is disrespectful, intemperate, disorderly or otherwise objectionable, shall at the written request of the Engineer be forthwith reassigned or discharged and shall not be deployed again on any portion of the work without written consent of the Engineer.
- D. Persons assigned to this project and identified by the Contractor during Pre-Award requirements as Key Personnel shall not be replaced without prior consent and approval of a substitute by the Owner. Contractor will not be allowed to commence or continue any work until Key Personnel is approved by the Engineer. Prior to replacing any Key Personnel after initial acceptance by the Owner, a resume and work history shall be submitted to the Engineer for review and recommendation for approval.

1.6 EMERGENCY COMMUNICATION

- A. The Contractor shall always maintain during construction, a local telephone number where responsible supervisory personnel may be contacted twenty-four hours a day for the full duration of the project. The telephone number shall be given to the County of El Paso's Project Manager, Engineer and to everyone requiring this information so that contact can be made in the event of any emergency.

1.7 VIDEO TAPING

- A. Prior to any construction, the project site shall be videotaped by the Contractor accompanied by the Engineer or representative, to show existing conditions of the adjacent properties, easements, structures, utilities, drainage structures, channels, and other existing improvements. After completion of the project, the site shall be videotaped by the Contractor accompanied by the Engineer or representative to show the condition of the finished construction of adjacent properties, easements, structures, utilities, drainage structures, channels and other completed improvements under this project. Two copies in DVD format shall be furnished to the Engineer prior to and after construction and shall include labels including project title, bid no., and date recorded.



PART 2 PRODUCTS – Not Used

PART 3 EXECUTION – Not Used

PART 4 PAYMENT

4.1 PAYMENT

- A. The work performed, and materials furnished as this bid item requires will not be paid for directly but will be subsidiary to its associated bid items.

END OF SECTION



SECTION 01 20 00

PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Schedule of Values.
- B. Applications for Payment.
- C. Change procedures.
- D. Defect assessment.
- E. Unit prices.

1.2 SCHEDULE OF VALUES

- A. Contractor shall submit a schedule of values as per the technical specifications. Schedule of values shall be submitted prior to the first Application of Payment.

1.3 APPLICATIONS FOR PAYMENT

- A. Submit five copies of each application on Owner's Standard Form.
- B. Content and Format: Utilize bid proposal for listing items in Application for Payment.
- C. Submit updated monthly construction schedule with each Application for Payment.
- D. Payment Period: Submit at intervals stipulated in the Agreement.
- E. Submit with transmittal letter as specified for Submittals in Section 01 33 00 - Submittal Procedures.

1.4 CHANGE PROCEDURES

- A. Submittals: Submit name of individual authorized to receive change documents and be responsible for informing others in Contractor's employ or Subcontractors of changes to the Work.
- B. The Engineer/Owner will advise of minor changes in the Work not involving adjustment to Contract Sum/Price or Contract Time by issuing supplemental instructions.
- C. The Engineer/Owner may issue a Notice of Change including a detailed description of proposed change with supplementary or revised Drawings and specifications, a change in Contract Time for executing the change and the period of time during which the requested price will be considered valid. Contractor will prepare and submit estimate within 5-days.
- D. Stipulated Sum/Price Change Order: Based on Notice of Change and Contractor's estimated price quotation as approved by Engineer/Owner.
- E. Force Account Change Order: Submit itemized account and supporting data after completion of change, within time limits indicated in Conditions of the Contract.



Engineer/Owner will determine change allowable in Contract Sum/Price and Contract Time as provided in Contract Documents.

- F. Maintain detailed records of work done on Force Account basis. Provide full information required for evaluation of proposed changes, and to substantiate costs for changes in the Work.
- G. Document each quotation for change in cost or time with sufficient data to allow evaluation of quotation.
- H. Execution of Change Orders: Engineer/Owner will issue Change Orders for signatures of parties as provided in Conditions of the Contract.
- I. Correlation of Contractor Submittals:
 - 1. Promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as separate line item and adjust Contract Sum/Price.
 - 2. Promptly revise progress schedules to reflect change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.
 - 3. Promptly enter changes in Project Record Documents.

1.5 DEFECT ASSESSMENT

- A. Replace the Work, or portions of the Work, not conforming to specified requirements.
- B. If, in the opinion of the Engineer/Owner, it is not practical to remove and replace the Work, the Engineer/Owner will direct appropriate remedy or adjust payment.
- C. The defective Work may remain, but unit sum/price will be adjusted to new sum/price at discretion of Engineer/Owner.
- D. Defective Work will be partially repaired to instructions of Engineer/Owner, and unit sum/price will be adjusted to new sum/price at discretion of Engineer/Owner.
- E. Individual specification sections may modify these options or may identify specific formula or percentage sum/price reduction.
- F. Authority of Engineer/Owner to assess defects and identify payment adjustments is final.
- G. Non-Payment for Rejected Products: Payment will not be made for rejected products for any of the following:
 - 1. Products wasted or disposed of in a manner that is not acceptable.
 - 2. Products determined as unacceptable before or after placement.
 - 3. Products not completely unloaded from transporting vehicle.
 - 4. Products placed beyond lines and levels of required Work.
 - 5. Products remaining on hand after completion of the Work.



6. Loading, hauling, and disposing of rejected products.

1.6 LUMP SUM BID

- A. Payment shall include: Full compensation for required labor, products, tools, equipment, plant and facilities, transportation, services and incidentals; erection, application or installation of item of the Work; overhead and profit.
- B. Provisions for Earthwork Items: Contractor shall submit certified earthwork volume quantities along with the corresponding monthly pay application. Earthwork quantities shall be certified by a Professional Registered Land Surveyor (RPLS) registered in the State of Texas. Refer to Section 01 30 00 – Administrative Requirements.

1.7 PAYMENT PROCEDURES

1. **MOBILIZATION, DEMOBILIZATION, INSURANCE, BONDS, AND TPDES REQUIREMENTS NOT TO EXCEED 5% OF BASE BID I (ITEMS 2 THROUGH 19)**
 - A. Payment: This price is full compensation for mobilization, demobilization, insurance, bonds, all activities and associated costs for transportation of contractor's personnel, equipment, operating supplies to the site, establishment of offices, buildings, job trailers, or other necessary general facilities for the contractor's operations at the site, utilities to the office, building, or job trailers including power, construction permits and fees, site administration expenses, temporary fencing, potholing of utilities, telephone, and videotaping requirements. Payment shall also include all activities and costs for demobilization to include transportation of personnel, equipment, and supplies from the site, disassembly, removal, and site cleanup of offices, buildings, job trailers, or other facilities assembled on the site, contract closeout, as-built drawings and specifications, and all other incidentals associated with contractor's demobilization from the site. This item shall be limited to five (5) percent of the total bid price and shall be paid 50% at the beginning of project and 50% at closeout on a lump sum basis.
2. **IMPLEMENT STORM WATER POLLUTION PREVENTION BEST MANAGEMENT PRACTICES**
 - A. Payment: This price is full compensation for the management and implementation of the storm water pollution prevention best management practices to include furnishing, installing and removing silt fencing; construction entrances/exits; erosion control measures; concrete washout pits; haul roads; equipment and supply areas; removal of litter; repair to devices and features damaged by the Contractor; 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; minor adjustments including but not limited to plumbing posts, reattaching fabric, minor grading to maintain slopes on an erosion embankment feature; moving sandbags; TPDES applications/forms, administration and correspondence with TCEQ, TPDES permits and fees, equipment, labor, tools, and incidentals. Contractor shall be responsible for the repair of damages or distress to adjacent properties, structures, and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.



3. FURNISH, INSTALL, AND IMPLEMENT TRAFFIC CONTROL PLAN

- A. Payment: This price is full compensation for the TCP and shall include preparation of a formal TCP by a Texas Licensed Professional Engineer; submitting and obtaining approval of the formal TCP from the required governing agencies (El Paso Street and Maintenance Department); furnishing, installing, and maintaining the approved TCP complete for the duration of the project. Implementing and maintaining the TCP in conformance to the specifications and principles given in the "Texas Manual on Uniform Traffic Control Devices" over the entire project area; and all other incidentals required for Contractor to complete, implement, and maintain the TCP requirements. Conflicting pavement markings/signs must be removed/covered for long-term projects. Work-zone markings must be installed where needed. Original markings/signs that are removed must be replaced upon completion. All costs for installation, maintenance, adjustments, replacements, removal, materials, equipment, labor, tools, traffic mounted attenuators, and incidentals shall be compensated under this pay item. Payment shall include for daily, overnight, and long-term traffic control. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.

4. SITE CLEARING AND GRUBBING, DEMOLITION, REMOVAL, RELOCATION, AND PROPER DISPOSAL OF MISCELLANEOUS EXISTING ITEMS

- A. Payment: This price is full compensation for site clearing and grubbing, demolition, removal and proper disposal of miscellaneous existing items to include: guardrails, concrete sidewalks, curbs, driveways, reinforced concrete channels, concrete headwalls, gabion structures, bridges, concrete driveways, concrete wheelchair ramps, relocation of mailboxes, miscellaneous signs, miscellaneous posts, fire hydrants, miscellaneous abandoned conduits, reinforcing steel within existing concrete structures, asphalt pavement (thickness varies), base course (thickness varies), concrete headwalls, rock walls, fencing, demolition, removal and proper disposal of any accessories and/or fixtures that may be part of the existing structures, clearing and grubbing the natural area from vegetation including roots, trash, and debris and other incidentals to allow for the new construction within the limits as shown on the drawings. Contractor shall be responsible for the repair of damages or distress to adjacent properties, structures, utilities caused by these operations. Vegetation shall include grass, weeds, shrubs, bushes, and tree stumps. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on percentage of stationing completed.

5. PREPARING RIGHT OF WAY

- A. Payment: Price is full compensation for rough grading and removing and disposing of all obstructions when removal of such obstructions is not specifically shown on the plans to be paid by other Items. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.

6. EXCAVATION AND PROPER DISPOSAL OF UNCLASSIFIED MATERIAL (CUT TO FILL)

- A. Payment: Price is full compensation for excavation and shall include excavation of areas as shown on the plans or as directed, removal and disposal of excavated spoil materials, testing, equipment, materials, labor, tools, temporary excavation support systems, shoring, bracing and incidentals. Materials being excavated are unclassified. Materials shall be considered unclassified throughout the entire project limits. Removal and proper



disposal of unclassified materials encountered during excavation such as lumped soil, boulders, rock, andesite rock, debris, asphalt, and concrete of any type and size will not be paid directly but will be subsidiary to this item. Payment for excavation shall be taken to the neat lines, grades, and typical sections as shown on the plans and cross-sections. Shrinkage or swell factors will not be considered for payment. Contractor shall be responsible of the repair of damages or distress to adjacent properties, structures and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.

7. EXCAVATION AND PROPER DISPOSAL OF UNCLASSIFIED MATERIAL (CUT TO WASTE)

- A. Payment: Price is full compensation for excavation and shall include excavation of areas as shown on the plans or as directed, removal and disposal of excavated spoil materials, testing, equipment, materials, labor, tools, temporary excavation support systems, shoring, bracing and incidentals. Materials being excavated are unclassified. Materials shall be considered unclassified throughout the entire project limits. Removal and proper disposal of unclassified materials encountered during excavation such as lumped soil, boulders, rock, andesite rock, debris, asphalt, and concrete of any type and size will not be paid directly but will be subsidiary to this item. Payment for excavation shall be taken to the neat lines, grades, and typical sections as shown on the plans and cross-sections. Shrinkage or swell factors will not be considered for payment. Contractor shall be responsible of the repair of damages or distress to adjacent properties, structures and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.

8. EMBANKMENT

- A. Payment: Price is full compensation for embankment including furnishing embankment, hauling, placing. Compacting, finishing and reworking, disposal of waste material, correction of soft spots in the subgrade, testing, equipment, labor, tools, and incidentals. All sprinkling, rolling and proof rolling will not be paid for directly but will be considered subsidiary to this item. Payment for embankment shall be taken for volume compacted between the original ground surface or the surface upon which the embankment is to be constructed and the neat lines, grades, and slopes of the embankment. Shrinkage and swell factors will not be considered for payment. Contractor shall be responsible for the repair of damages or distress to adjacent properties, structures and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.

9. RIPRAP (STONE)(GROUT)(12 IN)

- A. Payment: Price is full compensation for the import and proper placement of rock material to the limits and depths as specified and shown on the drawings, preparation of subgrade material, equipment, labor, tools, and incidentals. The thickness of the riprap shall be 12". All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.



- 10. FURNISH AND INSTALL REINFORCED CONCRETE RIPRAP (4")**
A. Payment: Price is full compensation for furnishing and installing the reinforced concrete riprap and shall include hauling, mixing concrete materials, bending, fabricating, splicing, welding, 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, disposal of excavated material, forms, falsework, equipment, testing of materials, water stops, labor, tools, backfilling, soil cement backfilling, flowable backfill or two sack backfilling, compaction as specified and incidentals. Contractor shall be responsible for the repair of damages or distress to adjacent properties, structures, and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.
- 11. FURNISH AND INSTALL REINFORCED CONCRETE RIPRAP FLUMES**
A. Payment: Price is full compensation for furnishing and installing the reinforced concrete riprap flumes and shall include hauling, trenching, mixing concrete materials, bending, fabricating, splicing, welding, 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, disposal of excavated material, forms, falsework, equipment, testing of materials, water stops, labor, tools, backfilling, soil cement backfilling, flowable backfill or two sack backfilling, compaction as specified and incidentals. Contractor shall be responsible for the repair of damages or distress to adjacent properties, structures, and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.
- 12. RIPRAP(CONC)(DISSIPATOR)**
A. Payment: Price is full compensation for furnishing and installing the reinforced concrete baffle blocks and shall include hauling, mixing concrete materials, bending, fabricating, splicing, welding, 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, disposal of excavated material, forms, falsework, equipment, testing of materials, water stops, labor, tools, backfilling, soil cement backfilling, flowable backfill or two sack backfilling, compaction as specified and incidentals. Contractor shall be responsible for the repair of damages or distress to adjacent properties, structures, and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.
- 13. FURNISH AND INSTALL CONCRETE HEADWALL**
A. Payment: This price is full compensation for furnishing and installing the reinforced concrete headwall to include concrete, reinforcing steel, mortar, excavation, backfill, soil cement backfilling, flowable backfill or two sack backfilling, subgrade preparation, connection to box culvert, materials, equipment, labor, tools, and incidentals. This price



is also full compensation for the disposal of excavated material, clips, blocks, metal spacers, ties, wires, water stops, forms, and falsework. Contractor shall be responsible for the repair of damages or distress to adjacent properties, structures, and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.

14. FURNISH AND INSTALL WINGWALLS

- A. Payment: This price is full compensation for furnishing and installing the reinforced concrete wingwall to include concrete, reinforcing steel, mortar, excavation, backfill, soil cement backfilling, flowable backfill or two sack backfilling, subgrade preparation, connection to box culvert, materials, equipment, labor, tools, and incidentals. This price is also full compensation for the disposal of excavated material, clips, blocks, metal spacers, ties, wires, water stops, forms, and falsework. Contractor shall be responsible for the repair of damages or distress to adjacent properties, structures, and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.

15. FURNISH AND INSTALL GABION BASKET (9'x3'x3')

- A. Payment: Price is full compensation for furnishing and installing gabion baskets (9'x3'x3') and shall include gabion basket, specified mesh, specified rock, fasteners, accessories, geotextile, rock placement, excavation, subgrade preparation, disposal of excavated material, forms, false work, equipment, labor, tools, and incidentals. Contractor shall be responsible for the repair of damages or distress to adjacent properties, structures, and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.

16. FURNISH AND INSTALL STEEL DIAMOND PLATES FOR FLUMES

- A. Payment: Price is full compensation for furnishing and installing the steel diamond plates for flumes and shall include concrete, reinforcing steel, brick, mortar, aluminum and castings, frames, grates, rings, covers, excavation, removal and disposal of excavated spoil materials, backfill, subgrade preparation, concrete collars, concrete penetration aprons, materials, testing, equipment, labor, tools, and incidentals. Contractor shall be responsible for the repair of damages or distress to adjacent properties, structures, and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.

17. REMOVING STAB BASE AND ASPH PAV (4")

- A. Payment: Price is full compensation for removing stabilized base and asphalt pavement (3") and shall include: equipment, labor, tools, and incidentals. Contractor shall be responsible for the repair of damages or distress to adjacent properties, structures, and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.

18. FURNISH AND INSTALL NEW FULL PAVEMENT RECONSTRUCTION: 4-INCH HMAC ASPHALT PAVEMENT (TYPE C) OVER 10-INCH COMPACTED BASE COURSE (TYPE A GRADE 3) WITH SUBGRADE PREPARATION



- A. Payment: price is full compensation for furnishing and installing 4-inch HMAC asphalt pavement (Type C), and 10-inch compacted base course (Type A Grade 3) with subgrade preparation and shall include: base course, compacted as specified, equipment, testing, labor, tools, prime coat placement, preparation of subgrade, blended and compacted subgrade materials, testing for subgrade compaction and incidentals. Contractor shall be responsible for the repair of damages or distress to adjacent properties, structures, and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.

19. FURNISH AND INSTALL CONCRETE CURB & GUTTER

- A. Payment: Price is full compensation for furnishing and installing concrete curb and gutter and shall include preparation of surface, preparation of subgrade and/or base materials, excavation, hauling and disposal of excavated material; drilling and doweling into existing pavement, concrete joint materials, reinforcement, equipment, testing, labor, materials, tools, and incidentals. Contractor shall be responsible for the repair of damages or distress to adjacent properties, structures, and utilities caused by these operations. All costs for this work shall be compensated under this pay item and will be paid on a lump sum basis based on work performed and completed.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION



SECTION 01 30 00

ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Coordination and project conditions.
- B. Field engineering.
- C. Preconstruction meeting.
- D. Progress meetings.

1.2 COORDINATION AND PROJECT CONDITIONS

- A. Coordinate scheduling, submittals, and Work of various sections of Project Specifications to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Verify utility requirements and characteristics of operating equipment are compatible with site utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, operating equipment.
- C. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion.
- E. It will be the responsibility of the Contractor to schedule and perform their work to provide proper passage of any storm water during operations. All labor, tools, equipment and supervision required to assure such proper passage of runoff water and any removal or handling of water in order to maintain dry conditions shall be considered incidental to the remainder of the work and shall be at the expense of the Contractor.

1.3 FIELD ENGINEERING

- A. Locate and protect survey control and reference points. Promptly notify Engineer of discrepancies discovered.
- B. Control datum for survey is the County Monument at the intersection of Timothy Drive and Celeste Drive. Topographic Survey was performed by Barragan & Associates, Inc. The survey was completed on March 26, 2020.
- C. Verify setbacks and easements; confirm drawing dimensions and elevations.



- D. Provide field engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.
- E. Submit copy of site drawing and certificate signed by Land Surveyor certifying elevations and locations of the Work are in conformance with Contract Documents. Maintain complete and accurate log of control and survey work as Work progresses.
- F. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
- G. Promptly report to Engineer loss or destruction of reference point or relocation required because of changes in grades or other reasons.
- H. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Engineer.

1.4 PRECONSTRUCTION MEETING

- A. The County of El Paso will schedule meeting after Notice of Award and/or Notice to Proceed.
- B. Attendance Required: County of El Paso, Engineer, and Contractor.
- C. Agenda:
 - 1. Provided by the Engineer.
- D. Engineer will record minutes and distribute copies within two days after meeting to participants, with copies to Owner, and those affected by decisions made.

1.5 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work as required by the County of El Paso.
- B. Contractor shall make arrangements to attend construction meetings. Engineer will prepare agenda and provide copies to participants.
- C. Attendance Required: Job superintendent, major subcontractors and suppliers, the County of El Paso's Project Manager, and or the County of El Paso's representative, Engineer, and or Engineer's representative, as appropriate to agenda topics for each meeting.
- D. Agenda:
 - 1. Review minutes of previous meetings.
 - 2. Review of Work progress.
 - 3. Field observations, problems, and decisions.
 - 4. Identification of problems impeding planned progress.
 - 5. Review of submittals schedule and status of submittals.
 - 6. Review of off-site fabrication and delivery schedules.
 - 7. Maintenance of progress schedule.
 - 8. Corrective measures to regain projected schedules.
 - 9. Planned progress during succeeding work period.



10. Coordination of projected progress.
 11. Maintenance of quality and work standards.
 12. Effect of proposed changes on progress schedule and coordination.
 13. Other business relating to Work.
 14. Contractor shall provide look ahead schedule at Progress meeting (if Progress meetings are weekly, then look ahead schedule should be for two weeks).
- E. Engineer will record minutes and distribute copies within two days after meeting to participants, with copies to the County of El Paso, Contractor, and those affected by decisions made.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

PART 4 PAYMENT

4.1 PAYMENT

- A. The work performed, and materials furnished as this bid item requires will not be paid for directly but will be subsidiary to its associated bid items.

END OF SECTION



SECTION 01 30 01
PRE/POST CONSTRUCTION VIDEO

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all tools, qualified labor, materials, equipment, qualified superintendence and all services, transportation, other incidentals, assurances and guarantees, assumptions of risk, and responsibility for the performance of all Pre/Post Construction Video operations as indicated on the Construction Drawings. Complete work as shown and specified herein.

1.2 SECTION INCLUDES

- A. Pre-Construction and Post-Construction Video.

1.3 SUBMITTALS

- A. Refer to *Section 01 33 00 – Submittal Procedures* and *Section 01 78 39 – Project Record Documents*.
- B. The pre-construction video shall be submitted to the Engineer prior to mobilization.
- C. The post-construction video shall be submitted to the Engineer once the punch-list items haven been completed.
- D. Two copies in DVD format shall be furnished to the Project Inspector and Engineer prior to and after construction and shall include labels including project title, bid no., and date recorded.

1.4 RECORDING PROCEDURES

- A. Prior to any construction, the project construction site shall be video recorded by the Contractor accompanied by the Project Inspector or his representative, to show existing conditions of:
 - 1. Adjacent properties, including parkways, landscape, curbs, sidewalks, rock walls, trees;
 - 2. Easements and structures;
 - 3. Utilities and drainage structures;
 - 4. Pavement, monuments, and other existing improvements.
- B. The recording shall be in color and shall indicate item and date of the taping. A narrative dialogue of route shall be part of the recording. Image resolution shall be enough for clear high-resolution video. Minimum resolution shall be 1080i or 720 high definition (standard definition).
- C. No work shall commence until the Engineer reviews and approves the pre-construction recording.



- D. After completion of the project, the construction site shall be video recorded by the Contractor accompanied by the Project Inspector or his representative to show the condition of the finished construction of adjacent properties, easements, structures, utilities, drainage structures, and other completed improvements under this project.

1.5 PAYMENT

- A. The work performed, and materials furnished as this bid item requires will not be paid for directly but will be subsidiary to its associated bid items.

PART 2 PRODUCTS – Not Used

PART 3 EXECUTION – Not Used

END OF SECTION



SECTION 01 31 19

PROJECT MEETINGS

PART 1 GENERAL

1.1 PRECONSTRUCTION MEETING

- A. A Preconstruction meeting shall be held in accordance with the General and Supplemental Conditions.

1.2 PROGRESS AND SPECIAL MEETINGS

- A. Owner may request meetings with Contractor and its Subcontractors at any time during progress of Contract. It will be Contractor's responsibility to provide to Owner whatever information is requested by Engineer.
- B. Contractor shall attend bi-weekly meetings called by Engineer. Owner's representatives will be invited to attend meetings.
 - 1. It is generally intended that meetings will be complete within 2 hours; however, Contractor shall attend meeting until completion of all pertinent discussions.
 - 2. Engineer will chair all project meetings.
 - 3. Agenda of project meetings:
 - a. Varies to include, but is not limited to, general progress discussions of work to be performed and maintenance of overall progress schedule.
 - b. Engineer will provide project meeting minutes to all meeting participants.
 - 4. Construction work requiring shutdowns or major utility tie-ins shall be discussed by the Contractor at the meeting preceding such construction.
 - 5. The Contractor shall provide a written 2-week look-ahead schedule showing planned activities and locations of planned work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PART 4 PAYMENT

4.1 PAYMENT

- A. The work performed, and materials furnished as this bid item requires will not be paid for directly but will be subsidiary to its associated bid items.

END OF SECTION



SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. References.
- B. Quality assurance.
- C. Format.
- D. Schedules.
- E. Submittals.
- F. Updating schedules.
- G. Distribution.

1.2 REFERENCES

- A. For Products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by date of issue current on date of Contract Documents, except where a specific date is established by code.
- C. Obtain copies of standards where required by product specification sections.
- D. Neither the contractual relationships, duties, nor responsibilities of the parties in Contract nor those of the Engineer shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.3 QUALITY ASSURANCE

- A. Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in-sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.



- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- G. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.4 FORMAT

- A. Listings: Reading from left to right, in ascending order for each activity. Identify each activity with applicable specification section number.
- B. Diagram Sheet Size: 24 inches high x36 inches wide.
- C. Scale and Spacing: To allow for notations and revisions.

1.5 SCHEDULES

- A. Submit preliminary progress schedule.
- B. After review and approval, revise and resubmit schedule to comply with revised Project Schedule.
- C. During progress of work, revise and resubmit Project Schedule with Applications for Payment.
- D. Contractor shall update the Project Schedule and provide a 2-week look ahead.
- E. Contractor shall update the Project Schedule at least monthly and provide to Engineer.
- F. Prepare sub-schedules for each stage of Work identified in *Section 01 10 00 - Summary*.
- G. Coordinate contents with schedule of values in *Section 01 33 00 - Submittal Procedures*.

1.6 SUBMITTALS

- A. Submit shop drawings, product data and samples in accordance with Section 01 33 00 for review and compliance with Contract Documents, for field dimensions and clearances, for relation to available space, and for relation to work of separate contracts. Revise and resubmit as required.
- B. Shop drawings shall be prepared with enough detail and notation for field erection and installation. Shop drawings shall be separate drawings prepared by the supplier of materials. Photocopies of the contract documents for use as shop drawings will not be permitted.
- C. Submittals which utilize electronic files on any of the drawings in the contract documents may not be used, unless a written agreement that stipulates the conditions under which these documents may be used, is executed between the user and the Engineer of record.



- D. Submit requests for interpretation of Contract Documents and obtain instructions through the Engineer.
- E. Process requests for substitutions, and change orders, through the County of El Paso or designated agent.
- F. Deliver closeout submittals for review and preliminary inspection reports.
- G. Submit under transmittal letter form specified in *Section 01 33 00 - Submittal Procedures*.
- H. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents. Documents not having the stamp will be returned to the Contractor.

1.7 UPDATING SCHEDULES

- A. Maintain schedules to record actual start and finish dates of completed activities.
- B. Indicate progress of each activity to date of revision, with projected completion date of each activity update diagrams to graphically depict current status of Work.
- C. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
- D. Indicate changes required to maintain Date of Substantial Completion.
- E. Submit sorts required to support recommended changes.
- F. Prepare narrative report to define problem areas, anticipated delays, and impact on schedule. Report corrective action taken or proposed and its effect including effects of changes on schedules of separate contractors.

1.8 DISTRIBUTION

- A. Following joint review, distribute copies of updated schedules to Contractor's project site file, to Subcontractors, Suppliers, Engineer, and the County of El Paso.
- B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.



PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

PART 4 PAYMENT

4.1 PAYMENT

- A. The work performed, and materials furnished as this bid item requires will not be paid for directly but will be subsidiary to its associated bid items.

END OF SECTION



SECTION 01 32 50

SCHEDULE OF VALUES

PART 1 GENERAL

1.1 ITEMS

MOBILIZATION AND DEMOBILIZATION		
ITEM	DESCRIPTION	UNIT
1	MOBILIZATION, DEMOBILIZATION, INSURANCE, BONDS AND TPDES REQUIREMENTS NOT TO EXCEED 5% OF BID (ITEMS 2 THROUGH 19)	LS

EROSION & SEDIMENT CONTROL		
ITEM	DESCRIPTION	UNIT
2	IMPLEMENT STORM WATER POLLUTION PREVENTION BEST MANAGEMENT PRACTICES INCLUDING: FURNISH AND INSTALL SILT FENCE, CONSTRUCTION ENTRANCE/EXITS AND REMOVAL AND PROPER DISPOSAL OF SILT FENCE AND CONSTRUCTION ENTRANCES/EXITS AFTER COMPLETION OF WORK	LS

TRAFFIC CONTROL		
ITEM	DESCRIPTION	UNIT
3	FURNISH, INSTALL, IMPLEMENT AND REMOVE TRAFFIC CONTROL PLAN	MO

DEMOLITION		
ITEM	DESCRIPTION	UNIT
4	SITE CLEARING AND GRUBBING, DEMOLITION, REMOVAL AND PROPER DISPOSAL OF MISCELLANEOUS EXISTING ITEMS INCLUDING: CONCRETE SIDEWALK, CURBS, DRIVEWAYS, REINFORCED CONCRETE, ASPHALT PAVEMENT (HMAC & BASE COURSE WITH VARYING THICKNESS), CONCRETE HEADWALLS, GABION STRUCTURES, AND OTHER INCIDENTALS TO ALLOW FOR THE NEW CONSTRUCTION	LS
5	PREPARING RIGHT OF WAY	ACRES



DRAINAGE IMPROVEMENTS		
ITEM	DESCRIPTION	UNIT
6	EXCAVATION AND PROPER DISPOSAL OF UNCLASSIFIED MATERIAL (CUT TO FILL)	CY
7	EXCAVATION AND PROPER DISPOSAL OF UNCLASSIFIED MATERIAL (CUT TO WASTE)	CY
8	EMBANKMENT(FIILL MATERIAL)	CY
9	RIPRAP(STONE)(GROUT)(12IN)	CY
10	FURNISH AND INSTALL REINFORCED CONCRETE RIPRAP(4")	CY
11	FURNISH AND INSTALL REINFORCED CONCRETE RIPRAP FLUMES	CY
12	RIPRAP(CONC)(DISSIPATOR)	CY
13	FURNISH AND INSTALL CONCRETE HEADWALL	EA
14	FURNISH AND INSTALL WINGWALLS	EA
15	FURNISH AND INSTALL GABION BASKETS (9'x3'x3')	CY
16	FURNISH AND INSTALL DIAMOND PLATES FOR FLUMES	SY
ROADWAY IMPROVEMENTS		
ITEM	DESCRIPTION	UNIT
17	REMOVING STAB BASE AND ASPH PAV (4")	SY
18	REPAIR/REPLACE ALLOWANCE: 4-INCH HMAC ASPHALT PAVEMENT (TYPE C) OVER 10-INCH COMPACTED BASE COURSE (TYPE A GRADE 3) WITH SUBGRADE PREPARATION	TON
19	FURNISH AND INSTALL CONCRETE CURB & GUTTER	LF

END OF SECTION



SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Submittal Procedures.
- B. Proposed Products List.
- C. Product Data.
- D. Shop Drawings.
- E. Test Reports.
- F. Certificates.
- G. Manufacturer's Instructions.
- H. Video Taping.
- I. Submittal/Shop Drawing List.

1.2 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall be responsible for:
 - 1. The correctness of the drawings, fittings and field connections, and the results obtained by using such drawings;
 - 2. Verification of catalog numbers, and similar data;
 - 3. Determination and verification of field measurements and field construction criteria;
 - 4. Checking and coordination information in the submittal requirements of the Work and Contraction Documents;
 - 5. Accuracy and completeness of dimensions and quantities;
 - 6. Confirmation and coordination of dimension and field conditions at the site;
 - 7. Safety precautions;
 - 8. Errors and omissions on submittals;
 - 9. Coordination and performance of work of all trades; and
 - 10. Identification of deviation (s) from Contract requirements.
- B. The Contractor shall certify dimensional compatibility of the product with the space in which it is intended to be used and the review of submittals for compliance with Contract requirements.
- C. Each submittal shall have affixed to it the following Certification Statement including the Contractor's Company name and stamp, initials or signature on the transmittal/submittal form:



“Certification Statement: I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers, and similar data, and I have checked and coordinated each item with other applicable approved submittals and all Contract requirements.”

1.3 PROPOSED PRODUCTS LIST

- A. The Contractor shall submit, within 15 working days after date of Notice to Award, a list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.4 SUBMITTAL CATEGORIES

- A. Submittals fall into four categories: Shop Drawings, Product Data, Samples, Tests Reports and Certifications.
- B. **Shop Drawings:**
 - 1. Submit newly prepared information, drawn to accurate scale. Highlight, circle, or otherwise indicate deviations from the Contract Documents. The Contractor **SHALL NOT** reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to Project is not considered Shop Drawings.
 - 2. Shop drawings shall be prepared with sufficient detail and notation for field erection, fabrication, installation, setting diagrams, schedules, patterns, templates and similar drawings. Shop drawing shall also include dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, and notation of dimensions established by field measurements.
 - 3. Submittals which utilize electronic files on any of the drawings in the contract documents **SHALL NOT** be used, unless a written agreement that stipulates the conditions, under which these documents may be used, is executed between the user and the Engineer of record.
 - 4. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
 - 5. After review, produce copies and distribute in accordance with this section and for record documents described in *Section 01 70 00 – Execution and Closeout Requirements*.
- C. **Product Data:**
 - 1. Submit number of copies Contractor requires, plus two copies Engineer will retain.
 - 2. Supplement manufacturers' standard data to provide information specific to this Project.
 - 3. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.



4. After review, produce copies and distribute in accordance with article 1.2 of this section and for record documents described in *Section 01 70 00 - Execution and Closeout Requirements*.

D. Manufacturer's Certificates and Instructions:

1. When specified in individual specification sections, submit certification by manufacturer, installation/application subcontractor, or Contractor to Engineer, in quantities specified for Product Data.
2. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
3. Certificates may be recent or previous test results on material or Product, but must be acceptable to Engineer.
4. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Engineer for delivery to Owner in quantities specified for Product Data.
5. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

E. Samples:

1. Contractor shall submit product samples as specified under the technical specifications.
2. Contractor shall submit supplemental information related to product samples.

1.5 SUBMITTAL REQUIREMENTS

- A. Schedule submittals to expedite Project, and deliver to Project Inspector. Coordinate submission of related items.
- B. Submittal Delivery:
 1. A total of **3-hard copies** are required for each submittal. Substitution of electronic copies in lieu of hard-copies **shall** be approved by Owner and/or determined by the use of a Construction Management software program.
- C. Transmittal Form:
 1. Transmit each submittal with AIA Form G810, or similar Engineer accepted form.
 2. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.
 3. Identify Project, Contractor, subcontractor and supplier; pertinent drawing and detail number, and specification section number, appropriate to submittal on transmittal form.
 4. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents
 5. Allow space on submittals for Contractor and Engineer review stamps.
 6. Mark each copy (**highlighter markings shall not be accepted**) to identify applicable products, models, options, and other data
- D. Submittal Review Period:



1. The Contractor **shall allow 10-working days** for each submittal review, excluding delivery time to and from Contractor.
- E. Professional Seal Required:
 1. Submittals involving engineering design services, when required by the Contract Documents or by governing codes and regulations, such as shoring and underpinning, excavation support structures, falsework or concrete, fire protection system design, and load and design calculations, shall be sealed and signed in blue/black ink by a professional engineer, currently registered in the State of Texas, for the discipline involved.
 2. When required by individual specification sections, provide shop drawings signed and sealed by professional engineer responsible for designing components shown on shop drawings.
 - a. Include signed and sealed calculations to support design.
 - b. Submit drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
 - c. Make revisions and provide additional information when required by authorities having jurisdiction.
- F. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of completed Work.
- G. When revised for resubmission, identify changes made since previous submission.
- H. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.
- I. Submit requests for interpretation of Contract Documents, and obtain instructions through the Owner.
- J. Process requests for substitutions, and change orders, through the Owner or his designated agent.
- K. Deliver closeout submittals for review and preliminary inspection reports.
- L. Submittals not requested will not be recognized or processed.
- M. Changes in Approved Submittals:
 1. Changes in approved submittals shall not be allowed unless those approved submittals with changes have been resubmitted and approved, in the same manner as the original submittal.

1.6 ENGINEER'S REVIEW OF SUBMITTALS

- A. Submittals will be reviewed for general conformance with requirements of the Contract Documents.
- B. Submittals shall be understood as being made for approval, unless otherwise specified, for example, as being made for Project Information Only, For Review, or For Review. The Engineer will indicate its reviews of the submittals and the action taken (approvals and non-approvals) by means of its review stamp. The review stamp will be affixed by the



Engineer, the action block will be marked, and the stamp will be signed in blue/black ink and dated.

- C. The review stamp action-blocks/codes will have the following meanings:
1. **CODE 1 – REVIEWED** is in acceptance, and means that the submittal appears to conform to the respective requirements of the Contract Documents. Fabrication, assembly, manufacture, installation, application, and erection of the described and illustrated product may proceed.
 2. **CODE 2 – REJECTED** is a disapproval, and means that the submittal is deficient of the degree that the reviewer cannot correct the submittal with a reasonable degree of effort, has not made a thorough review of the submittal, and that submittal needs revision and is to be corrected and resubmitted to meet the intent of the Contract Documents.
 3. **CODE 3 – REVISE AND RESUBMIT** is a limited approval except for the work impacted by the notes and comments, and means that the submittal requires corrections to conform to the respective requirements of the Contract Documents. Fabrication, assembly, manufacture, installation, application, and erection of the described and illustrated product may proceed at the Contractor's risk for the elements of work not impacted by and changes required to incorporate the reviewer's corrections.
 4. **CODE 4 – FURNISH AS CORRECTED** is an acceptance, and means that the submittal appears to conform to the respective requirements of the Contract Documents upon incorporation of the reviewer's corrections. Fabrication, assembly, manufacture, installation, application, and erection of the described and illustrated production may proceed. Submittals so marked need not be resubmitted unless the Contractor challenges the reviewer's exception within **5-calendar days**. All noted changes will be reflected in the as-built drawings by the Contractor.
- D. Corrections or comments made on the shop drawings during this review do not relieve the Contractor from compliance with requirements of the drawings and specifications. This check is only for review of the general conformance with the design concept of the project and general compliance with the information given in the contract documents. The contractor is responsible for confirming and correlating all quantities and dimension, selection fabrication processes and techniques of construction; coordinating his/her work with that of all other trades and performing all work in a safe and satisfactory manner.

1.7 SUBMITTAL AND SHOP DRAWING LIST

- A. Contractor shall be responsible for delivering submittals for the Engineer to review as specified in the previous sections.
- B. The contractor is expected to submit at a minimum the submittals listed on Table 1.10.1 – Submittal and Shop Drawing Schedule. Submittals and shop drawings **SHALL include but are not limited** to those listed on Table 1.7.1.



Table 1.7.1 Submittal and Shop Drawing Schedule

Specification	Submittal Number	Required Items
01 10 00 Summary	01 10 00 – 1	• Contractor’s Key Personnel.
	01 10 00 – 2	• Emergency Contact Information.
	01 10 00 – 3	• Superintendent’s Resume.
01 02 00 TPDES Requirements	01 02 00 - 1	• NOI, Storm Water Pollution Prevention Plan, Contractor’s, Subcontractor’s Certification for TPDES permitting.
01 20 00 Price and Payment Procedures	01 20 00 – 1	• Schedule of Values.
01 30 00 Administrative Requirements	01 30 00 – 1	• Professional Land Surveyor Contact Information.
01 30 01 Pre/Post Construction Video	01 30 31 – 1	• Color Recording with Narrative.
01 31 19 Project Meetings	01 31 19 – 1	• Two-Week Look-Ahead Schedule.
01 32 16 Construction Progress Schedule	01 32 16 – 1	• Primary Baseline Schedule.
	01 32 16 - 2	• Construction Schedule.
01 33 00 Submittal Procedures	01 33 00 – 1	• Shop Drawings, Product Data, Samples, Test Reports and Certifications.
01 40 00 Quality Requirements	01 40 00 – 1	• Testing Agency Information.
01 50 00 Temporary Facilities and Controls	01 50 00 – 1	• Traffic Control Plan.
01 70 00 Execution and Closeout Requirements	01 70 00 – 1	• Record of As-built Specifications.
	01 70 00 – 2	• Record of As-built Drawings and Shop Drawings.
01 78 39 Project Record Documents	01 78 39 – 1	• As-built Drawings and One CD.
02 41 19 Selective Structure Demolition	02 41 19 – 1	• Demolition Schedule.



Table 1.7.1 Submittal and Shop Drawing Schedule

Specification	Submittal Number	Required Items
03 30 00 Cast-in-Place Concrete	03 30 00 - 1	• Product Data, Material's Source and Manufacturer's Certificate.
03 31 00 Structural Concrete	03 31 00 - 1	• Product Data, Material's Source and Manufacturer's Certificate.
05 80 00 Steel Diamond Floor Plate Cover	05 80 00 - 1	• Product Data, Material's Source and Manufacturer's Certificate.
07 92 00 Joint Sealants	07 92 00 - 1	• Product Data and Manufacturer's Certificate.
31 05 13 Soils for Earthwork	31 05 13 - 1	• Product Data, Material's Source and Manufacturer's Certificate.
31 10 00 Site Clearing	31 10 00 - 1	• Product Data, Material's Source and Manufacturer's Certificate. Herbicide for weed control. • Video Recording.
31 22 13 Rough Grading	31 22 13 - 1 31 22 13 - 2	• Hauling Routes. • Record of As-built Drawings (Existing Utilities).
31 23 16 Excavation	31 23 16 - 1	• Excavation Protection Plan and Shop Drawings.
31 23 17 Trenching	31 23 17 - 1	• Trench Safety Plan and Trench Safety System (Per OSHA Regulations).
31 23 23 Select Fill	31 23 23 - 1	• Product Data, Materials Source and Manufacturer's Certificate.
31 37 00 Riprap	31 37 00 - 1	• Product Data, Material's Source and Manufacturer's Certificate.
32 11 23 Aggregate Base Courses	32 11 23 - 1	• Product Data, Material's Source and Manufacturer's Certificate.
	32 11 23 - 2	• Product Data, Material's Source and Manufacturer's Certificate.
32 12 16 Asphalt Paving	32 12 16 - 1	• Product Data, Material's Source and Manufacturer's Certificate.
32 13 33 Concrete Paving	32 13 13 - 1	• Product Data, Material's Source and Manufacturer's Certificate.
32 13 40 Galvanized Gabion Basket	32 13 40 - 1	• Product Data, Material's Source and Manufacturer's Certificate.



Table 1.7.1 Submittal and Shop Drawing Schedule

Specification	Submittal Number	Required Items
32 14 00 Portland Cement Concrete	32 14 00 – 1	• Product Data, Material's Source, Manufacturer's Certificate and Mill Certificate.
32 15 00 Concrete Curing Compound	32 15 00 – 1	• Product Data and Manufacturer's Certificate.

1.8 MEASUREMENT AND PAYMENT

- A. The work performed, and materials furnished as this bid item requires will not be paid for directly but will be subsidiary to its associated bid items.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION



SECTION 01 40 00

QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Quality Control and Control of Installation.
- B. Tolerances.
- C. References.
- D. Testing and Inspection Services.
- E. Costs Paid by the Contractor.
- F. Contractor's Responsibilities.
- G. Manufacturer's Field Services and Reports.
- H. Examination.
- I. Preparation.

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.



1.3 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, the Contractor **shall request clarification** from Engineer before proceeding.
- C. Adjust products to appropriate dimensions and position before securing products in place.

1.4 REFERENCES

- A. For products or workmanship specified by association, trades, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.
- C. Obtain copies of standards where required by product specification sections.
- D. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
- E. Neither contractual relationships, duties, nor responsibilities of parties in Contract, nor those of Engineer shall be altered from Contract Documents by mention or inference otherwise in reference documents.

1.5 TESTING AND INSPECTION SERVICES

- A. Contractor **shall employ and pay** for specified services of an independent laboratory to perform testing and inspection.
- B. The independent laboratory will perform tests, inspections and other services specified in individual specification sections and as required by Project Inspector and Engineer.
- C. Testing, inspections and source quality control may occur on or off project site. Perform off-site testing as required by Project Inspector or Engineer.
- D. Reports will be submitted by independent laboratory to Project Inspector and Engineer, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
 - 1. Submit final report indicating correction of Work previously reported as non-compliant.
- E. Cooperate with independent laboratory; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
 - 1. Notify Project Inspector and independent laboratory 24-hours prior to expected time for operations requiring services.



2. Make arrangements with independent laboratory and pay for additional samples and tests required for Contractor's use.
- F. Testing and employment of testing agency or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.
- G. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same independent laboratory as directed by the Project Inspector. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.
- H. Agency Responsibilities:
 1. Test samples of mixes submitted by Contractor.
 2. Provide qualified personnel at site. Cooperate with Project Inspector and Contractor in performance of services.
 3. Perform specified sampling and testing of products in accordance with specified standards.
 4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 5. Promptly notify Project Inspector and Contractor of observed irregularities or non-conformance of Work or products.
 6. Perform additional tests required by Project Inspector/Engineer.
 7. Attend preconstruction meetings and progress meetings.
- I. Agency Reports: After each test, promptly submit two copies of report to Project Inspector and Engineer, Contractor, and authority having jurisdiction. When requested by Project Inspector or Engineer, provide interpretation of test results. Include the following:
 1. Date issued.
 2. Project title and number.
 3. Name of inspector.
 4. Date and time of sampling or inspection.
 5. Identification of product and specifications section.
 6. Location in Project.
 7. Type of inspection or test.
 8. Date of test.
 9. Results of tests.
 10. Conformance with Contract Documents.
- J. Limits on Testing Authority:
 1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 2. Agency or laboratory may not approve or accept any portion of the Work.
 3. Agency or laboratory may not assume duties of Contractor.
 4. Agency or laboratory has no authority to stop the Work.
- K. The testing laboratory shall e-mail copies of all test reports and results directly to the Project Inspector and Engineer on the same day the results are available.
- L. The Owner may conduct independent inspection and QA/QC testing of construction, materials and equipment throughout the duration of construction.



1.6 COSTS PAID BY THE CONTRACTOR

- A. Re-tests and re-inspections by the laboratory for all testing required due to defective work and testing, will be back-charged to Contractor (overtime and standby time).

1.7 CONTRACTOR'S RESPONSIBILITIES

- A. Cooperate with laboratory personnel; provide access to the work and to manufacturer's operations. Provide samples of materials to be tested, in the required quantities, to the laboratory representative at the Contractor's expense. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship to produce work specified quality. Comply fully with manufacturer's instructions, including performing each step-in sequence.
- B. Should manufacturer's instructions conflict with Contract Documents, request clarification from Project Inspector before proceeding. Comply with specified standards as a minimum quality for the work except when more stringent tolerances, codes or specified requirements indicate higher standards or more precise workmanship. Perform work by persons qualified to produce workmanship of specified quality. Furnish copies of mill test reports to the laboratory.
- C. Furnish labor and facilities:
 - 1. Access to work to be tested.
 - 2. To obtain and handle test samples at the site.
 - 3. To facilitate inspections and tests.
 - 4. For laboratory's exclusive use for storage and curing of test samples until removed to the laboratory.
 - 5. To repair any test holes in order to match original conditions.
- D. Testing shall not be cause for claims for delay by the Contractor, and all expenses accruing there from, shall be deemed to be incidental to the Contract.

1.8 MANUFACTURER'S FIELD SERVICES AND REPORTS

- A. When specified in individual specifications sections, suppliers or manufacturers shall provide qualified personnel to observe site conditions, installations and quality of workmanship, as applicable and to initiate instructions when necessary. Submit report to the Engineer for review within seven days of observations.

PART 2 PRODUCTS – Not Used

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.



- B. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Verify utility services are available, of correct characteristics, and in correct locations.

3.2 PREPARATION

- A. Existing pavement, topsoil, vegetation, roots, and any soft soils in the construction areas shall be stripped from the site and hauled away from the site as it is generated.

3.3 PAYMENT

- A. The work performed, and materials furnished as this bid item requires will not be paid for directly but will be subsidiary to its associated bid items.

END OF SECTION



SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Construction Facilities:
 - 1. Field offices and sheds.
 - 2. Vehicular access.
 - 3. Parking.
 - 4. Progress cleaning and waste removal.
 - 5. Project identification.
 - 6. Traffic regulation.
 - 7. Fire prevention facilities.
- B. Temporary Controls:
 - 1. Barriers.
 - 2. Enclosures and fencing.
 - 3. Security.
 - 4. Water control.
 - 5. Dust control.
 - 6. Erosion and sediment control.
 - 7. Protection of Streams, Laterals and Canals.
 - 8. Noise control.
 - 9. Pest control.
 - 10. Pollution control.
 - 11. Rodent control.
- C. Removal of utilities, facilities, and controls.

1.2 TEMPORARY ELECTRICITY

- A. Provide and pay for power service required from utility source as needed for construction operation.
- B. Provide temporary electric feeder from electrical service at location as directed by the El Paso County. Do not disrupt El Paso County's use of service.
- C. Complement existing power service capacity and characteristics as required for construction operations.
- D. Provide power outlets, with branch wiring and distribution boxes located as required for construction operations. Provide flexible power cords as required for portable construction tools and equipment.
- E. Permanent convenience receptacles may not be utilized during construction.



1.3 TELEPHONE SERVICE

- A. Provide, maintain, and pay for telephone service at time of project mobilization.

1.4 FACSIMILE SERVICE

- A. Provide, maintain and pay for facsimile service and dedicated telephone line at time of project mobilization.

1.5 TEMPORARY WATER SERVICE

- A. Provide and pay for suitable quality water service as needed to maintain specified conditions for construction operations. Connect to existing water source
- B. Extend branch piping with outlets located so water is available by hoses with threaded connections. Provide temporary pipe insulation to prevent freezing.

1.6 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Local businesses facility use is not permitted. Provide facilities at time of project mobilization.

1.7 VEHICULAR ACCESS

- A. Construct temporary all-weather access roads from public thoroughfares to serve construction area, of width and load bearing capacity to accommodate unimpeded traffic for construction purposes.
- B. Construct temporary bridges and culverts to span low areas and allow unimpeded drainage.
- C. Extend and relocate vehicular access as Work progress requires, provide detours as necessary for unimpeded traffic flow.
- D. Provide unimpeded access for emergency vehicles. Maintain 20 feet wide driveways with turning space between and around combustible materials.
- E. Provide and maintain access to fire hydrants and control valves free of obstructions.
- F. Provide means of removing mud from vehicle wheels before entering streets.

1.8 PARKING

- A. Arrange for temporary surface parking areas to accommodate construction personnel.
- B. Locate Contractor personnel parking as approved by El Paso County.
- C. When site space is not adequate, provide additional off-site parking.
- D. Use of existing on-site streets and driveways for construction traffic is not permitted. Tracked vehicles not allowed on paved areas.



- E. Use of existing parking facilities by construction personnel is not permitted.
- F. Do not allow heavy vehicles or construction equipment in parking areas.
- G. Do not allow vehicle parking on existing pavement.
- H. Maintenance:
 - 1. Maintain traffic and parking areas in sound condition free of excavated material, construction equipment, products, mud, snow, and ice.
 - 2. Maintain existing and permanent paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.
- I. Removal, Repair:
 - 1. Repair existing facilities damaged by use, to original specified condition.
- J. Mud from Site Vehicles: Provide means of removing mud from vehicle wheels before entering streets.

1.9 PROGRESS CLEANING AND WASTE REMOVAL

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, inlets, other closed or remote spaces, prior to enclosing spaces.
- C. Broom and vacuum clean interior areas prior to start of surface finishing and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and rubbish from site weekly and dispose off-site.

1.10 PROJECT IDENTIFICATION

- A. Design sign and structure to withstand 60 miles/hr wind velocity.
- B. Sign shall include the Project Name, Construction Duration, Contractor's Name, and shall have all applicable permits displayed.
- C. Maintenance: Maintain signs and supports clean, repair deterioration and damage.
- D. Removal: Remove signs, framing, supports, and foundations at completion of Project and restore area.

1.11 TRAFFIC REGULATION

- A. Signs, Signals, And Devices:
 - 1. Post Mounted and Wall Mounted Traffic Control and Informational Signs: As approved by authority having jurisdiction.



2. Traffic Control Signals: As approved by the County of El Paso and Texas Department of Transportation.
3. Traffic Cones and Drums, Flares and Lights: As approved by the County of El Paso and Texas Department of Transportation.
4. Flag person Equipment: As required by the County of El Paso and Texas Department of Transportation.
5. Portable Changeable Message Signs:
 - a. The Engineer/Inspector shall approve all messages used on portable changeable message signs (PCMS).
 - b. Messages on PCMS should contain no more than 8 words (about four to eight characters per word), not including simple words such as "TO," "FOR," "AT," etc.
 - c. Messages should consist of a single phase, or two phases that alternate. Three-phase message are not allowed. Each phase of the message should convey a single thought, and must be understood by itself.
 - d. When in use the bottom of a stationary PCMS message panel should be a minimum 7 feet above the roadway, where possible.
 - e. The Engineer/Inspector may select one of two options which are available for displaying a two-phase message on a PCMS. Each phase may be displayed for either four seconds each or for three seconds each.
 - f. Do not "flash" messages or words included in a message. The message should be steady burn or continuous while displayed.
 - g. Do not present redundant information on a two-phase message: i.e., keeping two lines of the message the same and changing the third line.
 - h. Do not use the word "Danger" in message.
 - i. Do not display the message "LANES SHIFT LEFT" or "LANES SHIFT RIGHT" on a PCMS. Drivers do not understand the message.
 - j. Do not display messages that scroll horizontally or vertically across the face of the sign.
 - k. The following table lists abbreviated words and two-word phrases that are acceptable for use on a PCMS, shown in Table 1. Both words in a phrase must be displayed together. Words or phrases not on this list should not be abbreviated, unless shown in the TMUTCD.
 - l. PCMS character height should be at least 18 inches for trailer mounted units. They should be visible from at least ½ (.5) mile and the text should be legible from at least 600 feet at night and 800 feet in daylight. Truck mounted units must have a character height of 10 inches and must be legible from at least 400 feet.
 - m. Each line of text should be centered on the message board rather than left or right justified.
 - n. If disabled, the PCMS should default to an illegible display that will not alarm motorists and will only be used to alert workers that the PCMS has malfunctioned. A pattern such as a series of horizontal solid bars is appropriate.
 - o. PCMS signs within the ROW shall be behind guardrail or concrete barrier or shall have a minimum of four (4) plastic drums placed perpendicular to traffic on the upstream side of the PCMS, when exposed to one direction of traffic. When exposed to two way traffic, the four drums should be placed with one drum at each of the four corners of the unit.



TABLE 1 - ACCEPTABLE ABBREVIATED WORDS AND PHRASES FOR USE ON A PCMS

Word or Phrase	Abbreviation	Word or Phrase	Abbreviation
Access Road	ACCS RD	Major	MAJ
Alternate	ALTNATE	Miles	MI
Avenue	AVE	Miles Per Hour	MPH
Best Route	BEST RTE	Minor	MNR
Boulevard	BLVD	Monday	MON
Bridge	BRDG	Normal	NORM
Cannot	CANT	North	N
Center	CTR	Northbound	(route) N
Construction Ahead	CONST AHD	Parking	PKING
Crossing	XING	Road	RD
Detour Route	DETOUR RTE	Right Lane	RT LN
Do Not	DON'T	Saturday	SAT
East	E	Service Road	SERV RD
Eastbound	(route) E	Shoulder	SHLDR
Emergency	EMER	Slippery	SLIP
Emergency Vehicle	EMER BEH	South	S
Entrance, Enter	ENT	Southbound	(route) S
Express Lane	EXP LN	Speed	SPD
Expressway	EXWY	Street	ST
XXXX Feet	XXXX FT	Sunday	SUN
Fog Ahead	FOG AHD	Telephone	PHONE
Freeway	FRWY, FWY	Temporary	TEMP
Freeway Blocked	FWY BLKD	Thursday	THURS
Friday	FRI	To Downtown	TO DWNTN
Hazardous Driving	HAX DRIVING	Traffic	TRAF
Hazardous Material	HAXMAT	Travelers	TRVLRS
High-Occupancy	HOV	Tuesday	TUES
Vehicle Highway	HWY	Time Minutes	TIME MIN
Hour(s)	HR, HRS	Upper Level	UPR LEVEL
Information	INFO	Vehicles (s)	VEH, VEHS
It Is	ITS	Warning	WARN
Junction	JCT	Wednesday	WED
Left	LFT	Weight Limit	WT LIMIT
Left Lane	LFT LN	West	W
Lane Closed	LN CLOSED	Westbound	(route) W
Lower Level	LWR LEVEL	Wet Pavement	WT PVMT
Maintenance	MAINT	Will Not	WONT



- B. Flag Persons: Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.
- C. Flares and Lights: Use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.
- D. Haul Routes:
 - 1. Shall be approved by the owner. Establish public thoroughfares to be used for haul routes and site access.
- E. Traffic control for all areas of the project shall be the responsibility of the Contractor. The traffic control plan (TCP) shall conform to the specifications and principles given in the "TEXAS MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES", latest edition and version issued by the Texas Department of Transportation (TxDOT). The TCP shall be sealed by a licensed professional engineer in the State of Texas. The Contractor shall prepare a TCP acceptable to and approved by EPDOT. Contractor shall maintain permit active. All traffic control plans shall include an electronic traffic message board that is programmable and is to be strategically placed at the site.
- F. The Contractor shall erect portable message signs for a period of six (6) days prior to commencement of staging construction activities. Signs shall display message notifying traveling public of upcoming construction. Contact EPDOT representatives for exact message to be displayed and location of signs.
- G. Businesses, emergency facilities, schools, and E.M.S. shall be advised and/or consulted prior to the start of construction. Access to the public and private property – local access shall be maintained to all surrounding properties at all times during construction and maintenance activities. The TCP shall show the hours of the day and the tentative total number of days it will be in effect.

1.12 FIRE PREVENTION FACILITIES

- A. Designate area on site where smoking is permitted. Provide approved ashtrays in designated smoking areas.
- B. Establish fire watch for cutting and welding and other hazardous operations capable of starting fires. Maintain fire watch before, during, and after hazardous operations until threat of fire does not exist.
- C. Portable Fire Extinguishers: NFPA 10; 10-pound capacity, 4A-60B; C UL rating.
 - 1. Provide minimum one fire extinguisher in every construction trailer and storage shed.

1.13 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition.



- B. Provide barricades and covered walkways required by authorities having jurisdiction for public rights-of-way and for public access to existing building.
- C. Provide protection for plants designated to remain. Replace damaged plants.
- D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.14 ENCLOSURES AND FENCING

- A. Construction: Contractor's option.
- B. Provide protection.

1.15 SECURITY

- A. Security Program:
 - 1. Protect Work existing premises from theft, vandalism, and unauthorized entry.
 - 2. Initiate program at project mobilization.
 - 3. Maintain program throughout construction period until Owner acceptance.
- B. Entry Control:
 - 1. Restrict entrance of persons and vehicles into Project site and existing facilities.
 - 2. Allow entrance only to authorized persons with proper identification.
 - 3. Maintain log of workers and visitors, make available to Owner on request.
 - 4. Coordinate access of Owner's personnel to site in coordination with Owner's security forces.

1.16 WATER CONTROL

- A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
- B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.
- C. It will be the responsibility of the Contractor to schedule and perform the work to provide proper passage of any storm water during the course of the operations. All labor, tools, equipment and supervision required to assure such proper passage of runoff water and any removal or handling of water in order to maintain dry conditions shall be considered as incidental to the remainder of the work and shall be at the expense of the Contractor.

1.17 DUST CONTROL

- A. Execute Work by methods to minimize raising dust from construction operations.
- B. Provide positive means to prevent air-borne dust from dispersing into atmosphere.
- C. Water as needed to prevent air-borne dust; a minimum of twice a day.



1.18 EROSION AND SEDIMENT CONTROL

- A. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
- B. Minimize surface area of bare soil exposed at one time.
- C. Provide temporary measures including berms, dikes, and drains, and other devices to prevent water flow.
- D. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.
- E. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.

1.19 PROTECTION OF POND AND DRAINAGE STRUCTURES

- A. Care shall be taken to prevent any damage to the pond and drainage structures from pollution by debris, sediment, or other material, or from the manipulation of equipment and/or materials in or near the structures. Water that has been used for washing or processing, or that contains oil that may reduce the quality of the pond shall be removed from the site.
- B. All preventative measures shall be taken to avoid spillage of petroleum products and other pollutants. In the event of any spillage, prompt remedial action shall be taken in accordance with local and state agency regulations.

1.20 NOISE CONTROL

- A. Provide methods, means, and facilities to minimize noise and noise produced by construction operations.
- B. Working hours to comply with City of El Paso's work hours within residential areas.

1.21 PEST CONTROL

- A. Provide methods, means, and facilities to prevent pests and insects from damaging the Work.

1.22 POLLUTION CONTROL

- A. Comply with pollution and environmental control requirements of authorities having jurisdiction.
- B. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.
- C. The control of environmental pollution requires consideration of air, water, land, and involves management of noise and solid waste, as well as other pollutants.



- D. During the life of this Contract, maintain all facilities constructed for pollution control if the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created.

1.23 RODENT CONTROL

- A. Provide methods, means, and facilities to prevent rodents from accessing or invading premises.

1.24 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Substantial Completion inspection.
- B. Clean and repair damage caused by installation or use of temporary work.
- C. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

1.25 STORMWATER MANAGEMENT

- A. It will be the responsibility of the Contractor to schedule and perform the work to provide proper passage of any storm water during the operations. All labor, tools, equipment and supervision required to assure such proper passage of runoff water and any removal or handling of water in order to maintain dry conditions shall be considered as incidental to the remainder of the work and shall be at the expense of the Contractor.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

PART 4 PAYMENT

4.1 PAYMENT

- A. The work performed, and materials furnished as this bid item requires will not be paid for directly but will be subsidiary to its associated bid items.

END OF SECTION



SECTION 01 60 00

PRODUCT REQUIREMENTS

1.1 SECTION INCLUDES

- A. Products.
- B. Product delivery requirements.
- C. Product storage and handling requirements.

1.2 PRODUCTS

- A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.
- B. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.
- C. Furnish interchangeable components from same manufacturer for components being replaced.

1.3 PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect products in accordance with manufacturers' instructions.
- B. Store with seals and labels intact and legible.
- C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- D. For exterior storage of fabricated products, place on sloped supports above ground.
- E. Provide off-site storage and protection when site does not permit on-site storage or protection.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.



- G. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.
- H. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

PART 4 PAYMENT

4.1 PAYMENT

- A. The work performed, and materials furnished as this bid item requires will not be paid for directly but will be subsidiary to its associated bid items.

END OF SECTION



SECTION 01 70 00

EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Closeout procedures.
- B. Final cleaning.
- C. Protecting installed construction.
- D. Project record documents.
- E. Product warranties and product bonds.

1.2 CLOSEOUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's review.
- B. Provide submittals to Engineer and the County of El Paso required by authorities having jurisdiction.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, sum remaining due, and in accordance with the County of El Paso's requirements.

1.3 FINAL CLEANING

- A. Execute final cleaning prior to final project assessment.
- B. Clean equipment and fixtures to sanitary condition with cleaning materials appropriate to surface and material being cleaned.
- C. Clean debris from the drainage system.
- D. Clean site; sweep paved areas, rake clean landscaped surfaces.
- E. Remove waste and surplus materials, rubbish, and construction facilities from site.

1.4 PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual specification sections.



- B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- C. Prohibit traffic from landscaped areas.

1.5 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed Shop Drawings, Product Data, and Samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress, not less than weekly.
- E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and modifications.
- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 2. Field changes of dimension and detail.
 - 3. Details not on original Contract drawings.
- G. Submit documents to owner with claim for final Application for Payment.

1.6 PRODUCT WARRANTIES AND PRODUCT BONDS

- A. Obtain warranties and bonds executed in duplicate by responsible subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.
- B. Execute and assemble transferable warranty documents and bonds from subcontractors, suppliers, and manufacturers.
- C. Verify documents are in proper form, contain full information, and are notarized.
- D. Co-execute submittals when required.



- E. Include Table of Contents and assemble in three D side ring binder with durable plastic cover.
- F. Submit prior to final Application for Payment.
- G. Time of Submittals:
 - 1. Make other submittals within ten days after Date of Substantial Completion, prior to final Application for Payment.
 - 2. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within ten days after acceptance, listing date of acceptance as beginning of warranty or bond period.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

PART 4 PAYMENT

4.1 PAYMENT

- A. The work performed, and materials furnished as this bid items requires will not be paid for directly but will be subsidiary to its associated bid items.

END OF SECTION



SECTION 01 78 39
PROJECT RECORD DRAWINGS

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all tools, qualified superintendence and all services for the recording of all As-built Contract Drawings and As-built Specifications as required by the Contract Documents. Complete work as shown and specified herein.

1.2 SECTION INCLUDES

- A. As-built Contract Drawings.
- B. As-built Specifications.

1.3 DEFINITIONS

- A. Record Documents: As-built Contract Drawings and As-built Specifications completed by the Contractor.
- B. As-built Contract Drawings or Contract Specifications: Drawings or specification section of the Contract Documents marked-up (a.k.a. "red-lined") by Contractors to indicate work as completed that deviates from work as designed, and changes from Addendum, Change Orders, Requests for Information, Shop Drawings, Submittals, Architect's Supplemental Instructions, or Requests for Proposals.
- C. Record Drawings or Contract Specifications: Drawings or specification section of the Contract Documents showing work as completed, compiled (incorporating all Contractor As-built Drawings) by the Engineer.

1.4 SUBMITTALS

- A. Refer to *Section 01 33 00 – Submittal Procedures*.
- B. Within ten (10) working days of completion of site improvements, the Contractor shall submit to the Engineer the original As-built Drawings and one (1) CD with scanned color copies of each As-built Contract Drawing.
- C. Submit Project Record Documents to Project Inspector and/or Engineer with claim for Final Application of Payment.

1.5 AS-BUILT CONTRACT DRAWINGS

- A. During construction, the Contractor shall maintain a set of As-built Documents specifically for the sole purpose of creating As-built documents, separate from the set used for construction. The Contractor shall not use the Record Documents for construction purposes. Maintain As-built Documents in good order.



- B. The Contractor shall mark As-built Contract Drawings to show the actual installation where the installation varies from the installation shown originally. Give attention to information on concealed elements that would be difficult to identify or measure and record later. Items required to be marked include, but are not limited to, the following:
1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 2. Horizontal locations shall be recorded with northing and easting coordinates. Refer to *Section 01 30 00 – Administrative Requirements*.
 3. Vertical locations shall be recorded as the distance between the finished grades to the actual soffit of the utility line/pipe.
 4. Locations of concealed internal utilities and appurtenances.
 5. Actual equipment locations.
 6. Revisions to routing of piping and conduits.
 7. Depths of foundations.
 8. Dimensional changes to the Drawings.
 9. Revisions to details on the Drawings.
 10. Details not on original Contract Drawings
 11. Changes made by Addendum, Change Orders, Requests for Information (RFIs), Architect's Supplemental Instructions (ASIs), or Requests for Proposals (RFPs).

1.6 AS-BUILT SPECIFICATIONS

- A. Mark As-built Specifications to show Addendum, Change Orders, Requests for Information (RFIs), Architect's Supplemental Instructions (ASIs), or Requests for Proposals (RFPs).

PART 2 PRODUCTS – Not Used

PART 3 EXECUTION

3.1 RECORDING

- A. During construction, the Contractor shall maintain a set of As-built Documents specifically for the purpose of creating As-built documents, separate from the set used for construction. The Contractor shall not use the Record Documents for construction purposes. Maintain As-built Documents in good order and in a clean, dry, legible condition.
- B. The Contractor shall mark As-built Documents to indicate actual work done that deviates from the Contract Drawings.
- C. The Contractor shall mark important additional information that was either shown schematically or omitted from Contract Documents. The As-built Documents shall be marked completely and accurately.
- D. The Contractor shall use colors to distinguish between changes for different categories of the Work at the same location. As-built Documents shall be marked with an erasable colored pencil conforming to the following color code:
1. **Additions – Green**
 2. **Deletions – Red**



3. Comments – Blue
4. Dimensions – Graphite

- E. All marks shall be photo-reproducible.
- F. Reference any changes to the Contract, including but not limited to Addenda, Change Orders, Change Directives, Supplemental Instructions, and other issued modifications. Use specific document numbers.
- G. Make all documents and samples available at all times for the Owner's and Engineer's inspections.

3.2 RESPONSIBILITY FOR MARKUP

- A. The individual or entity who obtained as-built data, whether the individual or entity is the installer, contractor, subcontractor, or similar entity, shall record the markup.
- B. The Contractor shall record changes and modifications daily.
- C. The Contractor shall record and check the markup prior to enclosing concealed installations.

3.3 PAYMENT

- A. The work performed, and materials furnished as this bid item requires will not be paid for directly but will be subsidiary to its associated bid items. Record keeping activities will be reviewed at the end of each month by the Owner's representative and requests for payment will be withheld if they are not kept current, and until corrected.

END OF SECTION

DIVISION 02
EXISTING CONDITION



SECTION 02 41 19

SELECTIVE STRUCTURE DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Demolishing existing reinforced concrete drainage structures and designated construction.
- B. Protecting items designated to remain and adjacent properties.
- C. Removing demolished materials.

1.2 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 SUBMITTALS

- A. Requirements for submittals: Refer to *Section 01 33 00 - Submittal Procedures*.
- B. Schedule of Selective Demolition Activities:
 - 1. Detailed sequence of selective demolition and removal of work, with starting and ending dates for each activity.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Locations of proposed dust and noise control temporary partitions and means of egress.
 - 5. Means of protection for items to remain and items in path of waste removal.
- C. Prior to any construction, the project site shall be videotaped by the Contractor accompanied by the Engineer or representative, to show existing conditions of the adjacent properties, easements, structures, utilities, drainage structures, channels, and other existing improvements. After completion of the project, the site shall be videotaped by the Contractor accompanied by the Engineer or representative to show the condition of the finished construction of adjacent properties, easements, structures, utilities, drainage structures, channels and other completed improvements under this project. Two copies in DVD format shall be furnished to the Engineer prior to and after construction and shall include labels including project title, bid no. and date recorded.



1.4 CLOSEOUT SUBMITTALS

- A. Requirements for submittals: Refer to *Section 01 70 00 - Execution and Closeout Requirements*.
- B. Project Record Documents: Accurately record actual locations of capped utilities, concealed utilities discovered during demolition, subsurface obstructions, and changes in the drawings.

1.5 QUALITY ASSURANCE

- A. Conform to the County of El Paso code for demolition work, and dust control.
- B. Conform to the County of El Paso and TCEQ code for procedures when hazardous or contaminated materials are discovered. If materials are suspected of containing hazardous materials are encountered, do not disturb, immediately notify the Engineer or the County of El Paso.
- C. Obtain required permits from authorities having jurisdiction.
- D. Storage or sale of removed items or materials on-site is not permitted.
- E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition activities.
- F. Maintain fire-protection facilities in service during selective demolition operations.
- G. Perform Work in accordance with the County of El Paso standards.
- H. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
- I. Conduct Pre-Demolition conference at Project site to review methods and procedures related to selective demolition including, but not limited to the following:
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.

1.6 SCHEDULING

- A. Schedule Work to coincide with new construction and construction by others.
- B. Cooperate with Owner in scheduling noisy operations and waste removal that may impact Owners operation and in adjoining spaces.



1.7 PROJECT CONDITIONS

- A. Conduct demolition to minimize interference with adjacent building areas.
- B. Cease operations immediately if structure appears to be in danger and notify the County of El Paso and Engineer. Do not resume operations until directed.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 EXAMINATION

- A. Notify affected utility companies before starting work and comply with their requirements. Mark location and termination of utilities. Verify utilities have been disconnected and capped. Annotate Record Drawings indicating location and type of service for capped utilities remaining after demolition.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the conditions of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated elements conflict with intended function or design are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the Engineer and the County of El Paso.

3.2 PREPARATION

- A. Conduct selective demolition and debris removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- B. Erect, and maintain temporary barriers and security devices, including warning signs and lights, and similar measures, for protection of the public and existing improvements indicated to remain.

3.3 DEMOLITION

- A. Conduct demolition to minimize interference with adjacent building areas or existing improvements.
- B. Demolish in orderly and careful manner. Protect existing improvements.
- C. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.
- D. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.



- E. Remove temporary Work.

END OF SECTION

DIVISION 03
CONCRETE



SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials equipment, tools, superintendence, and incidentals required and install cast in place concrete complete as shown on the Drawings and as specified herein.
- B. Furnish all sampling and testing of products and materials proposed for use. Testing shall be performed by an independent testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor.

1.02 RELATED WORK

- A. Grout is included in Section 03600.
- B. Modifications and Repair to Concrete are included in Section 03740.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data shall include the following:
 - 1. Sources of cement, pozzolan, and aggregates.
 - 2. Material Safety Data Sheets (MSDS) for all concrete components and admixtures.
 - 3. Air entraining admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, field testing methods, and conformity to ASTM standards.
 - 4. Water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, and conformity to ASTM standards.
 - 5. High range water reducing admixture (plasticizer). Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature



considerations, retarding effect, slump range, and conformity to ASTM standards. Identify proposed locations of use.

6. Sheet curing material. Product data including catalogue cut, technical data, and conformity to ASTM standards.
7. Liquid curing compound. Product data including catalogue cut, technical data, storage requirements, product life, application rate, and conformity to ASTM standards. Identify proposed locations of use.

B. Samples

1. Fine and coarse aggregates, 5 pounds each.

C. Test Reports

1. Sieve analysis, mechanical properties, and deleterious substance content for coarse and fine aggregate.
2. Chemical analysis and physical tests of each type of cement and conformity to ASTM standards.
3. Chemical analysis and physical tests of pozzolan and conformity to ASTM standards, where applicable.
4. Concrete mix for each formulation of concrete proposed for use including constituent quantities per cubic yard, water cementitious ratio, concrete slump, type, and manufacturer of cement.
 - a. Standard deviation data for each proposed concrete mix based on statistical records.
 - b. Water cementitious ratio curve for concrete mixes based on laboratory tests. Give average cylinder strength test results at 28 days for laboratory concrete mix designs. Provide results of 7- and 14-day tests if available.

D. Certifications

1. Certify admixtures used in the same concrete mix are compatible with each other and the aggregates.
2. Certify the Contractor is not associated with the independent testing laboratory nor does the Contractor or its officers have a beneficial interest in the laboratory.



E. Qualifications

1. Independent testing laboratory: Name, address, and qualifications. Laboratories affiliated with the Contractor, or in which the Contractor or its officers have a beneficial interest, are not acceptable.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
2. ASTM C33 Standard Specification for Concrete Aggregates
3. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
4. ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
5. ASTM C94 Standard Specification for Ready Mixed Concrete
6. ASTM C143 Standard Test Method for Slump of Hydraulic Cement Concrete
7. ASTM C150 Standard Specification for Portland Cement
8. ASTM C171 Standard Specification for Sheet Materials for Curing Concrete
9. ASTM C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
10. ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
11. ASTM C260 Standard Specification for Air Entraining Admixtures for Concrete
12. ASTM C309 Standard Specification for Liquid Membrane Forming Compounds for



Curing Concrete

- 13. ASTM C311 Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete
- 14. ASTM C494 Standard Specification for Chemical Admixtures for Concrete
- 15. ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

B. American Concrete Institute (ACI)

- 1. ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
- 2. ACI 301 Specification for Structural Concrete
- 3. ACI 304R Guide for Measuring, Mixing, Transporting and Placing Concrete
- 4. ACI 304.2R Placing Concrete by Pumping Methods
- 5. ACI 305R Hot Weather Concreting
- 6. ACI 306R Cold Weather Concreting
- 7. ACI 318 Building Code Requirements for Reinforced Concrete
- 8. ACI 350R Environmental Engineering Concrete Structures

- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Only one source of cement and aggregates shall be used on any one structure. Concrete shall be uniform in color and appearance.



- B. Well in advance of placing concrete, discuss with the Engineer the sources of individual materials and batched concrete proposed for use. Discuss placement methods, waterstops, and curing. Propose methods of hot and cold weather concreting as required.
- C. A meeting shall be held prior to placement of plasticized concrete. The plasticizer (high range water reducer) manufacturer's representative and the Contractor shall be available to discuss the properties and techniques of batching and placing plasticized concrete.
- D. If, during the progress of the work, it is impossible to secure concrete of the required workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the desired properties. All changes so ordered shall be made at the Contractor's expense.
- E. If, during the progress of the work, the materials from the sources originally accepted change in characteristics, the Contractor shall, at his expense, make new acceptance tests of aggregates and establish new design mixes. Such testing and design shall be accomplished with the assistance of an independent testing laboratory acceptable to the Engineer.
- F. Reinforced concrete shall comply with ACI 301, ACI 318, the recommendations of ACI 304R and ACI 350R, and other stated requirements, codes, and standards, except as modified herein.
- G. Samples of constituents and of concrete as placed will be subjected to laboratory tests. All materials incorporated in the work shall conform to accepted samples.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Cement: Store in weathertight buildings, bins, or silos to provide protection from dampness and contamination and to minimize warehouse set.
- B. Aggregate: Arrange and use stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding 3 foot in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregate.
- C. Sand: Arrange and use stockpiles to avoid contamination. Allow sand to drain to a uniform moisture content before using. Do not use frozen or partially frozen aggregates.
- D. Admixtures: Store in closed containers to avoid contamination, evaporation or damage. Provide suitable agitating equipment to assure uniform dispersion of ingredients in admixture solutions which tend to separate. Protect liquid admixtures from freezing and other temperature changes which could adversely affect their characteristics.



- E. Pozzolan: Store in weathertight buildings, bins, or silos to provide protection from dampness and contamination.
- F. Sheet Curing Materials: Store in weathertight buildings or off the ground and under cover.
- G. Liquid Curing Compounds: Store in closed containers.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance, and manufacturer's service.

2.02 MATERIALS

- A. Materials shall comply with this Section and any applicable state or local requirements.
- B. Cement: Domestic portland cement complying with ASTM C150. Air entraining cements shall not be used. Cement brand shall be subject to approval by the Engineer and one brand shall be used throughout the Work. The following cement type(s) shall be used:
 - 1. Type II low alkali cement.
 - 2. Type I low alkali cement with fly ash, resulting in C3A being below 8 percent of total cementitious content.
 - 3. Type III low alkali cement limited to 8 percent C3A, where approved by the Engineer.
 - 4. Type V when in contact with wastewater.
- C. Fine Aggregate: Washed inert natural sand conforming to the requirements of ASTM C33.
- D. Coarse Aggregate: Well graded crushed stone or washed gravel conforming to the requirements of ASTM C33. Size numbers for the concrete mixes shall be as shown in Table 1 herein. Grading requirements shall be as listed in ASTM C33 Table 2 for the specified coarse aggregate



size number. Limits of Deleterious Substances and Physical Property Requirements shall be as listed in ASTM C33 Table 3 for severe weathering regions.

- E. Water: Potable water free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other deleterious substances.
- F. Admixtures: Admixtures shall be free of chlorides and alkalis (except for those attributable to water). When it is required to use more than one admixture in a concrete mix, the admixtures shall be from the same manufacturer. Admixtures shall be compatible with the concrete mix including other admixtures.
 - 1. Air Entraining Admixture: The admixture shall comply with ASTM C260. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 - 2. Water Reducing Agent: The admixture shall comply with ASTM C494, Type A. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 - 3. High Range Water Reducer (Plasticizer): The admixture shall comply with ASTM C494 Type F and shall result in non segregating plasticized concrete with little bleeding and with physical properties of low water/cement ratio concrete. The treated concrete shall be capable of maintaining its plastic state in excess of 2 hours. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 - 4. Admixtures causing retarded or accelerated setting of concrete shall not be used without written approval from the Engineer. When allowed, the admixtures shall be retarding or accelerating water reducing or high range water reducing admixtures.
- G. Pozzolan (Fly ash)
 - 1. Pozzolan shall be Class C or Class F fly ash complying with ASTM C618, including the requirements of Table 1 except the Loss on Ignition (LOI) shall be limited to 3 percent maximum.
 - 2. Testing of the fly ash and/or the fly ash and concrete mixture is required to provide test data confirming that the fly ash in combination with the cement to be used meets all strength requirements and is compatible with the other concrete additives. The testing shall be performed by the independent testing laboratory engaged by the Contractor.
 - a. Pozzolan shall be tested in compliance with ASTM C311 with the following restriction: A minimum of one sample weighing 4 pounds shall be taken from each 200 tons of pozzolan supplied for the project.



- H. Sheet Curing Materials. Waterproof paper, polyethylene film, or white burlap polyethylene sheeting all complying with ASTM C171.
- I. Liquid Curing Compound. Liquid membrane forming curing compound shall comply with the requirements of ASTM C309 Type 1 D (clear or translucent with fugitive dye) and shall contain no wax, paraffin, or oil.

2.03 MIXES

- A. Development of mix designs and testing shall be by an independent testing laboratory acceptable to the Engineer engaged by and at the expense of the Contractor.
- B. Select proportions of ingredients, in accordance with ACI 211.1, to meet the design strength and materials limits specified in Table 1, and to produce concrete having proper placability, durability, strength, appearance, and other required properties. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing excessive free water to collect on the surface.
- C. The design mix shall be based on one of the following:
 - 1. Standard deviation data of prior mixes, with essentially the same proportions of the same constituents, in accordance with ACI 318.
 - 2. Trial mixtures developed by laboratory tests. Water content of the concrete shall be based on a curve showing the relation between water cementitious ratio and 7- and 28-day compressive strengths of concrete made using the proposed materials. The curves shall be determined by four or more points, each representing an average value of at least three test specimens at each age. The curves shall have a range of values sufficient to yield the desired data, including the compressive strengths specified, without extrapolation. The water content of the concrete mixes to be used, as determined from the curve, shall correspond to strengths 16 percent greater than the required design strengths. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content as specified in Table 1.
- D. Compression Tests: Provide testing of the proposed concrete mix or mixes to demonstrate compliance with the compression strength requirements in conformity with the provisions of ACI 318.
- E. Entrained air, as measured by ASTM C231, shall be as shown in Table 1.



1. If the air entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the air entraining admixture submittal.
- F. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1. If plasticizer is used, the slump indicated, shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 7- to 10-inches.
- G. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other.
- H. Where fly ash is included in the mix, the fly ash content shall be no less than 15 percent nor more than 25 percent of the total cement plus pozzolan content, by weight.
- I. Where Type III cement is used, the concrete shall conform to Table 1, except that the design strength shall be attained at 7 days.

Table 1				
Class	Design Strength (1)	Fine Aggregate (2)	Coarse Aggregate (3)	Cementitious Content (4)
A	2,500	C33	57	440
D	4,000	C33	57	560
Class	W/C Ratio (5)	AE Range (6)	WR (7)	Slump (8)
A	0.62 max.	3.5 to 5	Yes	1 to 4
D	0.44 max.	3.5 to 5	Yes	3 to 5
NOTES: (1) Minimum compressive strength in psi at 28 days (2) ASTM designation (3) Size Number in ASTM C33 (4) Minimum cementitious content in pounds per cubic yard (5) W/C is Water Cementitious ratio by weight (6) AE is percent air entrainment (7) WR is water reducing admixture (8) Permissible slump range, inches				



PART 3 EXECUTION

3.01 PREPARATION, INSPECTION, AND COORDINATION

- A. The batching, mixing, transporting, placing and curing of concrete shall be subject to the inspection of the Engineer at all times. The Contractor shall advise the Engineer of his/her readiness to proceed at least 24 hours prior to each concrete placement. The Engineer will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing and the alignment, cleanliness, and tightness of formwork. No placement shall be made without the inspection and acceptance of the Engineer.
- B. Embedments
1. Ensure that all required embedded items are accurately placed at correct locations and orientations.
 2. Support embedded items against displacement during concrete placement. Provide templates for positioning embedded anchor bolts.
 3. Voids in sleeves, inserts, anchors, etc. shall be filled temporarily with readily removable material to prevent the entry of concrete.
 4. Ensure that all aluminum embedments are effectively coated or covered to prevent aluminum concrete reaction or electrolytic action between aluminum and steel.
 5. Unless otherwise shown or approved, conduits and pipes embedded within a slab, wall, or beam (other than those merely passing through) shall satisfy the following:
 - a. Maximum outside dimension shall be no greater than one-third the overall thickness of slab, wall, or beam.
 - b. Spacing shall be greater than or equal to three diameters or widths on center.
 - c. Size, number, and placement shall not significantly impair the strength of the member.
- C. Concrete for the work shall provide a homogeneous structure which, when hardened, will have the required strength, durability, and appearance. Mixtures and workmanship shall be such that concrete surfaces, when exposed, will require no patching or repairs due to defects. When concrete surfaces are stripped, the concrete when viewed in good lighting from 10 feet away shall be pleasing in appearance, and at 20 feet shall show no visible defects.

3.02 MEASURING MATERIALS



- A. Concrete shall be composed of portland cement, pozzolan (where applicable), fine aggregate, coarse aggregate, water, and admixtures, as specified and shall be produced by a concrete mixing plant conforming to ACI 301 and acceptable to the Engineer. All constituents, including admixtures, shall be batched at the plant.
- B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified. Scales shall have been certified by the local Sealer of Weights and Measures within one year of use.
- C. Measure the amount of free water in fine aggregates within 0.3 of a percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as batched on printed batching tickets.
- D. Admixtures shall be dispensed either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
 - 1. Charge air entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.
 - 2. Inject multiple admixtures separately during the batching sequence.

3.03 MIXING AND TRANSPORTING

- A. Concrete shall be ready mixed concrete produced by equipment acceptable to the Engineer. No hand mixing will be permitted. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant. Equip each transit mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.
- B. Contractor shall submit a plan describing the method of transporting concrete to the remote project location for approval of the Engineer.
- C. Ready mix concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the nameplate.
- D. Keep the water tank valve on each transit truck locked at all times. Any addition of water must be directed by the Engineer. Added water shall be incorporated by additional mixing of at least 35 revolutions. All added water shall be metered and the amount of water added shall be shown on each delivery ticket.



- E. All central plant and rolling stock equipment and methods shall comply with ACI 301 and ACI 318.
- F. Select equipment of size and design to ensure continuous flow of concrete at the delivery end. Metal or metal lined non aluminum discharge chutes shall be used and shall have slopes not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal. Chutes more than 20 feet long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.
- G. Retempering of concrete or mortar, (that is, mixing with or without additional cement, aggregate, or water), which has obtained initial set, will not be permitted.
- H. Handle concrete from mixer to placement as quickly as practicable while providing concrete of required quality in the placement area. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required, thus avoiding excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms.
- I. Furnish a delivery ticket for ready mixed concrete to the Engineer as each truck arrives. Each ticket shall provide a printed record of the weight of cement and each aggregate as batched individually. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Clearly indicate the weight of fine and coarse aggregate, cement and water in each batch, the quantity delivered, the time any water is added, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of transit mix truck.
- J. Temperature and Mixing Time Control
 - 1. In cold weather (see Paragraph 3.05D below) maintain the as mixed temperature of the concrete and concrete temperatures at the time of placement in the forms as indicated in Table 2.
 - 2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90°F.
 - 3. In hot weather, cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90°F. If necessary, substitute well crushed ice for all or part of the mixing water.
 - 4. The maximum time interval between the addition of mixing water and/or cement to the batch and the placing of concrete in the forms shall not exceed the following:



Table 2	
Concrete Temperature	Maximum Time
80 to 90°F (27 to 32°C)	45 minutes
70 to 79°F (21 to 26°C)	60 minutes
40 to 69°F (5 to 20°C)	90 minutes

If an approved high range water reducer (plasticizer) is used to produce plasticized concrete, the maximum time interval shall be 90 minutes.

- K. Concrete mix showing either poor cohesion or poor coating of the coarse aggregate with paste shall be remixed. If this does not correct the condition, the concrete shall be rejected. If the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed, changes in the concrete mix shall be obtained only by adjusting one or more of the following:

1. The gradation of aggregate.
2. The proportion of fine and coarse aggregate.
3. The percentage of entrained air, within the allowable limits.

3.04 PLACING AND COMPACTING

A. Placing

1. Verify that all formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. Remove ice, excess water, dirt, and other foreign materials from forms. Confirm that reinforcement and other embedded items are securely in place. Have a competent workman at the location of the pour who can assure that reinforcement and embedded items remain in designated locations while concrete is being placed. Sprinkle semiporous subgrades or forms to eliminate suction of water from the mix. Seal extremely porous subgrades in an approved manner.
2. Deposit concrete as near its final position as possible to avoid segregation due to rehandling or flowing. Place concrete continuously at a rate which ensures the concrete is being integrated with fresh plastic concrete. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials or on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.



3. Pumping of concrete will be permitted in accordance with the recommendations of ACI 304.2R. Use a mix design and aggregate sizes suitable for pumping and submit for approval.
4. Remove temporary spreaders from forms when the spreader is no longer useful. Temporary spreaders may remain embedded in concrete only when made of galvanized metal or concrete and if prior approval has been obtained.
5. Do not place concrete for supported elements until concrete previously placed in the supporting element (columns, slabs, and/or walls) has reached adequate strength.
6. Where surface mortar is to form the base of a finish, especially surfaces designated to be painted, work coarse aggregate back from forms with a suitable tool to bring the full surface of the mortar against the form. Prevent the formation of excessive surface voids.
7. Slabs
 - a. After suitable bulkheads, screeds, and jointing materials have been positioned, the concrete shall be placed continuously between construction joints beginning at a bulkhead, edgeform, or corner. Each batch shall be placed into the edge of the previously placed concrete to avoid stone pockets and segregation.
 - b. Avoid delays in casting. If there is a delay in casting, the concrete placed after the delay shall be thoroughly spaded and consolidated at the edge of that previously placed to avoid cold joints. Concrete shall then be brought to correct level and struck off with a straightedge. Bullfloats or darbies shall be used to smooth the surface, leaving it free of humps or hollows.
 - c. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow 1 hour to pass between placement of the wall and the overlying slab to permit consolidation of the wall concrete. Keep the top surface of the wall moist so as to prevent cold joints.
8. Formed Concrete
 - a. Place concrete in forms using tremie tubes and taking care to prevent segregation. Bottom of tremie tubes shall preferably be in contact with the concrete already placed. Do not permit concrete to drop freely more than 4 feet. Place concrete for walls in 12- to 24 inch lifts, keeping the surface horizontal. If plasticized concrete is used, the maximum lift thickness may be increased to 7 feet and the maximum free fall of concrete shall not exceed 15 feet.



B. Compacting

1. Consolidate concrete by vibration, puddling, spading, rodding, or forking so that concrete is thoroughly worked around reinforcement, embedded items, and openings and into corners of forms. Puddling, spading, etc. shall be continuously performed along with vibration of the placement to eliminate air or stone pockets which may cause honeycombing, pitting, or planes of weakness.
2. All concrete shall be placed and compacted with mechanical vibrators. The number, type, and size of the units shall be approved by the Engineer in advance of placing operations. No concrete shall be ordered until sufficient approved vibrators (including standby units in working order) are on the job.
3. A minimum frequency of 7,000 revolutions per minute is required for mechanical vibrators. Insert vibrators and withdraw at points from 18- to 30-inches apart. At each insertion, vibrate sufficiently to consolidate concrete, generally from 5 to 15 seconds. Do not overvibrate so as to segregate. Keep a spare vibrator on the site during concrete placing operations.
4. Concrete Slabs: Concrete for slabs less than 8-inches thick shall be consolidated with vibrating screeds; slabs 8- to 12-inches thick shall be compacted with internal vibrators and (optionally) with vibrating screeds. Vibrators shall always be placed into concrete vertically and shall not be laid horizontally or laid over.
5. Walls and Columns: Internal vibrators (rather than form vibrators) shall be used unless otherwise approved by the Engineer. In general, for each vibrator needed to melt down the batch at the point of discharge, one or more additional vibrators must be used to densify, homogenize and perfect the surface. The vibrators shall be inserted vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.
6. Amount of Vibration: Vibrators are to be used to consolidate properly placed concrete but shall not be used to move or transport concrete in the forms. Vibration shall continue until:
 - a. Frequency returns to normal
 - b. Surface appears liquefied, flattened, and glistening
 - c. Trapped air ceases to rise
 - d. Coarse aggregate has blended into surface but has not disappeared

3.05 CURING AND PROTECTION

- A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.



B. Curing Methods

1. Curing Methods for Concrete Surfaces: Cure concrete to retain moisture and maintain specified temperature at the surface for a minimum of 7 days after placement. Curing methods to be used are as follows:
 - a. Water Curing: Keep entire concrete surface wet by ponding, continuous sprinkling, or covering with saturated burlap. Begin wet cure as soon as concrete attains an initial set and maintain wet cure 24 hours a day.
 - b. Sheet Material Curing: Cover entire surface with sheet material. Securely anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.
 - c. Liquid Membrane Curing: Apply over the entire concrete surface except for surfaces to receive additional concrete. Curing compound shall NOT be placed on any concrete surface where additional concrete is to be placed, where surface coatings are to be used, or where the concrete finish requires an integral floor product. Curing compound shall be applied as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Application shall be in compliance with the manufacturer's recommendations.
2. Specified applications of curing methods.
 - a. Slabs for water containment structures: Water curing only.
 - b. Slabs on grade and footings (not used to contain water): Water curing, sheet material curing, or liquid membrane curing.
 - c. Structural Slabs (other than water containment): Water curing or liquid membrane curing.
 - d. Horizontal surfaces which will receive additional concrete, coatings, grout, or other material that requires bond to the substrate: Water curing.
 - e. Formed surfaces: None if nonabsorbent forms are left in place for 7 days. Water cure if absorbent forms are used. Sheet cure or liquid membrane cure if forms are removed prior to 7 days. Exposed horizontal surfaces of formed walls or columns shall be water cured for 7 days or until next placement of concrete is made.
 - f. Concrete Joints: Water cured or sheet material cured.
3. Curing time may be reduced to 3 days after placement where Type III cement is approved and used.



C. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

D. Cold Weather Concreting:

1. "Cold weather" is defined as a period when for more than 3 successive days, the average daily outdoor temperature drops below 40°F. The average daily temperature shall be calculated as the average of the highest and the lowest temperature during the period from midnight to midnight.
2. Concrete placed during cold weather shall be batched, delivered, placed, cured, and protected in compliance with the recommendations of ACI 306R and the additional requirements specified herein.
3. Discuss a cold weather work plan with the Engineer. The discussion shall encompass the methods and procedures proposed for use during cold weather including the production, transportation, placement, protection, curing and temperature monitoring of the concrete. The procedures to be implemented upon abrupt changes in weather conditions or equipment failures shall also be discussed. Cold weather concreting shall not begin until the work plan is acceptable to the Engineer.
4. The minimum temperature of concrete immediately after placement and during the protection period shall be as indicated in Table 3. The temperature of the concrete in place and during the protection period shall not exceed these values by more than 20°F. Prevent overheating and non-uniform heating of the concrete.

Table 3	
Minimum Dimension of Section	Minimum Concrete Temperatures
< 12 inches	55°F
12 to 36 inches	50°F

5. During periods of cold weather, concrete shall be protected to provide continuous warm, moist curing (with supplementary heat when required) for a total of at least 350 degree-days of curing.
 - a. Degree-days are defined as the total number of 24-hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (e.g., 5 days at an average 70°F = 350 degree-days).
 - b. To calculate the weighted average daily air temperature, sum hourly measurements of the air temperature in the shade at the surface of the concrete taking any measurement less than 50°F as 0°F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.



6. Salt, manure, or other chemicals shall not be used for protection.
7. At the end of the protection period, allow the concrete to cool gradually to the ambient temperature. If water curing has been used, the concrete shall not be exposed to temperatures below those shown in Table 3 until at least 24 hours after water curing has been terminated.
8. During periods not defined as cold weather, but when freezing temperatures are expected or occur, protect concrete surfaces from freezing for the first 24 hours after placing.

E. Hot Weather Concreting

1. "Hot weather" is defined as any combination of high air temperatures, low relative humidity and wind velocity which produces a rate of evaporation as estimated in ACI 305R, approaching or exceeding 0.2 pounds per square foot per hour.
2. Concrete placed during hot weather, shall be batched, delivered, placed, cured and protected in compliance with the recommendations of ACI 305R and the additional requirements specified herein.
 - a. Temperature of concrete being placed shall not exceed 90°F and every effort shall be made to maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall be such that it will cause no difficulties from loss of slump, flash set, or cold joints.
 - b. All necessary precautions shall be taken to promptly deliver, to promptly place the concrete upon its arrival at the job, and to provide vibration immediately after placement.
 - c. The Engineer may direct the Contractor to immediately cover plastic concrete with sheet material.
3. Discuss with the Engineer a work plan describing the methods and procedures proposed to use for concrete placement and curing during hot weather periods. Hot weather concreting shall not begin until the work plan is acceptable to the Engineer.

3.06 REMOVAL OF FORMS

- A. Except as otherwise specifically authorized by the Engineer, forms shall not be removed before the concrete has attained a strength of at least 30 percent of its specified design strength, nor before reaching the following number of day degrees of curing (whichever is the longer):

Table 4



Forms for	Degree Days
Beams and slabs	500
Walls and vertical surfaces	100

(See definition of degree days in Paragraph 3.05D above).

- B. Shores shall not be removed until the concrete has attained at least 60 percent of its specified design strength and also sufficient strength to support safely its own weight and the construction live loads upon it.

3.07 FIELD TESTS

- A. Sets of field control cylinder specimens will be taken by the Engineer (or inspector) during the progress of the work, in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete placed each day shall not be less than once a day, nor less than once for each 150 cubic yards of concrete nor less than once for each 5,000 square feet of surface area for slabs or walls.
1. A "set" of test cylinders consists of four cylinders: one to be broken at 7 days and two to be broken and their strengths averaged at 28 days. The fourth may be used for a special break at 3 days or to verify strength after 28 days if 28 day breaks are low.
 2. When the average 28-day compressive strength of the cylinders in any set falls below the required compressive strength or below proportional minimum 7-day strengths (where proper relation between 7- and 28-day strengths have been established by tests), proportions, water content, or temperature conditions shall be changed to achieve the required strengths.
- B. Cooperate in the making of tests by allowing free access to the work for the selection of samples, providing an insulated closed curing box for specimens, affording protection to the specimens against injury or loss through the operations, and furnish material and labor required for the purpose of taking concrete cylinder samples. All shipping of specimens will be paid for by the Contractor. Curing boxes shall be acceptable to the Engineer.
- C. Slump tests will be made in the field immediately prior to placing the concrete. Such tests shall be made in accordance with ASTM C143. If the slump is greater the specified range, the concrete shall be rejected.
- D. Air Content: Test for air content shall be made on a fresh concrete sample. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If lightweight aggregates or aggregates with high absorptions are used, the latter test method shall be used.



- E. All passing construction tests requested by the Engineer will be paid for by the testing allowance. Should construction testing reveal that the item tested does not meet the requirements of the Construction Documents, retesting shall be required until the item does meet the requirements. All failing tests shall be at the Contractor's expense and shall not be paid for by the testing allowance. The Contractor may obtain any additional tests which he may require for quality control, using his testing laboratory, at his expense. The testing allowance shall not be used for testing desired by the Contractor.

3.08 FIELD CONTROL

- A. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection, or determining the continuation of concrete work.
- B. Cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding, and such incidental equipment as may be required. Repair all core holes. The work of cutting and testing the cores will be at the expense of the Owner.

3.09 FAILURE TO MEET REQUIREMENTS

- A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the Engineer shall have the right to require changes in proportions outlined to apply to the remainder of the work. Furthermore, the Engineer shall have the right to require additional curing on those portions of the structure represented by the test specimens which failed. The cost of such additional curing shall be at the Contractor's expense. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer shall have the right to require strengthening or replacement of those portions of the structure which fail to develop the required strength. The cost of all such core borings and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be entirely at the expense of the Contractor. In such cases of failure to meet strength requirements, the Contractor and Engineer shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in ASTM C94 is the Contractor in this Section.
- B. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In case of failure of the cores, the Engineer may require, at the Contractor's expense and in addition to other recourses, load tests on any one of the slabs, beams, piles, caps, and columns in which such concrete was used. Test need not be made until concrete has aged 60 days.



- C. Should the strength of test cylinders fall below 60 percent of the required minimum 28-day strength, the concrete shall be rejected and shall be removed and replaced.

3.10 PATCHING AND REPAIRS

- A. Immediately after the forms have been stripped and before the concrete has changed color, fins and other projections shall be removed; recesses left by the removal of form ties shall be filled; and surface defects which do not impair structural strength shall be repaired. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete, to approval of the Engineer.
- B. Immediately after removal of forms, remove plugs and break off metal ties as required. Holes are then to be promptly filled upon stripping as follows: Moisten the hole with water, followed by a 1/16 inch brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spiderweb. Trowel smooth with heavy pressure. Avoid burnishing.
- C. Surface defects which do not impair the structural integrity shall be repaired as approved by the Engineer. Defective concrete and honeycombed areas, as determined by the Engineer, shall be replaced or repaired using methods specified in Section 03740.
- D. When patching defects in exposed surfaces, the same source of cement and sand as used in the parent concrete shall be employed. Adjust color if necessary by addition of proper amounts of white cement. Rub lightly with a fine Carborundum stone at an age of 1 to 5 days if necessary to bring the surface down with the parent concrete. Exercise care to avoid damaging or staining the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.

3.11 SCHEDULE

- A. The following (Table 5) are the general applications for the various concrete classes and design strengths:

Table 5		
Class	Design Strength (psi)	Description
A	2,500	Concrete fill and duct encasement
D	4,000	Walls, slabs on grade, tank ring beams, suspended slab and beam systems, columns, grade beams, sidewalks and all other structural concrete

PART 4 MEASUREMENT AND PAYMENT



4.01 MEASUREMENT AND PAYMENT

- A. No separate measurement and payment shall be made for this work item, but it shall be included in the unit price bid for pipeline, as noted in the Proposal.

END OF SECTION



SECTION 03 31 00

STRUCTURAL CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Reinforced concrete flumes, thrust block structures, headwalls, wingwalls, concrete lining on pond slopes, chutes and baffle blocks.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General Conditions and Division 1 Specification Sections, apply to work of this Section.

1.3 DESCRIPTION OF WORK

- A. Extent of concrete work shown on drawings.
- B. Concrete sidewalks, driveways, and, concrete curb and gutter are specified in *Section 32 13 13 – Concrete Paving*.

1.4 RELATED WORKS

- A. SECTION 07 92 00 - JOINT SEALANTS

1.5 SUBMITTALS

- A. Product Data: Submit data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, joint systems, curing compounds, and others as requested by the Engineer.
- B. Shop Drawings, Reinforcement: Submit original shop drawings prepared under the direction of a registered Professional Engineer for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures. Shop drawings shall include a full elevation of each wall showing all reinforcing required, and all special or additional reinforcing and all embedded plates. These details shall include the diagrammatic elevation of all walls, at a scale sufficiently large to show clearly the position of all marginal bars around openings, dowels, splices, etc., for these bars. The ends of reinforcing bars shall be located by appropriate dimensions in the shop drawings. Approval shall extend only to general arrangement and correspondence with the Contract Documents, and shall not relieve the Contractor from complying with the requirements of the Contract Documents as to dimension, laps, lengths, fit, spacing, size, etc.



1. In no case will concrete be placed unless the Contractor has used approved shop drawings for placement of steel reinforcing and has copies of approved shop drawings in the field for use by the Owner's representative when reviewing the reinforcement placement prior to concrete placement.
- C. Shop Drawings, Formwork: Submit shop drawings for forms for specific finished concrete surfaces. Show form construction including jointing, special form joint or reveals location and pattern of form tie placement, and other items, which affect exposed concrete visually.
- D. Samples: Submit samples of materials as requested by the engineer, including names, sources and descriptions.
- E. Laboratory Test Reports: Submit laboratory test reports by the Contractor's Testing Agency for concrete materials and mix design test.
- F. Material Certificates: Provide materials certificates in lieu of materials laboratory test reports when permitted by the Owner. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with, or exceeds, specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.
- G. Mill Certificates: Submit steel producer's certificates of mill analysis, tensile and bend tests for all reinforcement steel to be used on the project.

1.6 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 1. ACI 301 "Specifications for Structural Concrete for Buildings".
 2. ACI 318 "Building Code Requirements for Reinforced Concrete."
 3. Concrete Reinforcing Steel Institute, (CRSI) "Manual of Standard Practice".
- B. Concrete Testing and Inspection Laboratory: The Owner shall engage and pay for a Testing and Inspection Laboratory to perform all tests specified herein for determining quality or acceptability of materials and work specified in these documents.
- C. The Contractor shall engage and pay for a Testing Agency approved by the Owner to perform material evaluation tests and to prepare the concrete mix designs.
- D. Materials and installed work: Materials and installed work may require testing and retesting as directed by the Owner, at any time during the progress of work. Allow free access to material stockpiles and facilities. Test, not specifically indicated to be done at the Owner's expense, including the retesting of rejected materials for installed work, shall be done at the Contractor's expense.



1.7 PROJECT CONDITIONS

- A. Protection of Footings and Other Concrete Work Against Freezing: Cover completed work at footing level or elsewhere with enough temporary or permanent cover as required to protect footings, and other concrete elements and adjacent subgrade against possibility of freezing; maintain cover for necessary time period.
- B. Protect adjacent finish materials against spatter during concrete placement.

PART 2 PRODUCTS

2.1 FORM MATERIALS

- A. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.
- B. Form Coatings: Provide commercial formulation form-coating compounds on forms to be removed, that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.
- C. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spilling concrete upon removal. Provide units which will leave no metal closer than 1-1/2" to surface.
 - 1. Provide ties which, when removed, will leave holes not larger than 1" diameter in concrete surface.
- D. Earth as Forms: Excavated footings may be formed by using the excavated earth surfaces. Earth forms may be used only if the cut earth surfaces can maintain their shape without danger of cave-in. Sides and bottoms of earth forms shall be smooth, even and true vertical or horizontal planes.
- E. The Subgrade under slabs shall be fine graded and compacted, as specified in *Section 31 20 00 – Earthwork for Structures*.
- F. Expansion Joint Filler: Expansion joint filler shall be performed bituminous material consisting of mineral fibers impregnated with asphalt conforming to ASTM D 994. Joint material shall extend the full depth of the slab or joint and shall be of the thickness indicated on the drawings.
- G. No PVC Water Stops

2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60 & ASTM A706 Grade 60, deformed.
- B. Steel Wire: ASTM A 82, plain, cold-drawn steel.
- C. Welded Wire Fabric: ASTM A 185 welded steel wire fabric.
- D. Welded Deformed Steel Wire Fabric: ASTM A 497.



- E. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications.
1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 2. For exposed-to-view concrete surfaces (exposed face of channels and culverts), where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class I) or stainless steel protected (CRSI, Class 2).

2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or Type II.
- B. Fly-Ash: ASTM C 618, Type F, not to exceed 25% replacement of cement, by weight.
- C. Normal Weight Aggregates: ASTM C 33, and as herein specified. Provide aggregates from a single source for exposed concrete.
- D. Pea Gravel: ASTM C33, washed clean, hard, rounded gravel, except graded so 90% passes 3/8-inch screen and 90% is retained in 1/4 inch.
- E. Water: Potable.
- F. Air-Entraining Admixture: ASTM C 260 certified by manufacturer to be compatible with other required admixtures.
- G. Water Reducing Admixture: ASTM C 494, Type A, and containing not more than 0.1 percent chloride ions.

Available Products: Subject to compliance with requirements, products, which may be incorporated in the work, include, but are not limited to, the following:

"WRDA Hycol"; W.R. Grace.
"Eucon WR-75"; Euclid Chemical Co.
"Pozzolith 322N"; Master Builders.
"Plastocrete 160"; Sika Chemical Corp.
"Chemtard"; Chem-Masters Corp.

- H. High-Range Water-Reducing Admixture (Super Plasticizer): ASTM C 494, Type F or Type G and containing not more than 0.1 percent chloride ions.

Available Products: Subject to compliance with requirements, products, which may be incorporated in the work, include, but are not limited to, the following:

"WRDA 19" or "Duracem"; W.R. Grace.
"Sikament"; Sika Chemical Corp.
"Eucon 37"; Euclid Chemical Co.
"Rheobuild"; Master Builders.



- I. Water Reducing, Non-Chloride Accelerator Admixture: ASTM C 494, Type E, and containing not more than 0.1 percent chloride ions.

Available Products: Subject to compliance with requirements, products, which may be incorporated in the work, include, but are not limited to, the following:

"Accelguard 80"; Euclid Chemical Co.
"Pozzolith High Early"; Master Builders.

- J. Water-Reducing, Retarding Admixture: ASTM C 494, Type D, and contain no more than 0.1 percent chloride ions.

Available Products: Subject to compliance with requirements, products, which may be incorporated in the work, include, but are not limited to, the following:

"Pozzolith 300-R"; Master Builders.
"Eucon Retarder 75"; Euclid Chemical Co.
"Daratard"; W.R. Grace.
"Plastiment"; Sika Chemical Co.

Prohibited Admixtures: Calcium chloride thiocyanates or admixtures containing more than 0.1 percent chloride ions are not permitted.

2.4 RELATED MATERIALS

- A. Non-Shrink Grout, Non-Metallic: CRD-C 621, factory pre-mixed grout.

Available Products: Subject to compliance with requirements, products, which may be incorporated in the work include, but are not limited to, the following:

"Type D, Masterflow 713"; Master Builders
"SonogROUT"; Sonneborn-Rexnord.
"Euco-NS"; Euclid Chemical Co.
"Five Star Grout"; U.S. Grout Corp.

- B. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
Moisture-Retaining Cover: One of the following, complying with ASTM C 171.

1. Waterproof paper.
2. Polyethylene film.
3. Polyethylene-coated burlap.

- C. Liquid Membrane-Forming Curing Compound: Liquid type membrane-forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.055 gr./sq. cm. when applied at 200 sq. ft./gal.

Available Products: Subject to compliance with requirements products, which may be incorporated in the work, include, but are not limited to, the following:



"Masterseal"; Master Builders.
"Clear Seal"; W.R. Grace
"Sealkure"; Toch Div. - Carboline.
"Kure-N-Seal"; Sonneborn-Rexnord.
"L & M Cure"; L & M Construction Chemicals.

- D. Bonding Agent:
Available Product: Subject to compliance with requirements, a product, which may be incorporated in the work, is the following:
- "Sikastix 300 Series"; Sika Chemical Corporation
- E. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class" to suit project requirements.
- Available Products: Subject to compliance with requirements, products, which may be incorporated in the work, include, but are not limited to, to the following:
- "Thiopoxy"; W.R. Grace.
"Sikadur Hi-Mod"; Sika Chemical Corp.
"Euco Epoxy 452 or 620"; Euclid Chemical Co.
- F. Preformed Joint Filler: Non-extruding, resilient, non-bituminous type conforming to ASTM Designation D-1752, Type II.
- G. Elastomeric Joint Sealant: See *Section 07 92 00 - Joint Sealants*. Color shall closely match the color of the adjacent exposed surface of the concrete. Keep same color throughout project. Joint back-up material (backer rod) 1: Polyethylene foam, 60% closed cell.

2.5 PROPORTIONING AND DESIGN OF MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to the Owner for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.
1. Limit use of fly ash to not exceed 20 percent of cement content by weight.
- B. Submit written reports to the Owner of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by the Owner.
- C. Design mixes to provide normal weight concrete with the properties as shown on Concrete Quality Table on page 7, as indicated on drawings and schedules:



CONCRETE QUALITY TABLE

IDENT- IFICATION SYMBOL	CLASS OF CONC.	SPECIFIED COMPRES- SIVE CONST. OF CONC. (F'C) @ 28 DAYS (PSI)	MINIMUM NO. OF SACKS OF STRENGTH PER CU. YD. OF CONC.	MAXIMUM AGGRE- GATE CEMENT (INCHES)	REQUIRED SLUMP (INCHES) SIZE PLUS OR MINUS ONE INCH
B-2	Lean Concrete:	----	3	1 1/2	3 1/2"± 1"
A-1	Footings (rock walls, pond gauge, metal-beam guardrail):	4000	5	1 1/2	3 1/2"± 1"
A-2	Channel Slabs:	4000	6	1 1/2	3 1/2"± 1"
A-3	Vertical Walls:	4000	6	3/4	5 1/2"± 1"
A-4	Flumes (walls & slabs):	4000	6	3/4	5 1/2"± 1"

*Concrete mix design may be adjusted for lower slump values for placement of concrete slabs at 1:1 slopes

- D. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as accepted by the Owner. Laboratory test data for revised mix design and strength results must be submitted to and accepted by the Owner before using in work.

2.6 ADMIXTURES

- A. Use water reducing admixture or high range water-reducing admixture (super plasticizer) in concrete as required for placement and workability.
- B. Use non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F.
- C. Use high-range water reducing admixture in pumped concrete, concrete as required, below 0.45.
- D. Use air-entraining admixture in exterior exposed concrete, unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus-or- minus 1-1/2



percent within following limits:

1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or subjected to hydraulic pressure:
 - a. 4.5 percent (moderate exposure); 1" max. aggregate.
 - b. 3.0 percent for slabs on grade
 2. Other Concrete (not exposed to freezing, thawing, or hydraulic pressure): 2 percent to 4 percent air.
- E. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.
- F. Water Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows:
1. All concrete with F'C = 4000 psi: W/C 0.45
 2. All other concrete: W/C 0.50.
- G. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as shown in the Concrete Quality Table of this section of the specifications.

2.7 CONCRETE MIXING

- A. Ready-Mix Concrete: Comply with concrete mixing time requirements of ASTM C 94, and as herein specified.
- B. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required by the Owner at his discretion.

PART 3 EXECUTION

3.1 GENERAL

- A. Coordinate the installation of joint materials with placement of forms and reinforcing steel.

3.2 FORMS

- A. Design, erect, support, brace and maintain formwork to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation and position. Account for concrete slump where using High-Range Water-Reducing Admixture (super plasticizers). Maintain formwork construction tolerances complying with ACI 347.
- B. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.



- C. Construct forms to sizes shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures.
 - 1. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.
- D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.
- E. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
- F. Chamfer exposed corners and edges as indicated, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- G. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.
- H. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Retightening forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment.
- I. Temporary Shoring: Temporary shoring may be required, and where required, the Contractor shall be responsible for the design and installation in accordance with the applicable ACI code and temporary shoring shall be left in place until the slab attains 85% of its specified compressive strength.

3.3 PLACING REINFORCEMENT

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials, which reduce or destroy bond with concrete.
- C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.



- D. Place reinforcement to obtain at least minimum coverage's for concrete protection. Arrange space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.4 JOINTS

- A. Construction Joints: Locate and install construction joints as indicated, or if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to the Engineer.
- B. Unless shear keys are specifically shown on the details or plans, roughen the horizontal (mating) surface of footings, walls and slabs, where new concrete will be placed for walls or toppings, to a full amplitude of ¼-inch.

Provide keyways at least 1-1/2" deep in construction joints between walls and footings.

- C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints, except as otherwise indicated.
- D. Expansion Joints in Slabs and Walls: Construct expansion joints between areas of slab on grade and between walls as shown on the Drawings.
 - 1. Joint filler and sealant materials are specified in Division-7 sections of these specifications.
 - 2. Joint filler materials shall not be used to form a bulkhead between concrete placements at construction or expansion joints. Form fillers must be supported by bulkheads capable of withstanding the hydraulic forces imposed by the concrete during placement. If there is a bulkhead failure the Contractor shall remove improperly placed concrete by saw cutting and chipping concrete back to the profile shown on the drawings prior to placement of concrete to complete the joint.
 - 3. Align wall expansion joints with slab expansion joints.

3.5 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached thereto.
- B. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.



3.6 PREPARATION OF FORM SURFACES

- A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.
- B. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.
- C. Thin form-coating compounds only with thinning agent of type, and amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

3.7 CONCRETE PLACEMENT

- A. Placement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel and items to be embedded or cast-in. Notify other trades to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used. Do not place concrete until after reviewed by the Owner.
- B. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.
- C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.
- D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
- E. Use pea gravel when mixing concrete for use in sections less than 3 inches thick and where concrete fill is required.
- F. Slurry Concrete: Cement rich concrete slurry for use at the bottom of walls to insure proper density and bonding at the joint between the bottom of the wall and the top of the footing or slab on grade, when placing concrete for the wall. Mix design to include cement equivalent to 6 sacks per cubic yard, fine mineral aggregates (3/8-inch max), water to achieve 0.45 water cement ratio and high-range water reducing (super plasticizer) admixture as required to produce free flowing consistency without segregation.
- G. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.



- H. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into proceeding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
- I. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction or expansion joints, until the placing of a panel or section is completed.
- J. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
- K. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
- L. Maintain reinforcing in proper position during concrete placement operations.
- M. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.
 - 1. When air temperature has fallen to or is expected to fall below 40 deg, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F, and not more than 80 deg F at point of placement.
- N. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
- O. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.
- P. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
- Q. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F. Mixing water may be chilled or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.
- R. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
 - 1. Fog spray forms, reinforcing steel and subgrade just before concrete is placed.



- S. Use water reducing-retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

3.8 FINISH OF FORMED SURFACES

- A. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finish work or by other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.
- B. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or that are to be covered with a coating material applied directly to concrete. This is as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed.
- C. Related Uniformed Surfaces: At finish tops of walls, horizontal offsets and similar uniformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent uniformed surfaces, unless otherwise indicated.
 - 1. At tops of footings or wall sections, which will become a construction joint for placement of a slab or wall, strike-off to proper elevation, consolidate and leave a surface with a 1/4" profile.

3.9 SCREEDING

- A. Screed all floors and slabs-on-fill level or uniformly, using fixed screed points with steel screed guides on fixed supports (stakes, pins, etc.). Use of concrete for screed control will not be permitted.

3.10 MONOLITHIC SLAB FINISHES

- A. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, and as otherwise indicated. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units.
 - 1. Surface plane shall have a uniform slope matching the grades shown on the drawings. After the concrete has attained final set, the Engineer shall require that the finished surface be tested with a standard 10-foot straight edge in conformance with TxDOT specification 420. Cut down high spots and fill low spots.
- B. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view,



except as described below, and slab surfaces to receive an overlay coating or wearing surface.

- C. Fine Broom Finish: Where an overlay or wearing surface is to be installed immediately follow trowel finishing with fine brooming to create a lightly textured surface with an average profile of 0.025 inches in accordance with Test Method Tex-436-A.
- D. Broom Finish: Apply Broom finish to exposed floor slab surfaces scheduled to receive Broom finish. Broom finish shall consist of a finish applied immediately after the application of a trowel finish by drawing a course broom across the surface of the concrete slab, perpendicular to the center line of the channel or sidewalk while imprint is still possible, as directed by the Engineer.
- E. A sample area of 4'- 0" x 4'- 0" will be placed and finished with the above floor finishes for review and approval by the Engineer before proceeding with the slab finishes on the channels, culverts and sidewalks.

3.11 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Keep continuously moist for not less than 4 days, except as listed below. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 4 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.

- 1. Exceptions to 4-day curing.

Description	Type of Cement	Required Curing days
Top slab of direct traffic culverts, and concrete overlays	I or II	8
	II or I/II	10
	All types with fly ash	10

- B. Curing Methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.
- C. Provide moisture curing by following methods.
 - 1. Keep concrete surface continuously wet by covering with water and containing at edges four days.
 - 2. Continuous water-fog spray.
 - 3. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.



- D. Provide moisture cover curing as follows:
 - 1. Cover concrete surfaces with moisture- retaining cover and plywood for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape. Cure for 7 days.
- E. Provide curing and sealing compound slabs as follows:
 - 1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours). Apply one application uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period. Apply a second coat at right angles to the first within 2 weeks prior to inspection for substantial completion.
 - 2. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, unless otherwise acceptable to the Engineer.
- F. Curing Formed Surfaces: When forms are left in contact with the concrete, other curing methods will not be required except for exposed surfaces and for cold weather protection.
- G. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, overlays, and other flat surfaces by application of appropriate curing method.

3.12 REMOVAL OF FORMS

- A. Removal of forms: All forming material below the ground surface must be entirely removed.
- B. Formwork not supporting weight of concrete, such as sides of walls and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.
- C. Form facing material may be removed 4 days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.
- D. Formwork supporting weight of concrete, such as beam soffits, joints, slabs and other structural elements, may not be removed in less than 14 days and until concrete has attained design minimum compressive strength of 80% of their specified 28-day compressive strength based on field cured test cylinders. Determine potential compressive strength of in-place concrete by testing field cured specimens, at Contractor's option, representative of concrete location or members.

3.13 RE-USE OF FORMS



- A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to the Owner.

3.14 MISCELLANEOUS CONCRETE ITEMS

- A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.
- B. Inserts and embedded plates for pole and railing bases, located as shown on Civil Drawings. Set anchor bolts for equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing poles and railing.

3.15 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to the Owner.
- B. Cut out honeycomb, rock pockets, voids over 1/4" in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.
- C. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of the Engineer. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.
- D. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
- E. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having required slope.
- F. Repair finished unformed surfaces that contain defects, which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement or completely through non-reinforced sections



regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.

- G. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.
- H. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to the Owner.
- I. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
- J. Repair isolated random cracks and single holes not over 1" in diameter, subject to approval by the Engineer, by dry pack method. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one-part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack after bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.
- K. Do not perform structural repairs without prior written approval of repair procedures, by the Owner for method and procedure, using approved epoxy adhesive and mortar.
- L. Repair methods not specified above may be used, subject to acceptance of the Engineer.

3.16 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. The Owner will employ a Testing and Inspection Laboratory to perform tests and to submit test reports.
- B. Sampling and testing for quality control during placement of concrete shall include the following, as directed by the Owner.
- C. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
 - 1. Slump: ASTM C 143, one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 - 2. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231 pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.



3. Concrete Temperature: Test hourly when air temperature is 40 deg F and below, and when 80-deg F and above; and each time a set of compression test specimens made.
- D. Compression Test Specimen: ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
- E. Compressive Strength Tests: ASTM C 39; one set of four (4) cylinders for each 50 cu. yds. or fraction thereof or each concrete class placed in any one day or for each 5,000 sq. ft. of surface area placed; 1 specimen tested at 7 days, 2 specimens tested at 28 days, and one specimen retained in reserve for testing if required.
 1. When frequency of testing will provide less than 4 strength tests for a given class of concrete, conduct testing from at least 4 randomly selected batches or from each batch if fewer than four are used.
 2. When total quantity of a given class of concrete is less than 50 cu. yds, strength test may be waived by the Owner if, in his judgment, adequate evidence of satisfactory strength is provided.
 3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 4. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.
- F. Test results will be reported in writing to the Owner, the Engineer, the Structural Engineer and the Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.
- G. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the basis for acceptance or rejection but only as a method of comparison with other concrete, subject solely to the interpretations and approval of the Engineer.
- H. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by the Owner. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.



3.17 ACCEPTANCE OF CONCRETE

- A. The following procedure will be used to evaluate concrete where one or more project acceptance test specimens fail to meet the required design strength specified in this Item or on 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 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 the in-situ concrete strength is needed for the structural review, take cores at locations designated by the Engineer in accordance with Tex-424-A. The Engineer will test the cores. The coring and testing will be at the Contractor's expense.

If all the tested cores meet the required design strength, the concrete will be paid for at 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 payment adjustment using the following formula:

$$A = Bp [-5.37(Sa/Ss)^2 + 11.69(Sa/Ss) - 5.32]$$

A = Amount to be paid per unit of measure for the entire placement in question

Sa = Actual average strength from cylinders or cores. Use values from cores, if taken.

Ss = Minimum required strength (specified)

Bp = Unit Bid Price

If the structural review determines the concrete is not adequate to remain in service, the Engineer will determine the limits of the concrete to be removed.

The decision to reject structurally inadequate concrete or to apply the payment adjustment factor will be made no later than 56 days after placement.

END OF SECTION

DIVISION 05

METALS



SECTION 05 80 00

3/8" STEEL DIAMOND FLOOR PLATE COVER

PART 1 GENERAL

1.1 DESCRIPTION

- A. Furnish and install 3/8" Steel Diamond Floor Plate.

1.2 GENERAL

- A. Provide new materials that comply with the details shown on the plans, and the requirements of this item.
- B. Contractor shall provide manufacturing inspection testing reports deemed appropriate by the County Engineer or his/her designated representative.

1.3 CONSTRUCTION METHODS

- A. Perform work in accordance with the details shown on the plans and requirements of this item.

PART 2 PRODUCTS

2.1 MATERIALS

- A. 3/8" Steel Diamond Floor Plate at various lengths and widths as described in the plans.
- B. 1/4" Socket Head Machine Screws installed at 18" O.C., countersunk.
- C. 2"x2"x1/4" Angel Steel at various lengths as described in the plans.

PART 3 MEASUREMENT

3.1 MEASUREMENT

- A. Measurement and payment for surface application methods shall be by the square yard of floor plate installed and successfully inspected.

PART 4 PAYMENT

3.1 PAYMENT

- A. 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 "3/8" Steel Diamond Floor Plate Cover" of the type specified. This price is full compensations for the surface preparation of the 3/8" Steel Diamond Floor Plate Cover foundation; materials; removal and disposal of existing concrete or asphalt; excavation, hauling, and



disposal of excavated material; repair of adjacent pavement structures damaged by these operations; and equipment, labor materials, tools, and incidentals.

END OF SECTION

DIVISION 7
THERMAL AND MOISTURE PROTECTION



SECTION 07 92 00

JOINT SEALANTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

- A. This section covers the furnishing of material and installation including equipment, appliances necessary to properly complete, all caulking and sealing for interior and exterior joints where indicated or specified herein.

1.2 GOVERNING REFERENCE SPECIFICATIONS:

- A. The latest editions of the following specifications and references govern the work in this section and constitute minimum requirements. Where specific requirements of this section are more stringent, they shall supersede the corresponding requirements of these Reference Specifications.
- B. American Society for Testing Materials International (ASTM):
 - 1. ASTM C920 – Elastomeric Joint Sealants
 - 2. ASTM D217 – Cone Penetration of Lubricating Grease
- C. Federal Specifications
 - 1. TTS-001657 – Sealing Compound, Single-Component, Butyl Rubber (COM-NBS) Based, Solvent Release Type (for Buildings and Other Types of Construction)
 - 2. UU-P-270F - Paper Wrapping, waxed (dry) & Am-1.
 - 3. PPP-T-42C - Tape, Packaging/Masking, Paper.

1.3 DESCRIPTION OF WORK

- A. Sealants: The extent of each form and type of joint sealant is indicated on the drawings and by provisions of this section.
- B. Application: The applications for joint sealants as work of this section shall include, but not limited to the following:
 - 1. Reinforced Concrete expansion and construction joints:

1.4 JOB CONDITIONS:

- A. Weather Conditions: Do not proceed with installation of liquid sealants under unfavorable weather conditions. Install elastomeric sealants per the manufacturer's



recommendations under the temperature conditions specified for proper installation and adhesion.

PART 2 PRODUCTS

2.1 MATERIALS:

- A. General Performance: Except as otherwise indicated, joint sealants are required to establish and maintain waterproof continuous seals on a permanent basis, within the time period covered on Paragraph 3.5: WARRANTIES. Failure of installed sealants to comply with this requirement will be recognized as failures of materials and workmanship.
- B. Provide colors as selected by Engineer from manufacturer's standard colors. Select materials for compatibility with joint surfaces and other indicated exposures, and except as otherwise indicated select modulus of elasticity and hardness or grade recommended by manufacturer for each application indicated.
- C. Product Data: Submit manufacturer's product specifications, handling/installation/ curing instructions, and performance tested data sheets for each elastomeric product required.
- D. Elastomeric Sealants:
 - 1. Silicone Rubber Sealant: Silicone rubber-based, one-part elastomeric sealant, complying with ASTM C 920, Class 50, Type S (single Component) and NS (nonsag); recommended by manufacturer for exterior joints in concrete or rock.
 - 2. Acceptable manufactures:
Dow Corning Corporation; 791
Dow Corning Corporation; 795
GE Silicones; SilPruf NB SC9000
GE Silicones; UltraPruf II SCS2900
- E. Joint Fillers:
 - 1. Compressible Joint Filler: Provide compressible and non-extruding pre-molded polystyrene board.
 - 2. Backer Rod: Compressive rod stock of closed polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable non-absorptive material as recommended by sealant manufacturer for compatibility with sealant.
- J. Miscellaneous Materials:
 - 1. Joint Primer/Sealer: Provide type of joint primer/sealer recommended by sealant manufacturer for joint surfaces to be primed or sealed.
 - 2. Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer to be applied to sealant-contact surface where bond to substrate or joint



filler must be avoided for proper performance of sealant. Provide self-adhesive tape where applicable.

PART 3 MANUFACTURER'S INSTRUCTIONS

3.1 APPLICATIONS:

- A. Comply with manufacturer's printed instructions except where more stringent requirements are shown or specified, and except where manufacturer's technical representative directs otherwise.

3.2 JOINT PREPARATION:

- A. Clean joint surfaces: Immediately before installation of sealant or caulking compound. Remove dirt, insecure coatings, moisture and other substances, which could interfere with bond of sealant or caulking compound. Etch concrete joint surfaces as recommend by sealant manufacturer. Include other joint preparation requirements as required by the sealant manufacturer and as indicated on Drawings.
- B. Prime or seal joint surfaces: Where indicated and where recommended by sealant manufacturer. Do not allow primer/sealer to spill or migrate onto adjoining surfaces.

3.3 INSTALLATION:

- A. Set joint filler units at proper depth or position in joint to coordinate with other work, including installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between ends of joint filler units.
- B. Install sealant backer rod for elastomeric sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for application indicated.
- C. Install bond breaker tape where indicated and where required by manufacturer's recommendations to ensure that elastomeric sealants will perform properly.
- D. Employ only proven installation techniques, which will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite concave surface, slightly below adjoining surfaces.
 - 1. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
 - 2. For concrete joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75% of joint width, but neither more than 5/8" deep nor less than 3/8" deep.



- H. Spillage: Do not allow gaskets or compounds to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage.
- I. Recess exposed edges of gasket and exposed joint filler slightly behind adjoining surfaces, unless otherwise shown, so that compressed units will not protrude from joints.

3.4 CURE AND PROTECTION:

- A. Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Sealant Installer shall advise Contractor of procedures required for cure and protection of joint sealants during construction period, so that they will be without deterioration or damage (other than normal wear and weathering) at time of substantial completion.

3.5 WARRANTIES:

- A. Manufacturer's Warranty: Submit an executed copy of Sealant Manufacturer's Standard Warranty Agreement signed by an authorized representative of the Sealant System Manufacturer for one year.

PART 4 PAYMENT

4.1 PAYMENT:

- A. The work performed, and materials furnished as this bid item requires will not be paid for directly but will be subsidiary to its associated bid items.

END OF SECTION

DIVISION 31
EARTHWORK



SECTION 31 05 13

SOILS FOR EARTHWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Subsoil materials.
- B. Topsoil materials.

1.2 RELATED SECTIONS

- A. Section 31 23 16 – Excavation.
- B. Section 31 23 23 – Select Fill.

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and an 18-in. Drop.
- B. American Society of Testing Materials International (ASTM):
 - 1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
 - 2. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³).
 - 3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.4 SUBMITTALS FOR INFORMATION

- A. Materials Source: Submit name of imported materials source.

PART 2 PRODUCTS

2.1 SUBSOIL MATERIALS

- A. Select Fill should consist of granular clayey, silty sands or sandy clayey, silty gravel mixtures, free of clay lumps, deleterious materials, organic material, vegetation, roots, cobbles over 3 inches in nominal size. The select Fill should have a liquid limit less than 35 and a plasticity index of 12 or less. The Select Fill shall exhibit an optimum dry density of at least 120 pcf determined in accordance with ASTM D-1557.



- B. Select Fill soils should classify as SP-SM, SM, SC, SC-SM, GM, GC, GC-GM, and GP-GC in accordance with the Unified Soil Classification System (USCS).

2.2 SOURCE QUALITY CONTROL

- A. Testing and Analysis of Subsoil Material: Perform in accordance with AASHTO T180, ASTM D698, ASTM D1557, and ASTM D2487.
- B. If tests indicate materials do not meet specified requirements, change material and retest.
- C. Provide materials of each type from same source throughout the Work.
- D. Select fill materials shall be free of organic or other deleterious materials and shall have a maximum particle size less than 3-inches.

PART 3 EXECUTION

3.1 SOIL REMOVAL

- A. Excavate subsoil and subgrade from areas designated.
- B. Remove lumped soil, boulders, debris and rock.
- C. Remove excavated material from site.

3.2 STOCKPILING

- A. Stockpile materials on site at locations indicated by the El Paso County inspector.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate differing materials with dividers or stockpile apart to prevent mixing.
- D. Prevent intermixing of soil types or contamination.
- E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.3 STOCKPILE CLEANUP

- A. Remove stockpile; leave area in a clean and neat condition. Grade site surface to prevent free standing surface water.
- B. If a borrow area is indicated, leave area in a clean and neat condition. Grade site surface to prevent free standing surface water.



3.4 SITE PREPARATION

- A. In order to mitigate erosion of encountered sands it is recommended that slopes be protected from localized erosion.
- B. The owner should consider placing rip-rap along the slopes to reduce erosion within select areas. Surface water flows are anticipated to run down slope sections.
- C. The slopes will be covered with a minimum of 8 inches of native backfill soils that meet the requirements of the subsoils materials. The soils should be compacted to a minimum of 90 percent of maximum dry density per ASTM D 1557. The moisture content of the fill soils should be maintained within +/- 2 percent of optimum moisture content until covered.
- D. Prior to placement of concrete rip-rap, the exposed cut slopes should be cleared of all debris and vegetation. The slopes should be compacted to a minimum of 90 percent of maximum dry density per ASTM D 1557. The moisture content of the slope soils should be maintained within +/- 2 percent of optimum moisture content until permanently covered. Compaction of side slopes should be parallel to the long direction of the side slopes. Earthwork grading of the slopes should consider the installation of erosion control measures (i.e., geofabrics or rock rip-rap) in order to maintain the specified design grades.

PART 4 PAYMENT

4.1 PAYMENT

- A. The work performed, and materials furnished as this bid item requires will not be paid for directly but will be subsidiary to its associated bid items.

END OF SECTION



SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Removing surface debris and trash regardless of type.
- B. Removing designated trees, shrubs, and other plant life.
- C. Removing abandoned utilities.
- D. Removing large loose rocks.

1.2 SUBMITTALS

- A. Requirements for submittals: Refer to *Section 01 33 00 - Submittal Procedures*.
- B. Product Data: Submit data for herbicide. Indicate compliance with applicable codes for environmental protection.

1.3 QUALITY ASSURANCE

- A. Perform Work in accordance with the County of El Paso standards.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 EXAMINATION

- A. *Section 01 30 00 - Administrative Requirements*: Verification of existing conditions before starting work.
- B. Verify existing plant life designated to remain is tagged or identified.

3.2 PREPARATION

- A. Call Local Utility Line Information service not less than three working days before performing Work.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.

3.3 PROTECTION

- A. Locate, identify, and protect utilities indicated to remain, from damage.



- B. Protect trees, plant growth, and features designated to remain.
- C. Protect benchmarks, survey control points, and existing structures from damage or displacement.

3.4 CLEARING

- A. Clear areas required for access to site and execution of Work to minimum depth of 36 inches.
- B. Remove trees and shrubs within marked areas. Remove stumps, root system to depth of 36 inches, surface rock, and debris.
- C. Clear undergrowth and deadwood, without disturbing subsoil.
- D. Remove and dispose of large loose rock, debris, and trash regardless of type within the project limits.
- E. Apply herbicide to remaining stumps to inhibit growth.

3.5 REMOVAL

- A. Remove debris, rock (regardless of size), and extracted plant life from site.
- B. Partially remove paving, curbs, as indicated on Drawings. Neatly saw cut edges at right angle to surface.
- C. Remove abandoned utilities. Indicated removal termination point for underground utilities on Record Documents.
- D. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.
- E. Do not burn or bury materials on site. Leave site in clean condition.

END OF SECTION



SECTION 31 22 13

ROUGH GRADING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Rough grading for the site improvements.
- B. Cutting, grading, filling, rough contouring and compacting the site for site structures.

1.2 RELATED SECTIONS

- A. Section 31 10 00 – Site Clearing.
- B. Section 31 05 13 – Soils for Earthwork.
- C. Section 31 23 16 – Excavation.
- D. Section 31 23 23 – Select Fill.

1.3 REGULATORY REQUIREMENTS

- A. Obtain required permits from authorities.
- B. Conform to applicable codes for grading.

1.4 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and an 18-in. Drop.
- B. American Society of Testing Materials (ASTM International):
 - 1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
 - 3. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
 - 4. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³).
 - 5. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.



6. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
7. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head).
8. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
9. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.5 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Section 31 23 23 – Select Fill.
- B. Section 31 05 13 – Soils for Earthwork.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that survey benchmark and intended elevations for the Work are as indicated.

3.2 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Locate, identify, and protect utilities that remain, from damage.
- D. Notify utility field locators to identify existing utilities and depths.
- E. Protect above and below grade utilities that remain.
- F. Protect plant life, lawns and other features remaining as a portion of final landscaping.
- G. Protect benchmarks, survey control point, existing structures, fences, sidewalks, paving, and curbs to remain from excavating equipment and vehicular traffic.

3.3 BASE MATERIAL EXCAVATION

- A. Contractor shall not contaminate base material with subgrade.



- B. If the base material becomes contaminated, the Contractor shall remove the contaminated material and perform Work as indicated on these Specifications.
- C. The subgrade preparation and filling shall conform to *Section 31 05 13 - Soils for Earthwork* and *Section 31 23 23 - Select Fill*.

3.4 SUBSOIL EXCAVATION

- A. Excavate subsoil from areas to be further excavated or re-graded.
- B. Do not excavate wet subsoil or excavate and process wet material to obtain optimum moisture content.
- C. When excavating through roots, perform work by hand and cut roots with sharp axe.
- D. Remove subsoil from site.
- E. Stability: Replace damaged or displaced subsoil to same requirements as for specified select fill.

3.5 FILLING

- A. Installed select fill shall be in accordance with *Section 31 23 23 – Select Fill*.
- B. Fill areas to contours and elevations with unfrozen materials.
- C. Place fill material on continuous layers and compact per *Section 31 23 23 – Select Fill*.
- D. Maintain optimum moisture content of fill materials to attain required compaction density.
- E. Slope grade away from building surface platform.
- F. Make grade changes gradual. Blend slope into level areas.
- G. Remove surplus fill materials from site.

3.6 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 1/10 foot from required elevation.

3.7 FIELD QUALITY CONTROL

- A. Testing: In accordance with AASHTO T180, ASTM C136, ASTM D698, ASTM D1556, ASTM D1557, ASTM D2167, ASTM D2419, ASTM D2434, ASTM D2922 and ASTM D3017.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.



- C. Frequency of Tests: As recommended by the testing laboratory and agreed to by the Owner.

END OF SECTION



SECTION 31 23 16

EXCAVATION

PART 1 GENERAL

1.1 SECTION INCLUDE

- A. Excavating for site structures.
- B. Excavating for ponding areas.

1.2 RELATED SECTIONS

- A. Section 31 23 17 – Trenching.
- B. Section 31 23 23 - Select Fill.

1.3 REFERENCES

- A. American Society for Testing Materials International (ASTM):
 - 1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft³.
 - 2. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
 - 3. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - 4. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- B. Local utility standards when working within 24 inches of utility lines.

1.4 SUBMITTALS

- A. Requirements for submittals: Refer to *Section 01 33 00 - Submittal Procedures*.
- B. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.
- C. Shop Drawings: Indicate soil densification grid for each size and configuration footing requiring soils densification.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with the County of El Paso standards.



1.6 QUALIFICATIONS

- A. Prepare trench excavation protection plan under direct supervision of Professional Engineer experienced in design of this Work and licensed in the State of Texas.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 PREPARATION

- A. Call Local Utility Line Information service at not less than three working days before performing Work.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.
- B. Identify required lines, levels, contours, and datum.
- C. Notify utility company to remove and relocate utilities.
- D. Located, identify and protect utilities indicated to remain from damage.
- E. Protect plant life, lawns, rock outcroppings and other features remaining as portion of final landscaping.
- F. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- G. Remove subsoil and subgrade from areas designated.
- H. Remove lumped soil, boulders, debris and rock.
- I. Remove excavated material from site.

3.2 EXCAVATION

- A. Materials being excavated are unclassified. Material shall be considered unclassified throughout the entire project limits. Removal of unclassified materials encountered during excavation such as lumped soil, boulders, rock, debris and concrete, of any type and size will not be paid for directly but will be subsidiary to the excavation bid item.
- B. Due to the presence of near surface loose soils, soils below the new slope fill shall extend a minimum distance of twenty (20) feet beyond the toe of the slope and be over-excavated to a depth of at least 2-feet below the finished grade. The exposed subgrade shall be scarified to a depth of approximately 12-inches, be moisture conditioned to near optimum moisture content and then be compacted to at least 95 percent of the soil's maximum dry density, per ASTM D-1157. The compacted subgrade shall then be proof rolled with a loaded tandem axle truck, water truck or equivalent. Soils which are observed to rut or deflect excessively (greater than 1-inch) under the moving load shall be



undercut and replaced with properly compacted select fill. The proof rolling activities shall be witnessed by the County of El Paso's inspector and shall be performed during a period of dry weather.

- C. Underpin adjacent structures which may be damaged by excavation work.
- D. Excavate subsoil to accommodate foundations, slabs-on-grade, paving, site structures, and construction operations.
- E. Excavate to working elevation for piling work.
- F. Excavation shall be depicted as shown on drawings and shall not exceed the limits and elevations as portrayed on plans.
- G. Over excavation shall be required for sloped areas where filling materials are needed. See drawings for details.
- H. Slope banks with machine to angle of repose or less until shored.
- I. Do not interfere with 45 degree bearing splay of foundations.
- J. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- K. Trim excavation. Remove loose matter.
- L. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd measured by volume. Remove larger material as specified in *Section 31 23 23 – Embankment*.
- M. Notify Engineer of unexpected subsurface conditions.
- N. Correct areas over excavated with select fill specified in *Section 31 23 23 – Embankment*.
- O. Remove excess and unsuitable material from site.
- P. Stockpile subsoil in area designated on site to depth not exceeding 8 feet and protect from erosion.
- Q. If excavations extend to or below a depth of 5 feet below construction grade, the Contractor or others shall be required to develop a trench safety plan to protect personnel entering the trench or trench vicinity as specified in *Section 31 23 17 - Trenching*.
- R. Items indicated to remain damaged by excavation will have to be repaired or replaced by Contractor at no cost to Owner.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements
- B. *Section 01 70 00 - Execution and Closeout Requirements*: Field inspecting, testing, adjusting, and balancing.



- C. Testing and Analysis of Subsoil Materials: Perform in accordance with AASHTO T180, ASTM D698, ASTM D1557, and ASTM D2487.
- D. If tests indicate materials do not meet specified requirements, change material and retest.
- E. Provide materials of each type from same source throughout the project.

3.4 PROTECTION

- A. In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, part 1926, Subpart P". The document was issued to better ensure the safety of workmen entering trenches or excavations. It is mandated by this federal regulation that excavations, be constructed in accordance with the new OSHA guidelines.
- B. The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, shall evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case shall slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

END OF SECTION



SECTION 31 23 17

TRENCHING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Compacted fill from top of utility bedding to subgrade elevations.
- B. Backfilling and compaction.

1.2 RELATED SECTIONS

- A. Section 31 05 13 – Soils for Earthwork.
- B. Section 31 22 13 – Rough Grading.
- C. Section 31 23 16 – Excavation.
- D. Section 31 23 23 – Select Fill.

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and an 18-in. Drop.
- B. American Society for Testing Materials International (ASTM):
 - 1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft³.
 - 3. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
 - 4. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort 6,000 ft-lbf/ft³.
 - 5. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - 6. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 7. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).



1.4 DEFINITIONS

- A. Utility: Any buried pipe, duct, conduit, or cable.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures.
- B. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.
- C. Product Data: Submit data for geotextile fabric indicating fabric and construction.
- D. Samples: Submit, in air-tight containers, 10 lb. sample of each type of Type fill to testing laboratory.
- E. Materials Source: Submit name of imported fill materials suppliers.
- F. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with City of El Paso standards.

1.7 QUALIFICATIONS

- A. All materials and products incorporated into the Trench Safety System shall be suitable for their intended use; shall meet all design criteria and parameters used by the Trench Safety System designer in designing the system; and shall meet all applicable requirements of the OSHA regulations.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 COORDINATION

- A. Coordination and project conditions: Refer to *Section 01 30 00 - Administrative Requirements*.
- B. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.
- C. At least ten days prior to execution of any trenching operation, but no later than 30 Calendar Days following the effective date of the Agreement, the Contractor shall submit a site-specific Trench Safety System Plan for all portions of the work having trenches deeper than five feet. This safety plan must be designed and sealed by a Professional Engineer registered in the State of Texas with appropriate experience in soil mechanic's and structural engineering.



- D. The plan shall be detailed to the extent that it shows the proposed limits (to the nearest foot) of the various types of trench safety systems the Contractor proposes to use.
- E. After review as to form only, without review for adequacy, by the Engineer and Owner's staff, the plan will be forwarded to the Owner and/or Project Representative for use in monitoring the Contractor's construction activities.
- F. Contractor accepts sole responsibility for compliance with all applicable safety requirements. The review by the Engineer and Owner's staff is only for general conformance with the State of Texas and OSHA safety standards. Release of the safety plan for use in monitoring construction activities does not relieve Contractor from any or all construction means, methods, techniques and procedures; and any property damage or bodily injury (including death) that arises from use of the trench safety plan, from Contractor's negligence in performance of contract work, or from Engineer's or Owner's failure to note exceptions to the safety plan, shall remain the sole responsibility and liability of the Contractor.
- G. Changes in the Trench Safety Plan after initiation of construction, either for the Contractor's convenience or in response to unforeseen or differing conditions, are not cause for extension of time or change order and will require the same review process as the original plan.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 LINES AND GRADES

- A. Lay pipes to lines and grades indicated on Drawings.
 - 1. Engineer Owner reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.
- B. Use laser-beam instrument with qualified operator to establish lines and grades.

3.2 PREPARATION

- A. Call Local Utility Line Information service at not less than three working days before performing Work.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.
- B. Identify required lines, levels, contours, and datum locations.
- C. Protect plant life, lawns, rock outcropping and other features remaining as portion of final landscaping.
- D. Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.



- E. Maintain and protect above and below grade utilities indicated to remain.
- F. Establish temporary traffic control and detours when trenching is performed in public right-of-way. Relocate controls and reroute traffic as required during progress of Work.

3.3 TRENCHING

- A. Excavate subsoil required for utilities to utility service.
- B. Remove lumped subsoil, boulders, and rock up of 1/6 cubic yard, measured by volume.
- C. Perform excavation within 24 inches of existing utility service in accordance with utility's requirements.
- D. Do not advance open trench more than 200 feet ahead of installed pipe.
- E. Cut trenches to width sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work.
- F. Excavate bottom of trenches maximum 2 feet wider than outside diameter of pipe.
- G. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and pipe utilities.
- H. Do not interfere with 45 degree bearing splay of foundations.
- I. When Project conditions permit, slope side walls of excavation starting 2 feet above top of pipe. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this section.
- J. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Engineer until suitable material is encountered. Notify Engineer, and request instructions.
- K. Cut out soft areas of subgrade not capable of compaction in place. Backfill with Fill Type and compact to density equal to or greater than requirements for subsequent backfill material.
- L. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.
- M. Correct areas over excavated areas with compacted backfill as specified for authorized excavation or replace with fill concrete as directed by Engineer.
- N. Remove excess subsoil not intended for reuse, from site.
- O. Stockpile subsoil in area designated on site to depth not exceeding 8 feet and protect from erosion.



3.4 SHEETING AND SHORING

- A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.
- B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.
- C. Design sheeting and shoring to be left in place as part of the completed Work, cut off minimum 18 inches below finished grade.
- D. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.
- E. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.5 BACKFILLING

- A. Backfill trenches to contours and elevations with unfrozen fill materials.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
- C. Employ placement method that does not disturb or damage foundation perimeter drainage, or utilities in trench.
- D. Maintain optimum moisture content of fill materials to attain required compaction density.
- E. Do not leave more than 50 feet of trench open at end of working day.
- F. Protect open trench to prevent danger to the public.

3.6 TOLERANCES

- A. Tolerances: Refer to *Section 01 40 00 - Quality Requirements*.
- B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch 0.08 feet from required elevations.
- C. Top Surface of General Backfilling: Plus or minus 1 inch 0.08 feet from required elevations.

3.7 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements.
- B. *Section 01 70 00 - Execution and Closeout Requirements*: Field inspecting, testing, adjusting, and balancing.



- C. Perform laboratory material tests in accordance with ASTM D1557. ASTM D698. AASHTO T180.
- D. Perform in place compaction tests in accordance with the following:
 - 1. Density Tests: ASTM D1556, ASTM D2167, or ASTM D2922.
 - 2. Moisture Tests: ASTM D3017.
- E. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.
- F. Frequency of Tests.

3.8 PROTECTION OF FINISHED WORK

- A. *Section 01 70 00 - Execution and Closeout Requirements:* Protecting finished work.
- B. Reshape and re-compact fills subjected to vehicular traffic during construction.

3.9 SCHEDULE

- A. Storm and Sanitary Piping:
 - 1. Cover pipe and bedding with Fill Type: To subgrade elevation.
 - 2. Compact uniformly to minimum 95 percent of maximum density.
- B. Duct Bank:
 - 1. Cover duct and bedding with Fill Type: To subgrade elevation. thick.
 - 2. Compact uniformly to minimum 95 percent of maximum density.

END OF SECTION

OSHA REGULATIONS

REGARDING TRENCH SAFETY (FROM FEDERAL REGISTER)

§ 1926.650

(c) *Coaming*—The raised frame, as around a hatchway in the deck, to keep out water.

(d) *Jacob's ladder*—A marine ladder of rope or chain with wooden or metal rungs.

(e) *Rail*, for the purpose of §1926.605, means a light structure serving as a guard at the outer edge of a ship's deck.

Subpart P—Excavations

AUTHORITY: Sec. 107, Contract Worker Hours and Safety Standards Act (Construction Safety Act) (40 U.S.C. 333); Secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41 FR 25059), or 9-83 (48 FR 35736), as applicable, and 29 CFR part 1911.

SOURCE: 54 FR 45959, Oct. 31, 1989, unless otherwise noted.

§ 1926.650 Scope, application, and definitions applicable to this subpart.

(a) *Scope and application*. This subpart applies to all open excavations made in the earth's surface. Excavations are defined to include trenches.

(b) *Definitions applicable to this subpart*.

Accepted engineering practices means those requirements which are compatible with standards of practice required by a registered professional engineer.

Aluminum Hydraulic Shoring means a pre-engineered shoring system comprised of aluminum hydraulic cylinders (crossbraces) used in conjunction with vertical rails (uprights) or horizontal rails (walers). Such system is designed, specifically to support the sidewalls of an excavation and prevent cave-ins.

Bell-bottom pier hole means a type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a belled shape.

Benching (Benching system) means a method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

Cave-in means the separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support

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system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

Competent person means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Cross braces mean the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or wales.

Excavation means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

Faces or *sides* means the vertical or inclined earth surfaces formed as a result of excavation work.

Failure means the breakage, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities.

Hazardous atmosphere means an atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

Kickout means the accidental release or failure of a cross brace.

Protective system means a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

Ramp means an inclined walking or working surface that is used to gain access to one point from another, and is constructed from earth or from structural materials such as steel or wood.

Registered Professional Engineer means a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any

state is deemed to be a “registered professional engineer” within the meaning of this standard when approving designs for “manufactured protective systems” or “tabulated data” to be used in interstate commerce.

Sheeting means the members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

Shield (Shield system) means a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either premanufactured or job-built in accordance with § 1926.652 (c)(3) or (c)(4). Shields used in trenches are usually referred to as “trench boxes” or “trench shields.”

Shoring (Shoring system) means a structure such as a metal hydraulic, mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

Sides. See “Faces.”

Sloping (Sloping system) means a method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

Stable rock means natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or by another protective system that has been designed by a registered professional engineer.

Structural ramp means a ramp built of steel or wood, usually used for vehicle access. Ramps made of soil or rock are not considered structural ramps.

Support system means a structure such as underpinning, bracing, or shoring, which provides support to an adja-

cent structure, underground installation, or the sides of an excavation.

Tabulated data means tables and charts approved by a registered professional engineer and used to design and construct a protective system.

Trench (Trench excavation) means a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

Trench box. See “Shield.”

Trench shield. See “Shield.”

Uprights means the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. Uprights placed so that individual members are closely spaced, in contact with or interconnected to each other, are often called “sheeting.”

Wales means horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.

§ 1926.651 Specific excavation requirements.

(a) *Surface encumbrances.* All surface encumbrances that are located so as to create a hazard to employees shall be removed or supported, as necessary, to safeguard employees.

(b) *Underground installations.* (1) The estimated location of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work, shall be determined prior to opening an excavation.

(2) Utility companies or owners shall be contacted within established or customary local response times, advised of

the proposed work, and asked to establish the location of the utility underground installations prior to the start of actual excavation. When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours (unless a longer period is required by state or local law), or cannot establish the exact location of these installations, the employer may proceed, provided the employer does so with caution, and provided detection equipment or other acceptable means to locate utility installations are used.

(3) When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means.

(4) While the excavation is open, underground installations shall be protected, supported or removed as necessary to safeguard employees.

(c) *Access and egress*—(1) *Structural ramps*. (i) Structural ramps that are used solely by employees as a means of access or egress from excavations shall be designed by a competent person. Structural ramps used for access or egress of equipment shall be designed by a competent person qualified in structural design, and shall be constructed in accordance with the design.

(ii) Ramps and runways constructed of two or more structural members shall have the structural members connected together to prevent displacement.

(iii) Structural members used for ramps and runways shall be of uniform thickness.

(iv) Cleats or other appropriate means used to connect runway structural members shall be attached to the bottom of the runway or shall be attached in a manner to prevent tripping.

(v) Structural ramps used in lieu of steps shall be provided with cleats or other surface treatments on the top surface to prevent slipping.

(2) *Means of egress from trench excavations*. A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet (1.22 m) or more in depth so as to require no more than 25 feet (7.62 m) of lateral travel for employees.

(d) *Exposure to vehicular traffic*. Employees exposed to public vehicular traffic shall be provided with, and shall wear, warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.

(e) *Exposure to falling loads*. No employee shall be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped, in accordance with §1926.601(b)(6), to provide adequate protection for the operator during loading and unloading operations.

(f) *Warning system for mobile equipment*. When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation, and the operator does not have a clear and direct view of the edge of the excavation, a warning system shall be utilized such as barricades, hand or mechanical signals, or stop logs. If possible, the grade should be away from the excavation.

(g) *Hazardous atmospheres*—(1) *Testing and controls*. In addition to the requirements set forth in subparts D and E of this part (29 CFR 1926.50–1926.107) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements shall apply:

(i) Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than 4 feet (1.22 m) in depth.

(ii) Adequate precautions shall be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous

atmospheres. These precautions include providing proper respiratory protection or ventilation in accordance with subparts D and E of this part respectively.

(iii) Adequate precaution shall be taken such as providing ventilation, to prevent employee exposure to an atmosphere containing a concentration of a flammable gas in excess of 20 percent of the lower flammable limit of the gas.

(iv) When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.

(2) *Emergency rescue equipment.* (i) Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment shall be attended when in use.

(ii) Employees entering bell-bottom pier holes, or other similar deep and confined footing excavations, shall wear a harness with a life-line securely attached to it. The lifeline shall be separate from any line used to handle materials, and shall be individually attended at all times while the employee wearing the lifeline is in the excavation.

(h) *Protection from hazards associated with water accumulation.* (1) Employees shall not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation. The precautions necessary to protect employees adequately vary with each situation, but could include special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or use of a safety harness and lifeline.

(2) If water is controlled or prevented from accumulating by the use of water removal equipment, the water removal equipment and operations shall be monitored by a competent person to ensure proper operation.

(3) If excavation work interrupts the natural drainage of surface water (such as streams), diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering the excavation and to provide adequate drainage of the area adjacent to the excavation. Excavations subject to runoff from heavy rains will require an inspection by a competent person and compliance with paragraphs (h)(1) and (h)(2) of this section.

(i) *Stability of adjacent structures.* (1) Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of employees.

(2) Excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees shall not be permitted except when:

(i) A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure; or

(ii) The excavation is in stable rock; or

(iii) A registered professional engineer has approved the determination that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity; or

(iv) A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.

(3) Sidewalks, pavements, and appurtenant structure shall not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures.

(j) *Protection of employees from loose rock or soil.* (1) Adequate protection shall be provided to protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face. Such protection shall consist of scaling to remove loose material; installation of protective barricades at intervals as necessary on the face to stop and contain falling material; or other means that provide equivalent protection.

(2) Employees shall be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations. Protection shall be provided by placing and keeping such materials or equipment at least 2 feet (.61 m) from the edge of excavations, or by the use of retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations, or by a combination of both if necessary.

(k) *Inspections.* (1) Daily inspections of excavations, the adjacent areas, and protective systems shall be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. An inspection shall be conducted by the competent person prior to the start of work and as needed throughout the shift. Inspections shall also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated.

(2) Where the competent person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions, exposed employees shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.

(l) Walkways shall be provided where employees or equipment are required or permitted to cross over excavations. Guardrails which comply with § 1926.502(b) shall be provided where walkways are 6 feet (1.8 m) or more above lower levels.

[54 FR 45959, Oct. 31, 1989, as amended by 59 FR 40730, Aug. 9, 1994]

§ 1926.652 Requirements for protective systems.

(a) *Protection of employees in excavations.* (1) Each employee in an excavation shall be protected from cave-ins by an adequate protective system designed in accordance with paragraph (b) or (c) of this section except when:

(i) Excavations are made entirely in stable rock; or

(ii) Excavations are less than 5 feet (1.52m) in depth and examination of the ground by a competent person provides no indication of a potential cave-in.

(2) Protective systems shall have the capacity to resist without failure all loads that are intended or could reasonably be expected to be applied or transmitted to the system.

(b) *Design of sloping and benching systems.* The slopes and configurations of sloping and benching systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (b)(1); or, in the alternative, paragraph (b)(2); or, in the alternative, paragraph (b)(3), or, in the alternative, paragraph (b)(4), as follows:

(1) *Option (1)—Allowable configurations and slopes.* (i) Excavations shall be sloped at an angle not steeper than one and one-half horizontal to one vertical (34 degrees measured from the horizontal), unless the employer uses one of the other options listed below.

(ii) Slopes specified in paragraph (b)(1)(i) of this section, shall be excavated to form configurations that are in accordance with the slopes shown for Type C soil in appendix B to this subpart.

(2) *Option (2)—Determination of slopes and configurations using Appendices A and B.* Maximum allowable slopes, and allowable configurations for sloping and benching systems, shall be determined in accordance with the conditions and requirements set forth in appendices A and B to this subpart.

(3) *Option (3)—Designs using other tabulated data.* (i) Designs of sloping or benching systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and shall include all of the following:

(A) Identification of the parameters that affect the selection of a sloping or benching system drawn from such data;

(B) Identification of the limits of use of the data, to include the magnitude and configuration of slopes determined to be safe;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

(4) *Option (4)—Design by a registered professional engineer.* (i) Sloping and benching systems not utilizing Option (1) or Option (2) or Option (3) under paragraph (b) of this section shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include at least the following:

(A) The magnitude of the slopes that were determined to be safe for the particular project;

(B) The configurations that were determined to be safe for the particular project; and

(C) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite while the slope is being constructed. After that time the design need not be at the jobsite, but a copy shall be made available to the Secretary upon request.

(c) *Design of support systems, shield systems, and other protective systems.* Designs of support systems shield systems, and other protective systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (c)(1); or, in the alternative, paragraph (c)(2); or, in the alternative, paragraph (c)(3); or, in the alternative, paragraph (c)(4) as follows:

(1) *Option (1)—Designs using appendices A, C and D.* Designs for timber shoring in trenches shall be determined in accordance with the conditions and requirements set forth in appendices A and C to this subpart. Designs for aluminum hydraulic shoring shall be in accordance with paragraph (c)(2) of this section, but if manufacturer's tabulated data cannot be utilized, designs shall be in accordance with appendix D.

(2) *Option (2)—Designs Using Manufacturer's Tabulated Data.* (i) Design of support systems, shield systems, or other

protective systems that are drawn from manufacturer's tabulated data shall be in accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.

(ii) Deviation from the specifications, recommendations, and limitations issued or made by the manufacturer shall only be allowed after the manufacturer issues specific written approval.

(iii) Manufacturer's specifications, recommendations, and limitations, and manufacturer's approval to deviate from the specifications, recommendations, and limitations shall be in written form at the jobsite during construction of the protective system. After that time this data may be stored off the jobsite, but a copy shall be made available to the Secretary upon request.

(3) *Option (3)—Designs using other tabulated data.* (i) Designs of support systems, shield systems, or other protective systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and include all of the following:

(A) Identification of the parameters that affect the selection of a protective system drawn from such data;

(B) Identification of the limits of use of the data;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data, which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

(4) *Option (4)—Design by a registered professional engineer.* (i) Support systems, shield systems, and other protective systems not utilizing Option 1, Option 2 or Option 3, above, shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include the following:

(A) A plan indicating the sizes, types, and configurations of the materials to be used in the protective system; and

(B) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite during construction of the protective system. After that time, the design may be stored off the jobsite, but a copy of the design shall be made available to the Secretary upon request.

(d) *Materials and equipment.* (1) Materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function.

(2) Manufactured materials and equipment used for protective systems shall be used and maintained in a manner that is consistent with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards.

(3) When material or equipment that is used for protective systems is damaged, a competent person shall examine the material or equipment and evaluate its suitability for continued use. If the competent person cannot assure the material or equipment is able to support the intended loads or is otherwise suitable for safe use, then such material or equipment shall be removed from service, and shall be evaluated and approved by a registered professional engineer before being returned to service.

(e) *Installation and removal of support*—(1) *General.* (i) Members of support systems shall be securely connected together to prevent sliding, falling, kickouts, or other predictable failure.

(ii) Support systems shall be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.

(iii) Individual members of support systems shall not be subjected to loads exceeding those which those members were designed to withstand.

(iv) Before temporary removal of individual members begins, additional precautions shall be taken to ensure the safety of employees, such as in-

stalling other structural members to carry the loads imposed on the support system.

(v) Removal shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly so as to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.

(vi) Backfilling shall progress together with the removal of support systems from excavations.

(2) *Additional requirements for support systems for trench excavations.* (i) Excavation of material to a level no greater than 2 feet (.61 m) below the bottom of the members of a support system shall be permitted, but only if the system is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the support system.

(ii) Installation of a support system shall be closely coordinated with the excavation of trenches.

(f) *Sloping and benching systems.* Employees shall not be permitted to work on the faces of sloped or benched excavations at levels above other employees except when employees at the lower levels are adequately protected from the hazard of falling, rolling, or sliding material or equipment.

(g) *Shield systems*—(1) *General.* (i) Shield systems shall not be subjected to loads exceeding those which the system was designed to withstand.

(ii) Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.

(iii) Employees shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

(iv) Employees shall not be allowed in shields when shields are being installed, removed, or moved vertically.

(2) *Additional requirement for shield systems used in trench excavations.* Excavations of earth material to a level not greater than 2 feet (.61 m) below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces calculated for the full

depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield.

APPENDIX A TO SUBPART P OF PART 1926—SOIL CLASSIFICATION

(a) *Scope and application*—(1) *Scope*. This appendix describes a method of classifying soil and rock deposits based on site and environmental conditions, and on the structure and composition of the earth deposits. The appendix contains definitions, sets forth requirements, and describes acceptable visual and manual tests for use in classifying soils.

(2) *Application*. This appendix applies when a sloping or benching system is designed in accordance with the requirements set forth in §1926.652(b)(2) as a method of protection for employees from cave-ins. This appendix also applies when timber shoring for excavations is designed as a method of protection from cave-ins in accordance with appendix C to subpart P of part 1926, and when aluminum hydraulic shoring is designed in accordance with appendix D. This appendix also applies if other protective systems are designed and selected for use from data prepared in accordance with the requirements set forth in §1926.652(c), and the use of the data is predicated on the use of the soil classification system set forth in this appendix.

(b) *Definitions*. The definitions and examples given below are based on, in whole or in part, the following: American Society for Testing Materials (ASTM) Standards D653-85 and D2488; The Unified Soils Classification System, The U.S. Department of Agriculture (USDA) Textural Classification Scheme; and The National Bureau of Standards Report BSS-121.

Cemented soil means a soil in which the particles are held together by a chemical agent, such as calcium carbonate, such that a hand-size sample cannot be crushed into powder or individual soil particles by finger pressure.

Cohesive soil means clay (fine grained soil), or soil with a high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical sideslopes, and is plastic when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clayey silt, sandy clay, silty clay, clay and organic clay.

Dry soil means soil that does not exhibit visible signs of moisture content.

Fissured means a soil material that has a tendency to break along definite planes of fracture with little resistance, or a material that exhibits open cracks, such as tension cracks, in an exposed surface.

Granular soil means gravel, sand, or silt, (coarse grained soil) with little or no clay content. Granular soil has no cohesive

strength. Some moist granular soils exhibit apparent cohesion. Granular soil cannot be molded when moist and crumbles easily when dry.

Layered system means two or more distinctly different soil or rock types arranged in layers. Micaceous seams or weakened planes in rock or shale are considered layered.

Moist soil means a condition in which a soil looks and feels damp. Moist cohesive soil can easily be shaped into a ball and rolled into small diameter threads before crumbling. Moist granular soil that contains some cohesive material will exhibit signs of cohesion between particles.

Plastic means a property of a soil which allows the soil to be deformed or molded without cracking, or appreciable volume change.

Saturated soil means a soil in which the voids are filled with water. Saturation does not require flow. Saturation, or near saturation, is necessary for the proper use of instruments such as a pocket penetrometer or shear vane.

Soil classification system means, for the purpose of this subpart, a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability. The categories are determined based on an analysis of the properties and performance characteristics of the deposits and the environmental conditions of exposure.

Stable rock means natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Submerged soil means soil which is underwater or is free seeping.

Type A means cohesive soils with an unconfined compressive strength of 1.5 ton per square foot (tsf) (144 kPa) or greater. Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered Type A. However, no soil is Type A if:

- (i) The soil is fissured; or
- (ii) The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or
- (iii) The soil has been previously disturbed; or
- (iv) The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater; or
- (v) The material is subject to other factors that would require it to be classified as a less stable material.

Type B means:

- (i) Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or
- (ii) Granular cohesionless soils including: angular gravel (similar to crushed rock),

silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.

(iii) Previously disturbed soils except those which would otherwise be classed as Type C soil.

(iv) Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or

(v) Dry rock that is not stable; or

(vi) Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

Type C means:

(i) Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; or

(ii) Granular soils including gravel, sand, and loamy sand; or

(iii) Submerged soil or soil from which water is freely seeping; or

(iv) Submerged rock that is not stable; or

(v) Material in a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or steeper.

Unconfined compressive strength means the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, or estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

Wet soil means soil that contains significantly more moisture than moist soil, but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit cohesive properties when moist will lose those cohesive properties when wet.

(c) *Requirements—(1) Classification of soil and rock deposits.* Each soil and rock deposit shall be classified by a competent person as Stable Rock, Type A, Type B, or Type C in accordance with the definitions set forth in paragraph (b) of this appendix.

(2) *Basis of classification.* The classification of the deposits shall be made based on the results of at least one visual and at least one manual analysis. Such analyses shall be conducted by a competent person using tests described in paragraph (d) below, or in other recognized methods of soil classification and testing such as those adopted by the American Society for Testing Materials, or the U.S. Department of Agriculture textural classification system.

(3) *Visual and manual analyses.* The visual and manual analyses, such as those noted as being acceptable in paragraph (d) of this appendix, shall be designed and conducted to provide sufficient quantitative and qualitative information as may be necessary to identify properly the properties, factors, and conditions affecting the classification of the deposits.

(4) *Layered systems.* In a layered system, the system shall be classified in accordance with its weakest layer. However, each layer may be classified individually where a more stable layer lies under a less stable layer.

(5) *Reclassification.* If, after classifying a deposit, the properties, factors, or conditions affecting its classification change in any way, the changes shall be evaluated by a competent person. The deposit shall be reclassified as necessary to reflect the changed circumstances.

(d) *Acceptable visual and manual tests—(1) Visual tests.* Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as samples from excavated material.

(i) Observe samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of particle sizes and the relative amounts of the particle sizes. Soil that is primarily composed of fine-grained material is cohesive material. Soil composed primarily of coarse-grained sand or gravel is granular material.

(ii) Observe soil as it is excavated. Soil that remains in clumps when excavated is cohesive. Soil that breaks up easily and does not stay in clumps is granular.

(iii) Observe the side of the opened excavation and the surface area adjacent to the excavation. Crack-like openings such as tension cracks could indicate fissured material. If chunks of soil spall off a vertical side, the soil could be fissured. Small spalls are evidence of moving ground and are indications of potentially hazardous situations.

(iv) Observe the area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures, and to identify previously disturbed soil.

(v) Observe the opened side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.

(vi) Observe the area adjacent to the excavation and the sides of the opened excavation for evidence of surface water, water seeping from the sides of the excavation, or the location of the level of the water table.

(vii) Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.

(2) *Manual tests.* Manual analysis of soil samples is conducted to determine quantitative as well as qualitative properties of soil and to provide more information in order to classify soil properly.

(i) *Plasticity.* Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as 1/8-inch in diameter. Cohesive material can be successfully rolled into

threads without crumbling. For example, if at least a two inch (50 mm) length of 1/8-inch thread can be held on one end without tearing, the soil is cohesive.

(ii) *Dry strength.* If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular (any combination of gravel, sand, or silt). If the soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty, it may be clay in any combination with gravel, sand or silt. If the dry soil breaks into clumps which do not break up into small clumps and which can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.

(iii) *Thumb penetration.* The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (This test is based on the thumb penetration test described in American Society for Testing and Materials (ASTM) Standard designation D2488—"Standard Recommended Practice for Description of Soils (Visual—Manual Procedure).") Type A soils with an unconfined compressive strength of 1.5 tsf can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort. Type C soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb, and can be molded by light finger pressure. This test should be conducted on an undisturbed soil sample, such as a large clump of spoil, as soon as practicable after excavation to keep to a minimum the effects of exposure to drying influences. If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.

(iv) *Other strength tests.* Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated shearvane.

(v) *Drying test.* The basic purpose of the drying test is to differentiate between cohesive material with fissures, unfissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick (2.54 cm) and six inches (15.24 cm) in diameter until it is thoroughly dry:

(A) If the sample develops cracks as it dries, significant fissures are indicated.

(B) Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as a unfissured cohesive material and the unconfined compressive strength should be determined.

(C) If a sample breaks easily by hand, it is either a fissured cohesive material or a granular material. To distinguish between

the two, pulverize the dried clumps of the sample by hand or by stepping on them. If the clumps do not pulverize easily, the material is cohesive with fissures. If they pulverize easily into very small fragments, the material is granular.

APPENDIX B TO SUBPART P OF PART 1926—SLOPING AND BENCHING

(a) *Scope and application.* This appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in §1926.652(b)(2).

(b) *Definitions.*

Actual slope means the slope to which an excavation face is excavated.

Distress means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; the spalling of material from the face of an excavation; and raveling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

Maximum allowable slope means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

Short term exposure means a period of time less than or equal to 24 hours that an excavation is open.

(c) *Requirements—(1) Soil classification.* Soil and rock deposits shall be classified in accordance with appendix A to subpart P of part 1926.

(2) *Maximum allowable slope.* The maximum allowable slope for a soil or rock deposit shall be determined from Table B-1 of this appendix.

(3) *Actual slope.* (i) The actual slope shall not be steeper than the maximum allowable slope.

(ii) The actual slope shall be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope shall be cut back to an actual slope which is at least 1/2 horizontal to one vertical (1/2H:1V) less steep than the maximum allowable slope.

(iii) When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall

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determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such reduction is achieved. Surcharge loads from

adjacent structures shall be evaluated in accordance with §1926.651(i).

(4) *Configurations*. Configurations of sloping and benching systems shall be in accordance with Figure B-1.

TABLE B-1
MAXIMUM ALLOWABLE SLOPES

SOIL OR ROCK TYPE	MAXIMUM ALLOWABLE SLOPES (H:V) [1] FOR EXCAVATIONS LESS THAN 20 FEET DEEP [3]
STABLE ROCK TYPE A [2] TYPE B TYPE C	VERTICAL (90°) 3/4 : 1 (53°) 1:1 (45°) 1½ : 1 (34°)

NOTES:

- Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
- A short-term maximum allowable slope of 1/2H:1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4H:1V (53°).
- Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

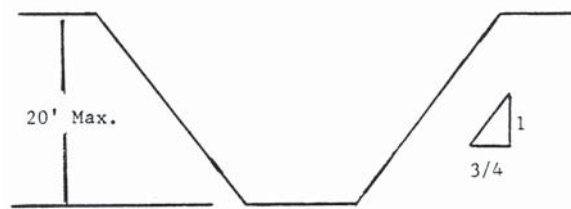
Figure B-1

Slope Configurations

(All slopes stated below are in the horizontal to vertical ratio)

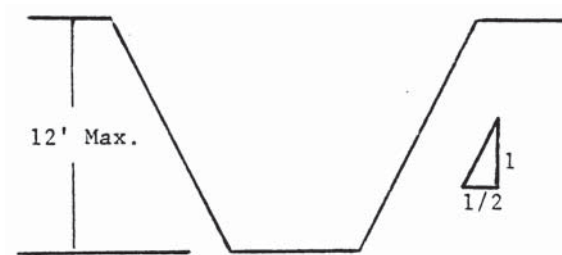
B-1.1 Excavations made in Type A soil.

- All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of ¾:1.



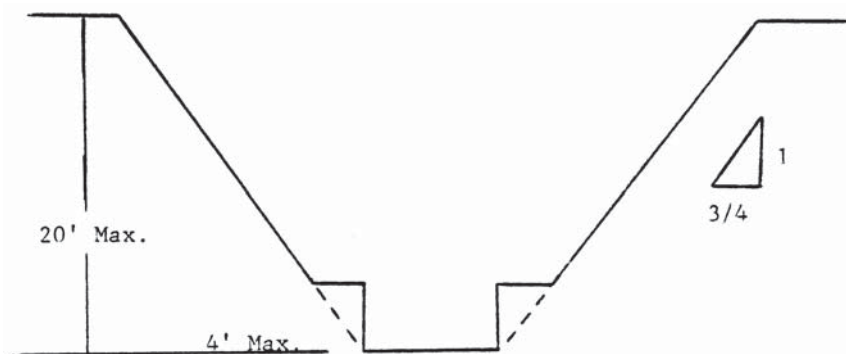
SIMPLE SLOPE—GENERAL

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of ½:1.

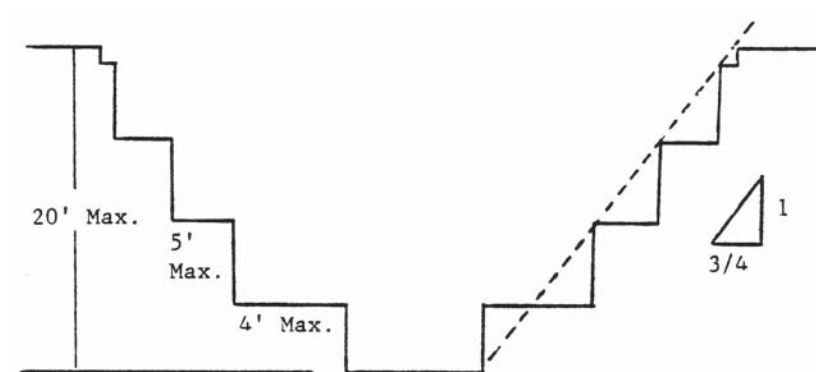


SIMPLE SLOPE—SHORT TERM

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of $\frac{3}{4}$ to 1 and maximum bench dimensions as follows:

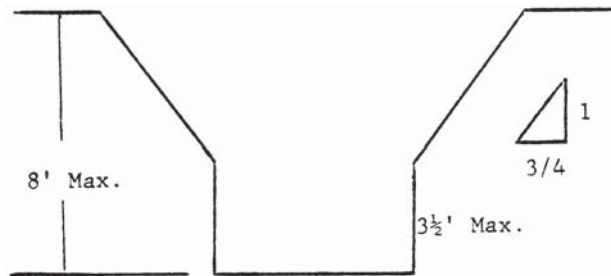


SIMPLE BENCH



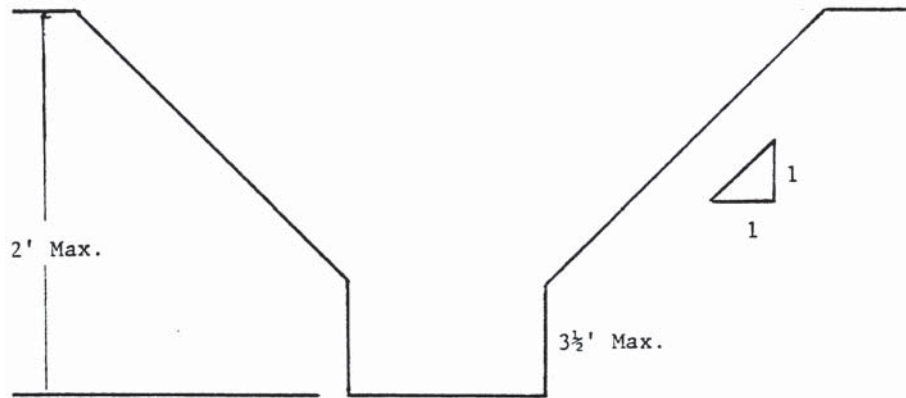
MULTIPLE BENCH

3. All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of $3\frac{1}{2}$ feet.



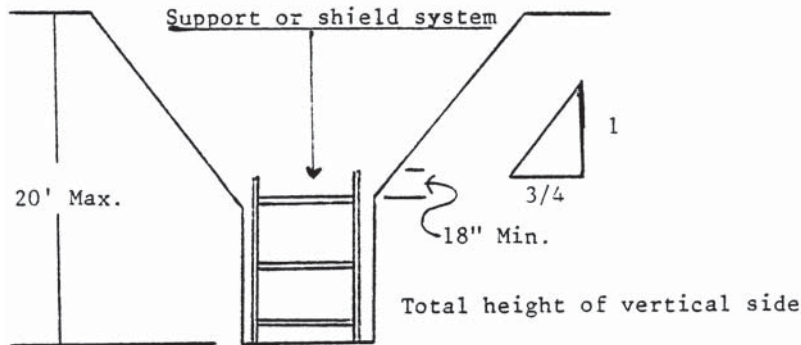
UNSUPPORTED VERTICALLY SIDED LOWER PORTION—MAXIMUM 8 FEET IN DEPTH

All excavations more than 8 feet but not more than 12 feet in depth which unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3½ feet.



UNSUPPORTED VERTICALLY SIDED LOWER PORTION—MAXIMUM 12 FEET IN DEPTH

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of ¾:1. The support or shield system must extend at least 18 inches above the top of the vertical side.

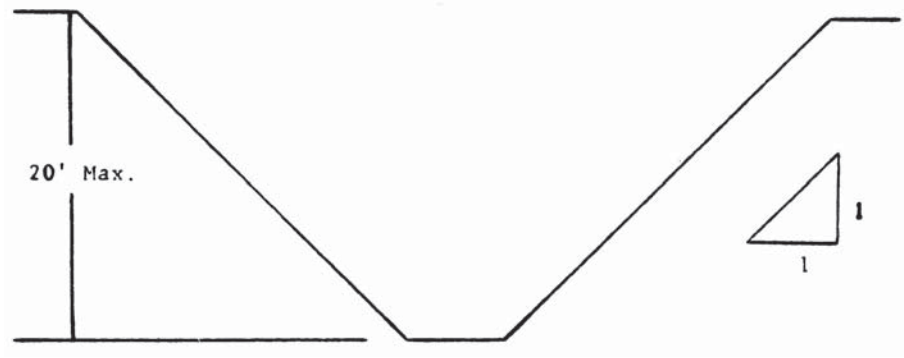


SUPPORTED OR SHIELDED VERTICALLY SIDED LOWER PORTION

4. All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under § 1926.652(b).

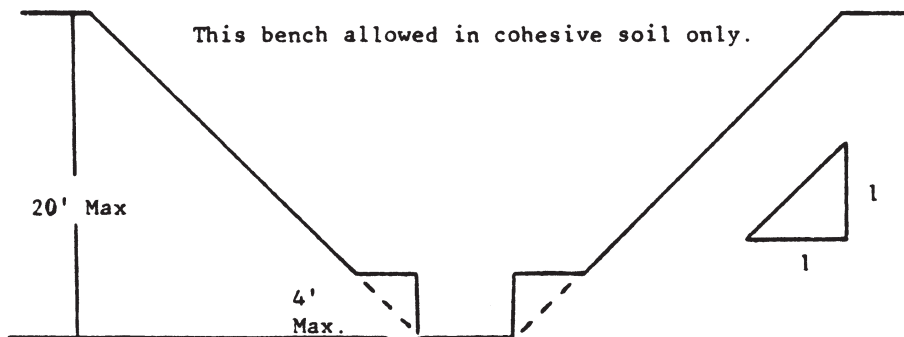
B-1.2 Excavations Made in Type B Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.

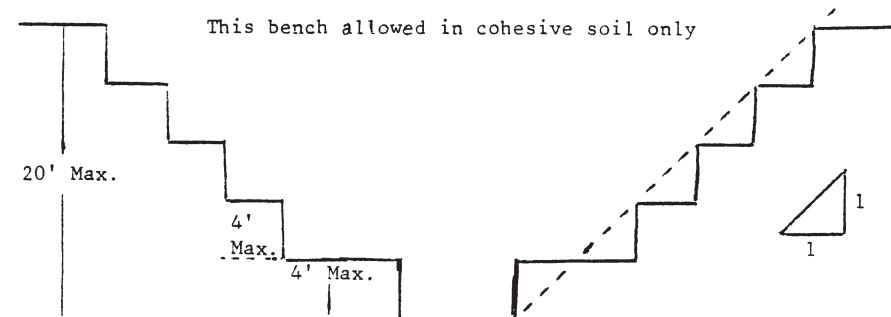


SIMPLE SLOPE

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:

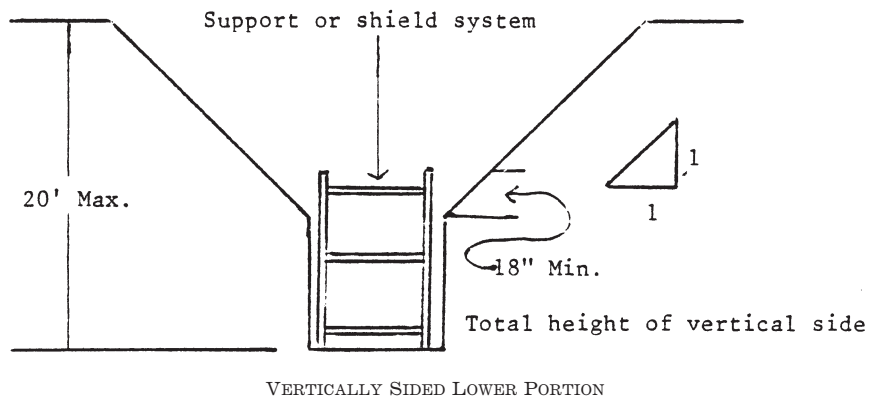


SINGLE BENCH



MULTIPLE BENCH

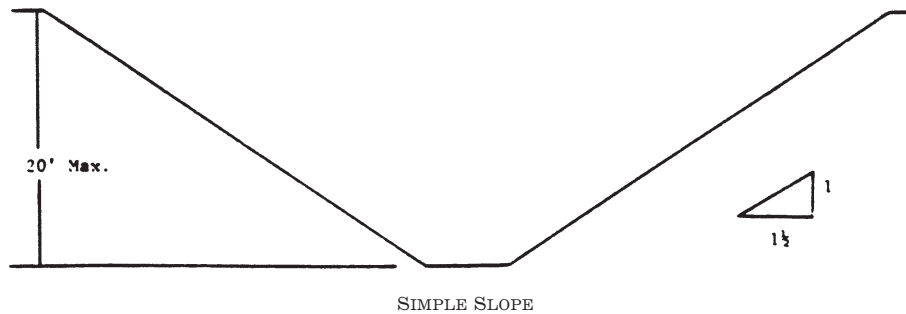
3. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.



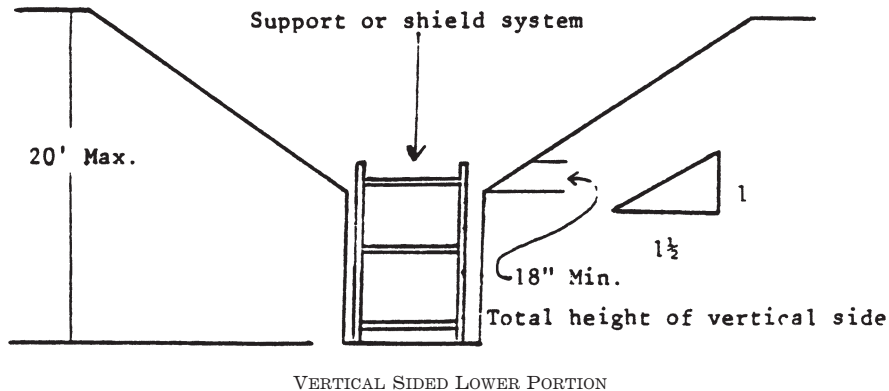
4. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).

B-1.3 Excavations Made in Type C Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of $1\frac{1}{2}:1$.



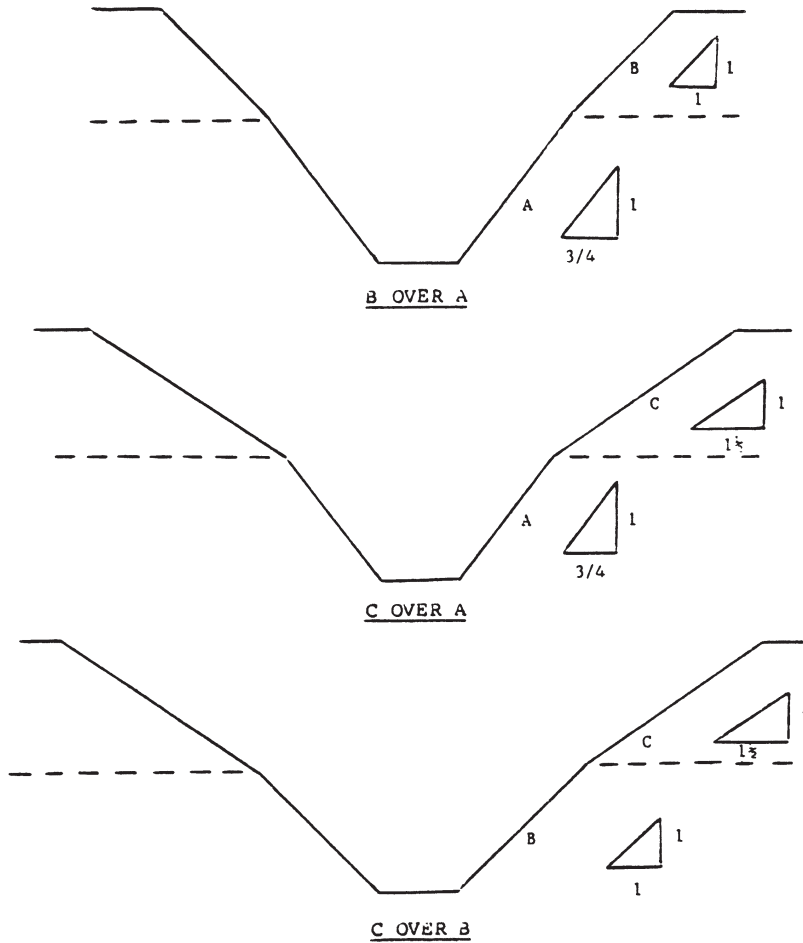
2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of $1\frac{1}{2}:1$.

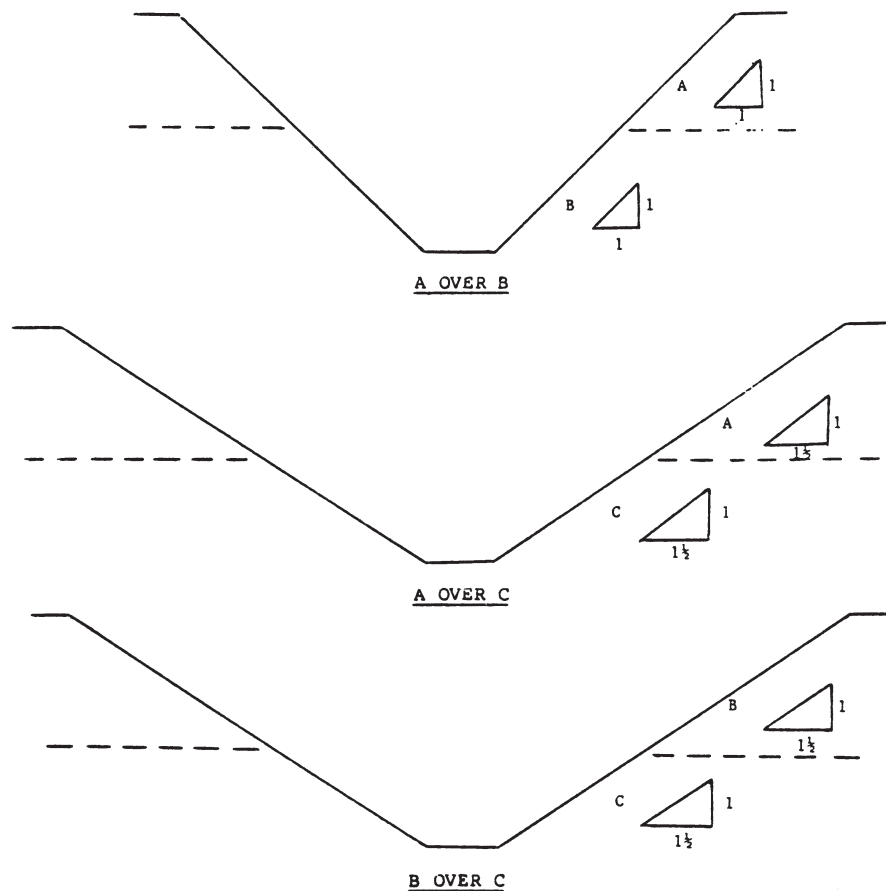


3. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).

B-1.4 Excavations Made in Layered Soils

1. All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below.





2. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).

APPENDIX C TO SUBPART P OF PART 1926—TIMBER SHORING FOR TRENCHES

(a) *Scope.* This appendix contains information that can be used timber shoring is provided as a method of protection from cave-ins in trenches that do not exceed 20 feet (6.1 m) in depth. This appendix must be used when design of timber shoring protective systems is to be performed in accordance with §1926.652(c)(1). Other timber shoring configurations; other systems of support such as hydraulic and pneumatic systems; and other protective systems such as sloping, benching, shielding, and freezing systems must be designed in accordance with the requirements set forth in §1926.652(b) and §1926.652(c).

(b) *Soil Classification.* In order to use the data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of this part.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables C-1.1, C-1.2, and C-1.3, and Tables C-2.1, C-2.2 and C-2.3 following paragraph (g) of the appendix. Each table presents the minimum sizes of timber members to use in a shoring system, and each table contains data only for the particular soil type in which the excavation or portion of

the excavation is made. The data are arranged to allow the user the flexibility to select from among several acceptable configurations of members based on varying the horizontal spacing of the crossbraces. Stable rock is exempt from shoring requirements and therefore, no data are presented for this condition.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix, and on the tables themselves.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations regarding Tables C-1.1 through C-1.3 and Tables C-2.1 through C-2.3 are presented in paragraph (g) of this Appendix.

(d) *Basis and limitations of the data*—(1) *Dimensions of timber members.* (i) The sizes of the timber members listed in Tables C-1.1 through C-1.3 are taken from the National Bureau of Standards (NBS) report, "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations." In addition, where NBS did not recommend specific sizes of members, member sizes are based on an analysis of the sizes required for use by existing codes and on empirical practice.

(ii) The required dimensions of the members listed in Tables C-1.1 through C-1.3 refer to actual dimensions and not nominal dimensions of the timber. Employers wanting to use nominal size shoring are directed to Tables C-2.1 through C-2.3, or have this choice under §1926.652(c)(3), and are referred to The Corps of Engineers, The Bureau of Reclamation or data from other acceptable sources.

(2) *Limitation of application.* (i) It is not intended that the timber shoring specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be designed as specified in §1926.652(c).

(ii) When any of the following conditions are present, the members specified in the tables are not considered adequate. Either an alternate timber shoring system must be designed or another type of protective system designed in accordance with §1926.652.

(A) When loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by a two-foot soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.

(B) When vertical loads imposed on cross braces exceed a 240-pound gravity load distributed on a one-foot section of the center of the crossbrace.

(C) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(D) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables.* The members of the shoring system that are to be selected using this information are the cross braces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are six tables of information, two for each soil type. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is then made. The selection is based on the depth and width of the trench where the members are to be installed and, in most instances, the selection is also based on the horizontal spacing of the crossbraces. Instances where a choice of horizontal spacing of crossbracing is available, the horizontal spacing of the crossbraces must be chosen by the user before the size of any member can be determined. When the soil type, the width and depth of the trench, and the horizontal spacing of the crossbraces are known, the size and vertical spacing of the crossbraces, the size and vertical spacing of the wales, and the size and horizontal spacing of the uprights can be read from the appropriate table.

(f) *Examples to Illustrate the Use of Tables C-1.1 through C-1.3.*

(1) *Example 1.*

A trench dug in Type A soil is 13 feet deep and five feet wide.

From *Table C-1.1*, for acceptable arrangements of timber can be used.

Arrangement #B1

Space 4x4 crossbraces at six feet horizontally and four feet vertically.

Wales are not required.

Space 3x8 uprights at six feet horizontally. This arrangement is commonly called "skip shoring."

Arrangement #B2

Space 4x6 crossbraces at eight feet horizontally and four feet vertically.

Space 8x8 wales at four feet vertically.

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Space 2x6 uprights at four feet horizontally.

Arrangement #B3

Space 6x6 crossbraces at 10 feet horizontally and four feet vertically.

Space 8x10 wales at four feet vertically.

Space 2x6 uprights at five feet horizontally.

Arrangement #B4

Space 6x6 crossbraces at 12 feet horizontally and four feet vertically.

Space 10x10 wales at four feet vertically.

Spaces 3x8 uprights at six feet horizontally.

(2) Example 2.

A trench dug in Type B soil in 13 feet deep and five feet wide. From Table C-1.2 three acceptable arrangements of members are listed.

Arrangement #B1

Space 6x6 crossbraces at six feet horizontally and five feet vertically.

Space 8x8 wales at five feet vertically.

Space 2x6 uprights at two feet horizontally.

Arrangement #B2

Space 6x8 crossbraces at eight feet horizontally and five feet vertically.

Space 10x10 wales at five feet vertically.

Space 2x6 uprights at two feet horizontally.

Arrangement #B3

Space 8x8 crossbraces at 10 feet horizontally and five feet vertically.

Space 10x12 wales at five feet vertically.

Space 2x6 uprights at two feet vertically.

(3) Example 3.

A trench dug in Type C soil is 13 feet deep and five feet wide.

From Table C-1.3 two acceptable arrangements of members can be used.

Arrangement #B1

Space 8x8 crossbraces at six feet horizontally and five feet vertically.

Space 10x12 wales at five feet vertically.

Position 2x6 uprights as closely together as possible.

If water must be retained use special tongue and groove uprights to form tight sheeting.

Arrangement #B2

Space 8x10 crossbraces at eight feet horizontally and five feet vertically.

Space 12x12 wales at five feet vertically.

Position 2x6 uprights in a close sheeting configuration unless water pressure must be resisted. Tight sheeting must be used where water must be retained.

(4) Example 4.

A trench dug in Type C soil is 20 feet deep and 11 feet wide. The size and spacing of members for the section of trench that is over 15 feet in depth is determined using Table C-1.3. Only one arrangement of members is provided.

Space 8x10 crossbraces at six feet horizontally and five feet vertically.

Space 12x12 wales at five feet vertically.

Use 3x6 tight sheeting.

Use of Tables C-2.1 through C-2.3 would follow the same procedures.

(g) Notes for all Tables.

1. Member sizes at spacings other than indicated are to be determined as specified in §1926.652(c), "Design of Protective Systems."

2. When conditions are saturated or submerged use Tight Sheeting. Tight Sheeting refers to the use of specially-edged timber planks (e.g., tongue and groove) at least three inches thick, steel sheet piling, or similar construction that when driven or placed in position provide a tight wall to resist the lateral pressure of water and to prevent the loss of backfill material. Close Sheeting refers to the placement of planks side-by-side allowing as little space as possible between them.

3. All spacing indicated is measured center to center.

4. Wales to be installed with greater dimension horizontal.

5. If the vertical distance from the center of the lowest crossbrace to the bottom of the trench exceeds two and one-half feet, uprights shall be firmly embedded or a mudsill shall be used. Where uprights are embedded, the vertical distance from the center of the lowest crossbrace to the bottom of the trench shall not exceed 36 inches. When mudsills are used, the vertical distance shall not exceed 42 inches. Mudsills are wales that are installed at the toe of the trench side.

6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

7. Placement of crossbraces. When the vertical spacing of crossbraces is four feet, place the top crossbrace no more than two feet below the top of the trench. When the vertical spacing of crossbraces is five feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

TABLE C-1.1

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE A $P_a = 25 \times H + 72 \text{ psf}$ (2 ft Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS **												
	CROSS BRACES					MALES			UPRIGHTS				
	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING				
	HORIZ. SPACING (FEET)	UP TO 4	UP TO 6	UP TO 9	UP TO 12				CLOSE	4	5	6	8
5 TO 10	UP TO 6	4X4	4X4	4X6	6X6	4	Not Req'd	---				2X6	
	UP TO 8	4X4	4X4	4X6	6X6	4	Not Req'd	---					2X8
	UP TO 10	4X6	4X6	4X6	6X6	4	8X8	4			2X6		
	UP TO 12	4X6	4X6	6X6	6X6	4	8X8	4				2X6	
10 TO 15	UP TO 6	4X4	4X4	4X6	6X6	4	Not Req'd	---					
	UP TO 8	4X6	4X6	6X6	6X6	4	8X8	4				3X8	
	UP TO 10	6X6	6X5	6X6	6X8	4	8X10	4		2X6			
	UP TO 12	6X6	6X6	6X6	6X8	4	10X10	4				3X8	
15 TO 20	UP TO 6	6X6	6X6	6X6	6X8	4	6X8	4		3X6			
	UP TO 8	6X6	6X6	6X6	6X8	4	8X8	4					
	UP TO 10	8X8	8X8	8X8	8X10	4	8X10	4		3X6			
	UP TO 12	8X8	8X8	8X8	8X10	4	10X10	4		3X6			
OVER 20	SEE NOTE 1												

* Mixed oak or equivalent with a bending strength not less than 850 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-1.2

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE B $P_a = 45 \text{ X H} + 72 \text{ psf (2 ft. Surcharge)}$

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**										
	CROSS BRACES					WALES		UPRIGHTS			
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)				VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING		
		UP TO 4	UP TO 6	UP TO 9	UP TO 12				CLOSE	2	3
5	UP TO 6	4X6	4X6	6X6	6X6	5	6X8	5			2X6
TO	UP TO 8	6X6	6X6	6X6	6X8	5	8X10	5			2X6
10	UP TO 10	6X6	6X6	6X6	6X8	5	10X10	5			2X6
	See Note 1										
10	UP TO 6	6X6	6X6	6X6	6X8	5	8X8	5		2X6	
TO	UP TO 8	6X8	6X8	6X8	8X8	5	10X10	5		2X6	
15	UP TO 10	8X8	8X8	8X8	8X10	5	10X12	5		2X6	
	See Note 1										
15	UP TO 6	6X8	6X8	6X8	8X8	5	8X10	5	3X6		
TO	UP TO 8	8X8	8X8	8X8	8X10	5	10X12	5	3X6		
20	UP TO 10	8X10	8X10	8X10	10X10	5	12X12	5	3X6		
	See Note 1										
OVER 20	SEE NOTE 1										

* Mixed oak or equivalent with a bending strength not less than 850 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-1.3

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE C P_a = 80 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**												UPRIGHTS	
	CROSS BRACES						VERT. SPACING (FEET)	SIZE (IN.)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET) (See Note 2)				
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)												
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15								
5 TO 10	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	8X10	5	2X6				
	UP TO 8	8X8	8X8	8X8	8X8	8X10	5	10X12	5	2X6				
	UP TO 10	8X10	8X10	8X10	8X10	10X10	5	12X12	5	2X6				
	See Note 1													
10 TO 15	UP TO 6	8X8	8X8	8X8	8X8	8X10	5	10X12	5	2X6				
	UP TO 8	8X10	8X10	8X10	8X10	10X10	5	12X12	5	2X6				
	See Note 1													
15 TO 20	UP TO 6	8X10	8X10	8X10	8X10	10X10	5	12X12	5	3X6				
	See Note 1													
	See Note 1													
OVER 20	See Note 1													

SEE NOTE 1

* Mixed Oak or equivalent with a bending strength not less than 850 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.1

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE A $P_a = 25 \text{ X H} \pm 72 \text{ psf}$ (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **										UPRIGHTS			
	CROSS BRACES					WALES					MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)			
	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)					VERT. SPACING (FEET)			
	UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15	UP TO 4	UP TO 6	UP TO 8	UP TO 10	UP TO 12	CLOSE	4	5	8
5 TO 10	UP TO 6	4X4	4X4	4X4	4X6	4	4	4	4	4	Not Req'd	4X6		
	UP TO 8	4X4	4X4	4X4	4X6	4	4	4	4	4	Not Req'd			4X8
	UP TO 10	4X6	4X6	4X6	6X6	4	4	4	4	4	4X6			
10 TO 15	UP TO 12	4X6	4X6	4X6	6X6	4	4	4	4	4	Not Req'd	4X6		
	UP TO 6	4X4	4X4	4X4	6X6	4	4	4	4	4	Not Req'd			4X10
	UP TO 8	4X6	4X6	4X6	6X6	4	4	4	4	4	4X6			
15 TO 20	UP TO 10	6X6	6X6	6X6	6X6	4	4	4	4	4	4		4X8	
	UP TO 12	6X6	6X6	6X6	6X6	4	4	4	4	4		4X6		4X10
	UP TO 6	6X6	6X6	6X6	6X6	4	4	4	4	4	3X6			
20 TO 25	UP TO 8	6X6	6X6	6X6	6X6	4	4	4	4	4	4	4X12		
	UP TO 10	6X6	6X6	6X6	6X8	4	4	4	4	4	3X6			
	UP TO 12	6X6	6X6	6X6	6X8	4	4	4	4	4	3X6	4X12		
OVER 25														

TABLE C-2.2

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *
 SOIL TYPE B $P_a = 45 \text{ X H} + 72 \text{ psf}$ (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **													
	CROSS BRACES						WALES			UPRIGHTS				
	HORIZ. SPACING (FEET)		WIDTH OF TRENCH (FEET)				VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
			UP TO 4	UP TO 6	UP TO 9	UP TO 12				UP TO 15	CLOSE	2	3	4
5	UP TO 6	4X6	4X6	4X6	6X6	6X6	5	6X8	5			3X12 4X8		4X12
TO	UP TO 8	4X6	4X6	6X6	6X6	6X6	5	8X8	5		3X8		4X8	
10	UP TO 10	4X6	4X6	6X6	6X6	6X8	5	8X10	5			4X8		
	See Note 1													
10	UP TO 6	6X6	6X6	6X6	6X8	6X8	5	8X8	5	3X6	4X10			
TO	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X10	5	3X6	4X10			
15	UP TO 10	6X8	6X8	8X8	8X8	8X8	5	10X12	5	3X6	4X10			
	See Note 1													
15	UP TO 6	6X8	6X8	6X8	6X8	8X8	5	8X10	5	4X6				
TO	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X12	5	4X6				
20	UP TO 10	8X8	8X8	8X8	8X8	8X8	5	12X12	5	4X6				
	See Note 1													
OVER 20	SEE NOTE 1													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.3
TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *
SOIL TYPE C $P_a = 80 \text{ X H} + 72 \text{ psf}$ (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **									
	CROSS BRACES					WALES		UPRIGHTS		
	HORIZ. SPACING (FEET)		WIDTH OF TRENCH (FEET)			VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)	
	UP	TO	UP	TO	UP	TO	UP	TO	CLOSE	
5	UP	TO	4	6	6	9	6X6	8X8	5	3X6
	UP	TO	6X6	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	8	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	10	6X6	6X6	6X6	6X6	8X8	5	3X6
10	UP	TO	4	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	6	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	8	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	10	6X6	6X6	6X6	6X6	8X8	5	3X6
15	UP	TO	4	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	6	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	8	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	10	6X6	6X6	6X6	6X6	8X8	5	3X6
20	UP	TO	4	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	6	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	8	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	10	6X6	6X6	6X6	6X6	8X8	5	3X6
OVER 20	UP	TO	4	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	6	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	8	6X6	6X6	6X6	6X6	8X8	5	3X6
	UP	TO	10	6X6	6X6	6X6	6X6	8X8	5	3X6

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.

APPENDIX D TO SUBPART P OF PART 1926—ALUMINUM HYDRAULIC SHORING FOR TRENCHES

(a) *Scope.* This appendix contains information that can be used when aluminum hydraulic shoring is provided as a method of protection against cave-ins in trenches that

do not exceed 20 feet (6.1m) in depth. This appendix must be used when design of the aluminum hydraulic protective system cannot be performed in accordance with § 1926.652(c)(2).

(b) *Soil Classification.* In order to use data presented in this appendix, the soil type or types in which the excavation is made must

first be determined using the soil classification method set forth in appendix A of subpart P of part 1926.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables D-1.1, D-1.2, D-1.3 and E-1.4. Each table presents the maximum vertical and horizontal spacings that may be used with various aluminum member sizes and various hydraulic cylinder sizes. Each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. Tables D-1.1 and D-1.2 are for vertical shores in Types A and B soil. Tables D-1.3 and D-1.4 are for horizontal waler systems in Types B and C soil.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations (footnotes) regarding Table D-1.1 through D-1.4 are presented in paragraph (g) of this appendix.

(6) Figures, illustrating typical installations of hydraulic shoring, are included just prior to the Tables. The illustrations page is entitled "Aluminum Hydraulic Shoring; Typical Installations."

(d) *Basis and limitations of the data.* (1) Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in the D-1 Tables. Aluminum material is 6061-T6 or material of equivalent strength and properties.

(2) Hydraulic cylinders specifications. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at extensions as recommended by product manufacturer.

(3) Limitation of application.

(i) It is not intended that the aluminum hydraulic specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be otherwise designed as specified in §1926.652(c).

(ii) When any of the following conditions are present, the members specified in the Ta-

bles are not considered adequate. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with §1926.652.

(A) When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.

(B) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(C) When only the lower portion or a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables D-1.1, D-1.2, D-1.3 and D-1.4.* The members of the shoring system that are to be selected using this information are the hydraulic cylinders, and either the vertical shores or the horizontal wales. When a waler system is used the vertical timber sheeting to be used is also selected from these tables. The Tables D-1.1 and D-1.2 for vertical shores are used in Type A and B soils that do not require sheeting. Type B soils that may require sheeting, and Type C soils that always require sheeting are found in the horizontal wale Tables D-1.3 and D-1.4. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is made. The selection is based on the depth and width of the trench where the members are to be installed. In these tables the vertical spacing is held constant at four feet on center. The tables show the maximum horizontal spacing of cylinders allowed for each size of wale in the waler system tables, and in the vertical shore tables, the hydraulic cylinder horizontal spacing is the same as the vertical shore spacing.

(f) *Example to Illustrate the Use of the Tables:*

(1) Example 1:

A trench dug in Type A soil is 6 feet deep and 3 feet wide. From Table D-1.1: Find vertical shores and 2 inch diameter cylinders spaced 8 feet on center (o.c.) horizontally and 4 feet on center (o.c.) vertically. (See Figures 1 & 3 for typical installations.)

(2) Example 2:

A trench is dug in Type B soil that does not require sheeting, 13 feet deep and 5 feet wide. From Table D-1.2: Find vertical shores and 2 inch diameter cylinders spaced 6.5 feet o.c. horizontally and 4 feet o.c. vertically. (See Figures 1 & 3 for typical installations.)

(3) A trench is dug in Type B soil that does not require sheeting, but does experience some minor raveling of the trench face. The

trench is 16 feet deep and 9 feet wide. From Table D-1.2: Find vertical shores and 2 inch diameter cylinder (with special oversleeves as designated by footnote #B2) spaced 5.5 feet o.c. horizontally and 4 feet o.c. vertically, plywood (per footnote (g)(7) to the D-1 Table) should be used behind the shores. (See Figures 2 & 3 for typical installations.)

(4) Example 4: A trench is dug in previously disturbed Type B soil, with characteristics of a Type C soil, and will require sheeting. The trench is 18 feet deep and 12 feet wide. 8 foot horizontal spacing between cylinders is desired for working space. From Table D-1.3: Find horizontal wale with a section modulus of 14.0 spaced at 4 feet o.c. vertically and 3 inch diameter cylinder spaced at 9 feet maximum o.c. horizontally. 3x12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(5) Example 5: A trench is dug in Type C soil, 9 feet deep and 4 feet wide. Horizontal cylinder spacing in excess of 6 feet is desired for working space. From Table D-1.4: Find horizontal wale with a section modulus of 7.0 and 2 inch diameter cylinders spaced at 6.5 feet o.c. horizontally. Or, find horizontal wale with a 14.0 section modulus and 3 inch diameter cylinder spaced at 10 feet o.c. horizontally. Both wales are spaced 4 feet o.c. vertically. 3x12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(g) *Footnotes, and general notes, for Tables D-1.1, D-1.2, D-1.3, and D-1.4.*

(1) For applications other than those listed in the tables, refer to §1926.652(c)(2) for use of manufacturer's tabulated data. For trench depths in excess of 20 feet, refer to §1926.652(c)(2) and §1926.652(c)(3).

(2) 2 inch diameter cylinders, at this width, shall have structural steel tube (3.5x3.5x0.1875) oversleeves, or structural oversleeves of manufacturer's specification, extending the full, collapsed length.

(3) Hydraulic cylinders capacities. (i) 2 inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe work capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(4) All spacing indicated is measured center to center.

(5) Vertical shoring rails shall have a minimum section modulus of 0.40 inch.

(6) When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a group.

(7) Plywood shall be 1.125 in. thick softwood or 0.75 inch. thick, 14 ply, arctic white birch (Finland form). Please note that plywood is not intended as a structural member, but only for prevention of local raveling (sloughing of the trench face) between shores.

(8) See appendix C for timber specifications.

(9) Wales are calculated for simple span conditions.

(10) See appendix D, item (d), for basis and limitations of the data.

ALUMINUM HYDRAULIC SHORING TYPICAL INSTALLATIONS

FIGURE NO. 1

VERTICAL ALUMINUM
HYDRAULIC SHORING
(SPOT BRACING)

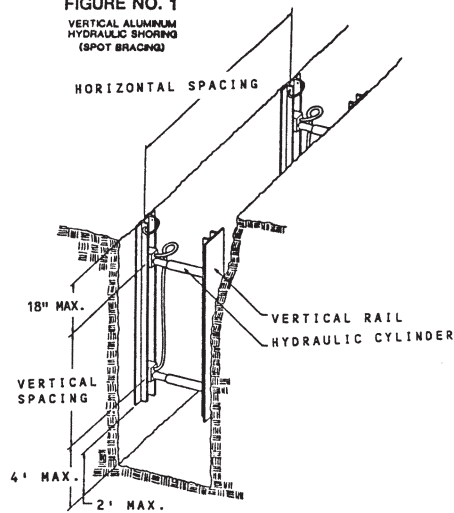


FIGURE NO. 2

VERTICAL ALUMINUM
HYDRAULIC SHORING
(WITH PLYWOOD)

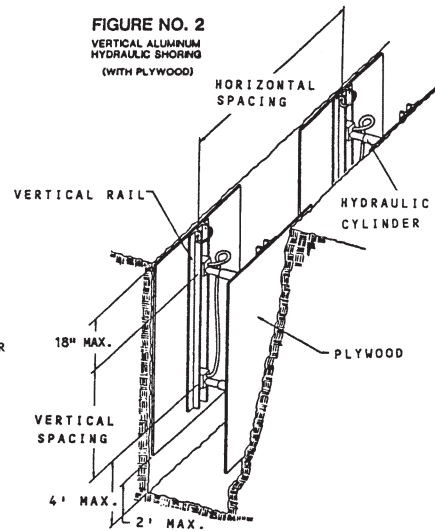


FIGURE NO. 3

VERTICAL ALUMINUM
HYDRAULIC SHORING
(STACKED)

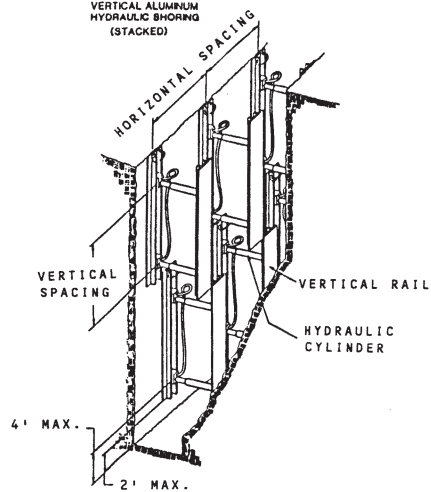


FIGURE NO. 4

ALUMINUM HYDRAULIC SHORING
WALER SYSTEM
(TYPICAL)

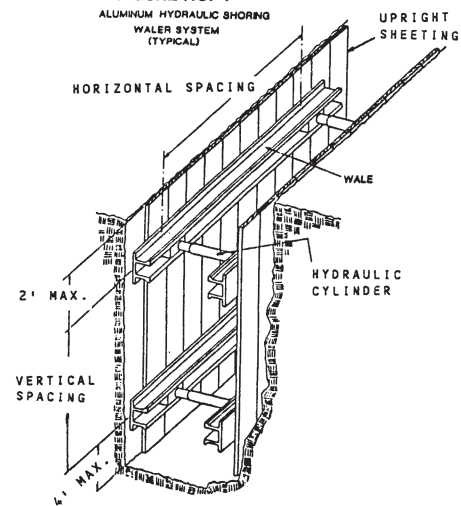


TABLE D - 1.1
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
FOR SOIL TYPE A

HYDRAULIC CYLINDERS				
DEPTH OF TRENCH (FEET)	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)	WIDTH OF TRENCH (FEET)	
			UP TO 8	OVER 8 UP TO 12
OVER 5 UP TO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)
OVER 10 UP TO 15	8			
OVER 15 UP TO 20	7			
OVER 20	NOTE (1)			

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Note (1): See Appendix D, Item (g) (1)

Note (2): See Appendix D, Item (g) (2)

TABLE D - 1.2
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
FOR SOIL TYPE B

HYDRAULIC CYLINDERS				
DEPTH OF TRENCH (FEET)	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)	WIDTH OF TRENCH (FEET)	
			UP TO 8	OVER 8 UP TO 12
OVER 5 UP TO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)
OVER 10 UP TO 15	6.5			
OVER 15 UP TO 20	5.5			
OVER 20	NOTE (1)			
			3 INCH DIAMETER	

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Note (1): See Appendix D, Item (g) (1)

Note (2): See Appendix D, Item (g) (2)

TABLE D - 1.3
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
FOR SOIL TYPE B

DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS						TIMBER UPRIGHTS		
	VERTICAL SPACING (FEET)	SECTION MODULUS (IN ³)	WIDTH OF TRENCH (FEET)						MAX. HORIZ. SPACING (ON CENTER)		
			UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO 15		SOLID SHEET	2 FT.	3 FT.
			HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER			
OVER 5 UP TO 10	4	3.5	8.0	2 IN	8.0	2 IN	8.0	3 IN			
		7.0	9.0	2 IN	9.0	NOTE(2)	9.0	3 IN			3x12
		14.0	12.0	3 IN	12.0	3 IN	12.0	3 IN			
OVER 10 UP TO 15	4	3.5	6.0	2 IN	6.0	NOTE(2)	6.0	3 IN		3x12	
		7.0	8.0	3 IN	8.0	3 IN	8.0	3 IN			
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN			
OVER 15 UP TO 20	4	3.5	5.5	2 IN	5.5	NOTE(2)	5.5	3 IN			
		7.0	6.0	3 IN	6.0	3 IN	6.0	3 IN	3x12		
		14.0	9.0	3 IN	9.0	3 IN	9.0	3 IN			
OVER 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Notes (1): See Appendix D, item (g) (1)

Notes (2): See Appendix D, Item (g) (2)

* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

TABLE D - 1.4
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
FOR SOIL TYPE C

DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS							TIMBER UPRIGHTS		
	VERTICAL SPACING (FEET)	SECTION MODULUS (IN ³)	WIDTH OF TRENCH (FEET)							MAX. HORIZ SPACING (ON CENTER)	SOLID SHEET	
			UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO 15					
			HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER				
OVER 5 UP TO 10	4	3.5	6.0	2 IN	6.0	2 IN NOTE(2)	6.0	3 IN	3x12	3x12	2 FT.	3 FT.
		7.0	6.5	2 IN	6.5	NOTE(2)	6.5	3 IN				
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN				
OVER 10 UP TO 15	4	3.5	4.0	2 IN	4.0	2 IN NOTE(2)	4.0	3 IN	3x12	3x12	—	—
		7.0	5.5	3 IN	5.5	3 IN	5.5	3 IN				
		14.0	8.0	3 IN	8.0	3 IN	8.0	3 IN				
OVER 15 UP TO 20	4	3.5	3.5	2 IN	3.5	2 IN NOTE(2)	3.5	3 IN	3x12	3x12	—	—
		7.0	5.0	3 IN	5.0	3 IN	5.0	3 IN				
		14.0	6.0	3 IN	6.0	3 IN	6.0	3 IN				
OVER 20	NOTE (1)											

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Notes (1): See Appendix D, item (g) (1)

Notes (2): See Appendix D, Item (g) (2)

* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

APPENDIX E TO SUBPART P OF PART 1926—ALTERNATIVES TO TIMBER SHORING

Figure 1. Aluminum Hydraulic Shoring

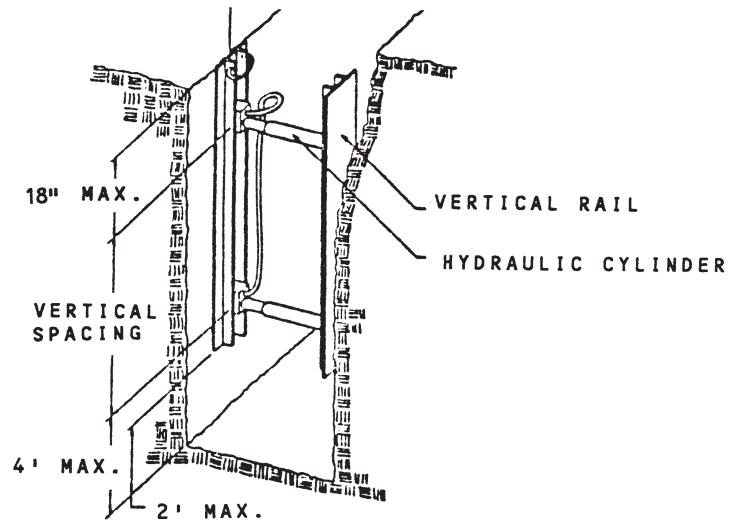


Figure 2. Pneumatic/hydraulic Shoring

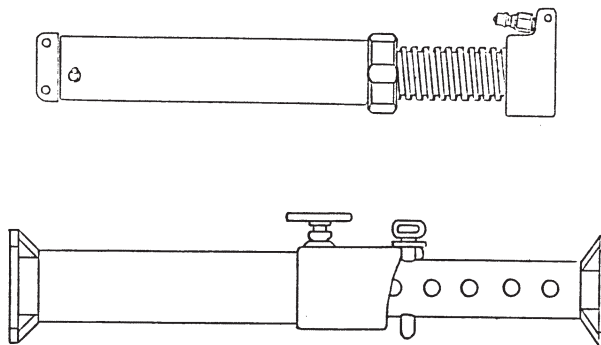


Figure 3. Trench Jacks (Screw Jacks)

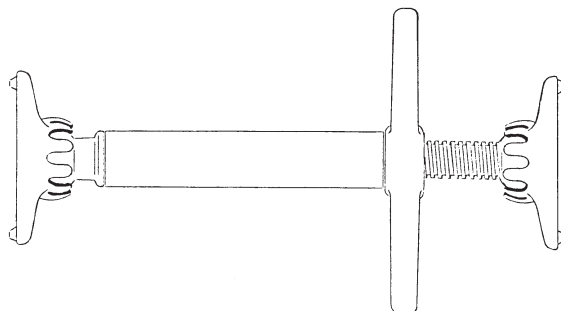
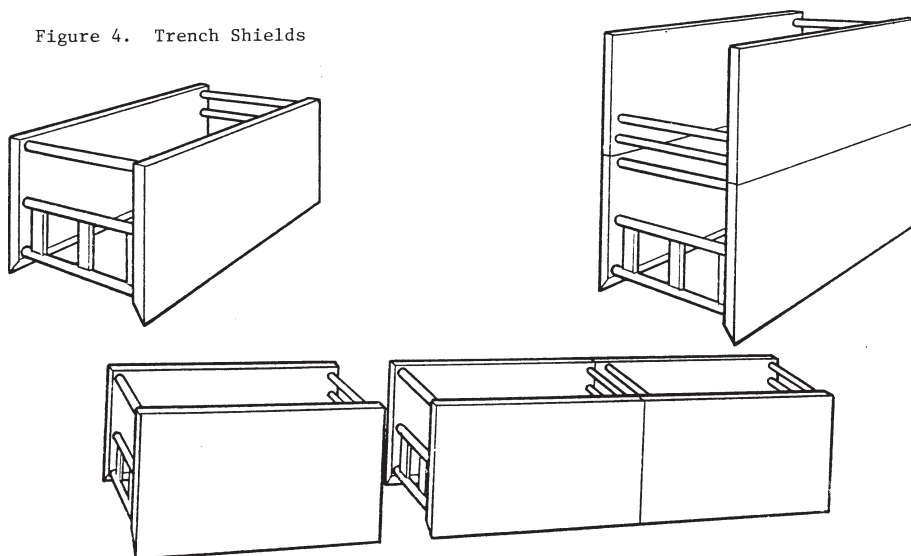


Figure 4. Trench Shields

APPENDIX F TO SUBPART P OF PART
1926—SELECTION OF PROTECTIVE
SYSTEMS

The following figures are a graphic summary of the requirements contained in sub-

part P for excavations 20 feet or less in depth. Protective systems for use in excavations more than 20 feet in depth must be designed by a registered professional engineer in accordance with § 1926.652 (b) and (c).

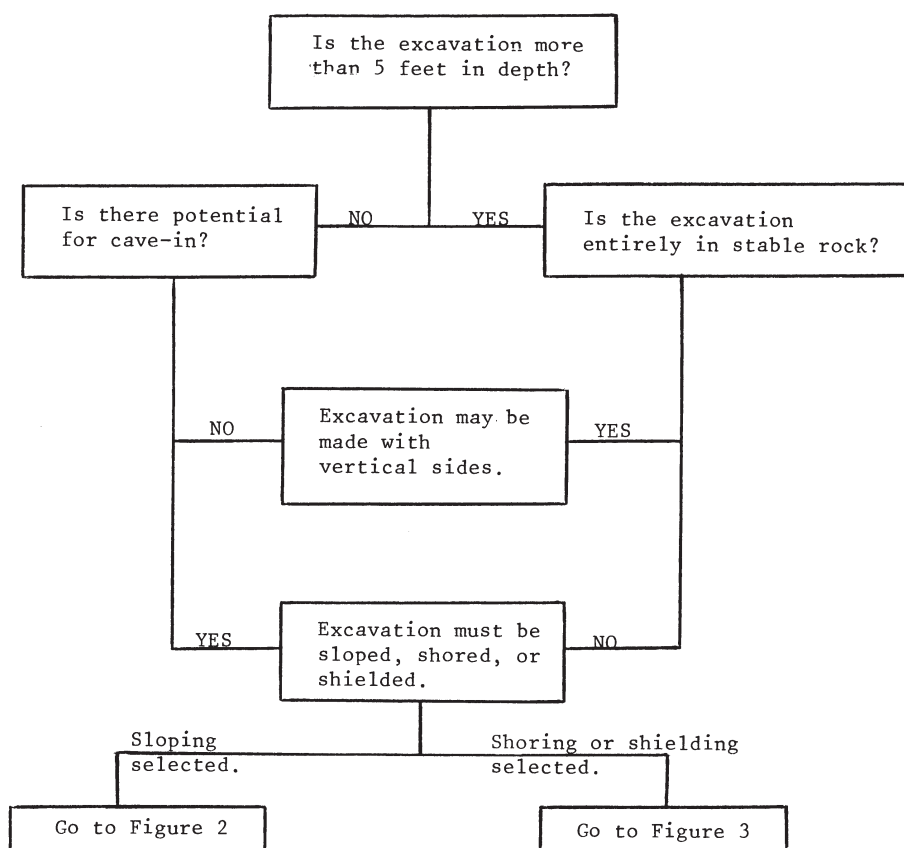


FIGURE 1 - PRELIMINARY DECISIONS

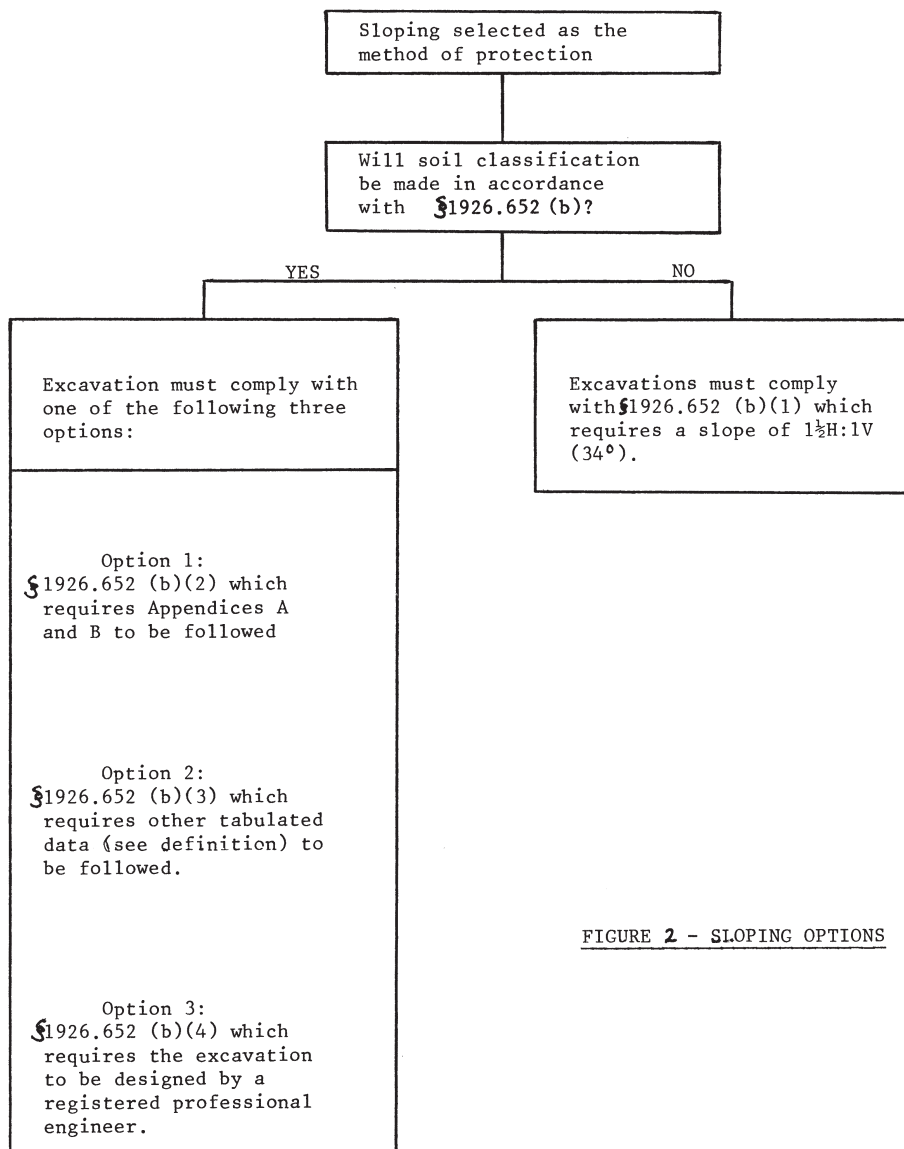


FIGURE 2 - SLOPING OPTIONS

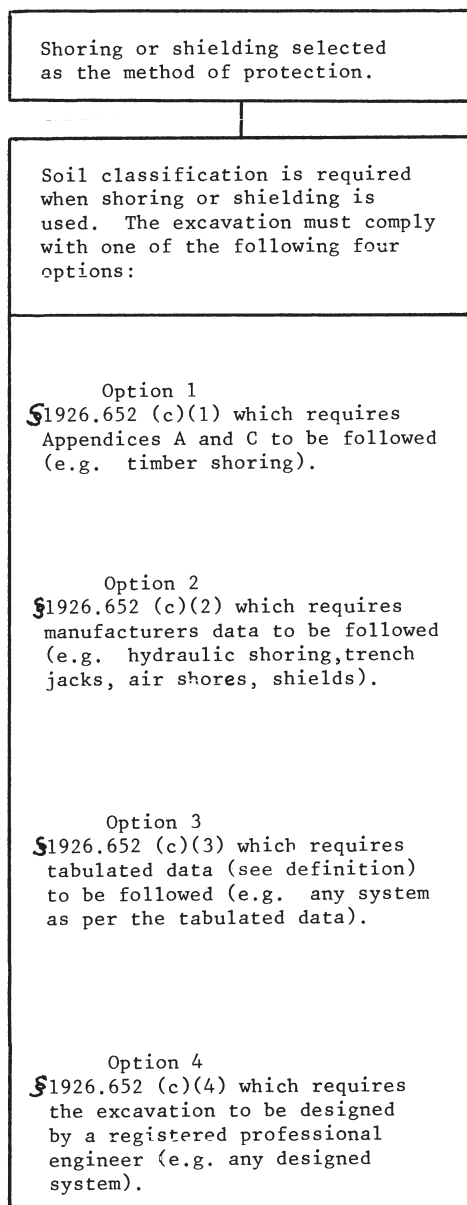


FIGURE 3 - SHORING AND SHIELDING OPTIONS



SECTION 31 23 23

EMBANKMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Backfilling site structures to subgrade elevations.
- B. Fill for ponding area.
- C. Fill under paving.
- D. Fill for over-excavation.

1.2 RELATED SECTIONS

- A. Section 31 05 13 – Soils for Earthwork.
- B. Section 31 23 16 – Excavation.
- C. Section 31 23 17 – Trenching.

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and an 18-in. Drop.
- B. American Society for Testing Materials International (ASTM):
 - 1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft³.
 - 2. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
 - 3. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort 6,000 ft-lbf/ft³.
 - 4. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - 5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).



7. ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

1.4 SUBMITTALS

- A. Requirements for submittals: Refer to *Section 01 33 00 - Submittal Procedures*.
- B. Product Data: Submit data for geotextile fabric indicating fabric and construction.
- C. Materials Source: Submit name of imported fill materials suppliers.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with City of El Paso standard.

PART 2 PRODUCTS

2.1 SELECT FILL MATERIALS

- A. On-site soils meeting the following criteria can be reused as select fill: GW, GP, GC, GM, GP-GM, GP-GC, SW, SP, SC, SM, SC-SM, SP-SM, and SP-SC.
- B. Soils classified as CH, CL, MH, ML, OH, OL, CL-CM and PT or soils that exceed a plasticity index of 15 are not considered suitable for use as select fill materials.
- C. On site material shall not be approved as fill material unless it is compliant with specifications above.

PART 3 EXECUTION

3.1 EXAMINATION

- A. *Section 01 30 00 - Administrative Requirements*: Coordination and project conditions.
- B. Verify sub-drainage, damp-proofing, or waterproofing installation has been inspected.
- C. Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.
- D. Verify structural ability of unsupported walls to support loads imposed by fill.

3.2 SITE PREPARATION

- A. Following the subgrade preparation, select fill placement may begin. The first layer of select fill shall be placed in a relatively uniform horizontal lift and be adequately keyed into the stripped and scarified subgrade soils as previously discussed. Fill materials for select fill shall be free of organic or other deleterious materials and shall have a maximum particle less than 3-inches. Soils proposed to be used as select fill materials shall be classified in accordance with procedures stated in ASTM D-2487.



- B. The resulting select fill must produce a stable, uniform and consistent compacted fill body. Select fill material shall be placed in maximum lifts of 8-inches of loose material and shall be compacted within the range of 2-percentage points below to 2-percentage points above the optimum moisture content value (-2% to +2% of OMC) for cohesionless soils and at optimum to 3-percentage points above optimum (0 to +3% of OMC) for cohesive soils, as determined by the Modified Proctor Maximum Dry Density Test (ASTM D-1557).
- C. Compaction of select fill material shall be performed with appropriate types of power, pneumatic or tamping equipment. Each lift shall be compacted to a density which is not less than 95 percent of maximum dry density for cohesionless materials and 90 percent of maximum density for cohesive materials. Maximum dry density should be determined in accordance with ASTM D-1557. Monitoring of the backfilling should include enough compaction testing by the Geotechnical Engineering representative to document that each lift of fill has been compacted to the required density. Should any lift or any portion of a lift not conform to the density requirements, the lift shall be scarified and recompact until the required density is obtained. If water must be added, it shall be uniformly applied and thoroughly mixed into the soil by disking or scarifying. Each lift of compacted select fill shall be tested by a representative of the Geotechnical Engineer prior to placement of any subsequent lifts. Care shall be taken to apply compactive effort throughout the fill and fill slope areas. The moisture content and degree of compaction of the select fill soils shall be maintained until the construction of the structures within the area.

3.3 BACKFILLING

- A. Backfill areas to contours and elevations with unfrozen materials.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
- C. Employ placement method that does not disturb or damage other work.
- D. Maintain optimum moisture content of backfill materials to attain required compaction density.
- E. Backfill against supported foundation walls and. Do not backfill against unsupported foundation walls.
- F. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.
- G. Slope grade away from building minimum 2 percent slope for minimum distance of 10 ft, unless noted otherwise.
- H. Make gradual grade changes. Blend slope into level areas.
- I. Remove surplus backfill materials from site.
- J. Leave fill material stockpile areas free of excess fill materials.



3.4 TOLERANCES

- A. Tolerances: Refer to *Section 01 40 00 - Quality Requirements*.
- B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.
- C. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.5 FIELD QUALITY CONTROL

- A. Testing will be performed in accordance with ASTM D-2922 or D-1556.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.
- C. Frequency of Tests:
 - 1. Earthwork: At least one (1) moisture-density (Proctor) test, Atterberg limits test and percent finer #200 sieve test shall be performed per soil type for subgrade, backfill, and fill materials.

3.6 PROTECTION OF FINISHED WORK

- A. *Section 01 70 00 - Execution and Closeout Requirements*: Protecting finished work.
- B. Reshape and re-compact fills subjected to vehicular traffic.

END OF SECTION



SECTION 31 37 00

RIPRAP

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Riprap placed loose.
 - 2. Riprap placed in bags.
- B. Related Sections:
 - 1. Section 31 05 16 - Aggregates for Earthwork.
 - 2. Section 31 22 13 - Rough Grading.
 - 3. Section 31 23 16 - Excavation: Excavating for riprap.
 - 4. Section 31 23 17 – Trenching.
 - 5. Section 31 23 23 - Fill.

1.02 UNIT PRICE - MEASUREMENT AND PAYMENT

- A. Riprap:
 - 1. Basis of Measurement: By square yard of riprap area; summing areas of individual layers, of riprap sacks.
 - 2. Basis of Payment: Includes supply and placing riprap mix in sacks, moist cured.

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data for riprap bags, binder and geotextile fabric.
- C. Samples: Submit, in air-tight containers, 10 lb. sample of riprap aggregate materials to testing laboratory.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

- A. Furnish each aggregate material from single source throughout the Work.
- B. Perform Work in accordance with State Municipality of Highways Public Work's standard.
- C. Maintain one copy copies of each document on site.



PART 2 PRODUCTS

2.01 MATERIALS

- A. Riprap: Granite Limestone type; broken stone angular shaped rock; solid and nonfriable; 12-inch minimum size, 18-inch maximum size;
- B. Or placed shotcrete;
- C. Or Riprap: Dumped rubble; solid and nonfriable; 12-inch minimum size, 18-inch maximum size;
- D. Bags: Woven jute Geotextile fabric.
- E. Binder: Portland cement Lime.
- F. Geotextile Fabric: Non-biodegradable, woven non-woven; manufactured by.

2.02 BAGGED RIPRAP

- A. Mix riprap, cement, sand and aggregate dry.
 - 1. Cement: Maximum 10 percent of dry mixed materials by volume.
- B. Fill bags with dry ingredients to 70 percent capacity and close by sewing or stapling to straight seam.

2.03 CONCRETE RIPRAP

- A. Provide weep holes at 10' on center 4" minimum diameter staggered, as indicated on plans.

PART 3 EXECUTION

3.01 EXAMINATION

- A. *Section 01 30 00 - Administrative Requirements:* Verification of existing conditions before starting work.
- B. Do not place riprap bags over frozen or spongy subgrade surfaces.

3.02 PLACEMENT

- A. Place geotextile fabric over substrate, lap edges and ends.
- B. Place riprap at culvert pipe ends, at embankment slopes, and as indicated on Drawings.
- C. Place bags into position. Knead, ram, or pack filled bags to conform to contour of adjacent material and other bags previously placed.



- D. Place bags in staggered pattern. Remove foreign matter from bag surfaces.
- E. Installed Thickness: As scheduled in this section. As indicated on Drawings.
- F. Place rock evenly and carefully over bagged riprap to minimize voids, do not tear bag fabric, place bags and rock in one consistent operation to preclude disturbance or displacement of substrate.
- G. Cover riprap with topsoil as specified in *Section 32 91 19*.
- H. After placement, spray with water to moisten bagged mix. Keep bagged mix moist for 24 hours.

3.03 SCHEDULES

- A. Culvert Pipe Ends: Bagged riprap, placed one layer thick, 6-inch average thickness, concealed with topsoil fill.
- B. Sloped Grade at Retaining Wall: Individual riprap units, 6 inch thickness; placed prior to finish topsoil.

END OF SECTION

DIVISION 32
EXTERIOR IMPROVEMENTS



SECTION 32 11 23

AGGREGATE BASE COURSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Aggregate subbase.
- B. Aggregate base course.

1.2 RELATED SECTIONS

- A. Section 31 22 13 – Rough Grading.
- B. Section 31 23 17 – Trenching.
- C. Section 31 23 23 – Select Fill.
- D. Section 32 12 16 – Asphalt Paving.
- E. Section 32 13 13 – Concrete Paving.

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
 - 2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.
- B. American Society for Testing Materials International (ASTM):
 - 1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft³.
 - 2. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
 - 3. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort 6,000 ft-lbf/ft³.
 - 4. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - 5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 6. ASTM D2940 - Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports.



7. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS

- A. *Section 01 33 00 - Submittal Procedures*: Requirements for submittals.
- B. Product Data:
 1. Submit data for geotextile fabric and herbicide.
- C. Materials Source: Submit name of aggregate materials suppliers.

1.5 QUALITY ASSURANCE

- A. Furnish each aggregate material from single source throughout the Work.
- B. Perform Work in accordance with City of El Paso standards.

PART 2 PRODUCTS

2.1 AGGREGATE MATERIALS

- A. Flexible base course shall be crushed limestone conforming to TxDOT Standard Specifications 2004, Item 247, Type A, Grades 1 or 2.

2.2 ACCESSORIES

- A. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.

PART 3 EXECUTION

3.1 EXAMINATION

- A. *Section 01 30 00 - Administrative Requirements*: Verification of existing conditions before starting work.
- B. Verify compacted substrate is dry and ready to support paving and imposed loads.
 1. Remove soft substrate and replace with compacted fill as specified in *Section 31 23 23 – Select Fill*.
- C. Verify substrate has been inspected, gradients and elevations are correct.

3.2 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place fill on soft, muddy, or frozen surfaces.



3.3 AGGREGATE PLACEMENT

- A. Base course shall be placed in loose lifts with a maximum thickness of 8-inches and compacted to 100 percent of the maximum dry density at a moisture content range 2 percentage points below and 2 percentage points above the optimum moisture content as determined by ASTM D1557.
- B. Level and contour surfaces to elevations, profiles, and gradients indicated.
- C. Add small quantities of fine aggregate to coarse aggregate when required to assist compaction.
- D. Maintain optimum moisture content of fill materials to attain specified compaction density.
- E. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.4 TOLERANCES

- A. *Section 01 40 00 - Quality Requirements:* Tolerances.
- B. Maximum Variation from Flat Surface: 1/4 inch measured with 10-foot straight edge.
- C. Maximum Variation from Thickness: 1/4 inch.
- D. Maximum Variation from Elevation: 1/2 inch.

3.5 FIELD QUALITY CONTROL

- A. *Section 01 40 00 - Quality Requirements, and Section 01 70 00 - Execution and Closeout Requirements:* Field inspecting, testing, adjusting, and balancing.
- B. Compaction testing will be performed in accordance with ASTM D1557.
- C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
- D. Frequency of Tests: One test for every 1000 square yards of each layer compacted aggregate.

END OF SECTION



SECTION 32 12 16

ASPHALT PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Asphalt materials.
- B. Aggregate materials.
- C. Aggregate subbase.
- D. Asphalt paving base course, binder course, and wearing course.
- E. Asphalt paving overlay for existing paving.
- F. Surface slurry.

1.2 RELATED SECTIONS

- A. Section 31 22 13 – Rough Grading.
- B. Section 31 23 23 – Select Fill.
- C. Section 32 11 23 – Aggregate Base Courses.
- D. Section 33 05 13 – Manholes and Structures.
- E. Section: Supply of gutter drainage grilles, covers, and frames for placement by this section.
- F. Section: Concrete curbs.

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M17 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
 - 2. AASHTO M29 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
 - 3. AASHTO M140 - Standard Specification for Emulsified Asphalt.
 - 4. AASHTO M208 - Standard Specification for Cationic Emulsified Asphalt.
 - 5. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.



6. AASHTO M320 - Standard Specification for Performance-Graded Asphalt Binder.
7. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
8. AASHTO MP1a - Standard Specification for Performance-Graded Asphalt Binder.
- B. Asphalt Institute:
 1. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot- Mix Types.
 2. AI MS-19 - Basic Asphalt Emulsion Manual.
 3. AI SP-2 - Superpave Mix Design.
- C. American Society for Testing Materials International (ASTM):
 1. ASTM D242 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
 2. ASTM D692 - Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.
 3. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
 4. ASTM D977 - Standard Specification for Emulsified Asphalt.
 5. ASTM D1073 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
 6. ASTM D1188 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens.
 7. ASTM D2027 - Standard Specification for Cutback Asphalt (Medium-Curing Type).
 8. ASTM D2397 - Standard Specification for Cationic Emulsified Asphalt.
 9. ASTM D2726 - Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
 10. ASTM D2950 - Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
 11. ASTM D3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
 12. ASTM D3515 - Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.



13. ASTM D3549 - Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
14. ASTM D3910 - Standard Practices for Design, Testing, and Construction of Slurry Seal.
15. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

1.4 PERFORMANCE REQUIREMENTS

- A. Paving: Designed for residential streets, main street arteries and movement of trucks up to 60,000 lbs.

1.5 SUBMITTALS

- A. *Section 01 33 00 - Submittal Procedures*: Requirements for submittals.
- B. Product Data:
 1. Submit product information for asphalt and aggregate materials.
 2. Submit mix design with laboratory test results supporting design.
- C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

- A. Mixing Plant: Conform to TxDOT Standard Specifications 2004, Item 340, Type C.

1.7 QUALIFICATIONS

- A. Installer: Company specializing in performing work of this section with minimum years documented experience approved by manufacturer.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. *Section 01 60 00 - Product Requirements*: Environmental conditions affecting products on site.
- B. Do not place asphalt mixture between November 1 and March 1.
- C. Do not place asphalt mixture when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen.
- D. Place asphalt mixture when temperature is not more than 15 degrees F less than initial mixing temperature.



PART 2 PRODUCTS

2.1 ASPHALT MATERIALS

- A. Asphalt Binder Cement: In accordance with TxDOT Standard Specification 2004, Item 340, Type C requirements.
- B. Primer: In accordance with TxDOT Standard Specification 2004, Item 340, Type C requirements.
- C. Tack Coat: ASTM D977 AASHTO M140; diluted emulsified asphalt, setting type.
- D. Tack Coat: In accordance with TxDOT Standard Specification 2004, Item 340, Type C requirements.
- E. Oil. In accordance with TxDOT Standard Specification 2004, Item 340, Type C requirements.

2.2 AGGREGATE MATERIALS

- A. Coarse Aggregate: In accordance with TxDOT Standard Specification 2004, Item 340, Type C requirements.
- B. Fine Aggregate: In accordance TxDOT Standard Specification 2004, Item 340, Type C requirements.
- C. Mineral Filler: ASTM D242 or AASHTO M17; finely ground mineral particles, free of foreign matter.

2.3 ACCESSORIES

- A. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.
- B. Sealant: ASTM D6690 AASHTO M324, Type I; hot applied type.

2.4 MIXES

- A. Asphalt Paving Mixtures: Designed in accordance with TxDOT Standard Specification 2004, Item 340, Type C requirements with maximum percent by weight reclaimed asphalt pavement.
 - 1. Base Course.
 - 2. Binder Course.
 - 3. Wearing Course: with skid resistance level.
- B. Surface Slurry: ASTM D3910, Type 1; emulsified asphalt slurry.

2.5 SOURCE QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.
- B. Submit proposed mix design of each class of mix for review prior to beginning of Work.



- C. Test samples in accordance with AI MS-2.

PART 3 EXECUTION

3.1 EXAMINATION

- A. *Section 01 30 00 - Administrative Requirements:* Verification of existing conditions before starting work.
- B. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.
- C. Verify compacted subgrade granular stabilized soil subbase is dry and ready to support paving and imposed loads.
 - 1. Proof roll subbase with in minimum two perpendicular passes to identify soft spots.
 - 2. Remove soft subbase and replace with compacted fill as specified in *Section 31 23 23 – Select Fill*.
- D. Verify gradients and elevations of base are correct.
- E. Verify gutter drainage grilles and frames, manhole frames are installed in correct position and elevation.

3.2 SUBBASE

- A. Aggregate Subbase: Install as specified in *Section 32 11 23 – Aggregate Base Courses*.

3.3 EXISTING WORK

- A. Saw cut and notch existing paving as indicted on Drawings.
- B. Clean existing paving to remove foreign material, excess joint sealant and crack filler from paving surface.
- C. Repair surface defects in existing paving to provide uniform surface to receive new paving.

3.4 PRIMER

- A. Apply primer in accordance with TxDOT Standard Specification 2004, Item 340, Type C requirements.

3.5 TACK COAT

- A. Apply tack coat in accordance with TxDOT Standard Specification 2004, Item 340, Type C requirements.



3.6 SINGLE COURSE ASPHALT PAVING

- A. Install Work in accordance with TxDOT Standard Specification 2004, Item 340, Type C requirements.
- B. Place asphalt within 24 hours of applying primer or tack coat.
- C. Place asphalt wearing course to inch compacted thickness thickness identified in schedule at end of section thickness indicated on Drawings.
- D. Compact paving by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
- E. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.
- F. The asphaltic concrete shall be compacted to a minimum of 97 percent of the maximum theoretical specific gravity (Rice) of the mixture determined according to Test Method ASTM D2041.

3.7 DOUBLE COURSE ASPHALT PAVING

- A. Place asphalt binder course within 24 hours of applying primer or tack coat.
- B. Place binder course to inch compacted thickness thickness identified in schedule at end of section thickness indicated on Drawings.
- C. Place wearing course within 24 hours of placing and compacting binder course. When binder course is placed more than 24 hours before placing wearing course, clean surface and apply tack coat before placing wearing course.
- D. Place wearing course to inch compacted thickness thickness identified in schedule at end of section thickness indicated on Drawings.
- E. Compact each course by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
- F. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.8 ASPHALT PAVING OVERLAY

- A. Apply asphalt cement tack coat to existing paving surface at rate recommended by geotextile fabric manufacturer.
- B. Install geotextile fabric in accordance with manufacturer's instructions to permit asphalt saturation of fabric. Lap fabric edge and end joints 4 inches.
- C. Place wearing course to inch compacted thickness thickness identified in schedule at end of section thickness indicated on Drawings.



- D. Compact overlay by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
- E. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.9 SURFACE SLURRY

- A. Install uniform thickness surface slurry over existing paving in accordance with ASTM D3910.
- B. Allow slurry to cure.
- C. Roll paving to achieve uniform surface.

3.10 CURBS

- A. Install extruded asphalt curbs of profile as indicated on Drawings.
- B. Saw cut at lip of proposed curb as indicated on Drawings.

3.11 ERECTION TOLERANCES

- A. Section 01 40 00 - Quality Requirements: Tolerances.
- B. Flatness: Maximum variation of 1/4 inch measured with 10-foot straight edge.
- C. Scheduled Compacted Thickness: Within 1/4 inch.
- D. Variation from Indicated Elevation: Within 1/2 inch.

3.12 FIELD QUALITY CONTROL

- A. *Section 01 40 00 - Quality Requirements and Section 01 70 00 - Execution and Closeout Requirements:* Field inspecting, testing, adjusting, and balancing.
- B. Take samples and perform tests including mat density tests in accordance with TxDOT Standard Specification 2004, Item 340, Type C requirements.
- C. Asphalt Paving Mix Temperature: Measure temperature at time of placement.
- D. Asphalt Paving Thickness: ASTM D3549; test one core sample from every 500 square yards compacted paving.
- E. Asphalt Paving Density: ASTM D1188 or ASTM D2726; test one core sample from every 500 square yards compacted paving.

3.13 PROTECTION OF FINISHED WORK

- A. *Section 01 70 00 - Execution and Closeout Requirements:* Requirements for protecting finished Work.



- B. Immediately after placement, protect paving from mechanical injury for hours or until surface temperature is less than 140 degrees F.

END OF SECTION



SECTION 32 13 13
CONCRETE PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Reinforced concrete paving, reinforced concrete flumes, and concrete curb and gutter.

1.2 RELATED SECTIONS

- A. Section 31 23 23 – Select Fill.

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
1. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
- B. American Concrete Institute (ACI):
1. ACI 301 - Specifications for Structural Concrete.
 2. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
- C. American Society for Testing Materials International (ASTM):
1. ASTM A184/A184M - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
 2. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
 3. ASTM A497 - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
 4. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 5. ASTM A706/A706M - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 6. ASTM A767/A767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
 7. ASTM A775/A775M - Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
 8. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.



9. ASTM A934/A934M - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
10. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
11. ASTM C33 - Standard Specification for Concrete Aggregates.
12. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
13. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
14. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.
15. ASTM C150 - Standard Specification for Portland Cement.
16. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
17. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
18. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
19. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
20. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
21. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
22. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
23. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
24. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.
25. ASTM C989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
26. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
27. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.



28. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
29. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
30. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
31. ASTM C1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
32. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
33. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
34. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
35. ASTM E408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
36. ASTM E903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
37. ASTM E1918 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
38. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

1.4 SUBMITTALS FOR REVIEW

- A. Product Data: Provide data on joint filler, admixtures and curing compounds.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301.
- B. Obtain cementitious materials from same source throughout.

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable standards for paving work on public property.

1.7 ENVIRONMENTAL REQUIREMENTS



- A. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

PART 2 PRODUCTS

2.1 FORM MATERIALS

- A. Form Materials:
 - 1. Steel used or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.
 - 2. Use flexible spring steel forms or laminated boards to form radius bends as required.
 - 3. Coat forms with a non-staining form release agent that will not discolor or deface of concrete.

2.2 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615; 60 ksi yield grade; deformed billet steel bars; unfinished finish.
- B. Welded Steel Wire Fabric: Not used.
- C. Dowels: ASTM A615; 60 ksi yield grade, plain steel, unfinished finish.

2.3 ACCESSORIES

- A. Curing Compound: ASTM C309, Type 1, Class A.
- B. Joint Materials: AASHTO M324, ½" bituminous type preformed joint filler.

2.4 CONCRETE MIX - BY PERFORMANCE CRITERIA

- A. Mix concrete in accordance with ACI 304. Deliver concrete in accordance with ASTM C94.
- B. Select proportions for normal weight concrete in accordance with ACI 301 Method 3.
- C. Provide concrete sidewalks, curbs, and driveways to the following criteria:
 - 1. Compressive Strength: 3,500 psi @ 28 days.
 - 2. Slump: 3 inches.
 - 3. Minimum Water/Cement Ratio: 0.45.
 - 4. Air Entrained: Not to exceed 3 percent.

Provide reinforced concrete pavement to the following criteria:

- 1. Compressive Strength: 4,500 psi @ 28 days.
- 2. Slump: 3 inches.
- 3. Minimum Water/Cement Ratio: 0.45.
- 4. Air Entrained: ±4 percent.



- D. Use accelerating admixtures in cold weather only when approved by the City inspector. Use of admixtures will not relax cold weather placement requirements.
- E. Use calcium chloride only when approved by the City inspector.
- F. Use set retarding admixtures during hot weather only when approved by the City inspector.

2.5 SOURCE QUALITY CONTROL AND TESTS

- A. Submit proposed mix design to the City inspector for review and approval prior to commencement of work.
- B. Tests on cement and aggregates will be performed to ensure conformance with specified requirements.
- C. Test samples in accordance with ACI 301.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.2 REPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Notify City inspector minimum 24 hours prior to commencement of concreting operations.

3.3 FORMING

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.4 REINFORCEMENT

- A. Interrupt reinforcement at expansion joints.
- B. Place dowels and reinforcement to achieve pavement and curb alignment as detailed.
- C. Provide doweled joints 12-inch o/c at transverse joints and interruptions of concrete.



3.5 PLACING CONCRETE

- A. Place concrete by methods that prevent segregation of mix.
- B. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator.
- C. Keep vibrator away from joint assemblies, reinforcement, or side forms.
- D. Use only square-faced shovels for hand spreading and consolidation.
- E. Consolidate with care to prevent dislocation of reinforcing, dowels and joint devices.
- F. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- G. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.
- H. Place concrete continuously over the full width of the panel and between predetermined construction joints.
- I. Place concrete to pattern indicated.
- J. Deposit and spread concrete in a continuous operation between transverse joints as far as possible.
- K. If interrupted for more than ½ hour, place a construction joint.

3.7 JOINTS

- A. Expansion Joints:
 - 1. Place expansion joints at 20-foot intervals. Align curb, gutter, and sidewalk joints.
 - 2. Place joint filler between paving components and building or other appurtenances. Recess top of filler 1/4 inch for sealant placement.
 - 3. Provide scored joints at 5 feet intervals between sidewalks.
 - 4. Provide keyed joints as indicated.
 - 5. Provide pre-molded joint filler for expansion joints abutting concrete curbs, structures, walks and other fixed objects, unless otherwise indicated.
 - 6. Furnish joint fillers in one-piece lengths for full width being placed wherever possible, when more than one length is required, or clip joint filler sections together.
 - 7. Protect top edge of joint filler during concrete placement with a metal cap or other temporary materials.
 - 8. Remove protection after concrete has been placed on both sides of joint.
- B. Construction Joints:
 - 1. Place construction joints at end of placements and at locations where placement operations are stopped for more than ½ hour.



2. Where load transfer-slip dowel devices are used, install so that one end of each dowel bar is free to move.
- C. Fillers and Sealants:
 1. Where joints in concrete construction are shown to be sealed, the joint sealing compound shall be a cold-applied two-component poly-sulfide sealant.
 2. The handling, mixing, and placing of the material and preparation of the joint prior to sealing shall be in strict accordance with the recommendations of the manufacturer.
 3. A two-component epoxy primer compatible with the sealer shall be used in all joints.
 4. Provide joint sealers and other related materials that are compatible with one another and with joint substrates.

3.8 FINISHING

- A. Area Paving: Light broom.
- B. Sidewalk Paving: Light broom, radius to ½-inch radius, and trowel joint edges.
- C. Curbs and Gutters: Light broom.
- D. Direction of Texturing: Transverse to pavement direction.
- E. Inclined Vehicular Ramps: Broomed perpendicular to slope.
- F. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.9 CURING AND PROTECTION

- A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Cure floor surfaces in accordance with ACI 308.
- D. Ponding: Maintain 100 percent coverage of water over slab areas continuously for 4 days.
- E. Spraying: Spray water over floor slab areas and maintain wet for 7 days.

3.10 TOLERANCES

- A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.
- B. Maximum Variation from True Position: 1/4 inch.

3.11 PATCHING



- A. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.
- B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify City inspector upon discovery.
- C. Patch imperfections as directed.

3.12 DEFECTIVE CONCRETE

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Repair or replacement of defective concrete will be determined by the City inspector.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of the City inspector for each individual area.

3.13 FIELD QUALITY CONTROL

- A. Three concrete test cylinders will be taken for every 75 cubic yards or less of concrete placed each day.
- B. One additional test cylinder will be taken during cold weather and cured on site under same conditions as concrete it represents.
- C. One slump test will be taken for each set of test cylinders taken.
- D. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.14 PROTECTION

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.
- B. Do not permit pedestrian and vehicular traffic over pavement until 75 percent design strength of concrete has been achieved.

3.15 ACCEPTANCE OF CONCRETE

- A. The following procedure will be used to evaluate concrete where one or more project acceptance test specimens fail to meet the required design strength specified in this Item or on 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 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 the in-situ concrete strength is needed for the structural review, take cores at locations designated by the Engineer in accordance with Tex-424-A. The Engineer will test the cores. The coring and testing will be at the Contractor's expense.

If all the tested cores meet the required design strength, the concrete will be paid for at 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 payment adjustment using the following formula:

$$A = Bp [-5.37(Sa/Ss)^2 + 11.69(Sa/Ss) - 5.32]$$

A = Amount to be paid per unit of measure for the entire placement in question

Sa = Actual average strength from cylinders or cores. Use values from cores, if taken.

Ss = Minimum required strength (specified)

Bp = Unit Bid Price

If the structural review determines the concrete is not adequate to remain in service, the Engineer will determine the limits of the concrete to be removed.

The decision to reject structurally inadequate concrete or to apply the payment adjustment factor will be made no later than 56 days after placement.

END OF SECTION



SECTION 32 13 40

GALVANIZED GABION BASKET

PART 1 GENERAL

1.1 DESCRIPTION

- A. This work shall consist of furnishing, assembling, and filling woven wire mesh gabions with rock as specified in the contract to the dimensions, lines and grades shown on the plans, or as determined by the engineer. These specifications are in accordance with ASTM A975.

1.2 SUBMITTALS FOR REVIEW

- A. Product Data: Galvanized woven mesh Gabions, Lacing wire and internal stiffeners.

PART 2 MATERIALS

2.1 WOVEN WIRE MESH (ZINC COATED):

- A. All tests on the wire must be performed prior to manufacturing the mesh.
- B. Tensile strength: both the wire used for the manufacture of gabions and the lacing wire, shall have a maximum tensile strength of 75,000 psi, in accordance with ASTM A641.
- C. Elongation: the test must be carried out on a sample at least 12 in. long. Elongation shall not be less than 12%, in accordance with ASTM A370.
- D. Zinc coating: minimum quantities of zinc according to ASTM A641, Class III soft temper coating.
- E. Adhesion of zinc coating: the adhesion of the zinc coating to the wire shall be such that, when the wire is wrapped six turns around a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with the bare fingers, in accordance with ASTM A641.

2.2 GALVANIZED (ZINC COATED) WOVEN WIRE MESH GABIONS (8 X 10 MESH TYPE):

- A. Wire mesh: Diameter - 0.120 in.
- B. Selvedge wire: Diameter - 0.153 in.
- C. Mesh opening: Nominal Dimension D = 3.25 in., as per Fig.1

2.3 GALVANIZED (ZINC COATED) LACING WIRE AND INTERNAL STIFFENERS:

- A. Lacing wire: Diameter - 0.087 in.



- B. Cross tie/stiffer wire: Diameter – 0.087 in.
- C. Preformed Stiffener: Diameter – 0.153 in. internal.

2.4 STEEL MESH PROPERTIES

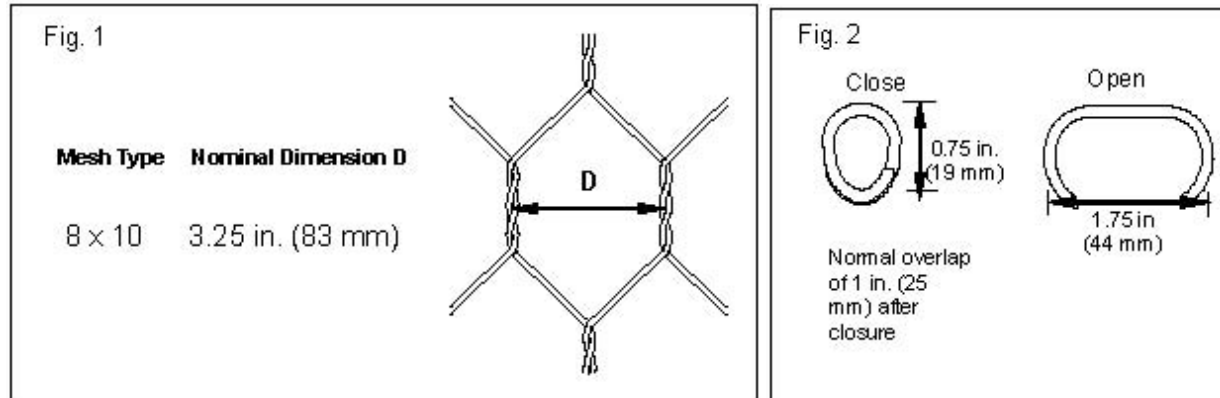
- A. Mesh Tensile Strength shall have a minimum strength of 3500 lb/ft when tested in accordance with ASTM A975 section 13.1.1
- B. Punch Test Resistance shall have a minimum resistance of 6000 lb when tested in accordance with ASTM A975 section 13.1.4
- C. Connection to selvages shall have a minimum resistance of 1400 lb/ft when tested in accordance with ASTM A975.

2.5 FASTENERS (OVERLAPPING FASTENERS):

- A. Overlapping fasteners may be used in lieu of, or to complement, lacing wire for basket assembly and installation.
- B. High tensile fasteners shall have a nominal spacing of 4 in. not to exceed 6 in for all assembly and installation. This is based on a 1,400 lb/ft pull apart resistance for galvanized mesh with this spacing (ASTM A975 section 13.1.2).
- C. Fasteners used for assembly and installation of the units on the field shall be tested for compliance with the ASTM A975 section 13.1.2.2 Pull-Apart Resistance. Producer or supplier of the wire mesh shall provide certification no later than 15 days prior of starting construction.
- D. When tested in accordance with the section 13.1.2.1, the average maximum resistance of the fasteners from the field shall not be lower than 90% of the resistance provided in the certification.
- E. Galvanized Fasteners: Diameter = 0.120 in., according to ASTM A764, Type B, Class 3.
- F. Tensile strength: 230,000 to 273,000 psi in accordance with ASTM A764 Table 2.
- G. Proper installation of rings: A properly formed fastener shall have a nominal overlap of one (1) in. after closure (Fig. 2).

2.6 TOLERANCES

- A. Wire: Zinc coating, in accordance with ASTM A641, Class III soft temper coating.
- B. Gabion sizes: $\pm 5\%$ on the length, width, and height.
- C. Mesh opening: Tolerances on the hexagonal, double twisted wire mesh opening shall not exceed $\pm 10\%$ on the nominal dimension D values (see Fig.1):



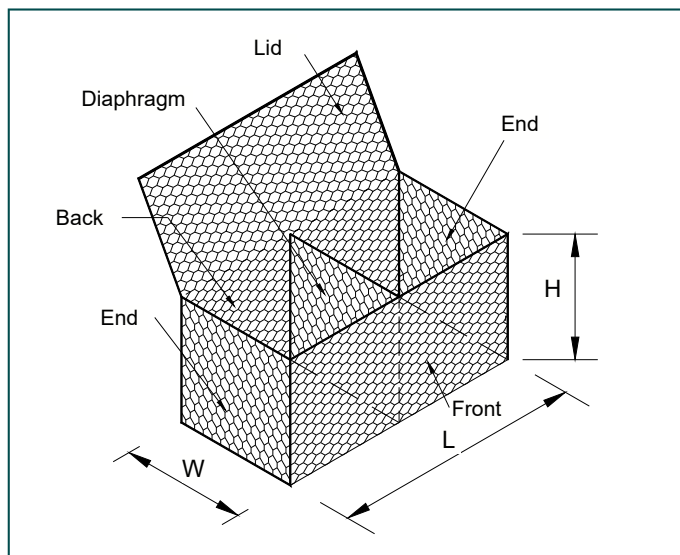
2.7 STANDARD UNIT SIZE

- A. All sizes and dimensions are nominal. Tolerances of $\pm 5\%$ of the width, and length height, of the gabions shall be permitted. See Figure 3 for reference.

TABLE OF SIZES FOR GABIONS			
Length (ft)	Width (ft)	Height (ft)	# of cells
6	3	3	2
9	3	3	3
12	3	3	4
6	3	1.5	2
9	3	1.5	3
12	3	1.5	4
6	3	1	2
9	3	1	3
12	3	1	4
4.5	3	3	1

2.8 FABRICATION

- A. Gabions shall be manufactured and shipped with all components mechanically connected at the production facility. The front, base, back and lid of the gabions shall be woven into a single unit. The ends and diaphragm(s) shall be factory connected to the base. All perimeter edges of the mesh forming the basket and top, or lid, shall be selvaged with wire having a larger diameter. The gabion is divided into cells by means of diaphragms positioned at approximately 3 ft centers. The diaphragms shall be secured in position to the base so that no additional lacing is necessary at the jobsite.
- B. The gabion mat is divided into cells by means of diaphragms. The diaphragms create cells of 3-ft by 9-ft. The diaphragms shall be secured in position of the base so that no additional typing is necessary at the jobsite.



2.9 ROCK

- A. The rock for gabions shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure. Gabion rocks shall range between 4 in. and 8 in. The range in sizes may allow for a variation of 5% oversize and/or 5% undersize rock, provided it is not placed on the gabion exposed surface. The size shall be such that a minimum of two layers of rock must be achieved when filling the gabions. Prevent contamination when storing and handling stone. Use stone with a minimum bulk specific gravity of 2.50.

PART 3 CONSTRUCTION REQUIREMENTS

3.1 ASSEMBLY

- A. Gabions are supplied folded flat and packed in bundles. The units are assembled individually by erecting the sides, ends, and diaphragms, ensuring that all panels are in the correct position, and the tops of all sides are aligned. The four corners shall be connected first, followed by the internal diaphragms to the outside walls. All connections should use lacing wire or fasteners as previously described in Section 2.4 and Section 2.5.
- B. The procedure for using lacing wire consists of cutting a sufficient length of wire, and first looping and/or twisting to secure the lacing wire to the wire mesh. Proceed to lace with alternating double and single loops through every mesh opening approximately every 6 in. pulling each loop tight and finally securing the end of the lacing wire to the wire mesh by looping and/or twisting.



- C. The use of fasteners shall be in accordance with the manufacturer's recommendations as specified in Section 2.5.

3.2 INSTALLATION

- A. Prepare the subgrade that will receive the gabion mats per Specification Section 31 05 13. Place the MX-275 Geotextile on top of the prepared subgrade which lies beneath the gabion mats.
- B. After assembly, the gabion baskets are carried to their final position and are securely joined together along the vertical and top edges of their contact surfaces using the same connecting procedure(s) described in Section 3.1. Whenever a structure requires more than one layer, the upper empty baskets shall also be connected to the top of the lower layer along the front and back edges of the contact surface using the same connecting procedure(s) described in Section 3.1.

3.3 FILLING

- A. Baskets shall be filled with rock as specified in Section 2.5. During the filling operation some manual stone placement is required to minimize voids. It is also recommended to slightly overfill the baskets by 1 to 2 in. to allow for settlement of the rock. The exposed faces of vertical structures may be carefully hand placed to give a neat, flat, and compact appearance.
- B. The cells shall be filled in stages so that local deformation may be avoided. That is, at no time shall any cell be filled to a depth exceeding 1-foot higher than the adjoining cell. Behind gabion walls, compact the backfill material simultaneously to the same level as the filled gabions.

3.4 INTERNAL CONNECTING WIRES

- A. Preformed stiffeners or lacing wire can be use as internal connecting wires when a structure requires more than one layer of gabions to be stacked on top of each other. Internal Connecting Wires with lacing wire shall connect the exposed face of a cell to the opposite side of the cell. Internal Connecting Preformed stiffeners shall connect the exposed face of a cell to the adjacent side of the cell. Preformed stiffeners are installed at 45° to the face/side of the unit, extending an equal distance along each side being braced (approximately 1 ft.). An exposed face is any side of a gabion cell that will be exposed or unsupported after the structure is completed.

3.4.1 3 Feet High Gabions

3 feet high gabions shall be filled in three layers, 1 foot at a time. Connecting wires/bracings shall be installed after the placement of each layer, that is, at 1 foot high and 2 feet high.

3.4.2 1.5 Feet (0.5 m) High Gabions

1.5 feet high gabions do not require connecting wires/bracings unless the baskets are used to build vertical structures. In some cases, these units shall be filled in two layers, 9 in. at a time. Connecting wires shall be installed after the placement of the first layer, which is



at 9 in. high.

3.4 LID CLOSING

- B. Once the gabion baskets are completely full, the lids are pulled tight until the lid meets the perimeter edges of the basket. A tool such as a lid closer can be used. The lid must then be tightly laced and/or fastened along all edges, ends and tops of diaphragm(s) in the same manner as described in Section 3.1.

3.6 MESH CUTTING AND FOLDING

- A. Where shown on the drawings or otherwise directed by the engineer, the basket mesh shall be cut, folded and fastened together to suit existing site conditions. The mesh must be cleanly cut and surplus mesh either folded back or overlapped so that it can be securely fastened together with lacing wire or fasteners in the manner described in Section 3.1. Any reshaped gabions shall be assembled, installed, filled and closed as specified in the previous sections.

3.6 FILTER PLACEMENT

- A. Spread filter material, when required, uniformly on the prepared foundation surface to the slopes, lines, and grades indicated on the plans. Do not place filter material by methods that tend to segregate particle sizes. Repair all damage to the foundation surface that occurs during filter placement before proceeding with the work. Compaction of the filter material is not required; but finish the material to present a reasonably even surface without mounds of windrows.

3.6 FILTER FABRIC PLACEMENT

- A. Place filter fabric as shown on the plans when required. Any defects, rips, holes, flows, or damage to the material may be cause for rejection. Place the material with the long axis parallel to the centerline of the structure, highway, or dam. Place securing pins in the lapped longitudinal joints, spaced on approximately 10-ft. centers. Keep the fabric material free of tension, stress, folds, wrinkles, or creases. Lap the material at least 3 ft. along the longitudinal joint of material, or lap the joints 1 ft. and sew them. Lap the ends of rolls at joints by at least 3 ft. Repair torn or punctured fabric by placing a layer of fabric over the damaged area. Overlapping at least 3 ft. beyond the damaged area in all directions.

Place securing pins through both strips of material at lapped joints at approximately the midpoint of the overlap. Place additional securing pins as necessary to hold filter fabric in position. Store filter fabric out of direct sunlight. Cover filter fabric as soon as possible after placing, but within 3 days.

PART 4 MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The payment quantities for excavation shall be determined by the outside limits of the gabion structure. Quantities will be determined from cross sections and the linear distance, and paid for under the appropriate excavation bid items.



- B. The quantity to be paid for “In place gabions” shall be the number of cubic yards of gabions measured in their final position. Project conditions and material availability will determine the actual size of gabions to be used.
- C. Excavated material beyond the limits of the gabions shall be backfilled with gravel, crushed rock or other material approved by the engineer.
- D. This bid price shall include the installed in place cost of all materials, equipment, and labor, including gabions, rock, and backfill material.

4.2 BASIS OF PAYMENT

- A. Accepted gabions will be paid for at the unit price for each pay item included in the contract. The price bid is full compensation for wire baskets, stone fill, lacing and fasteners, filter fabric, filter material, excavation, grading and backfill, materials, tools, equipment, labor, and incidentals. Filter fabric and filter material, if used, will not be paid for directly but will be considered subsidiary to this item.

END OF SECTION



SECTION 32 14 00
PORTLAND CEMENT CONCRETE

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all tools, qualified labor, materials, equipment, qualified superintendence and all services, transportation, other incidentals, assurances and guarantees, assumptions of risk, and responsibility for the performance of all Portland Cement Concrete operations as indicated on the Construction Drawings. Complete work as shown and specified herein.

1.2 SECTION INCLUDES

- A. Portland Cement Concrete.
- B. Aggregates.
- C. Admixtures.
- D. Pozzolanic Materials.
- E. Testing.

1.3 RELATED SECTIONS

- A. Section 32 13 13 – Concrete Flatwork.
- B. Section 32 15 00 – Concrete Curing Compound.

1.4 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. ACI 211 – Standard Practice for Selecting Proportions for Concrete.
 - 2. ACI 301 – Specifications for Structural Concrete.
 - 3. ACI 304R – Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 - 4. ACI 318 – Building Code Requirements for Reinforced Concrete.
- B. American Society of Testing Materials (ASTM International):
 - 1. ASTM C31/C31M – Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - 2. ASTM C33 – Standard Specification for Concrete Aggregates.



3. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C42/C42M – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C78/C78M – Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
6. ASTM C94/C94M – Standard Specification for Ready-Mixed Concrete.
7. ASTM C143/C143M – Standard Test Method for Slump of Hydraulic Cement Concrete.
8. ASTM C172 – Standard Practice for Sampling Freshly Mixed Concrete.
9. ASTM C192/C192 M – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
10. ASTM C227-03 – Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
11. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.
12. ASTM C289-94 – Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).
13. ASTM C293/C293M – Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading).
14. ASTM C311/C311M – Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland Cement Concrete.
15. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

1.5 SUBMITTALS

- A. Refer to *Section 01 33 00 – Submittal Procedures*.
- B. Materials Source: Submit name of imported materials source.
- C. Product Data: Submit mix design, aggregate gradation, and admixtures for each type of concrete.
- D. Manufacturer's Certificate: Certify products meet or exceed the specified requirements.



- E. Mill Certificate.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Concrete will be laboratory design mix, identified by design mix number which will be submitted to the Project Engineer. No structural concrete mixture shall contain less than 5 sacks of cement per cubic yard. All concrete placed under this section shall be air-entrained in accordance with Subsection 2.5. Weighing and metering devices used for the purpose of proportioning materials shall fulfill requirements as to accuracy and tolerance prescribed by the Superintendent of Weights and Measures, and such devices shall be sealed and certified by him or a certified representative. This certification shall not be over 12 months old and shall be renewed whenever deemed necessary by the Engineer or his/her designated representative. When portable plants are setup at a new location, the scales and scale assembly shall be inspected, and certificate issued before work commences regardless of the date when the scales were last tested. ASTM C94 shall apply to all ready-mixed concrete produced in accordance with the provisions of this Section. Chapter 5, ACI 318 shall also apply to the mixing and placing of concrete.

2.2 PORTLAND CEMENT

- A. Cement to be used or furnished under this specification shall be Portland cement, conforming to the requirements of ASTM C150. The type to be used shall be Type I or Type II, except when another type including high early strength (Type III) is specified in the Detailed Specifications or shown on the Project Drawings or approved by the Engineer or his/her designated representative. Where the presence of water-soluble sulfates (as SO₄) in groundwater exceeds 1,000 parts per million, the tricalcium aluminate in the cement shall be limited to 5 percent.
- B. Cement shall be sampled and tested as prescribed in said ASTM specifications. The Contractor shall obtain a certification of compliance signed by the cement manufacturer identifying the cement and stating that the cement delivered to the batching site complies with these specifications. When requested by the Engineer or his/her designated representative, the Contractor shall furnish him with three copies of said certification.
- C. When suitable facilities (such as those recommended by the Concrete Plant Manufacturer's Bureau and/or approved by the Engineer or his/her designated representative) are available for handling and weighing bulk cement, such facilities shall be used. Otherwise, the cement shall be delivered in original unopened bags of the manufacturer and the type of cement plainly marked thereon, each bag to contain 94 pounds of cement.
- D. Cement shall be stored in such a manner as to permit ready access for the purpose of inspection and be suitably protected against damage by contamination or moistures. Should



any lot of bulk cement delivered to the site show evidence of contamination, the Engineer or his/her designated representative may require such lot be removed from the site.

- E. Portland cement used in the manufacture of concrete for any individual structure shall be of the same brand or type unless otherwise approved by the Engineer or his/her designated representative.
- F. Cement used in the construction of sewer lines and appurtenances and other structures coming in contact with sewage and sewage gases shall be Type II or other types of equal quality and character as approved by the Engineer or his/her designated representative.
- G. Low alkali cement shall conform to the requirement for Portland cement, as specified in ASTM C150 and, in addition, shall contain no more than 0.60 percent by weight of alkalis calculated as Na_2O plus $0.659 \text{ K}_2\text{O}$.

2.3 AGGREGATES

- A. Aggregates shall conform to ASTM C33 and none shall be incorporated in the work unless they comply with these specifications as designated by and until approved by the Project Engineer. Prior to delivery of the aggregates, the Contractor will be required to furnish samples for testing and shall notify the Engineer or his/her designated representative as to when and where they will be available.
- B. In placing materials in storage or in moving them from storage to the mixer, no method shall be employed which may cause the segregation, degradation, or the combining of materials of different grading which will result in any stockpile not meeting specified requirements.
- C. In the event the aggregates are considered reactive and/or low-alkali cement is unavailable locally, the addition of an approved fly ash to counteract the alkali-aggregate reaction shall be permitted.
- D. The use of reactive aggregates shall be considered as solely for the benefit of the Contractor and no additional allowance will be made for the use of low-alkali cement or an approved fly ash.
- E. Aggregates shall meet the requirements of ASTM C227 amended as follows:
 - 1. The maximum allowable expansion at six months is 0.05 percent and at twelve months is 0.10 percent. The Contractor will be required to furnish certified laboratory tests indicating the aggregates meet these requirements.

2.4 AGGREGATE GRADING

- A. Coarse aggregates shall meet the gradation limits as specified in Table 2 of ASTM C33.



- B. The maximum aggregate size shall be as specified in Table 2.1 and the applicable sections of specifications unless otherwise shown on the Construction Documents or specified in the Supplementary Specifications. Reference is made to ACI 318, Chapter 3.
- C. Sand, rock, and cement for concrete shall be measured by weight except that when the amount of concrete required for any one job is 10 cubic yards or less, upon the approval of the Engineer or his/her designated representative, and with a proportion design approved by the Engineer or his/her designated representative, these materials may be measured either by weight or volume.

2.5 WATER

- A. The amount of water shall be varied in accordance with the moisture content of the aggregates and the requirements for workability.
- B. The equipment for measuring and supplying the water to the mixer shall be so constructed and arranged that the amount of water to be added to the mixture can be measured, in gallons or by weight, positively and that the predetermined quantity of water required can be discharged rapidly in one operation into the mixing drum without dribbling. Tanks or other equipment for measuring and discharging water into the mixer shall be sufficiently accurate that the amount of water delivered to the mixer for any batch shall not vary more than one percent from the required quantity. Adequate means for determining and checking the accuracy of the equipment shall be provided and made available to the Engineer or his/her designated representative.
- C. The water used for mixing with concrete shall be free from oil, vegetable matter, and other deleterious substances and shall conform to the following requirements:
- D. Water for pre-stressed concrete shall not contain chlorides calculated as sodium chloride in excess of 400 parts per million nor sulfates calculated as sodium sulfate in excess of 1,000 parts per million. Water shall not contain an amount of impurities that will cause a change in the time of setting of Portland cement of more than 25 percent nor a reduction in the compressive strength of mortar of more than 5 percent compared to results obtained with distilled water.

2.6 ADMIXTURES

- A. Admixtures of any type, except as otherwise specified herein, shall not be used unless written authorization has been obtained from the Engineer or his/her designated representative.
- B. Air-entraining agent, conforming to ASTM C260, shall be measured accurately by mechanical means into each batch by equipment and in a method approved by the Engineer or his/her designated representative. Air content shall be in accordance with Table 2.5.1.



- C. Other admixtures, if used, shall conform to approved standards. Admixtures shall be included in the bid price of the concrete.
- D. Fly ash shall meet the requirements of ASTM C618 and amendments to Tables 2 and 2A, as shown in Table 2.5.2. Testing and certification of fly ash shall be required as part of the design mix.

Table 2.6.1 – Portland Cement Concrete Parameters

Type of Placement	Typical Design Strength* (psi)	% Air Entrainment	Class Fly-Ash (see note 4)	Fly-Ash to Cement Ratio	Slump Range (inches)
Driveways	3,500 Comp	Not to Exceed 3	C or F optional	1 to 4 (Max.)	3 (+/- 1)
Curbs, Curb and Gutter, Sidewalks	3,500 Comp	Not to Exceed 3	C or F optional	1 to 4 (Max.)	3 (+/- 1)
Miscellaneous	3,500 Comp	Not to Exceed 3	C or F optional	1 to 4 (Max.)	3 (+/- 1)

* Minimum compressive strength of 3,000 psi at 28 days in public Right-Of-Way

Notes:

1. Use of ingredients not listed must be approved by the Engineer or his/her designated representative
2. When approved by the Engineer or his/her designated representative, slumps may also be increased using dispersing agents and/or plasticizers.
3. Maximum aggregate size shall be in accordance with ACI Recommendations for the placement. In no case shall the size of the aggregate be such as to promote shrinkage, to cause insufficient coverage, or to create rock pockets or voids.
4. Testing and analysis of local or imported aggregates should determine if fly-ash is required.

Table 2.6.2 – Amendment to Tables 2 and 2A of ASTM C618

Pozzolanic Activity Index: With Portland Cement at 28 days minimum percent of control	50
Reactivity with cement alkalis: Reduction of mortar expansion at 14 days minimum percent	60

PART 3 EXECUTION

3.1 PROPORTIONING



- A. The determination of the concrete design proportions shall be solely the Contractor's responsibility and shall be established, using the cement and water contents on the basis either of laboratory trial batches designed in accordance with ACI 211.1 and Table 2.1 or of field experience with the materials to be employed. If suitable data from trial batches of field experience cannot be obtained, concrete proportions may be used on the method recommended in ACI 318. The proportions shall be selected to produce an average strength at the designated test age exceeding f'_c by the amount indicated in ACI 318. The aggregate proportions shall produce a workable mix, with coarse aggregate used in the greatest amount consistent with required workability.
- B. Weigh hoppers shall be charged from bins located directly over the weigh hoppers or from other conveyors approved by the Engineer or his/her designated representative. When conveyor belts are used, there shall be a separate belt for each size of aggregate.
- C. Bulk cement shall be weighed in an individual hopper and shall be kept separate from the aggregates until the batch ingredients are released for discharge. The cement hopper shall be attached to a separate belt.
- D. Scales utilized in the proportioning device may be of the spring less dial type or the multiple beam type or other type approved by the Project Engineer.
- E. If the dial type is used, the dial shall be of such size and so arranged that it may be read easily from the operating platform.
- F. If the multiple beam type is used, the scales shall be provided with an indicator operated by the main beam which will give positive visible evidence of over- under-weight. The indicator shall be so designed that it will operate during the addition of the last 400 pounds of any weighing. The over travel of the indicator hand shall be at least one-third of the loading travel. Indicators shall be enclosed against moisture and dust.
- G. Weighing equipment shall be as recommended by the Concrete Plant Manufacturer's Bureau and insulated against vibration or movement of other operating equipment in the plant. When the entire plant is running, the scale reading at cutoff shall not vary from the weight designated by the Engineer or his/her designated representative more than one percent for cement, one and one-half percent for any size aggregates nor one percent for the total aggregate in any batch.
- H. When proportioned at a mixing plant there shall be an approved method of determining the moisture in the aggregate, accurate to within one-half percent. If requested by the Engineer or his/her designated representative, details of the method and equipment for measuring and proportioning materials shall be submitted to him for approval.

3.2 MIXING

- A. Machine mixing will be required in all cases other than those in which it would obviously prove to be impractical; in which latter event, hand mixing will be permitted only to the



extent necessary. Regardless of the method employed, mixing shall be commenced as soon as possible after the cement is placed in contact with the aggregate.

- B. In the event haul distances are such that mixing time shall surpass that allowed, then a dry batch method may be employed when approved by the Engineer or his/her designated representative.
- C. All concrete mixers shall be of such design and construction and so operated as to provide a thoroughly and properly mixed concrete in which the ingredients are uniformly distributed.
- D. An acceptable dry batch method is as follows: A quick latch hatch is removed from the drum and the opening in the drum is rotated to the high point of the drum. Water is then introduced through the opening of the stationary drum followed by a layer consisting of all the coarse aggregate. The cement is layered on top of the fine aggregate; thus, cement does not come into contact with the water until the drum is rotated. The hatch is then replaced in the drum and mixing of the concrete does not occur until arrival at the jobsite. In the event free moisture content of fine aggregate exceeds 4.0 percent, this procedure shall be modified to allow transportation to the site of adjusted water and aggregate proportions. The cement shall be added at the site to conform to proper mix proportions of the accepted mix design. Measurement of cement shall be by standard bag amounts or an accepted scale approved by the Engineer or his/her designated representative.

3.3 MIXERS

- A. Paving and Stationary Mixers:
 - 1. Paving and stationary mixers shall be equipped with an accurate automatic timing device so designed and constructed as to lock the discharge lever before aggregate and cement enter the drum and release such lever only after the specified mixing time has elapsed. The setting of said device shall be under the observation of the Engineer or his/her designated representative. Water control equipment as described in Subsection 101.6 hereof shall be provided with each concrete mixer.
 - 2. Mixers shall be maintained in proper and serviceable working condition, and any part or portion thereof that is out of order or becomes worn to such extent as to detrimentally affect the quality of mixing shall be promptly repaired or replaced.
 - 3. The proper proportions of aggregate, cement, and water for each batch of concrete shall be placed in the mixer and shall be mixed for a period of not less than one and one-half minutes after all such materials are in the drum.
 - 4. The rotating speed at which the mixer shall be operated shall conform to that recommended by the manufacturer.
 - 5. The total volume of materials mixed in any one batch shall neither exceed the water level capacity of the mixer nor the manufacturer's catalog rated capacity of the mixer.
- B. Transit Mixers:



1. Transit mixers shall be high quality equipment and meet the general requirements herein above specified. They shall be equipped with modern type gauges capable of indicating all necessary load controls.
2. The total elapsed time between the addition of water at the batch plant and depositing the completed mix shall not exceed 90 minutes. Under conditions contributing to quick setting, the total elapsed time permitted may be reduced by the Engineer or his/her designated representative. Each mixer and agitator shall have attached thereto in a prominent place a metal plate or plates, installed by the manufacturer, on which is plainly marked the capacity of the drum in terms of the volume of mixed concrete and the speed of rotation for the agitating and mixing speeds of the mixing drum or blades.
3. No water shall be added to the concrete mix after the addition of water at the batch plant without the permission of the Engineer or his/her designated representative, and under no circumstances, if the total time elapsed since the addition of water at the batch plan exceeds 45 minutes.
4. Each mixer shall have an identification number, painted on the truck on such a location that it can be readily read from the batching platform.
5. The total volume of materials introduced into the mixer for mixing purposes shall not exceed the manufacturer's guaranteed mixing capacity. If the concrete so mixed does not meet the uniformity requirements of this section, the amount of materials charged into the mixer shall be reduced.
6. The total volume of materials mixed in any one batch shall neither exceed the water level capacity of the mixer nor the manufacturer's catalog rated capacity of the mixer.
7. Each batch of concrete placed in the mixer shall therein be mixed for not less than 70 nor more than 100 revolutions of the drum or blades, at the speed designated by the manufacturer of the agitating equipment. The revolving of the drum shall be continuous until the concrete is completely emptied from the drum. Before any portion of the materials for any batch of concrete is placed therein, the drum of the mixer shall be emptied of the previously mixed batch, including wash-up water, before any batch is placed therein.
8. Before unloading concrete at the construction site, the Engineer or his/her designated representative shall be provided with a legible weigh master's certificate (delivery ticket) which shall contain the following information concerning the concrete furnished by the manufacturer:
 - a. Name of ready-mix batch plant;
 - b. Serial number of ticket;
 - c. Date and truck number;
 - d. Name of Contractor;
 - e. Specific designation of job (name and location);
 - f. Specific class or designation of the concrete in conformance with that employed in the job specifications;
 - g. Amount of concrete (cubic yards);
 - h. Time loaded with first addition of water or of first mixing of cement and aggregates;



- i. Amount of cement (pounds);
 - j. Amount and class of fly ash, if included (pounds);
 - k. Water added at batch plant;
 - l. Water added by the receiver of concrete and his initials;
 - m. Type of admixture and amount of same.
 9. Additional information designated by the Engineer or his/her designated representative and required by the job specifications shall also be furnished upon request of the Engineer or his/her designated representative, such information may include:
 - a. Reading of revolution counter at the first addition of water;
 - b. Signature or initials of ready-mix representative;
 - c. Type and brand of cement;
 - d. W/C ratio;
 - e. Maximum size of aggregate;
 - f. Weights of fine and coarse aggregate; and
 - g. Indication that all ingredients are as previously certified or approved.
 10. The type, capacity and manner of operation of the mixing and transporting equipment for ready-mixed concrete, shall conform to the current "Standards for Operation of Truck Mixers and Agitators of the National Ready-Mix Concrete Association" and the "Truck Mixer Manufacturer's Bureau" and ASTM C94. Adequate control may require that additional water be added and mixed into the batch for a minimum mixing time of three minutes at the point of discharge. Water shall not be added to the batch during transit.
- C. Hand-Mixed Concrete:
1. Hand-mixed concrete shall be prepared on a water-tight level platform in batches of not to exceed 1/3 cubic yard each. The required amount of coarse aggregate shall first be spread on the platform in an even and uniform layer, over which the proper proportion of fine aggregate shall then be likewise spread. The combined depth of both such layers shall not be greater than one foot. The required quantity of cement shall then be evenly distributed over the fine aggregate, following which the entire batch shall be turned with shovels at least twice before the water is added. The proper amount of water shall then be uniformly sprinkled or sprayer over the batch, which shall thereafter be turned with shovels not less than 3 times before being removed from the platform.
- D. Prepackaged Unmixed Concrete:
1. Should the Contractor elect to use prepackaged unmixed concrete, an accurate automatic batch weight recorder shall be provided to record the quantities of cement, aggregate, and water batched into the containers; the weight of cement shall be recorded on either a separate chart from the aggregate or on the same chart using a separate needle. The recorder shall produce an autographic readable record on a visible chart of the weights of each of the materials batched. After batching, the needle on the chart shall return to zero. The chart scale along the ordinate shall be such that the major portion of the chart is used to record the total weights of the aggregates and water and the cement. The date of batching, the container number, and the batching certificate number shall be recorded on the



recorder chart at the time of batching. The recorder charts or copies thereof shall become the property of the Contracting Agency and shall be submitted upon request.

2. All prepackaged unmixed concrete delivered to the job site shall be stored in containers so constructed that the cement cannot commingle with the water and aggregate within the container. Any admixture added in powder form shall be added to the cement; added in liquid form, it shall be added to the water.
3. The contents of the container shall be discharged into a mixer at the job site. Following discharge of the first container into the mixer, the mixer shall be operated at mixing speeds during the discharge of the remaining containers. After the contents of the last container have been discharged into the mixer, the concrete shall be mixed as specified in Transit Mixers subsection or in accordance with Paving and Stationary Mixers subsection.
4. Any spillage of cement, aggregate, water or admixture during the filling, transporting, or the discharging of the container shall be cause for rejection of the container or the contents of the mixer if any portion of the rejected contained is discharged into the mixer

3.4 LOADING AND TRANSPORTATION OF MATERIALS AND MIXED CONCRETE

- A. The compartments of trucks or other equipment used for the purpose of transporting proportioned aggregates, bulk cement, or mixed concrete shall be sufficiently high and tight and otherwise suitably constructed and adequately protected to prevent loss or leakage of the contents thereof during transit or charging.

3.5 TESTS

- A. Concrete test samples for acceptance will be taken in the field by the Engineer or his/her designated representative or a qualified technician from a testing laboratory approved by the Engineer or his/her designated representative in strict accordance with ASTM C172. In no case shall concrete used for slump tests or air tests be used for molding specimens for strength tests.
- B. Slump tests will be made in the field in accordance with ASTM C143.
- C. Concrete cylinders for acceptance tests shall be molded in accordance with ASTM C31. Curing done in the field shall be sealed in metal or plastic molds provided the conditions, including the maintenance of temperature range, are in accordance with ASTM C31. Curing boxes approved by the Engineer or his/her designated representative shall be used for all concrete cured in the field. If the specified temperature range cannot be maintained, the samples shall be taken to the testing laboratory where they shall be molded as specified in ASTM C192, provided the cylinders can be molded within 15 minutes after sampling.
- D. Specimens will be tested in accordance with ASTM C39, C78 & C93. Quantity of tests shall be set forth in specific subsections. One test shall consist of no less than 3 specimens cast using concrete from one load.



- E. Evaluation and acceptance of concrete shall meet the criteria established in Section 4, ACI 318. Each strength test result shall be the average of two cylinders from the same sample tested at 28 days or the specified age. The strength level of the concrete will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the required $f'c$ and no individual strength test result falls below the required $f'c$ by more than 500 psi.
- F. If individual tests of laboratory-cured specimens produce strengths more than 500 psi below $f'c$ or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is adequate. If the presence of low-strength concrete is confirmed and computations indicate that the load-carrying capacity may have been significantly reduced, tests of cores drilled from the area in question shall be required in accordance with ASTM C42. Three cores shall be taken for each case of an individual cylinder test more than 500 psi below $f'c$ or where the average of any set of three consecutive strength test results is below $f'c$. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 degrees F., relative humidity less than 60 percent) for seven days before test and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be immersed in water for at least 48 hours and tested wet. Any cores or testing required because of low strength test results shall be paid for by the Contractor and at no expense to the Owner.
- G. Concrete in the area represented by the core tests shall be considered structurally adequate if the average of the three cores is equal to at least $f'c$, and if no single core is less than $f'c$ minus 500 psi. To check testing accuracy, locations represented by erratic core strength may be retested. If these strength acceptance criteria are not met by the core tests, and if structural adequacy remains in doubt, the Engineer or his/her designated representative may order load tests as outlined in Chapter 20, ACI 318 for the questionable portion of the structure. These load tests shall be paid for by the Contractor.
- H. If the structure under consideration does not satisfy the above strength acceptance criteria or the criteria of Section 20.2 or 20.4, ACI 318, the Owner may order the Contractor to remove and replace any portion of the structure which is not in compliance with the above. If so ordered, the Contractor shall perform such work at his own expense.

3.6 TEMPERATURE CONTROLS

- A. When the ambient temperature at the time of placing is less than 40 degrees F, the temperature of the concrete, as placed, shall not be less than 50 degrees F.
- B. The temperature of the concrete mix at the time it is placed in final position shall not exceed 95 degrees F.
- C. Placement of concrete in adverse weather conditions shall be as specified for the type of facility being constructed.



3.7 POZZOLANIC MATERIALS

- A. Pozzolan materials to be used in concrete or furnished under this specification shall conform to the requirements of ASTM C618.
- B. Pozzolans shall be sampled and tested as prescribed in ASTM C618 and ASTM C311. The Contractors shall obtain and deliver to the Project Engineer a certification of compliance signed by the Pozzolan supplier identifying the Pozzolan and stating the Pozzolan delivered to the batching site complies with applicable specifications.
- C. Pozzolan material shall be handled and stored in the same manner as Portland cement. When facilities for handling bulk Pozzolan are not available, the Pozzolan shall be delivered in original unopened sacks bearing the name and brand of the supplier, the type and source of the Pozzolan, and weight contained in each sack plainly marked thereon. A Pozzolan shall not be mixed with any other brand or type unless written permission has first been obtained from the Project Engineer
- D. No partial bags shall be used unless facilities are available to accurately weigh the partial bags.
- E. All Pozzolan to be incorporated into the concrete as a separate ingredient shall be weighed. When the cement scales are used for weighing both cement and Pozzolan, the cement shall be weighed first. If separate scales are provided, they shall be accurate to ± 0.3 percent of the scale capacity.

3.8 MEASUREMENT AND PAYMENT

- A. The work performed and materials furnished as this item requires will not be paid for directly but will be subsidiary to its associated bid items.

END OF SECTION



SECTION 32 15 00
CONCRETE CURING COMPOUND

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all tools, qualified labor, materials, equipment, qualified superintendence and all services, transportation, other incidentals, assurances and guarantees, assumptions of risk, and responsibility for the performance of all Concrete Curing operations as indicated on the Construction Drawings. Complete work as shown and specified herein.

1.2 SECITON INCLUDES

- A. Section includes initial and final curing of horizontal and vertical concrete surfaces.

1.3 RELATED SECTIONS

- A. Section 32 13 13 – Concrete Paving.
- B. Section 32 14 00 – Portland Cement Concrete.

1.4 REFERENCES

- A. American Society of Testing Materials (ASTM International):
 - 1. ASTM C156-98 - Standard Test Method for Water Retention by Concrete Curing Materials.
 - 2. ASTM C309-11 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - 3. ASTM E97-82 – Method of Test for Directional Reflectance Factor, 45-Deg 0-Deg, of Opaque Specimens by Broad-Band Filter Reflectometry.
 - 4. ASTM C171 – Standard Specification for Sheet Materials for Curing Concrete.
 - 5. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
 - 6. ASTM D2103 – Standard Specification for Polyethylene Film and Sheeting.
- B. American Concrete Institute (ACI):
 - 1. ACI 301 – Specifications for Structural Concrete.
 - 2. ACI 302.1 – Guide for Concrete Floor and Slab Construction.
 - 3. ACI 308.1 – Standard Specification for Curing Concrete.



1.5 SUBMITTALS

- A. Refer to *Section 01 33 00 – Submittal Requirements*.
- B. Product Data: Submit data on curing compound, mats, film, compatibilities and limitations.
- C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

- A. Perform work in accordance with the County of El Paso Standards.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Refer to *Section 01 60 00 – Product Requirements*.
- B. Deliver curing materials in manufacturer's packaging including application instructions.

PART 2 PRODUCTS

2.1 MATERIALS

- A. The curing compound shall consist of a liquid which, when applied to fresh concrete by means of a spray gun, will form an impervious membrane over the exposed surfaces of the concrete.
- B. In no case shall the coverage required be so great that the compound forms more than a continuous, unbroken film when applied to the work; nor shall the coverage exceed 250 square feet per gallon.
- C. The curing compound shall be as specified in ASTM C309, Type 2, Class A.

PART 3 EXECUTION

3.1 TEST OF CURING COMPOUND

- A. Tests of curing compounds shall be done in accordance with ASTM C156 and Type 2 compound shall also be done in accordance with ASTM E97.

3.2 CURING CONCRETE

- A. Obtain approval of the proposed curing methods, equipment, and materials before placing concrete. The Project Inspector or his/her designated representative 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.
- B. 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 hr. or, on colder days if the temperature of all surfaces



of the concrete is maintained above 40° F, for the entire 24-hours period. The required curing period begins when all concrete has attained its initial set. Tex-44-A may be used to determine when the concrete has attained its initial set.

- C. Cure all concrete for 4-consecutive days except as noted in Table 3.1.

Table 3.2.1 – 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 pilling buildups	All	6

- D. 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 as soon as possible after application of the evaporation retardant and after the water sheen has disappeared, but no more than 45-minutes. after application of the evaporation retardant. Apply membrane interim curing using a work bridge or other approved apparatus to ensure 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 104.4.1. 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.
- E. 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.
- F. Cure all other concrete as specified in the pertinent Items. Use the following methods for curing concrete, subject to the requirements of this Item.
- G. 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
- H. 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. Do not use seawater or water that stains or leaves an unsightly residue.



I. Wet Mats:

1. Keep the concrete continuously wet by maintaining wet cotton mats in direct contact with the concrete blankets made from 9 oz. 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 enough moisture inside the enclosure to keep all surfaces of the concrete wet.

J. Water Spray:

1. Overlay sprays or sprinklers to keep all uniformed surfaces continuously wet.

K. Ponding:

1. Cover the surfaces with at least 2 inches of clean granular material, kept wet at all times, or at least in 1-inch deep water. Use a dam to retain the water or saturated granular material.

L. Membrane Curing:

1. 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 one type of curing compound on any one structure.
2. Apply membrane curing just after free moisture has disappeared at a rate of approximately 180 square foot 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.
3. 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.

- M.** Concrete curing compound will be included in the measurement for concrete installed.

3.3 PAYMENT

- A.** The work performed, and materials furnished as this bid item requires will not be paid for directly but will be subsidiary to its associated bit items.

END OF SECTION