PART III

TECHNICAL REQUIREMENTS

CATEGORY 100

SECTION 101 — CLEARING AND GRUBBING

101.01 DESCRIPTION. This work shall consist of clearing and grubbing within the limits specified in the Contract Documents.

101.01.01 Definitions.

(a) Clearing. Clearing within the construction area includes removing and disposing of trees, brush, shrubs, vegetation, rotten wood, rubbish, fences and structures not specified in the Contract Documents for removal and disposal. Clearing outside the construction area is the removing and disposing of rubbish.

(b) Grubbing. Grubbing is removing from the ground and disposing of all stumps, roots and stubs, brush and debris.

(c) Limits. Limits of clearing and grubbing include the construction area and all ditch areas and stream or channel change areas. Limits of clearing may include the area between the construction area and the right-of-way or easement lines.

(d) Clearing and Grubbing Unit. A clearing and grubbing unit is the area of erodible earth material exposed at one time, not to exceed 20 acres.

(e) Disturbed Area. Any erodible material exposed by construction activities.

(f) Stabilization. Providing vegetation or structural measures (seed, temporary or permanent mulch, soil stabilization matting, riprap, stone aggregate, and paving by asphalt or concrete) that will prevent erosion. The placement of one or more of these temporary or permanent stabilization measures as directed by the Engineer shall satisfy the requirements to proceed with the next grading unit or operation.

(g) Stabilized. An area covered with erosion resistant material such as grass cover, seed and mulch, soil stabilization matting, riprap, stone aggregate, or paving by asphalt or concrete.

101.02 MATERIALS. Not applicable.

101.03 CONSTRUCTION.

101.03.01 Erosion and Sediment Control. Unless otherwise specified in the Contract Documents or as directed by the Engineer, the clearing and grubbing area shall be limited to a 20 acre grading unit per grading operation. Once this first unit is half graded, the Contractor will be allowed to proceed with the second 20 acre grading unit. With the permission of the Engineer, the Contractor will be allowed to exceed the one grading unit requirement to balance earth work or when grading interchanges. Erosion and sediment control shall conform to the Contract Documents and Section 308.

A grading operation is defined as the Contractor's ability to provide adequate resources to perform the grading in a timely manner and provide and maintain the proper erosion and sediment control measures. The Engineer will be the final authority in this determination. A grading unit need not be 20 contiguous acres. When wet soil conditions are encountered, the Contractor will be allowed to clear and grub and grade another unit providing the initial unit has been properly stabilized. No more than two grading units shall be active at any time.

101.03.02 Vegetation. The Engineer will designate and mark any trees, shrubbery and plants that are to remain in place, and the Contractor shall protect them from any damage as specified in GP-7.11. Branches of trees overhanging the roadway shall be cut and properly trimmed to maintain a vertical clearance of 16 ft. All trimming shall be done under the supervision of a tree expert employed by the Contractor and licensed by the State of Maryland, including trimming of trees by the Contractor for any other reason. Trimming and repair of cuts and scars shall conform to Section 712.

101.03.03 Fences. All fences within the right-of-way shall be removed and disposed of unless otherwise specified in the Contract Documents.

101.03.04 Mailboxes. All mailboxes within the limits of construction shall be removed and reset as directed by the Engineer.

101.03.05 Grubbing.

(a) Excavation Areas. Within areas to be excavated, all embedded stumps and roots shall be removed to a depth of not less than 3 ft below the subgrade or slope surfaces. All depressions made below the subgrade or slope surfaces by the removal of stumps shall be refilled with materials suitable for embankment and shall be compacted as specified in Section 204.

(b) Low Embankments. Areas where the total depth of the embankment is less than 3 ft shall be grubbed.

(c) High Embankments. Areas where the embankment is 3 ft or more in depth, trees and stumps shall be cut off as close to the ground as is practical but shall not exceed 1 ft above the ground surface. Near the toe of embankment slopes, stumps or trees are prohibited within 1 ft of the slope surfaces.

101.03.06 Stream and Channel Changes. Stream or channel change areas shall be cleared and grubbed 5 ft beyond the top of the cut slopes.

101.03.07 Disposal.

(a) Burning. When perishable material is burned, it shall be burned under the constant care of a watchperson. Burning shall conform to the applicable laws and ordinances of respective jurisdictions.

(b) Disposal Locations. Materials and debris that cannot be burned and perishable materials shall be removed from the right-of-way and disposed of by the Contractor. The Contractor shall make all necessary arrangements to obtain suitable disposal locations and shall furnish the Engineer with a copy of resulting agreements.

(c) Wood Disposal. Disposal of wood to the general public shall be accomplished off the job site. Any plan for disposal in this manner shall be submitted to and approved by the District Engineer prior to beginning the clearing and grubbing operation.

101.03.08 Destroying Trees or Wetlands, Beyond Clearing Limits. The Contractor shall not damage nor destroy any trees or wetland areas that exist beyond the clearing limits specified in Section 107.

The Contractor shall be responsible for all damage to trees and wetlands located beyond the clearing limits due to the Contractor's operations. The Contractor shall restore, to the satisfaction of the Engineer, any trees that have been damaged or destroyed at no additional cost to the Administration. Replacement of trees shall be in conformance with Section 710.

Mitigation of wetland impact shall be in conformance with the Occupying Wetlands provisions contained in the Contract Documents.

Replacement trees shall be of the same species as those damaged or destroyed unless otherwise directed by the Engineer. The replacement size shall be the same as the damaged or destroyed trees when the trees measure less than 4 in. diameter at breast height (DBH). Damaged trees

4 in. DBH or greater shall be replaced with 2 in. caliper trees in conformance with the following:

SIZE OF DAMAGED OR DESTROYED TREES in. DBH	NUMBER OF 2 in. CALIPER REPLACEMENT TREES
4	5
6	8
8	10
10	13
12	15
16	20
20	25
24	36
32	48
40	80
60	135
80	200
120 or Greater	360

NOTE: DBH shall be measured at 4.5 ft above the ground. Caliper shall be measured at 6 in. above the ground.

Replacement trees shall be planted within the limits of the project whenever possible, as determined by the Engineer. If not possible, a suitable location will be determined by the Engineer.

All work shall require a replacement period as specified in Category 700. In case of failure on the part of the Contractor to restore or replace the damaged tree or wetland at the start of the next appropriate planting season, the Contractor will have 48 hours to begin corrective action, after notification by the Engineer. If the Contractor has not taken the corrective actions within the specified time, the Engineer may proceed with corrective measures. The cost of the corrective measures will be deducted from any monies due under the Contract.

101.04 MEASUREMENT AND PAYMENT. Clearing and Grubbing will not be measured but will be paid for at the Contract lump sum price. The payment will be full compensation for the removal and disposal of fences, removal and resetting of mailboxes, selective tree trimming and scar repair, and removal and disposal of existing buildings when not covered as a specific pay item in the Contract Documents, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 102 — REMOVAL AND DISPOSAL OF EXISTING BUILDINGS

102.01 DESCRIPTION. This work shall consist of the removal and disposal of existing buildings, including foundations, footings or any part thereof, and backfilling, as specified in the Contract Documents. The work also includes protection of the buildings until the removal and disposal are accomplished as directed by the Engineer. Locations of buildings included in the work will be designated in the Contract Documents by the circled numbers ①, ②, ③, etc.

102.02 MATERIALS. Not applicable.

102.03 CONSTRUCTION. The Contractor shall schedule the buildings and appurtenances for removal, razing, or occupation as one of the first items of work.

Any building used by the Contractor for purposes such as field office, storage, etc., may remain as an exception to the above but shall be removed and disposed of immediately when vacated.

Buildings and appurtenances designated for removal may be disposed of by burning if they are not located close to habitable dwellings and if not prohibited by local or State laws, regulations, ordinances, or by the fire marshall.

Salvaged materials shall become the property of the Contractor. When materials are sold by the Contractor and are removed by the purchaser, it shall be done only during daylight working hours and in company with a Contractor's representative.

The Contractor shall be responsible for posting and protecting the buildings from vandalism or theft until they are removed.

102.04 MEASUREMENT AND PAYMENT. Removal and Disposal of Existing Buildings will not be measured but will be paid for

at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work. All buildings not designated for removal and disposal in the Contract Documents will not be measured but the cost will be incidental to Section 101. The Administration reserves the right to eliminate from this item any or all buildings or structures. For each building eliminated from this item, the item will be credited to the extent of the cost eliminated, which will be determined from a breakdown submitted by the Contractor showing the tabulation of individual unit costs used in arriving at the Contract price for this item. A breakdown of the Contract lump sum price for Removal and Disposal of Existing Buildings shall be submitted to the Engineer prior to beginning work.

SECTION 103 — ENGINEERS OFFICE

103.01 DESCRIPTION. This work shall consist of furnishing, cleaning, and maintaining in good condition an Engineers office at a location within the immediate vicinity of the project and approved by the Engineer. The Engineers office shall be separated from any offices used by the Contractor and it and all items therein shall be for the exclusive use of the Administration's Engineers and Inspectors. Rented properties that conform to the type of office specified in the Contract Documents will be acceptable.

103.02 MATERIALS. Not applicable.

103.03 CONSTRUCTION. The office shall be set up, equipped and made ready for use a minimum of five days prior to commencement of other work on the project and shall remain until all field records have been completed. Upon removal the location shall be restored and left in a condition acceptable to the Engineer.

Unless otherwise specified, the Engineers office and all equipment and accessories furnished by the Contractor shall become the property of the Contractor at the completion of the project.

103.03.01 Mobile Housing Unit. The Contractor shall provide a mobile housing unit having a minimum floor space of 60 ft^2, and a minimum window area of 10 ft^2 to provide natural light. It shall be entirely enclosed, waterproofed, and have a door that locks. It shall be equipped with at least one table 36 x 48 x 40 in. high and one closet equipped with lock for storing equipment. Two keys for each lock shall be provided to the Engineer. Satisfactory heating and cooling shall be provided.

The unit shall be relocated by the Contractor to the locations as directed by the Engineer.

103.03.02 Handicap Accessibility. When handicap accessibility is necessary, it shall comply with the Federal Register-Volume 56 No. 144-Americans with Disability Act (ADA) Accessibility Guidelines for Buildings and Facilities.

103.03.03 Mobile Office Trailers. Office trailers shall be anchored in conformance with the manufacturer's recommendations. Office trailers defined under the Industrial Building and Mobile Act of Maryland shall be approved by the Maryland Department of Housing and Community Development and bear the Maryland Certification Insignia. The Insignia shall be located in the interior of the office.

103.03.04 Quality Control Laboratory. Refer to Section 915.

103.03.05 Construction Requirements for all Offices.

(a) Entirely enclosed, waterproofed, and completely insulated to a minimum R11 rating.

(b) Double thick floor with building paper placed on top of the lower floor.

(c) Finished inside and outside as approved by the Engineer.

(d) The building shall have a minimum ceiling height of 7 ft, and have a pitched roof with a ventilating louver in each gable.

(e) A 4 X 1 ft minimum sign with the message "ENGINEERS OFFICE - STATE HIGHWAY ADMINISTRATION", shall be attached to or mounted in front of the office. The sign shall have a black background with minimum 3 in. height white lettering. It shall have a 1 in. wide white border around the entire sign.

(f) A 5 X 7 in. minimum no smoking sign shall be posted on the outside of each entrance to the office, plant laboratory, and mobile housing unit.

(g) Interior and exterior doors shall be equipped with different key locks. Interior doors shall be keyed alike and exterior doors shall be keyed alike. Exterior doors shall have an additional dead bolt lock. The Contractor shall provide the Engineer four keys for the interior and exterior locks.

(h) Windows shall be capable of being opened and closed and be equipped with latches and screens. Each window shall have venetian blinds or shades.

(i) Electrified to conform to national and State electrical codes with satisfactory artificial lighting and lighting services. The minimum illumination level shall be 75 ft-c.

(j) Equipment shall be provided to enable heating the office to at least 70 F and cooling to at least 78 F.

(k) The restroom facility shall include wash basin, water closet, soap holder, paper towel holder, and mirror. It shall be connected to water and sewage, or a well and septic system. A pressurized water system capable of maintaining a minimum pressure of 20 psi shall be provided. These facilities shall conform to the State Department of Health and Mental Hygiene or other authorities having jurisdiction.

(l) The Contractor shall maintain the Engineer's facilities in a clean and sanitary condition, and have the trash removed daily. Floors shall be swept daily and damp mopped and waxed biweekly. The interior and exterior of all windows shall be cleaned monthly. Additionally, this work shall be performed on an as needed basis when requested by the Engineer.

(m) The Contractor shall be responsible for protecting the Administration and Administration employees from any loss or damage to their property stored in the Engineers Office. The protection shall be in the amount of twenty thousand dollars ($20,000), nondeductible, per each occurrence, for any loss or damage due to fire, theft, vandalism, storms or floods. Reimbursement, replacement, or repair shall be completed within 30 days from the date the Engineer reports the loss to the Contractor.

(n) A designated parking area, with the specified number of spaces, shall be provided for the exclusive use of Administration employees. The Contractor shall post signs to designate the assigned parking areas and enforce the parking rules. The parking area shall be stabilized as directed by the Engineer.

(o) Fire extinguishers shall be dry chemical, multi-purpose ABC type (minimum 10 lb), equipped with a visual air pressure gauge. They shall be maintained in conformance with OSHA safety and health standards.

(p) A 24 unit first aid kit shall be furnished and maintained as described in the Code of Federal Regulations, Title 29 Subpart D, Section 1926.50(d)2.

(q) A waterproof bulletin board, minimum 4 X 8 ft, shall be installed within the limits of the project in an easily accessible area and shall be conspicuously displayed to all employees. The Contractor shall post all pertinent and required notices and shall maintain it for the duration of the project.

(r) Touch-tone telephones equipped with an answering device capable of answering, recording, storing, and playing back messages at least 30 minutes in length. The machine shall be voice activated, beeperless, to record as long as speaker speaks, and shall play back recorded messages without dial tone or pauses. The machine shall be capable of recording outgoing messages up to 15 seconds in length.

If a telephone or answering machine becomes defective, is stolen, or for any other reason does not function as intended, it shall be replaced with an equal or better unit within eight hours after the Contractor is notified at no additional cost to the Administration.

Emergency telephone numbers shall be conspicuously posted in the office.

(s) One 12 ft^3 electric refrigerator.

(t) One modern cassette player/recorder with cassettes and approved by the Engineer.

(u) One modern one-step operation paper copier machine. The Contractor shall supply paper and provide service as needed.

(v) One sanitary type electric water cooler including bottled water and disposable cups.

103.03.06 Microcomputer System for all Offices.

(a) Desktop Unit.

(1) Pentium microprocessor minimum, processor shall be year 2000 compliant.

(2) Minimum microprocessor speed of 700 MHz.

(3) One 3-1/2 in. HD (high-density) floppy diskette drive.

(4) Minimum hard drive storage of 6.0 GB (gigabyte).

(5) Minimum of 64 MB RAM (Random Access Memory).

(6) Enhanced 101 key keyboard with wrist rest.

(7) Super Video Graphics Accelerator (SVGA) with minimum 2 MB memory.

(8) Modem shall have a minimum of 56K BPS, ITU V.90 compliant, with separate independent telephone line and phone number to dedicated phone jack.

(9) Mouse with mouse pad.

(10) One CD-ROM drive having a minimum of 8X speeds.

(11) One Iomega compatible ZIP Drive.

(b) Operating System. Minimum Microsoft® Windows 98™.

(c) Video Monitor. Color Super VGA monitor conforming to Energy Star requirements with a minimum screen size of 17 in.

(d) Printer. HP Compatible Color Inkjet or Color Laser Printer with minimum resolution of 600 DPI (dots per in.) and a minimum of 2 MB of RAM. Officejets and Bubblejets will not be accepted. Printer shall have a minimum print speed of 10 PPM (pages per minute) in black and white mode and 6 PPM in color.

(e) Software.

(1) Microsoft® Office 97 Professional for Windows™ or later.

(2) Symantec® pcAnywhere32 for Windows™ version 8.0 or later.

(f) Internet Access. The microcomputer system shall be provided with Internet access.

(g) Accessories.

(1) Uninterruptible power supply (UPS).

(2) Standard computer workstation with minimum desk space of 60 X 30 in. and a swivel type office chair, padded with arm rests.

(3) 8-1/2 x 11 in. xerographic paper to be supplied as needed.

(4) 3-1/2 in. disks as needed.

(5) Toner or ink as needed for printer.

(6) Maintenance agreement to provide for possible down time.

(7) Physical security system to deter theft of computer components.

(8) Four 100 MB Cartridges for Iomega compatible Zip Drive.

(h) Notes.

(1) The microcomputer system shall be completely set up ready for use on or before the day the Engineers office is to be occupied.

(2) All software stated above shall be supplied on original disks with original manuals and be retained in the construction field office for the duration of the Contract.

(3) If for any reason the system fails to operate, the system shall be replaced or repaired within 48 hours.

(4) When the microcomputer system is no longer required, the Construction Management software system including original user/operator guide manuals, program disks, and all data files will be removed by the Engineer and delivered to the District Engineer and become the property of the Administration. The remaining microcomputer system shall remain the property of the Contractor.

103.03.07 Facsimile (FAX) Transceiver for all Offices.

(a) Shall have separate independent telephone line and phone number to dedicated phone jack.

(b) Shall conform to and be compatible with CCITT Group Transmission Standards (see specific line items for compatibility requirements).

(c) Shall use public switched telephone networks and standard two wire leased line through RJ11C jacks or similar devices.

(d) Shall transmit at a minimum of 9600 BPS with automatic stepdown to compensate for phone line conditions.

(e) Shall transmit a standard 8-1/2 x 11 in. page within 20 seconds through a clear phone line, based on CCITT #1 test chart.

(f) Shall have a minimum of two levels of resolution with contrast control:

(1) Standard 200/96 lines

(2) Fine 200/196 lines

(g) Shall have self-test capability, provide activity reports, and provide page headers, time and date.

(h) Shall use standard copy paper for receiving transmissions.

(i) Shall have automatic document feeder tray (see specific requirements for each transceiver class).

(j) Shall be supplied with handsets.

(k) Shall provide for automatic answer, receive, and disconnect features.

(l) FCC registration number, ringer equivalence, and connection circuitry shall be provided for each transceiver.

103.03.08 Specific Field Office Requirements.

Type A Engineers Office – Standard office trailer with a minimum of 200 ft^2 of floor area under one roof.

Type B Engineers Office – Standard office trailer with a minimum of 400 ft^2 of floor area under one roof.

Type C Engineers Office – Standard office trailer with a minimum of 700 ft^2 of floor area under one roof.

Type D Engineers Office – One-story structure containing a minimum of 1300 ft^2 of floor area under one roof. Modular construction is acceptable. Office trailers are not acceptable.

Table 103 Specific Requirements

ENGINEERS OFFICE				ITEM
A	**B**	**C**	**D**	
–	1	2	–	Inner Offices–100 ft^2 each
–	1	1	–	General office area
–	–	–	4	Inner Offices–120 ft^2 each
–	–	–	1	Conference room–240 ft^2
–	–	–	1	Storeroom with shelves–120 ft^2
1	1	1	2	Restroom, minimum 30 ft^2
–	1	1	1	Inner office ingress and egress to the other rooms
3	4	4	5	Executive type desks with center drawers. Minimum top dimensions of 32 X 60 in.
3	4	4	5	Swivel chairs, padded with arm rests
1	1	1	1	Slant top drafting table and stool, approximately 40 in. high at the front edge and having minimum top dimensions of 30 X 72 in.
1	2	3	6	Folding utility tables, 30 in. high and having minimum top dimensions of 30 X 72 in.
–	–	–	1	Conference table with padded chairs for 12 persons
2	6	10	12	Additional padded chairs
1	2	2	3	Plan racks
1	1	1	2	Coat racks
1	1	1	1	3 X 6 ft blackboard or whiteboard
1	2	3	3	Electronic desk calculators with memory and tape readout (including instruction manuals and replacement tapes as needed)
1	1	2	6	Legal size steel filing cabinets, four-drawer fire resistant (D label) with locks
–	2	2	2	Standard size steel filing cabinets, four-drawer with locks
1	1	1	5	Bookcases having four shelves 36 X 12 in.
1	2	2	2	Closets extending the full height from floor to ceiling, measuring not less than 24 X 30 in. and equipped with locks and at least two shelves in each
1	1	1	–	Utility cabinet with three adjustable shelves
1	1	1	–	Overhead cabinet minimum dimensions of 8 ft long 15 in. deep, and 18 in. high
1	1	1	2	Fire extinguisher as described in 103.03.05
1	2	2	4	Touch-tone telephones with separate lines, as described in 103.03.05
2	2	2	2	Battery-operated smoke detectors
4	8	10	15	Designated parking spaces

103.04 MEASUREMENT AND PAYMENT. Engineers office will not be measured but will be paid for at the Contract lump sum price for the pertinent Engineers Office specified in the Contract Documents.

Payment of 50 percent of the Contract lump sum price will be payable on the first estimate subsequent to complete installation of the Engineers office. The remaining 50 percent will be prorated and paid in equal amounts on each subsequent monthly estimate. The number of months used for prorating will be the number estimated to complete the work. The final month's prorata amount will not be paid until the office is removed and the area is restored. The payment will be full compensation for site preparation, utility costs, all specified furnishings, to provide, equip, clean, maintain, insure, remove and dispose of the office, restore the site and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

The only exception to the all inclusive Contract lump sum price is the stabilization of the parking area, which will be measured and paid for using the pertinent items as directed by the Engineer.

SECTION 104 — MAINTENANCE OF TRAFFIC

104.00 GENERAL. This work shall consist of maintaining vehicular and pedestrian traffic on or along any transportation facility as specified in the Contract Documents. This Section sets forth the traffic control requirements necessary for the safe and continuous maintenance of traffic throughout the area affected by the work, and is intended to minimize inconveniences to the traveling public, while providing for the safety of motorists, pedestrians, and workers.

When speed of traffic is noted, this means the posted speed or prevailing travel speed, whichever is higher unless otherwise specified.

Items used for temporary maintenance of traffic shall be removed from the project site when no longer needed and become the property of the Contractor, unless otherwise specified in the Contract Documents.

Ninety percent of all reflective barrier markers, warning lights, and raised pavement markers shall be operational at any given time unless more are specified by the Engineer. Any deficiencies shall be corrected within 24 hours.

Upon initial installation reflectorized traffic control signs shall have a minimum of 70 percent reflectivity specified in 950.03 over 90 percent of their reflectorized surface, and channelizing devices shall have a

minimum of 80 percent reflectivity specified in 950.03 over 90 percent of their reflectorized surface.

The Contractor shall replace damaged traffic control devices, such as yield or stop signs, within four hours of notification by the Engineer. The Contractor shall take the necessary corrective action as approved by the Engineer to adequately warn and protect the public until the signs are replaced.

The Contract Documents will specify one or more of the items listed in the following sections. When work is specified to be accomplished under the Maintenance of Traffic item, the work will be incidental to the Contract price for Maintenance of Traffic.

104.01 TRAFFIC CONTROL PLAN (TCP).

104.01.01 DESCRIPTION. This work shall consist of the development and implementation of a TCP. The TCP will include the design and placement of items such as signing, pavement markings, delineation, channelization, barriers, crash cushions, and other items as required.

TCPs may be implemented within a single project or jointly between two or more projects. In situations where TCPs are jointly implemented, care shall be exercised to present correct and nonconflicting guidance to the traveling public.

The Contractor shall implement the Administration's TCP (Option 1) or may modify the Administration's TCP (Option 2) or develop their own TCP (Option 3). The Contractor's TCP shall be submitted in writing to the Engineer at least 20 days prior to starting any work. Changes to the approved TCP shall be submitted in writing at least five days prior to implementing the change. For emergencies the approval process will be completed within four hours. The Contractor shall have written approval of any TCP changes from the Engineer prior to their implementation. No work shall begin until the required traffic control patterns and devices are in place.

The Contractor shall make a request to the Engineer for any lane or shoulder closures 24 hours in advance of the time any traffic lane or shoulder is to be closed. Unless otherwise specified in the Contract Documents, all travel lanes shall be restored at the end of the work day and no travel lane shall be reduced to less than 10 ft. Prior to opening the closed lane or shoulder, the Contractor shall clear the lane or shoulder of all material, equipment, and debris.

When TCP Option 2 or Option 3 has been selected by the Contractor on the Traffic Control Plan Certification Form included in the Contract Documents, the following shall apply:

(a) Plans or revisions to plans submitted for approval shall be drawn to the same degree, likeness, and sophistication as that of the Contract Plans.

(b) Submittals shall be on sheets measuring 22 X 34 in. with a standard margin and a standard title block at the lower right corner approximately 4 X 8 in., or on 8-1/2 X 11 in. paper with a 1 in. margin and a title block.

The title block shall contain the following information in the order listed.

Name of Contractor (and subcontractor, if applicable)
Address of Contractor (and subcontractor, if applicable)
Sheet Title
Administration Contract Numbers and
Complete Federal Aid Number, if any
"Prepared for Maryland State Highway Administration"
Signature block for approval by Contractor's Traffic Manager and date of approval

(c) All lines shall be clean, sharp, solid, and heavy enough to permit adequate reproduction. The scale of phase details on the TCP shall be 1 in. equals 100 ft. Additional plans that revise the design plans shall be at the same scale as the Contract Plans.

(d) The use of white pigment to cover lines is prohibited.

(e) Plans shall indicate the proposed traffic movements throughout the area affected by the work for each phase of construction, have all routes labeled, show north arrow, and any other information that would clarify the TCP.

Any monetary savings from changes to the TCP made by the Contractor and approved by the Engineer will be divided equally between the Contractor and the Administration.

104.01.02 MATERIALS. Not applicable.

104.01.03 CONSTRUCTION. Not applicable.

104.01.04 MEASUREMENT AND PAYMENT. Any traffic control plan developed by the Contractor will not be measured but the

cost will be incidental to other pertinent items specified in the Contract Documents.

104.02 MAINTENANCE OF TRAFFIC (MOT).

104.02.01 DESCRIPTION. This work shall consist of maintaining traffic safely and efficiently through and around the area affected by the work.

104.02.02 MATERIALS.

Traffic Materials 950

104.02.03 CONSTRUCTION.

(a) Maintenance of Existing Roadway. The Contractor shall be responsible for maintaining the existing roadway surface and shoulders, including crossroads, ramps, approaches, crossovers, medians, detour roads, entrances, and pavement markings within the limits of the project, throughout the duration of the Contract.

Any hazardous condition which exists or develops throughout the duration of the Contract, such as potholes or shoulder defects, shall be repaired or patched by the Contractor as directed by the Engineer.

(b) Existing Regulatory Signs, Warning Signs, Guide Signs and Pavement Markings. Existing signs that are not applicable due to temporary traffic conditions, shall be relocated when necessary, turned, completely covered with opaque material, or removed with the approval of the Engineer. They shall be properly redisplayed to traffic as soon as conditions warrant. The Contractor shall replace any existing signs misplaced or damaged by the Contractor's operations at no additional cost to the Administration.

The Contractor shall inventory the locations of all existing pavement markings including legends and symbols with the Engineer prior to construction. The inventory shall include type, size, location, and color and be submitted to the Engineer. The Contractor may mark up a set of Contract Plans or submit their own sketches or drawings.

(c) Storage and Movement of Equipment, Material, and Vehicles. No equipment or material shall be stored or permitted to stand in unprotected areas or open areas within 30 ft from where traffic is

being maintained unless protected by traffic barriers. The Contractor's employees shall not park their vehicles within the right-of-way of the through highway, unless written permission for an exception is given by the Engineer. All equipment, material, storage, and parking areas shall have advance written approval from the Engineer. Storage of equipment and material may be permitted closer than 30 ft, subject to the following restrictions:

(1) Approved temporary traffic barrier shall be in place prior to storage of any equipment or materials.

(2) Equipment and material are prohibited from being within 4 ft behind the face of the traffic barrier.

(3) No equipment or material shall be stored or standing in open areas closer than 30 ft from where traffic is being maintained, unless the equipment or material is stored in conformance with the AASHTO Roadside Design Guide.

Areas used for storage of equipment and material shall be restored to their original condition immediately upon completion of their use. No additional compensation will be provided for this work.

Vehicles and equipment shall enter and leave the work area in the direction of traffic flow.

Work performed on, or adjacent to the traveled way, shall be performed in the direction of traffic flow unless written approval is obtained from the Engineer prior to beginning the work.

The Contractor's vehicles and equipment shall enter on and exit from the roadway at interchanges or legally allowed public use crossovers. Making U-turns across any medians or crossovers signed FOR USE OF AUTHORIZED AND EMERGENCY VEHICLES ONLY by the Contractor's vehicles or equipment is prohibited unless written approval is granted by the Engineer.

(d) Warning Lights and Devices. Warning lights and flags shall be used on warning signs as specified in the TCP, the Contract Documents, or as directed by the Engineer. During hours of darkness, any channelizing device used to warn of a spot hazard shall have one Type A low intensity flashing warning light attached to the side adjacent to traffic. Two Type A low intensity flashing warning lights shall be attached to the top of each Type III barricade.

(e) General Requirements for Temporary Pavement Markings (TPMs). For pavement marking dimensions refer to Pavement Marking Dimension Table following (f)(10) below.

(1) Temporary pavement markings are those markings placed upon the roadway to serve an area of work activity or a work phase for a period of time after which they are to be removed.

When approved by the Engineer, a less than full complement of pavement markings and reduced dimension markings for dashed center lines and lane lines may be permitted. Where less than a full complement of pavement markings or reduced dimension markings are used, the time of use shall not exceed two weeks.

(2) TPMs may be either full dimension or reduced dimension as specified in the Contract Documents or as directed by the Engineer.

(3) Full dimension TPMs shall conform to the MUTCD and the Pavement Marking Dimension Table following (f)(10).

(4) Reduced dimension TPMs shall conform to the MUTCD and the Pavement Marking Dimension Table following in (f)(10), except that the dashed center lines and lane lines may consist of 4 ft segments and 36 ft gaps. All other dimension elements shall be as specified in the MUTCD and the Pavement Marking Dimension Table.

(5) TPMs generally use short lived marking materials that are easily removed. Material requirements are described elsewhere in these Specifications.

(f) Specific Requirements for TPMs.

(1) As a minimum at the close of each day, the roadway shall have all center and lane lines in place.

(2) During the work day while work activity is underway, center and lane lines shall be in place or the lines shall be represented by channelizing devices, signs, or other traffic control devices to clearly define and mark all vehicle paths.

(3) Along two-lane, two-way roadways, the center line shall consist of a continuous double solid yellow center line, a single dashed yellow center line at full dimension, or a

single dashed yellow center line at reduced dimension as directed by the Engineer.

(4) No passing zones shall be marked and signed as specified in the Contract Documents or as directed by the Engineer. All no passing zones may be identified by signing for a period not to exceed seven days.

(5) Along multilane, undivided roadways the center line shall be identified using a continuous double solid yellow line.

If a two-way left turn is present, see (6) below.

If the roadway is three lanes, the center line may be either a continuous double solid yellow center line or, where passing is permitted in the single lane direction, a continuous single solid yellow and single dashed yellow combination center line. For the placement of no passing zones see (f)(4) above.

(6) Along multilane undivided roadways having a two-way left turn lane, the two-way left turn lane need not be marked provided that channelizing devices are used continuously throughout the length of the left turn lane at a maximum spacing of 200 ft to delineate the left turn lane, separate the opposing flows of traffic and provide areas within which left turning vehicles may store while awaiting opportunities to turn.

(7) Along multilane roadways having reversible lanes, the lanes shall be marked with the full complement of pavement markings as described in the MUTCD.

(8) Where edge lines are not in place, appropriate channelizing devices or other delineation shall be used to delineate the edge of the roadway.

(9) Specific pavement marking and complementary signing details are shown on the Temporary Traffic Control (TTC) Typical Applications.

(10) Contact the Office of Materials and Technology (OMT) for the latest approved TPM materials.

PAVEMENT MARKING DIMENSION TABLE			
LINE TYPE	**MATERIAL**	**REQUIRED MINIMUM EFFECTIVE WIDTH, in.**	
		EXPRESSWAYS AND FREEWAYS	**OTHER ROADWAYS**
Lane Lines	Paint	5	5
	Preformed Tape	4	4
Lane Shifts, Lane Divides and Severe Alignment Changes	Paint	10	5
	Preformed Tape	5	5
Center Lines * See Note	Paint	5 (if operated two-way)	5
	Preformed Tape	4 (if operated two-way)	4
Edge Lines	Paint Preformed Tape	Same as adjacent lane or shift line	Same as adjacent lane or shift line
Ramp Edge Lines	Paint	5	5
	Preformed Tape	4	4
Gore Marking	Paint	10	—
	Preformed Tape	10	—
Auxiliary	Paint Preformed Tape	Same as particular line being extended	Same as particular line being extended

Note: Discernible space between double lines shall be 4 to 5 in.

(g) Channelizing Devices. When channelizing traffic the requirements shall conform to the MUTCD and the following:

(1) Maximum spacing in feet for channelizing devices in a taper shall be the posted speed limit.

(2) Maximum spacing in feet for channelizing devices in a tangent shall be twice the posted speed limit in mph.

(3) Channelizing devices shall be spaced at 25 ft intervals to define interchange gore areas or other unusual highway alignments unless a closer spacing is directed by the Engineer.

104.02.04 MEASUREMENT AND PAYMENT. Unless otherwise specified, Maintenance of Traffic will not be measured but will be paid

for at the Contract lump sum price. The payment will be full compensation for relocating, turning, completely covering and uncovering or removing and resetting, maintaining in like new condition and cleaning all existing and temporary traffic signs, and any other traffic control device. Also included is the inventory of all existing pavement markings and the treatment of any other traffic control device not included in these Specifications but are necessary for the fulfillment of the Contract requirements and implementation of the approved Traffic Control Plan, and for all material, labor, equipment, tools, and incidentals necessary to complete the work. Payment of the Contract lump sum price will be prorated and paid in equal amounts on each monthly estimate. The number of months used for prorating will be the number estimated to complete the work.

(a) When additional Contract pay items for Maintenance of Traffic are specified in the Contract Documents, measurement and payment will conform to the pertinent pay items included in the Contract Documents.

(b) Cones, reflective collars, anchoring devices, STOP/SLOW paddles, sign flags, and warning lights will not be measured but the cost will be incidental to the Contract price for Maintenance of Traffic unless otherwise specified in the Contract Documents.

(c) Temporary traffic control devices, which in the Engineer's opinion need replacement, shall be replaced immediately by the Contractor. The cost to replace traffic control devices, including all material, labor, equipment and tools, will not be measured but will be incidental to the Contract price for Maintenance of Traffic except when specifically set up in the Contract Documents as a separate Contract pay item.

(d) Material, equipment, and labor necessary for the construction and removal of temporary or detour roads will be measured and paid for at the Contract unit price for the pertinent items used.

104.02.04.01 When specified in the Contract Documents, Maintenance of Traffic will be measured and paid for at the Contract unit price per unit day.

104.02.04.02 When there is no item in the Contract Documents, maintenance of traffic will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents.

104.03 TEMPORARY RAISED PAVEMENT MARKERS (RPMs).

104.03.01 DESCRIPTION. This work shall consist of furnishing, installing and removal as necessary of temporary RPMs as specified in the Contract Documents or as directed by the Engineer.

104.03.02 MATERIALS. Temporary RPMs shall conform to the approved list maintained by the Office of Traffic and Safety.

104.03.03 CONSTRUCTION. All material, labor, equipment, tools and incidentals necessary for the complete installation of temporary RPMs, as specified in the Contract Documents, shall conform to the manufacturer's recommendations.

104.03.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Increases or decreases in quantities will not be a basis for renegotiation of the Contract unit price.

(a) Temporary Raised Pavement Markers will be measured and paid for at the Contract unit price per each.

(b) Removal of Temporary Raised Pavement Markers will be measured and paid for at the Contract unit price per each.

(c) The Administration will reimburse the Contractor at the Contract unit price per each marker damaged by snowplow operations.

104.04 TEMPORARY CONCRETE TRAFFIC BARRIER (TCB) FOR MAINTENANCE OF TRAFFIC.

104.04.01 DESCRIPTION. This work shall consist of furnishing, placing, resetting, and removing TCBs for use at locations specified in the Contract Documents or as directed by the Engineer.

104.04.02 MATERIALS.

Precast Concrete Traffic Barrier	950.01
Vertical Panels, Reflective Barrier Markers and Warning Lights	As approved by the Office of Traffic and Safety

104.04.03 CONSTRUCTION. The Contractor shall maintain TCBs in alignment and in a like new condition.

Resetting TCBs shall consist of removing and relocating TCBs as directed by the Engineer.

Items such as reflective barrier markers, vertical panels (object markers), and warning lights, shall be installed on the TCB as specified in the Contract Documents.

104.04.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for furnishing, placing, maintaining and removal from the project site as directed by the Engineer, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

(a) Temporary Concrete Traffic Barrier for Maintenance of Traffic and Reset Temporary Concrete Traffic Barrier for Maintenance of Traffic will be measured and paid for at the Contract unit price per linear foot measured along the center line of the top of the barrier.

(b) Reflective Barrier Markers, Vertical Panels, and Warning Lights will be measured and paid for at the Contract unit price per each.

(c) The payment to Reset the Temporary Concrete Traffic Barrier for Maintenance of Traffic will also include removal from its original placement, transporting and resetting it in its new temporary location, and applicable portions of 104.04.04(a).

104.05 TRAFFIC BARRIER W BEAM (TBWB) FOR MAINTENANCE OF TRAFFIC.

104.05.01 DESCRIPTION. This work shall consist of furnishing, erecting, maintaining, resetting, and removing temporary TBWB at locations specified in the TCP or as directed by the Engineer.

104.05.02 MATERIALS.

Traffic Barrier W Beam	918.01
Traffic Barrier Posts	918.02
Hardware for Traffic Barriers	918.03
Wood Offset Blocks	918.04

104.05.03 CONSTRUCTION.

TBWB. Construction methods shall conform to the applicable portions of Section 605.

TBWB Replacement. Any portion of the TBWB that is damaged shall be replaced immediately. This work shall be accomplished utilizing the Contract item TBWB for Maintenance of Traffic Replacement. The TBWB shall be installed to the correct horizontal and vertical alignments. The offset blocks shall be of the same kind.

TBWB Reset. When work is sufficiently completed through a traffic control area, and TBWB is no longer required, the TBWB and all components shall be removed and reset in a new work area as specified in the Contract Documents or as directed by the Engineer. The area shall be restored to its original condition.

TBWB End Treatments. Refer to 104.09 and 104.10.

All ends of TBWB shall have an approved end treatment placed prior to opening to traffic.

104.05.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for furnishing and installing all cables, posts, brackets, traffic barrier W beam, hardware, galvanizing, excavation, backfilling, connections to rigid structures, removal, restoration of the area, and for all material, labor, equipment, tools, and incidentals necessary to complete the work as directed by the Engineer.

(a) Traffic Barrier W Beam for Maintenance of Traffic will be measured and paid for at the Contract unit price per linear foot.

(b) Replacing sections of the traffic barrier that have been damaged by vehicular traffic while in place will be measured and paid for at the Contract unit price per linear foot for the Traffic Barrier W Beam Replacement for Maintenance of Traffic item.

(c) Reset Traffic Barrier W Beam for Maintenance of Traffic will be measured and paid for at the Contract unit price per linear foot.

104.06 TUBULAR MARKERS.

104.06.01 DESCRIPTION. This work shall consist of furnishing, installing and removing tubular markers for maintenance of traffic as specified in the Contract Documents or as directed by the Engineer.

104.06.02 MATERIALS.

Tubular Markers	As approved by the Office of Traffic and Safety
Reflectorization	950.03

104.06.03 CONSTRUCTION. Tubular markers shall be installed as recommended by the manufacturer and as approved by the Engineer.

104.06.04 MEASUREMENT AND PAYMENT. Tubular Markers will be measured and paid for at the Contract unit price per each. The payment will be full compensation for the removal of and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Tubular markers that are damaged as a result of traffic operations shall be replaced and will be measured and paid for at the Contract unit price per each for Replacement of Tubular Marker Mast. If the base detaches from the pavement, the entire tubular marker assembly shall be replaced by the Contractor at no additional cost to the Administration, unless damaged by Administration snow removal operation.

104.07 ARROW PANEL (AP).

104.07.01 DESCRIPTION. This work shall consist of furnishing and placing APs for temporary use. APs shall supplement, but not replace, standard signing as specified in the Contract Documents.

APs shall be self-contained, vehicle mounted or portable and shall be approved by the Engineer. Self-contained trailer units shall be used unless otherwise specified in the Contract Documents.

APs shall have both manual and automatic dimmer devices. These devices shall be capable of reducing the light intensity by 50 percent. Photo cells for the automatic dimmers shall be periodically cleaned to prevent malfunctioning of the brightness control. The use of dimmer devices shall be mandatory during the night operation of any APs. Manual and automatic dimmer devices shall be designed to include a fail safe system which shall ensure that maximum brightness is displayed during sunlight and 50 percent brightness is displayed during darkness, regardless of which dimmer device is operational.

104.07.02 MATERIALS. Not applicable.

104.07.03 CONSTRUCTION. The Contractor shall furnish and test the APs as directed by the Engineer 24 hours in advance of actual use to ensure that the units are functioning properly. The AP unit shall conform

to the Arrow Panel table and shall be arranged with double pointed arrow configuration capable of displaying a left arrow, right arrow, double arrow, and a four corner caution mode. Sequential chevron display is also acceptable if all operational mode can be displayed.

ARROW PANEL				
AP UNIT	**MUTCD TYPE**	**LAMP OPTIONS***		
		No. 4412 A-Par 46	**No. 4415A**	**1295 GE**
Portable	A	—	X	X
Vehicle Mounted	B	X	—	—
Self-Contained Trailer	C	X	—	—
Portable	D	—	X	X

*Or as approved by the Engineer.

APs shall be used to close any lanes of a multilane highway. APs shall be placed as directed by the Engineer. The Contractor shall maintain all APs in good operating order.

(a) APs shall conform to the applicable requirements of the MUTCD. APs shall only be used to supplement other required traffic control devices. APs shall be used in the "Arrow" mode only when closing a through travel lane on a multilane roadway. Only one AP in the "Arrow" mode shall be used for each stationary lane closure. Moving work operations may utilize one or more APs for a single lane closure. Care shall be taken in the placement of APs to avoid driver confusion in the vicinity of ramps, median crossovers, and side road intersections.

(b) APs shall be aimed at approaching traffic in conformance with the minimum legibility distance specified in the MUTCD. APs shall be erected so that the arrow is level in relation to the roadway.

(c) For stationary lane closures, the AP shall be placed on the shoulder at the beginning of the taper (nearest to oncoming traffic) or, where there are narrow or no existing shoulders in the closed lane behind the channelizing devices as near to the beginning of the taper as possible.

(d) For moving maintenance type activities along multilane highways where a lane is closed, the AP shall be placed at the rear of the activity in the closed lane on a vehicle separate from the

maintenance vehicle itself. For paint striping activities, additional vehicles with APs in the arrow mode may be required to supplement this work operation. APs shall always remain upstream of the maintenance vehicle where adequate recognition distance is available. The vehicle carrying the AP shall also be equipped with signing and lighting as required by the standard TCPs.

(e) APs shall only display the "Caution" mode for a lane closure on a two-lane, two-way roadway, or for a shoulder closure on any roadway. The "Caution" mode on an AP shall show only one light in each corner of the AP.

104.07.04 MEASUREMENT AND PAYMENT. Arrow Panels will be measured and paid for at the Contract price per unit day. A unit day shall consist of any approved usage within a 24 hour calendar day period. Each Arrow Panel will be paid for only once per unit day, regardless of how many times it is relocated. When an arrow panel is used for part of a day, it will be measured and paid for as a unit day.

The payment will be full compensation for all material, labor, equipment, tools, incidentals required to set up and operate at the site as required, and at any relocated site as required by the Traffic Control Plan or as directed by the Engineer.

104.08 TEMPORARY TRAFFIC SIGNS (TTS).

104.08.01 DESCRIPTION. This work shall consist of furnishing and installing TTS on or along any transportation facility as specified in the Contract Documents.

The Contractor shall maintain sign faces free of tape, tape residue, or any other foreign matter, and shall remove any advertisements from signs and supports. Supplemental signs shall not cover any part of the face of the primary sign.

104.08.02 MATERIALS.

Wood Sign Supports	921.05 and 921.06
Reflectorization	950.03
Signs	950.08
Portable Sign Supports	As approved by the Office of Traffic and Safety

104.08.03 CONSTRUCTION. TTS shall be as specified in the Contract Documents or as directed by the Engineer.

The signing shall conform to MUTCD or the Administration's Standard Highway Sign Booklet (SHSB). All work area warning signs shall be 48 X 48 in. unless otherwise specified. The SHSB may be obtained from the Office of Traffic and Safety, Traffic Engineering Design Division. Designs of signs not included in the SHSB may be prepared by the Contractor in sketch form, to scale, and approved by the Engineer or the sign designs may be obtained upon seven day request from the Office of Traffic and Safety. Requests shall be directed to the Engineer in writing.

Signs that will be in place for more than three working days shall be mounted on two 4 X 4 in. wood posts unless otherwise specified. The height of the sign shall be as specified in the Contract Documents. Additional bracing of signs is prohibited. The tops of the wood posts shall not protrude more than 3 in. beyond the nearest edge of the sign. Wood posts 4 X 4 in. shall be placed a minimum of 4 ft into the ground. Wood posts 4 X 6 in. shall be placed a minimum of 5 ft into the ground.

Signs on portable supports for temporary conditions shall be mounted so that the bottom of the sign shall not be less than 1 ft above the roadway pavement elevation. Portable sign supports shall be self-erecting, able to withstand a wind velocity of 70 mph, and shall be able to maintain themselves within five degrees rotation around their vertical axis.

Fabricated wood signs or flexible roll up signs shall be used only as directed by the Engineer. Fabricated aluminum signs, including material thickness, shall conform to the SHSB. Diamond shaped warning signs 48 X 48 in. or larger shall be a minimum of 0.125 in. thick.

TTS shall not be installed until inspected and approved by the Engineer. The signs shall not be displayed to traffic until directed by the Engineer. TTS shall be properly maintained, remain in place only as needed, and be immediately removed thereafter. Where operations are performed in phases or stages, only those signs that apply to the present conditions shall be displayed to traffic.

Special care shall be exercised to properly space signs along the highway to ensure that traffic is provided adequate sight distance to both work zone signs and existing signs. When a sign is not indicative of actual conditions such as during periods of temporary shutdown or extended periods of no work being performed (including lunchtimes and overnight periods), the Contractor shall remove the entire work zone setup and remove the sign, turn it away from all traffic (turning parallel to traffic is prohibited), or completely cover it with an opaque material that is approved by the Engineer. This will not be required for nonwork periods of time up to one hour.

Signs shall not be obscured by weeds, shrubs, trees, construction equipment, materials or waste materials, personal vehicles, or any other obstruction and shall conform to the sight distance requirements as specified in the Contract Documents.

TTS for both daytime and nighttime use shall be reflectorized.

Sign Replacement. Signs shall be new or in like new condition. Signs that become faded, illegible, or damaged shall be replaced as directed by the Engineer. Signs damaged due to the Contractor's operations shall be replaced at no additional cost to the Administration. Signs that are not new will be permitted to be used only if their reflective intensity at a divergence angle of 0.2 degrees and incidence angle of minus 4 degrees conforms to at least 70 percent of the values specified in 950.03. At other times throughout the duration of the Contract, the sign reflectivity intensity shall be a minimum of 60 percent. The acceptability of the signs shall be measured by means of 60 percent and 70 percent calibrated 1 ft square test plates at the appropriate times. The test plates shall conform to these requirements.

104.08.04 MEASUREMENT AND PAYMENT. Temporary traffic signs will be measured and paid for at the Contract unit price per square foot for the pertinent Temporary Traffic Sign item. The payment will be full compensation for furnishing the signs and supports, wood posts, erection, relocation, maintenance, cleaning, replacement due to nontraffic damage or normal wear, removal, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Where signs have been set and are subsequently damaged by traffic, and the Engineer determines that they are not repairable, they shall be replaced and will be measured and paid for at the Contract unit price.

Temporary traffic signs and all associated hardware, fittings, posts, brackets, and incidentals shall be removed from the project site when no longer needed and become the property of the Contractor.

104.09 TEMPORARY TRAFFIC BARRIER END TREATMENTS.

104.09.01 DESCRIPTION. This work shall consist of furnishing, erecting, maintaining, resetting, and removal of temporary traffic barrier end treatments in conformance with the manufacturer's recommendations or as directed by the Engineer. The traffic barrier end treatments shall be located as specified in the Contract Documents or as directed by the Engineer.

104.09.02 MATERIALS.

Temporary Traffic Barrier End Treatments	Refer to the Contract Documents or Administration's approved list.
Temporary Crash Cushion Sand Filled Plastic Barrels (SFPB)	Refer to 104.10.02

104.09.03 CONSTRUCTION.

Temporary End Treatments.

(a) Temporary Type E and J Traffic Barrier End Treatments shall be installed in conformance with the manufacturer's recommendations and as approved by the Engineer.

The nose section on the traffic barrier end treatment shall be reflectorized as approved by the Office of Traffic & Safety.

(b) SFPB shall be installed in conformance with 104.10.03.

Inspection of End Treatments.

(a) Daily visual inspections of the devices shall be performed in conformance with the Contract Documents to determine that no undetected damage has occurred, and that the end treatment is capable of functioning as intended.

(b) Following an impact, an approved reflectorized drum conforming to the Contract Documents will suffice temporarily as reflectorization of the end treatment until the damaged end treatment can be replaced. The damaged end treatment shall be repaired or replaced no later than four hours after the Contractor is notified.

104.09.04 MEASUREMENT AND PAYMENT. Temporary Traffic Barrier End Treatments, Remove and Reset Temporary Traffic Barrier End Treatments, and Repairing Temporary Traffic Barrier End Treatments will be measured and paid for at the Contract unit price for one or more of the items listed below unless otherwise specified in the Contract Documents.

(a) Temporary Traffic Barrier End Treatments will be measured and paid for at the Contract unit price per each for the type specified in the Contract Documents. The payment will be full compensation for all base pads, anchors, fastenings, fixtures, reflectorization, erection of materials, backup blocks, supports,

galvanizing of metal parts, connections to bridges, structures or fixed objects, and for all material, labor, equipment, tools, and incidentals necessary to provide a complete temporary traffic barrier end treatment.

(b) Temporary crash cushion sand filled plastic barrels will be measured and paid for as specified in 104.10.04.

(c) Remove and Reset Temporary Traffic Barrier End Treatments will be measured and paid for at the Contract unit price per each for the type specified in the Contract Documents, removed, relocated, and reset in a manner acceptable to the Engineer. The conditions specified for the initial installation and removal of the end treatment shall be applicable to removing and resetting the end treatment.

(d) Temporary Traffic Barrier End Treatment Spare Parts Package furnished and installed will be measured and paid for at the Contract unit price per each for the type specified in the Contract Documents. The payment will be full compensation for the complete furnishing and installation, complete clearing and removal of debris and damaged unsalvageable parts, and for all material, labor, equipment, tools, and incidentals necessary to construct the temporary end treatment to the configuration specified in the Traffic Control Plan or as directed by the Engineer.

When spare parts packages are furnished by the Administration, Repairing Temporary Traffic Barrier End Treatments will be measured and paid for at the Contract unit price per each for the type specified in the Contract Documents. The payment will be full compensation for all transportation, installation, reconnection to fixed objects where necessary, complete clearing and removal of debris and damaged unsalvageable parts, and for all material, labor, equipment, tools, and incidentals necessary to construct the temporary end treatment to the configuration specified in the Traffic Control Plan or as directed by the Engineer.

Payment will not be made for spare parts packages used for end treatments damaged due to the Contractor's operations as determined by the Engineer.

(e) Removal of the temporary traffic barrier end treatments will not be measured but the cost will be incidental to the initial Contract unit price per each. Removal shall include patching of any holes made to anchor or stabilize the end treatment, and cleaning and clearing the area of all debris.

104.10 TEMPORARY CRASH CUSHION SAND FILLED PLASTIC BARRELS (SFPB).

104.10.01 DESCRIPTION. This work shall consist of furnishing and installing SFPB. SFPB shall be arranged as specified in the TCP or as directed by the Engineer.

104.10.02 MATERIALS.

Sand	901.01
Plastic Barrels (Yellow)	As approved by the Office of Traffic and Safety

104.10.03 CONSTRUCTION. The ground shall be leveled with material comparable to the existing ground or as approved by the Engineer to support the system prior to installing the SFPB.

The components, assembly, placing configuration, and filling of the individual plastic barrels with varying weights of sand shall conform to the manufacturer's recommendations or as specified in the Contract Documents. The barrels shall be watertight. SFPB may be permitted to stand on pallets 4 in. high or less.

The first barrel of the SFPB configuration shall be reflectorized as specified in the Contract Documents. Following an impact, an approved reflectorized drum, conforming to the Contract Documents, will suffice temporarily as reflectorization of the SFPB until the damaged SFPB can be replaced. The damaged barrels shall be replaced within four hours after the Contractor is notified.

All sand to be placed in the barrels shall be dry and loose. Bags of sand are prohibited. The Contractor shall have available sufficient replacement materials including sand. An antifreeze agent shall be added to the sand in conformance with the manufacturer's recommendations.

Immediately after the SFPB have served their intended purpose, the Contractor shall remove the installation and restore the site as directed by the Engineer.

104.10.04 MEASUREMENT AND PAYMENT. Temporary Crash Cushion Sand Filled Plastic Barrels will be measured and paid for at the Contract unit price per barrel for one or more of the items listed below and specified in the Contract Documents.

(a) Temporary Crash Cushion Sand Filled Plastic Barrels for Maintenance of Traffic.

(b) Replace Temporary Crash Cushion Sand Filled Plastic Barrels for Maintenance of Traffic.

(c) Remove and Reset Temporary Crash Cushion Sand Filled Plastic Barrels for Maintenance of Traffic.

The payment will be full compensation for furnishing, excavation, placing, installing, cleaning, maintaining, sand, antifreeze agent, machinery, replacement, remove and reset, regrading, and removing from the project the individual weighted barrels in a manner acceptable to the Engineer and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

104.11 TEMPORARY PAVEMENT MARKINGS.

104.11.01 DESCRIPTION. This work shall consist of furnishing, installing, and removing temporary pavement markings as specified in the Contract Documents or as directed by the Engineer. These markings shall include lines, letters, numbers, arrows, and symbols.

104.11.02 MATERIALS.

Removable Preformed Pavement Marking Material	Refer to the Contract Documents
Nontoxic Waterborne Pavement Markings	

104.11.03 CONSTRUCTION. The Contractor shall maintain and be responsible for any defects in materials and workmanship of the pavement markings for a period of 180 days from the date of application. The Contractor shall replace them as necessary within this period as directed by the Engineer at no additional cost to the Administration.

The pavement markings shall be applied in conformance with the manufacturer's recommendations and the Contract Documents. Markings shall be applied in the same direction as the flow of traffic. The location of these markings shall be as specified in the Contract Documents or as directed by the Engineer.

Pavement markings may be applied to either new or existing paved surfaces. When applied to newly paved surfaces, the markings shall be placed before traffic is allowed on the pavement. Nontoxic waterborne pavement markings shall be used for all temporary pavement markings except for the final surface. The Contractor may use removable preformed pavement markings on intermediate pavement lifts at no additional cost to the Administration.

When at the "end of season", the temperatures are too low to allow the placement of removable tape, a written exception request may be made to the Engineer to allow the use of nontoxic waterborne paint in lieu of removable tape until the following striping season.

When it is appropriate to shift lanes, all nonapplicable pavement markings within the travel way and adjacent to the travel way as directed by the Engineer shall be completely removed.

(a) **Surface Condition**. Prior to application of pavement markings, the pavement surface shall be clean, dry and free of all contaminants, including curing compound, dirt, and loose particles. Residual pavement markings shall be removed. Loose or poorly constructed markings shall also be removed.

(b) **Pavement Marking Removal**. All removable preformed pavement markings shall be completely removed prior to application of the permanent markings. On stage construction or final surfaces of portland cement concrete pavements, any objectionable adhesive residue shall be removed by water blasting or other methods as may be approved by the Engineer. Open flame is prohibited to remove adhesive residue. The Contractor shall remove all nonapplicable pavement markings so that there is no damage to the existing or final surface.

104.11.04 MEASUREMENT AND PAYMENT. Payment for Removable Preformed Pavement Markings, Removal of Removable Preformed Pavement Markings, Nontoxic Waterborne Pavement Marking Paint, and the Removal of Existing Pavement Markings will be measured and paid for using one or more of the items listed below and as specified in the Contract Documents.

The payment will be full compensation for furnishing, placing, complete removal of lines, letters, numbers, arrows, symbols, and the removal of all residue. In addition, payment will cover maintenance and replacement during the 180 day period, and for all material, labor, equipment, tools, and incidentals necessary to complete the work. Removal and replacement of temporary pavement markings required beyond the 180 day period will be measured and paid for at the Contract unit price for the pertinent temporary pavement marking item.

(a) Nontoxic Waterborne Pavement Marking Paint per linear foot.

(b) Removable Preformed Pavement Line Markings per linear foot.

(c) Removable Preformed Letters, Symbols, Arrows, and Numbers per each.

(d) Removal of Removable Preformed Pavement Markings-Any Width per linear foot.

(e) Removal of Removable Preformed Letters, Symbols, Arrows and Numbers per each.

(f) Removal of Existing Pavement Line Markings-Any Width per linear foot.

(g) Removal of Existing Letters, Symbols, Arrows, and Numbers per each.

104.12 DRUMS FOR MAINTENANCE OF TRAFFIC.

104.12.01 DESCRIPTION. This work shall consist of furnishing and placing drums and maintaining in like new condition. The drums shall be located as specified in the Contract Documents or as directed by the Engineer.

104.12.02 MATERIALS.

Reflectorization	950.03
Plastic Drums	As approved by the Office of Traffic and Safety

Drums shall be manufactured of low density polyethylene (PE) to withstand impact without damage to themselves or vehicles. The drum shall have a height of 36 in. and a minimum diameter of 18 in. Drums may have one or more flat sides as long as the minimum 18 in. diameter is satisfied. The reflective stripes shall be horizontal, circumferential, orange and white, 6 in. wide, two each of white and orange alternating with the top stripe being orange.

104.12.03 CONSTRUCTION. Drums shall be adequately weighted with bags of sand or sand filled bases to keep them from moving. Sandbags, with no other attachments, shall rest on the base of the drum.

The Contractor will be permitted to neatly stencil their name or identification mark at the bottom of the nonreflective portion of the drum in maximum 2 in. high letters. No other markings or writings will be permitted on the vertical side of the drum.

Drums damaged by traffic shall be replaced within four hours after the Contractor is notified.

104.12.04 MEASUREMENT AND PAYMENT. Drums for Maintenance of Traffic will be measured and paid for once at the Contract unit price per each. The payment will include reflectorization, setting, resetting, removing, sandbags, maintenance, cleaning of drums to like new condition, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Where drums have been set and are subsequently damaged by traffic, and the Engineer determines that they are not repairable, they shall be replaced and will be measured and paid for at the Contract unit price.

104.13 BARRICADES FOR MAINTENANCE OF TRAFFIC.

104.13.01 DESCRIPTION. This work shall consist of furnishing and installing barricades for maintenance of traffic. Barricades shall be used as specified in the Contract Documents or as directed by the Engineer.

104.13.02 MATERIALS.

Reflectorization	950.03
Barricades	As approved by the Office of Traffic and Safety

104.13.03 CONSTRUCTION. All barricade rails shall conform to MUTCD unless otherwise specified in the Contract Documents. The barricade reflective sheeting and its installation shall be as approved by the Engineer.

Barricades damaged by traffic shall be replaced within four hours after the Contractor is notified.

104.13.04 MEASUREMENT AND PAYMENT. Barricades will be measured and paid for at the Contract unit price per each for the pertinent barricade item specified in the Contract Documents and accepted by the Engineer. The payment will be full compensation for the installation, maintenance, warning lights (when required by the Traffic Control Plan), the maintenance and removal of any required warning lights, removal of the barricades, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Where barricades have been set and are subsequently damaged by traffic, and the Engineer determines that they are not repairable, they shall be replaced and will be measured and paid for at the Contract unit price.

104.14 CONES FOR MAINTENANCE OF TRAFFIC.

104.14.01 DESCRIPTION. This work shall consist of furnishing and installing new or like new cones in conformance with the Contract Documents.

104.14.02 MATERIALS.

Reflectorization	950.03
Cones	As approved by the Office of Traffic and Safety

Cones shall have a minimum height of 28 in., with a minimum circular inside diameter of 10 in. at the base. Cones shall be reflectorized via reflectorized sheeting or collars during periods of darkness and be equipped with cone anchor collars as approved by the Engineer and as needed to maintain an upright position.

104.14.03 CONSTRUCTION. Cones shall be installed as specified in the Contract Documents or as directed by the Engineer.

Cones damaged by traffic shall be replaced within four hours after the Contractor is notified.

104.14.04 MEASUREMENT AND PAYMENT. Cones for maintenance of traffic and cones that have to be replaced will not be measured but the cost will be incidental to the Contract price for Maintenance of Traffic.

104.15 FLAGGER.

104.15.01 DESCRIPTION. This work shall consist of furnishing flaggers when specified in the Contract Documents or as directed by the Engineer. Flagging shall conform to MUTCD. All outfits and equipment (STOP/SLOW paddles, pilot cars or other vehicles, air horns or bull horns, field telephones, two-way radios, site illumination, etc.) will be subject to the approval of the Engineer. Flaggers shall have completed an Administration approved flagger training course within the last three years. The failure of any flagger to perform the required duties shall be grounds for the Engineer to require a replacement.

Two-way radios, field telephones, or pilot vehicles shall be used whenever flaggers are not within sight distance of each other, or when directed by the Engineer.

104.15.02 MATERIALS. Paddles shall be 24 x 24 in. with minimum 8 in. high letters. Reflective sheeting on the STOP/SLOW paddle shall conform to 950.03.

104.15.03 CONSTRUCTION. Flaggers shall use STOP/SLOW paddles unless otherwise permitted by the Engineer. Standard paddle sign designs shall be as specified in the Contract Documents.

104.15.04 MEASUREMENT AND PAYMENT. Flagger will not be measured but the cost will be incidental to the Contract price for Maintenance of Traffic unless otherwise specified in the Contract Documents.

When an item for Flagger is specified in the Contract Documents, the Flagger will be measured and paid for at the Contract unit price per hour unless otherwise specified in the Contract Documents. The payment will be full compensation for clothing, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

104.16 MODIFICATION OF EXISTING SIGNS.

104.16.01 DESCRIPTION. This work shall consist of relocating, removing, covering, modifying, reerecting, or changing existing highway signs relating to the construction activity. This work is in addition to the temporary traffic signs specified in 104.08.

104.16.02 MATERIAL. Not applicable.

104.16.03 CONSTRUCTION. Modification of existing signs shall be as specified in the Contract Documents or as directed by the Engineer.

104.16.04 MEASUREMENT AND PAYMENT. Modification of existing signs will be measured and paid for using one or more of the items listed below and specified in the Contract Documents. The payment will be full compensation for all excavation, backfill, hardware, relocation, removal, covering, modifying, reerecting, changes to existing highway signs, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

(a) Relocate Wood Sign Supports per each support.

(b) Sign Modifications to Overhead Sign Structures per square foot.

(c) Relocate Sign per square foot.

(d) Remove Sign per square foot.

(e) Modify Copy per each character.

(f) Install or Remove Shield per each.

(g) Cover Sign per square foot.

(h) Relocate Sign Luminaire per each.

104.17 TEMPORARY MOVABLE TYPE CONCRETE TRAFFIC BARRIER (MCTB).

104.17.01 DESCRIPTION. This work shall consist of furnishing, placing, assembling, maintaining, moving, removing, and disposing of a movable interlocking type concrete traffic barrier where specified in the Contract Documents or as directed by the Engineer. Movable barrier systems shall consist of individual units which remain connected for the total length when being moved in one continuous operation at a minimum speed of 3 mph and a minimum lane shift of 12 ft. The transfer device shall be capable of operating on the curve and grades as indicated in the Contract Documents.

104.17.02 MATERIAL.

Precast Movable Concrete Barrier and Transfer Device	As specified by the manufacturer
Reflective Barrier Markers	As approved by the Office of Traffic and Safety

104.17.03 CONSTRUCTION. The transfer device shall have the capability to move or transfer the barrier as specified in the Contract Documents. The device is prohibited from extending into oncoming traffic lanes from either direction during lane shifts.

The Engineer will inspect the movable barrier upon delivery and throughout the life of the project. Any units deemed damaged or defective in the concrete or joint connections affecting the performance of the barrier systems shall be replaced. Reflective barrier markers shall be as specified in the Contract Documents. The barrier and reflective barrier markers shall be maintained in a like new condition.

The Contractor shall perform all maintenance operations for the transfer device and shall have sufficient spare parts and personnel available to ensure that the required lane configurations are maintained at the required times. Failure to move the MCTB at the proper time will be cause for penalty under TC-4.02.

104.17.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

(a) The initial installation of the Temporary Movable Type Concrete Traffic Barrier will be measured and paid for at the Contract unit price per linear foot measured in place from end to end. The payment will also include furnishing, placing, maintenance, transfer device and all associated costs, replacing sections damaged during installation, and removing the barrier from the project site.

(b) Transfer shifts of the barrier will be measured and paid for at the Contract unit price per linear foot for the Transfer Shift of Movable Type Concrete Barrier item. The measurement will be end to end for the barrier actually shifted. The Contract unit price will apply to each shift. The payment will also include the shift, and the transfer device and associated costs.

(c) Replacing sections of the barrier which have been damaged by vehicular traffic while in place will be measured and paid for at the Contract unit price per each for the Replacement Sections for Movable Type Concrete Barrier item. At the direction of the Engineer, sections damaged by the Contractor's operations that require replacement, shall be replaced at no additional cost to the Administration. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

(d) Resetting the barrier will be measured and paid for at the Contract unit price per linear foot for the Reset Movable Type Concrete Barrier item. The payment will also include removal from its original placement, and transporting and resetting it in its new temporary location.

(e) Reflective barrier markers will be measured and paid for as specified in 104.04.04(b).

(f) When end treatments are required, they will be measured and paid for under the pertinent item specified in the Contract Documents.

104.18 TRAFFIC MANAGER (TM).

104.18.01 DESCRIPTION. This work shall consist of furnishing a Traffic Manager (TM) as specified in the Contract Documents.

104.18.02 MATERIALS. Not applicable.

104.18.03 CONSTRUCTION. The Contractor shall submit the TM's name to the Engineer for approval at least 10 days prior to commencing any work on the project. The TM shall provide proof of completing an Administration approved Temporary Traffic Control (TTC) training course within the last three years. Change in the appointment of any TM throughout the duration of the Contract will require a written submission to the Engineer for approval. The TM failure to perform the required duties shall be grounds for the Engineer to require a replacement.

The TM shall implement the Traffic Control Plan (TCP), maintain an up to date TCP and provide a copy to the Engineer following any changes.

The TM shall closely coordinate the operations with the Engineer and shall supervise the maintenance of traffic on the project, including those involving subcontractors. The TM shall make on-site inspections of the area affected by the work on a regular basis including Saturdays, Sundays, and holidays and be available for consultation at all times. When the TCP is in place, the TM shall be responsible for making daily inspections during hours of operations, and a minimum of one night inspection per week. More inspections may be required as directed by the Engineer. The monitoring of the maintenance of traffic by the TM shall include surveillance of any area affected by the work of the Contract during holiday periods. The TM shall maintain a daily log for the inspections and shall include the date, time, hours worked, condition of maintenance of traffic and any corrective action taken. A copy of the daily log shall be furnished to the Engineer by the following day.

The TM shall also be responsible for coordination between adjacent work zone operations to ensure that inappropriate or conflicting traffic control sign messages or devices are not displayed to traffic.

The TM shall immediately notify the Engineer of any accident or incident within the area affected by the Contract.

The TM shall make inspections during and immediately after adverse weather conditions to ensure that the traffic control devices are clean, undamaged, and in their proper position.

104.18.04 MEASUREMENT AND PAYMENT. The Traffic Manager will not be measured but the cost will be incidental to the Contract price for Maintenance of Traffic.

104.19 PORTABLE VARIABLE MESSAGE SIGNS (PVMS)

104.19.01 DESCRIPTION. This work shall consist of furnishing and installing portable, self-contained, trailer mounted, variable message signs as specified in the Contract Documents or as directed by the Engineer.

104.19.02 MATERIALS. Each unit shall contain the trailer, structural support system, sign panel assembly, lift mechanism, power supplies, sign mounted controller, and ancillary equipment.

All materials for PVMS shall be new, corrosion resistant, and unaffected by water spray, salt, oil, gasoline and all other contaminants in the quantities normally found along the edge of the traveled roadway. The PVMS construction, materials and operation shall conform to the NFPA, ULI, and NEC. All sign messages shall be visible and legible for a distance of 900 ft from any point along the approach traveled roadway during 24 hour operations. The PVMS shall be equipped with a sighting device to provide alignment for maximum visibility.

104.19.03 CONSTRUCTION.

104.19.03.01 Equipment.

Trailer. The trailer shall conform to Maryland Motor Vehicle Law governing trailers.

Structural Support. The structural support framework shall allow the system to be assembled into a unit and be mounted on the trailer, and shall provide the support mechanism between the sign panel assembly, the power supply, and the controller.

The framework shall provide sufficient support to prevent damage to any PVMS components when the sign is in down and locked position during normal highway travel.

The deployed structure shall supply adequate support to allow complete sign operation, including raising and lowering of the sign panel, during maximum sustained wind speeds of 85 mph.

The display windows shall be made of impact-resistant clear Lexan or as approved by the Engineer.

Sign Panel.

(a) Sign panel dimensions shall not exceed a 144 in. length; 90 in. height; 12 in. depth.

(b) The PVMS shall be capable of displaying three lines of text.

(1) Each line of text shall be constructed using a continuous or discrete matrix display.

(2) The sign shall be capable of displaying eight characters per line.

(3) The character height shall be a minimum of 18 in.

(4) If discrete matrix display is used, each character shall be displayed using a 5 X 7 array with a minimum of eight array modules per line.

(5) If discrete matrix display is used, a 4-1/4 to 7 in. space shall exist between each display line with no glare reflection. If full matrix display is used, the sign shall have at least 25 rows and 45 columns of disks. If continuous line matrix display is used, the sign shall have at least 7 rows and 45 columns of disks and a 4-1/4 to 7 in. space shall exist between each display line with no glare reflection.

Flip Disk Mechanism. Flip disk mechanism shall have the following characteristics:

(1) Be electromagnetically activated (flipped), with a minimum service life of 200 000 000 operations.

(2) Have a reflective surface that will maintain its color intensity for a minimum of three years.

(3) Be circular or rectangular in shape with a visible surface area between 3-3/4 and 4-1/4 in^2.

(4) When flip-disk technology is used, each sign shall have fluorescent light bulbs placed above and below each line for a total of four light bulbs to provide a continuous and uniform illumination pattern for night time visibility.

LED Illumination. LED illumination for each matrix element shall have the following characteristics:

(1) LED shall conform to the ITE specification for amber color.

(2) LED shall utilize A1lngap substrate.

(3) Each LED shall produce a minimum of 1 candela output on center at 25 ma drive current.

(4) Each matrix element shall have a minimum of two LED's located within the perimeter of the flipping disk.

(5) LED shall provide full illumination within a minimum of 24 degree cone perpendicular to the sign face.

(6) Operating temperature range of the LED shall be -40 to 160 F.

PVMS UNIT.

The Contractor shall submit a catalog cut and a character set for any PVMS for approval to the Office of Traffic and Safety, Chief Traffic Operations.

Lift Mechanism.

(a) The lift mechanism shall be an electric or electrically assisted hydraulic mechanism capable of raising and lowering the sign panel.

(b) The mechanism shall be capable of being raised and lowered manually.

(c) A stainless steel safety bolt shall be provided to prevent the sign panel from lowering once in the raised position. A self-locking mechanism shall be incorporated into the safety bolt which prevents it from being inadvertently dislodged.

(d) The lift mechanism shall allow the raised sign panel to rotate 360 degrees about the vertical axis.

(1) Rotation shall be possible in either a clockwise or counter-clockwise direction.

(2) A locking mechanism shall be provided to prevent rotation of the sign panel assembly once the sign panel is in place, at any position.

Electrical Connections and Gauges.

(a) All wiring from power sources to PVMS equipment shall use locking cable connectors.

(b) Volt and amp gauges shall be provided for both AC and DC.

(c) Standard negative ground system shall be tied to the sign chassis.

(d) Lightning protection shall be supplied to the load side of the sign system's distributed power lines to withstand multiple surges in excess of 600 volts.

Power Supply. The PVMS shall operate from either a solar powered electrical system, an existing commercial electrical service, or a diesel powered generator.

Solar Powered Electrical System. This system shall consist of battery power system and solar array panels and be capable of displaying two page message for 21 consecutive days without auxiliary charge.

Sign Controller. The controller shall:

(a) Be capable of driving the matrix display panel operating over a -50 to 150 F range and in a 20 to 100 percent noncondensing humidity range.

(b) Accommodate 100 preprogrammed, user-defined messages.

(c) Be capable of displaying three sequenced messages. On/Off time for each message in a sequence shall be user adjustable within a range of 0 to 5 seconds.

(d) Be designed for fail-safe prevention of improper information display in the case of a system malfunction.

(e) Cause a user defined default message to be displayed in case of failure of the PVMS unit when flip disk mechanism is used.

(f) Have the capability of retrieving all messages stored in temporary memory.

(1) Temporary memory shall be nonvolatile.

(2) All messages and programs shall remain resident in the controller's memory in the event of a power failure.

(3) Have an RS-232 port to facilitate connection of an external communication device.

(g) Be capable of automatic system recovery after power outages to the central controller without operator intervention, including the

ability to maintain an up-to-date status on a remote unit if sign is operated from a remote location.

(h) Monitor and display the battery output voltage and solar array activities (charging/discharging). The controller shall blank the sign when the battery output voltage drops below the manufacturer's recommended output level.

(i) Be capable of monitoring and displaying the status of the photocell and adjust the sign illumination to match the ambient light conditions. The controller shall have a minimum of nine levels of dimming from 10 to 100 percent brightness.

(j) Be contained in a sheet metal, weatherproof cabinet located on the controller housing, and insulated to protect against excessive vibration and temperature.

(1) The cabinet shall have a lockable door latch and interior cabinet dome light.

(2) A keyboard storage location shall be provided inside the cabinet.

Character Set Software. The character set software shall:

(a) Have all of the standard ASCII characters and symbols.

(b) Left and right arrows shall be provided.

(c) Have all alphanumeric entries performed with a keyboard that utilizes a standard QWERTY style layout.

(d) The corresponding character on the keyboard shall cause the same character to be displayed on the matrix. Arrow symbols shall be generated via a cursor pad on the keyboard.

(e) Have messages default to self-centering display with the ability to left or right justify a display when continuous matrix is used.

104.19.03.02 The PVMS shall be on the project site and operated 24 hours in advance of actual use to ensure that each unit is functioning properly and approved by the Engineer. The PVMS shall be installed as specified in the Contract Documents or as directed by the Engineer.

The PVMS shall be aimed at approaching traffic to ensure that it conforms to the 900 ft minimum legibility distance and that the sign face

is not obscured by highway alignment or glare from either sunlight or vehicle headlights. The PVMS shall be level.

104.19.04 MEASUREMENT AND PAYMENT. The Portable Variable Message Sign will be measured and paid for at the Contract price per unit day. A unit day shall consist of any approved usage within a 24 hour day period. Each Portable Variable Message Sign will be paid for only once per unit day, regardless of how many times it is relocated. When a unit is used for part of a day, it will be measured as a unit day. This unit price will be the same regardless of the type of unit used.

The payment will be full compensation for the installation, sign, diesel generator, all fuel and refueling, electrical power and hook up, setup and maintenance of computer programs, changing messages, relocating as required by the Traffic Control Plan or as directed by the Engineer, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

104.20 TEMPORARY ORANGE CONSTRUCTION FENCE.

104.20.01 DESCRIPTION. This work shall consist of furnishing and installing new or like new temporary orange mesh construction fence. The fence shall be used where specified in the Contract Documents or where directed by the Engineer. This fence is not a safety barrier.

104.20.02 MATERIALS.

Precast Concrete Blocks	903.05
Tie Wire, Tension Wires, Tension Wire Clips and Hardware	914.02
Orange Mesh Fencing	As approved by the Engineer

Fence posts shall be 4 ft high round posts having a 1.90 in. outside diameter, or a 5-1/2 ft high, 2 in. steel U channel.

Samples of the fence fabric, fence posts, movable precast concrete blocks, tie wire, tension wires and other miscellaneous hardware shall be submitted to the Engineer prior to installing any fencing.

104.20.03 CONSTRUCTION. Temporary orange construction fence shall be a minimum of 4 ft high with a maximum post spacing of 8 ft. When the fence is installed on a paved surface, a precast concrete block shall be used to support the round fence post. The concrete block shall have a round hole through the center of the block in which the round post shall be inserted. When the fence is installed in unpaved areas, steel U channel fence posts shall be driven 1-1/2 ft into the ground.

The fence fabric shall be attached to the posts using tie wire. Fabric shall be secured to the posts by wrapping a tie wire around the horizontal fence strands and the posts. A top tension wire shall be used to prevent sagging. When installed on paved surfaces, the Engineer will determine if a bottom tension wire is required. The Contractor may elect to install the construction fence in another manner if approved by Engineer.

Damaged Construction Fence. Damaged construction fence shall be repaired or replaced within four hours after the Contractor is notified. When the Engineer determines that the fence is no longer needed, the Contractor shall remove the fence, which shall become the property of the Contractor.

104.20.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for the installation, removal, maintenance and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Temporary Orange Construction Fence will be measured and paid for at the Contract unit price per linear foot for the actual number of linear feet measured to the centers of end posts.

Remove and Reset Temporary Orange Construction Fence will be measured and paid for at the Contract unit price per linear foot.

SECTION 105 — AGGREGATE FOR MAINTENANCE OF TRAFFIC

105.01 DESCRIPTION. This work shall consist of constructing base courses using either crusher run aggregate CR-6 for maintenance of traffic or bank run gravel subbase for maintenance of traffic as specified in the Contract Documents or as directed by the Engineer.

105.02 MATERIALS.

Crusher Run Aggregate CR-6	901.01
Bank Run Gravel Subbase	901.01

105.03 CONSTRUCTION. Refer to the applicable portions of 501.03.

105.04 MEASUREMENT AND PAYMENT. Crusher Run Aggregate CR-6 for Maintenance of Traffic and Bank Run Gravel Subbase for Maintenance of Traffic will be measured and paid for at the Contract unit price per ton. The payment will be full compensation for all

aggregate, hauling, placing, compacting, removal and disposal, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 106 — HOT MIX ASPHALT (HMA) FOR MAINTENANCE OF TRAFFIC

106.01 DESCRIPTION. This work shall consist of constructing HMA pavement for maintenance of traffic as specified in the Contract Documents or as directed by the Engineer.

106.02 MATERIALS.

Tack Coat (Rapid Setting)	904.03
HMA	904.04
Crack Filler	911.01 & 911.01.01
Production Plant	915

106.03 CONSTRUCTION. Refer to the applicable portions of 504.03.

106.04 MEASUREMENT AND PAYMENT. Hot Mix Asphalt for Maintenance of Traffic will be measured and paid for at the Contract unit price per ton. The payment will be full compensation for all tack coat, crack filler, hauling, placing, compacting, removal and disposal, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 107 — CONSTRUCTION STAKEOUT

107.01 DESCRIPTION. This work shall consist of furnishing, placing and maintaining construction layout stakes as specified in the Contract Documents or as directed by the Engineer.

The Contractor shall, as part of the construction stakeout operation, before any clearing operation commences, demarcate any wetlands and the limit of clearing throughout the entire project as shown in the Contract Documents and labeled as Limit of Clearing or Wetlands to the satisfaction of the Engineer.

Where limits of clearing are not shown in the Contract Documents, the limit of clearing will be the top of cut, toe of slope or limit of ditch excavation.

107.02 MATERIALS. The material for flagging the clearing limits shall be a 3 in. international orange vinyl material with "CLEARING LIMIT" printed on it with 2 in. letters. The material for flagging wetlands shall be the Administration's standard 1-1/2 in. pink and white striped vinyl flagging with "SHA WETLAND" printed on it with blue letters.

107.03 CONSTRUCTION.

107.03.01 Line and Grade. The Engineer will provide the Contractor the following:

(a) Roadway Stakeout.

(1) A staked center line of the roadway with the maximum spacing of stations (stakes, nails, crosses, etc.) of 100 ft.

(2) Establish appropriately spaced bench marks and the necessary references including all points of curvature (P.C.), and points of tangency (P.T.) for the preservation and control of the center line.

(3) Two sets of prints of the cross sections. The cross sections shall be used as guides only. Dimensions or elevations scaled from the cross sections are not sufficiently precise for use in the construction.

(b) Structure Stakeout.

(1) A staked out center line or working line, whichever applies, with stations not over 100 ft apart and extending at least 100 ft beyond ends of the structure.

(2) When the structure is on a curve, the Engineer will furnish a staked out center line or working line, whichever applies, consisting of stations not over 100 ft apart and including the P.C., P.T., and at least one point on the tangents beyond each end of the curve.

(3) At least two bench marks, one on each end of the structure, will be established by the Engineer.

107.03.02 Equipment and Personnel. The Contractor shall use competent personnel and state of the art equipment for all engineering work required to set and maintain the elevations and dimensions as specified in the Contract Documents.

107.03.03 Control Markers. The Contractor shall be responsible for preserving the center line and bench marks set by the Engineer. When the

center line and bench marks are disturbed or destroyed, they shall be replaced by the Contractor at no additional cost to the Administration.

107.03.04 Control Stakes. For roadways as specified in 107.03.01, the Contractor shall furnish, set and preserve stakes at each station along each side of the project on the right-of-way or easement line, whichever is furthest from the center line of construction. Where only part of an ultimate dual highway is to be constructed, the stakes on the side of the future improvement shall be set 10 ft beyond the construction limits. On each of these stakes shall be marked its offset distance from the center line and its top elevation or the cut or fill to the profile grade line. Additional stakes as needed for horizontal and vertical controls necessary for the correct layout of the work shall be set by the Contractor.

107.03.05 Layout. For structures as specified in 107.03.01, the Contractor shall proceed with the layout work. However, before any actual construction begins, the Contractor shall rerun and check the Engineer's lines and grades and then establish all center line or working line intersections with the center line or center of bearing of all piers, bents and abutments. From these field layouts, the Contractor shall check the proposed span lengths by electronic distance measurement or chaining. When chaining is used, the measurements shall be compensated for temperature, sag, and horizontal alignment. The Contractor shall also check the location of the structure to affirm its correct location with relation to existing structures, roads, and existing conditions that are to remain in their original positions. If any discrepancies are found, the Contractor shall notify the Engineer at once in writing, otherwise, it will be assumed that all planned dimensions, grades and field measurements are correct. All lines established on the ground shall be preserved or referenced, marked, and kept available at all times.

The Contractor shall establish the field elevations for all bridge seats and assume responsibility for finishing to proper grade. If any steel beams or girders are incorporated in the project, the Contractor shall run elevations over the tops of the beams or girders after they are in place, before any forms are attached to them, to determine the deflection of each member. This information shall then be applied to the deflection diagram to determine the corrected elevation of bottom slab forms and screed supports. After the Contractor has assembled this information, it will be checked by the Engineer before final adjustments are made and the placing of any concrete in the forms.

107.03.06 Utilities. The Contractor shall furnish to the utility companies or agencies working within the limits of the project, promptly upon request, reference to control points, alignment and grade data, so that they may properly locate and coordinate their work and improvements in relation to the project.

Intersection Utility Stakeout. The Contractor shall notify the appropriate agencies listed below a minimum of 72 hours (excluding weekends and holidays) prior to the Contractor's anticipated beginning of any underground work.

(a) Request a MISS UTILITY stakeout and possess a valid MISS UTILITY clearance ticket number for any underground work.

(b) Contact all utilities within the limits of the project who are not a member of MISS UTILITY and obtain a stakeout of their respective facilities.

(c) Request the Office of Traffic & Safety's Signal Operations Section to stakeout Administration maintained traffic signal facilities.

(d) Request the District Engineer to stakeout their lighting facilities.

The Contractor shall stakeout the proposed construction as indicated in the Contract Documents and allow the Engineer to verify location of the proposed facilities.

107.03.07 Right-of-Way and Easement Lines. The Contractor shall define only right-of-way and easement lines of the project for adjacent property owners, promptly upon request.

107.03.08 Subgrade, Subbase and Base Controls. The Contractor shall furnish for subgrade, subbase and base courses, a string line and grade with fixed controls having a maximum longitudinal and transverse spacing of 25 ft.

The Contractor shall place along each form line for cement concrete pavement line and grade with fixed controls not to exceed 25 ft.

107.03.09 Flagging. The flagging shall be placed continuously through wetland areas. In areas where trees are not to be disturbed, the Contractor shall individually flag those trees in a line along the clearing limits that are not to be moved or destroyed. If the clearing or wetland flagging has been destroyed and the Engineer determines that its use is still required, the Contractor shall reflag the areas.

If the Contractor does not replace destroyed flagging within 48 hours after notification by the Engineer that replacement flagging is needed, the Engineer may proceed to have the area reflagged. The cost of the reflagging by the Engineer will be charged to the Contractor and deducted from any monies due under the Contract.

At the completion of construction, the Contractor shall remove all flagging.

107.04 MEASUREMENT AND PAYMENT. Construction Stakeout will not be measured but will be paid for at the Contract lump sum price. The payment will be full compensation for furnishing, placing and maintaining construction layout stakes, flagging of clearing limits and wetlands, and for all material, labor, equipment, tools, and incidentals necessary to complete the work. Payment of the Contract lump sum price will be prorated and paid in equal amounts on each monthly estimate. The number of months used for prorating will be the number estimated to complete the work.

SECTION 108 — MOBILIZATION

108.01 DESCRIPTION. This work shall consist of the construction preparatory operations, including the movement of personnel and equipment to the project site and for the establishment of the Contractor's offices, buildings, and other facilities necessary to begin work.

108.02 MATERIALS. Not applicable.

108.03 CONSTRUCTION. All work performed in providing the facilities and services shall be done in a safe and workmanlike manner.

108.04 MEASUREMENT AND PAYMENT. Mobilization will not be measured but will be paid for at the Contract lump sum price. The cost of all required insurance and bonds will be incidental to the Mobilization item.

Payment of 50 percent of the Mobilization item will be made in the first monthly estimate after the Contractor has established the necessary facilities. The remaining 50 percent will be prorated and paid in equal amounts on each of the next five monthly estimates. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Payment of the Mobilization item will not be made more than once, regardless of the fact that the Contractor may have, for any reason, shut the work down on the project, moved their equipment away from the project and then back again.

If an item for mobilization is not provided, the cost of mobilization including the required insurance and bonds will be incidental to the other items specified in the Contract Documents.

SECTION 109 — CRITICAL PATH METHOD PROJECT SCHEDULE

109.01 DESCRIPTION. This work shall consist of the Contractor planning, scheduling, and constructing the project by using a Critical Path Method Project Schedule (CPM). The CPM shall be used for coordinating and monitoring all the work specified in the Contract Documents including all activities of subcontractors, vendors, suppliers, utilities, railroads, the Administration, and all other parties associated with the construction of the Contract. All work including but not limited to submittals, major procurement, delivery, and construction activities shall be included. All activities, including bid items**,** quantified in the Contract Documents shall be included in the CPM. The CPM shall be based upon the entirety of the Contract Documents. The software utilized for the CPM shall generate files that are compatible with Primavera Project Planner.

Float. The CPM utilizes float. Float is defined as the amount of time between when an activity "can start or finish" and when an activity "must start or finish". Float is a shared commodity for the use of the Administration and the Contractor and is not for the exclusive use or benefit of either party. The parties have the full use of the float until it is depleted.

Scheduling Representative. The Contractor shall designate a scheduling representative, prior to submission of the Initial Critical Path Method Project Schedule (ICPM). The scheduling representative is the person primarily responsible for development and maintenance of the Contractor's CPM schedule. The scheduling representative shall represent the Contractor in all matters regarding the schedule and shall attend all schedule related meetings. Replacement of the scheduling representative by the Contractor will require written approval from the Administration.

The Contractor shall submit the qualifications of the designated scheduling representative to the Administration for approval. This approval is required before the ICPM will be accepted. The designated scheduling representative shall have at least three years of verifiable experience for preparing and maintaining CPM project schedules on Contracts of the same or similar size and complexity.

Initial Critical Path Method Project Schedule (ICPM). The ICPM shall consist of:

(a) A time scaled diagram. The ICPM time scaled diagram shall have a scale and format that is acceptable to the Engineer. The

activities shall be labeled with the activity identification clearly shown for each activity. All relationships between activities shall be shown.

(b) Tabular reports with activities sorted as follows:

(1) Activity ID. This report shall include predecessors and successors for each activity with leads and lags shown.

(2) Activity ID. This report shall include resources. This report shall clearly define the resources assigned to each activity.

(3) Early Start, Total Float.

(4) Total Float, Early Start.

(5) Project Area (if applicable).

(6) Project Phase (if applicable).

(7) Responsibility, e.g., Contractor, specific subcontractor, specific supplier, the Administration, etc.

The header of each tabular report shall include the project name, Contract number, data date, run date and number, and report type.

The body of each report shall include the activity identification, activity description, original and remaining duration, early/late start and finish dates, percent complete, actual start/finish dates, total float, and calendar designation for every activity.

(c) Written Narrative (WN). The WN shall comply with the requirements described hereinafter.

(d) Printed Calendars. The printed calendars shall include a listing, description, and calendar form tabulation of all calendars used in the ICPM. The calendars shall contain the total number of anticipated work days required to complete all the work required in the Contract. The calendars shall delineate the holidays and anticipated nonwork days or periods. An explanation of the Contractor's basis for determining each nonwork day or period shall be included in the WN.

(e) Data disc containing all of the information contained in the CPM. The format shall be compatible with Primavera Project Planner software.

All construction activities shall have durations not exceeding 10 working days, unless otherwise approved by the Engineer. Activities required for review and approval of the working drawings and materials by the Administration shall be given a duration of not less than 30 calendar days. The Contractor may submit a short list of highly critical approval activities to the Engineer. The Engineer will make every effort to expedite the approval of these submittals, however, this will not alter the requirements to include 30 calendar days for all approvals in the ICPM. Activities for curing, pre-load, etc. shall be scheduled in calendar days. Durations for procurement activities will be evaluated on a case by case basis.

The latest calculated early finish date in the ICPM shall equal the Contract calendar date for completion specified in the Contract Documents. If the Contractor submits an earlier completion date than specified in the Contract Documents, the Administration, upon approval of the ICPM, will issue a change order to adjust the Contract time to the completion date shown on the ICPM.

The Contractor shall resource load all construction activities in its schedule with the material, equipment, and manpower planned to be utilized by the Contractor and its subcontractor in accomplishing each activity. Resource loading of the CPM shall be fully explained in the WN.

The Engineer reserves the right to specify the number of activities and to require at any time additional breakdown of the activities.

The Contractor shall utilize activity codes to categorize activities by at least the following: project area; project phase; and responsibility, e.g. Contractor or specific subcontractors.

The Contractor shall provide a WN as part of the ICPM. This WN shall explain the sequence of work, the critical path, interim completion dates, project phasing, nonwork days or periods, maintenance of traffic, and labor and equipment resources. In addition, the Contractor shall explain how it has provided for; permit requirements, environmental requirements, coordination with other public Contractors, milestone dates (for the Contract or other related contracts), coordination with other entities, coordination with all utility companies, special nonwork days or periods, and weather in its ICPM. The WN shall be used to explain the specific scope of each activity and the basis used to determine the original duration of each activity, i.e., production rates and anticipated quantities.

All activities quantified in the Contract Documents shall be addressed in the WN. The Contractor shall utilize the WN to explain the following:

(a) Relationships between activities not obviously identified

(b) Equipment usage and limitations.

(c) Manpower usage and limitations.

(d) Use of additional shifts and overtime.

(e) Activity codes, abbreviations, and activity identification system.

(f) All calendars utilized in the CPM.

(g) Date or time constraints.

(h) All abbreviations in the ICPM.

(i) Use of calendars.

(j) Scheduling of weather and temperature sensitive activities.

The Contractor shall complete and submit the proposed ICPM within 30 calendar days after receiving the Notice of Award and submit five sets of all information required to the Engineer for review and acceptance. No work shall begin until the Engineer has accepted the ICPM. Upon issuance of the Notice to Proceed, the start date utilized in the ICPM shall be adjusted to comply with the Notice to Proceed.

The Engineer will complete the review of the Contractor's ICPM within 30 calendar days after the submittal. If required, the Engineer will convene a Joint Review Conference at which time the Engineer and Contractor may make corrections and adjustments to the proposed ICPM. If a revision is necessary due to the Engineer's review or the Joint Review Conference, the proposed revision shall be submitted by the Contractor within seven calendar days after the Contractor receives the Engineer's review comments or within seven calendar days after the date of the Joint Review Conference whichever is the latest. Revisions shall conform to the requirements for the ICPM. The Engineer will respond to the revised ICPM within seven calendar days after the revised ICPM is received.

Any delay in starting work caused by the acceptance of the ICPM by the Engineer will not be considered as a basis for any adjustment in the Contract amount or time.

When the Engineer notifies the Contractor that the ICPM has been accepted, that document will become the CPM of record. The Contractor shall be responsible for implementing and executing the work specified in the Contract in strict conformance with the CPM of record. The CPM of record shall be the Contractor's work plan for completing the entire Contract as specified in the Contract Documents.

Failure of the Contractor to adhere to the CPM of record will be cause for the Administration to deny any and all requests for additional compensation or extensions of the Contract duration and may result in the Engineer withholding pay estimates.

CPM Updates. Monthly updates of the CPM of record are required. CPM update submissions shall contain the activity data as specified in (a) through (e) of the ICPM. The update shall be used to describe the progress of the project to date. The WN shall include a description of the work performed during the update periods, current critical path, the amount of float on the critical path, any delays or disruptions experienced by the Contractor during the period of the update, any change in manpower or equipment, and any potential delays or disruptions.

The Contractor's scheduling representative and the Engineer shall meet to review, mutually agree to, and sign-off on the information required to update (actual start and finish dates, remaining durations and percentages complete) the schedule. The Contractor shall use an update form acceptable to the Engineer. The data date for each update shall be seven days prior to the cut-off date of the pay estimate for that month. The update shall be submitted by the Contractor within seven calendar days from the data date. Failure to timely submit the update, may result in the Engineer withholding pay estimates. Upon acceptance by the Engineer, the update shall become the CPM of record for the period between its data date and the data date of the next approved update or revision.

Updates shall not include any revision to the CPM, unless prior approval by the Engineer is received for the insertion of minor revisions.

Revisions to the Schedule of Record. Revisions are defined as one or more of the following:

(a) A change in the original duration of an activity.

(b) A change in the logic of the schedule.

(c) A change in the calendars or to the calendar to which an activity is assigned.

(d) A change to resources.

(e) A change to any actual date, previously established.

(f) The deletion or addition of an activity.

(g) A change to, addition of, or deletion of a date or time constraint

(h) A change to, addition of, or deletion of an activity code.

(i) A change to an activity description.

(j) Any change other than updating an activity.

When the Contractor proposes to make a revision to the CPM, the Contractor shall verbally discuss the proposed revision with the Engineer. If the revision is minor in nature, the Engineer may allow the Contractor to include the revision on the next Update of the CPM. If the Engineer determines that the revision is not minor in nature, the Contractor shall submit the proposed revision to the Engineer for review and approval prior to deviating from the approved CPM.

When the Contractor is required to make a revision to the CPM due to changes in the Contract initiated by the Engineer, the Contractor shall immediately contact the Engineer to discuss the changes. If the revision is minor in nature, the Engineer may allow the Contractor to include the revision on the next Update of the CPM. If the Engineer determines that the revision is not minor in nature, the Contractor shall submit the proposed revision to the Engineer for review and approval prior to deviating from the approved CPM.

The Engineer may allow the Contractor to deviate from the approved CPM for specific mitigating activities.

The proposed revision shall be submitted to the Engineer in the same format and with the same requirements used for the ICPM. The proposed revision shall be made to the CPM of record at the time the revision is made, i.e. the revision shall include all update information and revisions previously approved and the additional progress to the date of the revision. The WN accompanying the proposed revision shall describe the reason for the revision, the resulting critical path, and all particulars of the revision. These shall include, but not be limited to, changes in the method or manner of the work, changes in specifications, changes in resources, addition or deletion of work, increased or decreased quantities, defective work, and acceleration of the work.

The Engineer will review and respond to the Contractor's proposed revision within 14 calendar days after its receipt. Resubmittal by the Contractor, if required, shall be made within seven calendar days after receipt of the Engineer's review comments. The Administration reserves the right to reject any proposed revision which adversely impacts the Administration, utilities, or other concerned parties.

Extensions of Contract Time or Incentive/Disincentive Date. All requests for an extension of Contract time shall be made in writing and are subject to the notice and timeliness of submission provisions as provided for elsewhere in the Contract. Any written request for an extension of Contract time or change in an incentive/disincentive date will be evaluated by the Engineer's analysis of the CPM of record and a proposed revision submitted by the Contractor. The request shall include a WN of the events which would require an extension of the Contract time or incentive/disincentive date.

Only delays to activities which affect the Contract completion date or incentive/disincentive date will be considered for an extension of Contract time. The extension of the specified Contract completion date or incentive/disincentive date will be based upon the number of calendar days the Contract completion date or incentive/disincentive date is impacted as determined by the Engineer's analysis.

When the Contractor fails to submit an acceptable Update or Revision within the time limits prescribed above, the Engineer may withhold pay estimates until an acceptable Update or Revision is submitted.

109.02 MATERIALS. Not Applicable.

109.03 CONSTRUCTION. Not Applicable.

109.04 MEASUREMENT AND PAYMENT. The accepted Initial Critical Path Method Project Schedule, Critical Path Method Project Schedule Revisions, and all accepted Critical Path Method Project Schedule Updates will be paid for at the Contract lump sum price for the CPM Project Schedule item. Fifty percent of the lump sum price will be paid upon acceptance of the Initial Critical Path Method Project Schedule (except when the price bid exceeds half of one percent of the total Contract price bid). The balance will be paid as a monthly prorated sum based upon the specified Contract duration. This monthly payment will be made on the next progress payment following the Administration's acceptance of the required monthly Critical Path Method Project Schedule updates.

When the price bid for the CPM Project Schedule exceeds half of one percent of the total Contract price, the total progress payments for the

Critical Path Method Project Schedule will be limited to half of one percent of the total Contract price. Any remaining balance (over half of one percent of the total Contract price bid) will be paid upon final Contract payment.

SECTION 110 — ACTIVITIES CHART PROJECT SCHEDULE

110.01 DESCRIPTION. This work shall consist of the Contractor planning, scheduling, and constructing this project using an Activities Chart (AC). The AC shall break down into detail the Contract time required to perform the work activities for the duration of the project. The AC shall be used for coordinating and monitoring all the work specified in the Contract Documents including all activities of subcontractors, vendors, suppliers, utilities, railroads, and all other parities associated with the construction of the Contract.

Initial Activities Chart Project Schedule (IAC). The IAC shall consist of:

(a) A chronologically sequenced bar chart in which work activity durations shall be represented by working days, days, or completion date as specified in the Invitation for Bids (IFB).

(b) A written narrative (WN) describing the original sequence of work, number of shifts per day, number of hours per shift, composition and number of crews, and the equipment to be utilized on each work activity. Subcontracting activities shall be listed.

The Contractor shall expend the entire Contract time specified in the IFB.

The Engineer reserves the right to specify the number of activities and require additional breakdown of the activities at any time.

The Contractor shall complete the proposed IAC within 14 days after receiving the Notice of Award and submit five sets to the Engineer for review and approval. The Engineer will review the Contractor's IAC within 30 days after the IAC is received. If required, the Engineer will convene a Joint Review Conference at which time the Engineer and Contractor may make corrections and adjustments to the IAC. Revisions to the IAC due to the Engineer's review or the Joint Review Conference shall be submitted to the Engineer by the Contractor within seven days from the date of the review for another review. Revisions shall conform

to the format used in the IAC. The Engineer will respond to the revised IAC within seven days after its receipt.

No construction work shall begin until the Engineer has accepted the IAC.

Time charges shall begin no later then the on or before date of the Notice to Proceed. Any delay in starting work caused by the acceptance of the IAC by the Engineer will not be a basis for any monetary claim; however, a noncompensable Contract time extension may be considered by the Administration, if warranted.

When the Engineer notifies the Contractor that the IAC has been accepted, that document will become the AC of Record (ACR). The Contractor shall implement and execute the work specified in the Contract in conformance with the ACR. The ACR shall be the Contractor's work plan for completing the entire Contract as specified in the Contract Documents.

Failure of the Contractor to adhere to the latest approved ACR will be cause for the Administration to deny any and all requests for additional compensation or extensions of the Contract duration.

Revisions to the ACR. Revisions shall consist of one or a combination of the following:

(a) A change in the duration of an activity.

(b) A change in the logic of the schedule.

(c) The deletion or addition of one or more activities.

The Contractor may submit a proposed revision to the ACR at any time during the life of the Contract.

The Contractor shall submit a proposed revision to the ACR whenever the activities differ from the accepted ACR. Proposed revisions shall be submitted by the Contractor within 30 days from the date on which the Contractor's activities deviated from the accepted ACR. The revisions shall be submitted to the Engineer in the same format used for the IAC. The revisions shall include data from all ACR Updates that have been accepted by the Administration. The WN accompanying the revisions shall describe the reason for the revision, the interdependence of the work activities, and all duration modifications to the ACR. These shall include, but not be limited to, changes in the method or manner of the work, changes in Specifications, addition or deletion of work, increased or decreased quantities, defective work and acceleration of the work.

The Engineer will review the ACR and respond to the Contractor's proposed revision within 30 days after its receipt. The Administration reserves the right to deny any proposed revision that adversely impacts the Administration, utilities, or other interested parties.

ACR Updates. Monthly updates of the ACR are required. Monthly updates shall be submitted in the same format as the IAC. The updates shall describe the progress of the project to date. Each update shall include a description of the current work, any delays or disruptions experienced by the Contractor during the period of the update, any change in manpower or equipment, the inclusion of any schedule revisions, and any potential delays or disruptions.

When a delay or a disruption to the work is identified in the ACR Update that the Contractor believes to be the responsibility of the Administration, the Contractor shall submit a revision to the ACR within 30 days after the submittal of the update.

Monthly Job Site Progress Meetings. The Administration and the Contractor shall hold monthly job site progress meetings to discuss the progress of the project and update the ACR. The Contractor shall arrange to have a representative of each subcontractor currently working on the project in attendance. The Contractor shall submit to the Engineer the ACR updates within 14 days from the date of the monthly meeting. The Engineer will review the update and advise the Contractor of its acceptability prior to the next monthly meeting.

Extensions Of Contract Time. Any written request for an extension of time shall be accompanied by a revised ACR, which documents the actual delay to the Contract completion date. The request shall include a WN of the events necessitating the extension of the Contract time. Only delays to activities that affect the Contract completion date will be considered for a time extension.

110.02 MATERIALS. Not applicable.

110.03 CONSTRUCTION. Not applicable.

110.04 MEASUREMENT AND PAYMENT. Activities chart project schedule will not be measured but the cost to develop, prepare, write, record, meetings, revise, update and all incidentals necessary to complete the work will be included in the other pay items specified in the Contract Documents.

SECTION 111 THRU 119 — RESERVED

SECTION 120 — TREE PRESERVATION

120.01 DESCRIPTION. This work shall consist of the establishment of a Tree Preservation Area (TPA) (an area of existing trees, which is to remain protected and preserved) as specified in the Contract Documents or as directed by the Engineer.

120.02 MATERIALS.

Temporary Orange Construction Fence	104.20.02

120.03 CONSTRUCTION.

The Contractor shall erect a temporary orange construction fence around the TPA at locations specified in the Contract Documents and as specified in 104.20.03.

The Contractor, the Administration's Landscape Operations Division representative, and the Engineer shall meet on the site to discuss all aspects of tree protection and maintenance prior to the commencement of any work.

Tree Expert. The Contractor shall engage a Maryland licensed tree expert to perform the following work:

(a) Recommend procedures to compensate for loss of roots (if any) and perform initial pruning of branches and stimulation of root growth where removed. This work shall be completed prior to commencing any construction activities.

(b) Inspect all trees at the completion of construction and perform follow-up care for any damage incurred.

(c) Submit a written Tree Protection Certification that trees have been protected during the course of construction in conformance with recognized standards of the industry. Certify that damaged trees were promptly and properly treated. Indicate any damaged trees that are incapable of reaching maturity and those recommended for removal and replacement.

Protective Fencing. Protective fencing shall be installed to clearly define the protected area as indicated on the Contract Documents. Prior to commencing with clearing and grubbing or erosion and sediment control, install temporary orange construction fence around areas to be left undisturbed. Temporary orange construction fence shall encompass any significant trees to be saved within and along the area designated as the

TPA. The location of the protective fencing shall be approved on site by the tree expert and the Engineer.

Wash-Out Area. Any "wash-out" area for trucks shall be located away from TPA, as approved by the Engineer.

Tree Roots. The Contractor shall protect tree root systems throughout the life of the project. Tree root systems shall be protected from smothering, flooding, excessive wetting resulting from dewatering operations, off-site runoff, spillage, and drainage of solutions containing materials that could be hazardous to tree roots. Removal of top soil or root mat within the TPA is prohibited.

Traffic. The Contractor is prohibited from parking any construction equipment, or from storing building supplies or material within the TPA. Foot traffic and vehicular traffic are prohibited within the TPA.

Tree Removal and Damaged Trees. The Contractor shall not remove any tree that is designated for preservation. Any tree damaged or destroyed within the TPA shall be the responsibility of the Contractor. The Contractor shall avoid the following:

(a) Placing backfill in protected areas.

(b) Felling trees into protected areas.

(c) Driving construction equipment into or through protected areas.

(d) Burning in or in close proximity to protected areas.

(e) Stacking or storing supplies in protected areas.

(f) Changing site grades which cause drainage to flow into, or to collect in protected areas.

(g) Conducting unauthorized trenching operations in the vicinity of trees.

(h) Grading in the vicinity of trees.

Work within the TPA.

(a) **Root Pruning.** The Contractor shall use a trenching machine, vibratory knife, or rock saw to a depth of 18 in. along the outside limits of disturbance, as shown in the Contract Documents, in the vicinity of existing trees prior to clearing and grubbing. When a trenching machine is used, the trench shall be immediately

backfilled. This root pruning operation shall occur concurrently with tree pruning and tree fertilization.

Some trees that are immediately adjacent to the root pruning may be affected adversely due to their close proximity to the excavation. Removal of any of these additional trees or any of their limbs shall require the concurrence of the Landscape Operations Division representative and the Engineer.

Upon satisfactory completion of these activities, protective fencing shall be installed along the outside edge of the trench line in conformance with 104.20.03.

(b) Replacing Damaged Trees. Existing trees that have been designated to remain but are damaged beyond repair due to construction operations, as determined by the Engineer, shall be removed and replaced at no additional cost to the Administration. Replacement trees shall be the same genus, species, variety, and size as the removed tree, except those trees having caliper greater than 6 in. shall have smaller trees furnished and installed. Caliper shall be measured as specified in 714.04. The replacement trees shall be a caliper and quantity acceptable to the Engineer. The minimum caliper shall be 3 in. Price adjustments for replacing trees with smaller caliper trees will be as specified in 120.04.

Planting of replacement trees shall be in conformance with Section 710 and include a one year warranty period.

(c) Repairing Tree Limbs, Branches, and Trunks. The Contractor shall repair limbs and branches that have been damaged by construction operations as determined by the Engineer. Repairing shall be accomplished by cutting damaged limbs and branches to healthy wood in conformance with Section 712 and this Specification at no additional cost to the Administration.

(d) Pruning Trees. All pruning shall be in conformance with the current edition of the National Arborist Association Standard for Pruning Shade Trees, Section 712, and this Specification. All pruning tools and methods employed shall be in conformance with accepted arboricultural practices performed by competent personnel under the direct supervision of the tree expert. The Contractor shall notify the Engineer 10 days prior to the beginning of any work.

Safety ropes shall be used to climb trees to be pruned. Climbing spurs are prohibited.

Existing injuries to bark, trunks, and limbs as designated by the Engineer, shall be repaired by properly cutting, smoothing the wood if necessary, tracing the bark to the proper shape to ensure rapid healing, and using only approved tools, materials and methods.

All pruned material shall be removed and disposed of by means acceptable to the Engineer.

The Contractor shall be responsible for all damage or injury to property of any character during the execution of the work resulting from any act, omission, neglect or misconduct, in the manner or method of executing this work satisfactorily.

Construction Activities within the TPA. When construction activities become necessary within the TPA, the Contractor shall obtain written permission from the Engineer prior to working in the area.

Removal and Clean-up.

(a) Removal. After construction has been completed, protective fencing and all surplus construction materials shall be removed from the site in a manner that will not cause damage within the TPA.

(b) Clean-up.

(1) The Contractor shall clean up all work areas.

(2) Grades shall be restored, stabilized, and blended into the adjacent areas.

(3) The Contractor shall haul away all debris, excess dirt and construction materials and dispose of off-site.

(4) The Contractor shall seed all disturbed areas within 24 hours in conformance with Section 705.

(5) The Contractor shall guard and protect the work to prevent vandal damage.

120.04 MEASUREMENT AND PAYMENT. Tree preservation, including the services of a Maryland licensed tree expert, will not be measured but the cost will be incidental to the Clearing and Grubbing item.

Temporary Orange Construction Fence will be measured and paid for as specified in 104.20.04.

Price Adjustment. If smaller trees are furnished and installed to replace larger trees that have been damaged beyond repair as determined by the Engineer, a reduction of the Contract price will be made at a rate of $200.00 per inch of caliper differential between the damaged tree and the smaller tree for calipers over 12 inches.

CATEGORY 200 GRADING

SECTION 201—ROADWAY EXCAVATION (CLASS 1, CLASS 1-A, CLASS 2)

201.01 DESCRIPTION. This work shall consist of the excavation and grading for roadways and their appurtenances to the lines and grades specified in the Contract Documents. The Contractor shall use all suitable materials from excavation in the construction of embankments throughout the limits of the work as directed by the Engineer.

201.01.01 Classification.

CLASS 1 — All excavation where the width of the bottom of the cut is 15 ft or more.

CLASS 1-A — All excavation of unsuitable material below the lowest excavation limits established.

CLASS 2 — All excavation where the width of the bottom of the cut is less than 15 ft. Excavation for flumes, ditches, and stream and channel changes are included in this classification unless otherwise specified in the Contract Documents.

201.01.02 Excavation. Excavation shall include the following:

(a) Cut areas within the boundary faces of the typical cross sections specified in the Contract Documents, including ditches within the cut sections, and excavation for entrances, approach roads, streets, intersections, gutters, ditches, berm ditches, and flumes.

(b) Topsoil to be salvaged within the limits of excavation as specified in the Contract Documents or as directed by the Engineer.

(c) The removal and disposal of existing pavement, sidewalks, curb and combination curb and gutter, when within the limits of any class of excavation. The work shall be as specified in Section 206.

(d) The removal and disposal of below grade structures other than as specified in Sections 102 or 207.

201.02 MATERIALS. Not applicable.

201.03 CONSTRUCTION.

201.03.01 Grading Units. Each grading unit shall be the surface area of erodible earth that can be exposed to construction operations without undue erosion or sedimentation. Refer to 101.03.01 for the size and number of these units that can be opened at one time.

201.03.02 Use of Excavated Materials. No excavated material shall be wasted without prior approval of the Engineer. Borrow shall not be used unless provisions have been made for utilizing all available suitable excavated material in embankments. Refer to TC-3.04 and Section 203.

201.03.03 Broken Pavement Material. Existing pavement, sidewalks, gutter, curb or combination curb and gutter materials from the excavation may be broken and used in embankments. The broken material shall be considered as rock conforming to 204.02.01. If the Engineer considers the material to be unsuitable, it shall be disposed of as excess or unsuitable material.

201.03.04 Rock Excavation.

(a) Boulders and Rock. Boulders and rock from the excavation may be broken and used in embankment provided the materials conform to 204.02.01.

(b) Blasting. Where rock encountered in cuts requires drilling and blasting, the finished slope shall remain reasonably straight and clean. The Contractor shall adjust blasting operations to obtain the required slope specified in the Contract Documents. Refer to TC-6.07.

(c) Presplitting. When presplitting of rock slopes is specified in the Contract Documents, the presplitting operation shall be carried out prior to the primary blasting so knowledge gained from excavation of the presplit face may be applied to subsequent presplitting operations. No portion of any primary blast hole shall be drilled closer than half the spacing of the drilling pattern to the proposed finished slope.

The Contractor shall submit a plan for the proposed presplitting operations to the Engineer for approval. The plan shall include the drill size, lift height, explosives and detonator specifications, loading pattern, stemming materials, stemming depth, charge size, and charge timing.

The initial presplit shot shall not be longer than 100 ft. The Contractor shall drill holes along the slope line having a diameter

of 2 to 3 in. Drill holes shall be placed at the slope angle as specified in the Contract Documents. All drill holes shall maintain the same plane. The initial presplit holes shall be drilled on maximum 3 ft centers and to a maximum depth of 20 ft unless otherwise directed by the Engineer. If the vertical depth of cut to be presplit is greater than the maximum permissible depth of holes as determined by the Engineer, the blasting shall be done in two or more lifts; in which case the first line of drill holes shall be set back a sufficient distance from the slope line to allow for a 1 ft offset for each succeeding line of drill holes.

The Contractor shall excavate the initial presplit shot for inspection by the Engineer prior to commencement of further presplitting. If the results are approved by the Engineer, the presplitting may continue using the approved drilling and loading pattern. Whenever the presplitting is found to be unsatisfactory, the Contractor shall make adjustments in the operations and repeat the inspection procedure used for the initial presplit shot.

The presplit face shall be within 6 in. from the front of the line of drill holes and 1 ft from the back of the line of drill holes except where the character of the formation being presplit (badly broken rock, vertical seams, etc.) will result in irregularities.

The line of presplit holes shall extend a minimum of 30 ft beyond the limits of the primary blast holes to be detonated or to the end of the cut.

Only cartridged explosives manufactured for presplitting shall be used. The maximum diameter of explosives used in presplit holes shall be half the diameter of the presplit hole. Bulk explosives are prohibited in presplit holes.

The Engineer may direct the discontinuance of the presplitting operations wherever the rock is of a character that no apparent advantage is gained.

201.03.05 Frozen Material. Frozen material is prohibited from being placed in embankments. It shall be stockpiled outside the construction limits and reserved for future use. Any material that is wasted shall be replaced. Rehandling of excavated material and replacement of wasted material shall be at no additional cost to the Administration.

201.03.06 Serrated Slopes. Serrated cut slopes are defined as slopes having continuously benched faces. Slopes that are to be serrated and the width and height of benches shall be as specified in the Contract Documents or as directed by the Engineer. The benches shall be

constructed parallel to each other, and they shall be level, not graded to drain, and shall be constructed as the excavation progresses.

201.03.07 Drainage. All drainage shall conform to Section 308. During construction of the roadway, the roadbed shall be maintained in a well drained condition at all times. Excavated material is prohibited from being deposited or left within 3 ft of the edge of the ditch or channel or be permitted to obstruct normal surface drainage into the ditch or channel. Ditches draining from cuts to embankments or otherwise shall be constructed to avoid damage to embankments by erosion. All drainage necessary to provide free and uninterrupted flow of the surface and underground water shall be installed before surfacing is placed. When stabilized side and outlet ditches provide the principal means for drainage, the cutting and stabilization of ditches for the disposition of surface water shall be the first work in the grading operation.

201.03.08 Excavation Beyond Specified Limits. The widening of cut or excavation sections beyond the limits of the typical cross section as specified in the Contract Documents is prohibited except by written authorization from the Engineer. When authorized by the Engineer the procurement of additional materials for embankments, unless otherwise specified under Borrow Excavation, shall conform to the following:

(a) Finished Excavation. The widening of cuts or excavation sections shall be finished so that completed flat and slope areas shall be uniform in appearance. The slopes shall not be steeper than the cut slopes specified in the Contract Documents or as directed by the Engineer.

(b) Roadway Excavation Limits.

(1) If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section originally proposed, prior to the starting of roadway excavation in a cut section, all material within the limits will be classified as Class 1 Excavation.

(2) If the Contractor, with approval of the Engineer, elects to obtain material by widening cuts beyond the limits of the typical cross section originally proposed and within the right-of-way or easement, the excavation of the materials will be classified as Class 1 Excavation.

(c) Borrow Excavation Beyond Specified Limits. If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section originally proposed after the Contractor has substantially completed the roadway excavation in a cut section,

all material removed beyond the limits of the typical cross section will be classified as Borrow Excavation.

201.03.09 Unsuitable Material. Unstable or other unsuitable material encountered at or below the typical section specified in the Contract Documents shall be removed to the extent directed by the Engineer and classified as Class 1-A Excavation. In rock areas the limit of measurement for excavation will be at the bottom of the typical section. All voids created by the removal of unsuitable material, except when rock is encountered at subgrade, shall be backfilled to the lines and grades with the material specified in the Contract Documents. Backfill material shall conform to Section 916.

201.03.10 Coal Deposits. The Contractor shall notify the Bureau of Mines when coal is encountered on any construction project. The notice shall be sent to the Director, Bureau of Mines, Maryland Department of Natural Resources. Any coal encountered on the project shall be disposed of as directed by the Engineer.

201.03.11 Widening Excavation Limits. The area to be excavated for widening shall be limited to the extent that the excavated area can be backfilled within the same working day using the excavated material or common borrow to form a temporary wedge. Refer to Standard No. MD-104.92 for the area to be backfilled. The 4:1 or flatter fill slope shall be maintained. The material shall be compacted as directed by the Engineer and remain in place until placement of the graded aggregate base course.

201.04 MEASUREMENT AND PAYMENT. Roadway excavation will be measured and paid for at the Contract unit price per cubic yard for the pertinent Class of Excavation. The payment will be full compensation for all excavation and hauling, blasting, formation and compaction of embankments and backfills, disposing of excess and unsuitable materials, preparation and completion of subgrade and shoulders except as otherwise specified, serrated slopes, rounded and transition slopes, and for all material, labor, equipment, tools, and incidentals necessary to complete the work. Payment will not be made for excavation of any material used for purposes other than those designated.

201.04.01 Limits of Measurement.

(a) Roadway Excavation. The lower limit of measurement will be the surface upon which roadway materials, including base course, surfacing or selected capping material is to be placed in either pavement or shoulder areas.

(b) Concrete Pavements. Measurement will be taken to 1 ft outside of the outer edge of the pavement on each side. Where concrete curb or combination concrete curb and gutter is built contiguous to the pavement, measurement for excavation will be the outer limits of the concrete curb or combination curb and gutter.

(c) Rocks and Boulders. If ledge rock, scattered rock, or boulders of 1/2 yd^3 or larger volume are removed, any resulting undercutting approved by the Engineer will be measured for payment.

(d) Slides or Breakages. Slides or breakages not attributable to the Contractor's negligence as determined by the Engineer will be measured and included in the final quantities for Class 1 Excavation.

(e) Topsoil and Root Mat. Measurement will be made for the removal of topsoil and root mat when it is required to be removed from fill areas. In the case of removal of root mat, however, Class 1 Excavation shall only apply when the strata underlying the root mat are suitable for supporting embankment. If material is unsuitable for supporting embankment then removal of root mat and unsuitable material will be measured as Class 1-A Excavation.

Excavation will always be measured in its original position. No liquids will be included in any measurement.

No measurement will be made for any additional excavation required to construct new curb, curb and gutter, paved ditch, paved gutter, paved flume, or sidewalk paving.

201.04.02 Template Method of Measurement. Unless otherwise specified, excavation will be computed using the template from preliminary cross sections of the original ground surface combined with templates of the typical cross sections. If this method is used, certain volumes will be excluded.

Excluded volumes are:

(a) Undercutting for cushion over rock.

(b) Entrances and intersections for which details are not specified in the Contract Documents and for which no quantity was allowed in the Contract Documents.

(c) Salvaged topsoil from under embankments.

(d) Removal of root mat from under embankments.

The template method will not be used:

(a) Where there are approved changes in design and typical section.

(b) Where there are approved deviations from planned slope faces in rock cuts.

(c) Where the original ground conditions upon which preliminary cross sections were taken have been changed before the Contractor begins work.

(d) For Class 1-A Excavation.

(e) When the work of the Contractor does not conform to the line, grade, or cross section specified in the Contract Documents or as changed by subsequent written authorization by the Engineer. Unless corrective action is required, payment will be based on the changed quantities as determined by the cross section method in 201.04.03.

201.04.03 Cross Section Method of Measurement. When specified, quantities for payment of Excavation will be computed by average end areas, from the cross sections of the original ground combined with cross sections of the completed work. Class 1 Excavation will be allowed in median areas of cut sections only where 4 in. or greater of topsoil are to be placed. This method will also apply to Class 1-A and Class 2 Excavation unless otherwise specified.

201.04.04 Presplitting will not be measured but the cost will be incidental to the Contract unit price per cubic yard for the pertinent Class of Excavation in which it occurs.

201.04.05 Removal of existing pavement, sidewalk, paved ditches, curb or combination curb and gutter outside the limits of construction will be measured and paid for as specified in 206.04.

201.04.06 Removal of existing pavement, sidewalk, paved ditches, curb or combination curb and gutter within the limits of any class of excavation will not be measured but the cost will be incidental to the Contract unit price per cubic yard for the pertinent Class of Excavation in which it occurs.

201.04.07 Recomputation of Quantities. The Contractor or the Administration may elect to recompute quantities in any section where it

is believed the planned quantities are incorrect. When recomputation reveals an error, the corrected quantity will be used.

201.04.08 The excavated material or common borrow required to fill the temporary wedge area in conformance with 201.03.11, maintaining the 4:1 or flatter slope, compaction, and removal of the material will not be measured but the cost will be incidental to the Contract unit price for the pertinent Class of Excavation. For measurement and payment of Drums refer to 104.12.04.

201.04.09 Backfill for unsuitable material will be measured and paid for at the Contract unit price for the pertinent item specified in the Contract Documents.

SECTION 202 — CHANNEL OR STREAM CHANGE EXCAVATION (CLASS 5)

202.01 DESCRIPTION. This work shall consist of excavation for changes in streams and channels when specified in the Contract Documents. The Contractor shall use all suitable materials from excavation in the construction throughout the Contract.

202.02 MATERIALS. Not applicable.

202.03 CONSTRUCTION. Refer to the applicable provisions of Section 201.

202.04 MEASUREMENT AND PAYMENT. Class 5 Excavation will be measured and paid for at the Contract unit price per cubic yard. The payment will be full compensation for all excavation and hauling, formation and compaction of embankments and backfill, backfilling old stream beds or otherwise disposing of excess and unsuitable materials, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Material will be measured in its original position and the volume computed by the Method of Average End Area. The cross sectional area measured will not include liquids. Measurement for Class 5 Excavation excludes any material removed outside the limits of payment as specified in the Contract Documents.

SECTION 203 — BORROW EXCAVATION

203.01 DESCRIPTION. This work shall consist of furnishing, excavating, hauling, and placing approved materials for embankments and backfills when sufficient quantities of suitable materials are not available from other excavations as specified in the Contract Documents. It shall include all work prescribed for backfills, embankments, subgrade, and earth shoulders, all necessary clearing and grubbing, the removal and disposal of overburden or other unsuitable spoil material and the trimming, shaping, dressing, draining, and reclamation of the pit or location from which borrow material is secured. Refer to 201.03.02 before securing borrow.

203.01.01 Contractor's Options. The Contractor, as a duly authorized agent of the Administration, may elect one of the following three methods to obtain borrow material for use on public highway Contracts:

OPTION 1 — Acquire material from a licensed commercial operating supplier.

OPTION 2 — Make application to the Department of Natural Resources under the Annotated Code of Maryland, Environment, Subtitle 8, entitled "Surface Mining".

OPTION 3 — Make application to the Administration to operate under the standard adopted in conformance with the Annotated Code of Maryland, Environment, Subtitle 8, Surface Mining, Subsection 15-834 entitled "Exemptions". A Contractor who elects to use Option 3 shall submit an application to the Administration fulfilling all the requirements of the cited subtitle.

203.01.02 Notice to Contractor—Borrow Pits. If the Contractor elects, a borrow pit may be established on privately owned property and the Administration may grant an "Exemption for a Surface Mining Permit" normally issued by the Water Resources Administration (WRA). Before a permit can be granted, the Contractor shall submit to the Administration written proof that all local permits or approvals have been secured for the borrow pits.

An exemption under Option 3 will require approval of an excavation and reclamation plan along with the drainage patterns and methods of attaining satisfactory drainage and soil conservation as the work progresses. The plan shall also provide for surface restoration suitable for

the proposed subsequent land use after reclamation is completed and the proposed method of accomplishment.

203.01.03 Borrow Pits Within 100 Year Floodplain. Borrow pits located within the 100 year floodplain of any waterway having a drainage area 400 acres or more (100 acres for Class II and IV trout streams) shall also have the Department of Natural Resources (DNR) approval. Borrow pit operations that impact either tidal or nontidal wetlands shall also be approved by DNR. Copies of the U.S. Army Corps of Engineers 404 permit or the State wetlands permit or license will be provided before an exemption will be granted.

The determination as to the applicability of waterway construction or wetland permits shall be the responsibility of the Contractor.

If the pit is in operation and the Administration discovers that the Contractor is not in conformance with these regulations, the Administration will take the appropriate action required including work shutdown, until the Contractor is in conformance.

203.02 MATERIALS. Refer to Section 916.

203.03 CONSTRUCTION.

203.03.01 Clearing and Grubbing. Refer to Section 101.

203.03.02 Borrow Pit Material. The Contractor shall notify the Engineer a minimum of 30 days in advance of the opening of any borrow pit so that soil analysis, elevations, and measurements of the ground may be made. After the pit is opened, the material excavated shall be used only for the project intended. The Contractor shall not excavate additional material for other purposes until a final survey is made of the pit.

Borrow Pit After Excavation. The borrow pit shall conform to the Reclamation (Permit) Plan after the necessary quantity of materials has been removed. Steep slopes and sheer faces shall be avoided. All disturbed areas shall be seeded and mulched as specified in Section 705 at no additional cost to the Administration. Shaping and seeding requirements do not apply to commercial borrow pits.

203.03.05 Borrow Excavation Beyond Specified Limits. Refer to 201.03.08.

203.03.06 Compaction. Refer to 204.03.04.

203.04 MEASUREMENT AND PAYMENT. Borrow excavation will be measured and paid for at the Contract unit price per cubic yard for the pertinent Borrow item. The payment will be full compensation for clearing and grubbing, furnishing, excavating and hauling, sloping, draining and reclamation of pits (if Option 2 or 3 is selected), the formation and compaction of embankments, backfills, subgrade, manipulation and additives for select borrow, all work and materials for earth shoulders except as otherwise specified, disposing of all unsuitable spoil material, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

When requested by the Contractor in writing, the Engineer may approve an alternate method of measurement for the computation of borrow excavation quantities. This alternate method will not be considered for approval unless the Contractor can show that the cross section method computed by average end area is not a feasible method of measurement. When approved in writing by the Engineer, this alternate method shall consist of measuring the borrow excavation in approved hauling vehicles in the following manner:

(a) The Contractor shall designate, prior to the start of hauling operations, the identification number of each vehicle to be used. The Engineer will determine the water level capacity of each vehicle. The measured capacity shall be multiplied by a factor of 0.85 to determine the pay volume.

(b) The Contractor shall furnish a delivery ticket to the Engineer for each load of borrow material delivered to the project. Any ticket not signed by the Engineer to acknowledge receipt will not be used in the computation of the borrow quantity.

The ticket shall include the following:

(1) The supplier's name.

(2) The Administration’s Contract number.

(3) The date and ticket number.

(4) Vehicle identification number.

(5) Type of material delivered.

(6) Pay volume computed as specified in (a).

SECTION 204 — EMBANKMENT AND SUBGRADE

204.01 DESCRIPTION. This work shall consist of constructing the embankment and subgrade of suitable material obtained from roadway, structure, borrow, and other excavation included in the Contract. The material shall be placed, processed, and compacted to the lines and grades specified in the Contract Documents.

204.02 MATERIALS. Soils and soil aggregate mixtures used in the construction of embankments shall conform to the common borrow requirements in Section 916 unless otherwise specified in the Contract Documents.

204.02.01 Rock. Rock may be used in embankments, provided that individual pieces do not exceed of 24 in. in any dimension. Larger size rocks may be wasted with the approval of the Engineer.

204.02.02 Frozen Material. Refer to 201.03.05 with the following addition:

Any material that freezes after being placed in the embankment shall not be covered until it has thawed.

204.02.03 Embankment Adjacent to Structures. The Engineer may require the use of specially selected material adjacent to structures to insure good compaction or to protect the structure from damage. Rock is prohibited. Embankment material at locations of pile supported foundations shall be a type that piles may be easily driven through the embankment.

204.03 CONSTRUCTION.

204.03.01 Embankment Foundation.

(a) Foundation Material. The Engineer will inspect the foundation prior to the construction of an embankment. Topsoil, root mat, or unsuitable material shall be removed to the depth directed by the Engineer.

(b) Embankment Over Existing Pavement. When embankment is placed on an existing pavement, the pavement shall be thoroughly broken up, scarified or removed as specified in the Contract Documents or as directed by the Engineer.

(c) Test Rolling. When test rolling is specified in the Contract Documents or directed by the Engineer, the foundation shall be tested by rolling with a 35 ton pneumatic tired roller, or as approved by the Engineer.

204.03.02 Placing and Spreading. The material shall be placed in horizontal layers across the full width of the embankment. An adequate crown shall be maintained to provide drainage at all times. Side slopes shall be maintained at the specified slope throughout the progress of the work.

(a) Embankment on Unstable Ground. When embankment is to be constructed on wet and unstable ground that will not support the weight of the construction equipment, the first layer of the fill may be constructed by depositing material in a layer no thicker than that required to support the equipment. Subsequent layers shall conform to (b).

(b) Earth Embankment. Except as otherwise specified, no layer shall exceed 8 in. compacted depth.

(c) Rock Embankment.

(1) In rock embankment the thickness of layers shall be determined by the size of the rock or a 24 in. maximum depth, whichever is less. The portion of the embankment less than 6 ft below the subgrade at the profile grade line shall be placed in layers not more than 8 in. compacted depth, and these layers shall be filled solid and fully choked with spalls, rock dust, or earth. Each layer shall be filled and compacted before the next layer is placed.

(2) The top of the rock material shall provide a uniform surface, determined by connecting with straight lines the points on the typical cross section which are 9 in. below any median ditch invert and 9 in. below the bottom of the pavement structure and then sloping downward and outward under the shoulders at the rate of 3/4 in. per ft to the outer slope of the embankment.

(3) The remaining upper portion of the embankment, unless otherwise specified in the Contract Documents, shall be constructed of suitable earth, free from stones that would be retained on a 3 in. sieve.

204.03.03 Benching. When embankment is to be placed and compacted on hillsides or when new embankment is to be compacted against existing

embankments, the slopes on which the embankment is to be placed shall be continuously benched where they are steeper than 4:1 when measured at right angles to the roadway. The benching operation shall be done as the embankment is brought up in layers. Benching shall be a minimum width of 5 ft. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cut. Material conforming to embankment requirements cut from the benches shall be compacted along with the new embankment material at no additional cost to the Administration.

204.03.04 Compaction. Immediately after spreading of each layer, the material shall be compacted with compaction equipment approved by the Engineer. Rolling shall be done in a longitudinal direction along the embankment, beginning at the outer edges and progressing towards the center. The travel paths of traffic and equipment shall be dispersed over the width of the embankment to aid in obtaining uniform compaction.

Material 1 ft below the top of subgrade shall be compacted to not less than 92 percent of the maximum dry density as specified in T 180. Material in the top 1 ft shall be compacted to not less than 97 percent of the maximum dry density. In-place density shall be determined by MSMT 350 or 352. When necessary, the layer shall be wetted or dried in order to compact the layer to the required density. The resultant moisture content of embankment material, when finally compacted to required density, shall be within two percentage points of optimum.

The Contractor shall provide a portland cement concrete compaction block having dimensions 18 X 18 X 9 in. and weighing at least 200 lb. One 18 X 18 in. working face shall have a level broomed surface.

204.03.05 Stability of Embankments. The Contractor shall be responsible for the stability of all embankments in the Contract and shall remove and replace with acceptable material any embankment or portion thereof that has been constructed with unsuitable material. The Contractor shall remove and replace unstable material and remove and replace portions of the embankment that become unstable or displaced as the result of the Contractor's operations at no additional cost to the Administration.

204.03.06 Protection of Structures and Utilities During Construction. The Contractor shall be responsible for protecting all structures and utilities from any damage in the handling, processing, or compacting of embankment or backfill material. Particular care shall be exercised in the vicinity of arches, retaining walls, culverts and utility trenches to assure that no undue strain or movement is produced. In areas where rollers cannot be used, the embankment or backfill shall conform to Section 210.

204.03.07 Subgrade. The subgrade shall be constructed and shaped to the specified cross section after all cuts, embankment and backfilling have been substantially completed. The subgrade shall be proof rolled as specified in 204.03.01(c).

204.03.08 Maintenance. During construction and after completion of the embankment and subgrade, the embankment and subgrade shall be maintained by the Contractor until finally accepted. Embankment and subgrade material that may be lost or displaced as a result of natural causes such as storms and cloudbursts, or as a result of unavoidable movement or settlement of the ground or foundation upon which the embankment and subgrade is constructed shall be replaced by the Contractor with acceptable material from excavation or borrow. The Contractor shall at all times maintain ditches and drains to provide adequate drainage. The travel paths of any traffic or construction equipment on the embankment and subgrade shall be held to a minimum to avoid the displacement of material or formation of ruts. When ruts 2 in. or more in depth are formed in the subgrade they shall be removed by reshaping and recompacting.

204.04 MEASUREMENT AND PAYMENT. Embankment, subgrade, and all necessary work will not be measured but the cost will be incidental to the Contract unit price per cubic yard for the pertinent Class of Excavation. The payment will be full compensation for the formation, sprinkling, compacting, test rolling, shaping, scarifying, breaking or removing of the existing pavement, sloping, trimming, finishing, maintaining embankments and subgrade, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Replacement of material lost as a result of natural causes will be measured and paid for at the Contract unit price per cubic yard for the pertinent Class of Excavation item or as directed by the Engineer.

Compaction by means of mechanical tampers or vibratory compactors will not be measured but the cost will be incidental to the pertinent Class of Excavation item.

SECTION 205 — TEST PIT EXCAVATION

205.01 DESCRIPTION. This work shall consist of excavation and backfilling for test pits to determine the location of underground structures and utilities as specified in the Contract Documents or as directed by the Engineer.

205.02 MATERIALS. Not applicable.

205.03 CONSTRUCTION. It shall be the responsibility of the Contractor to determine the location of underground structures and utilities by the use of test pit excavation prior to excavation operations.

Test pits shall be of the size, depth and location as authorized by the Engineer. Each pit shall be tamp backfilled as specified in Section 210.

205.04 MEASUREMENT AND PAYMENT. Test Pit Excavation will be measured and paid for at the Contract unit price per cubic yard for the material actually removed from within the limits specified. The payment will be full compensation for all excavation, tamped backfill and all material, labor, equipment, tools, and incidentals necessary to complete the work. Any pavement to be replaced will be measured and paid for as specified in Section 106.

SECTION 206 — REMOVAL OF EXISTING PAVEMENT, SIDEWALK, PAVED DITCHES, CURB, OR COMBINATION CURB AND GUTTER

206.01 DESCRIPTION. This work shall consist of the full depth removal and disposal of existing pavement, sidewalk, paved ditches, curb or combination curb and gutter as specified in the Contract Documents or as directed by the Engineer.

206.02 MATERIALS. Not applicable.

206.03 CONSTRUCTION.

206.03.01 Full Depth Saw Cut. The Contractor shall full depth saw cut the existing pavement, sidewalk, paved ditches, curb or combination curb and gutter along the lines specified in the Contract Documents or as directed by the Engineer.

206.03.02 Use of Removed Pavement, Sidewalk, Paved Ditches, Curb or Combination Curb and Gutter. Removed materials may be broken and used in the work with the approval of the Engineer. The broken material shall be considered as rock conforming to 204.02.01.

206.03.03 Protection of Retained Pavement, Sidewalk, Paved Ditches, Curb or Combination Curb and Gutter. The Contractor shall not damage sections that are not to be removed. Damage done by the Contractor to those areas to remain in place shall be repaired or replaced at no additional cost to the Administration.

206.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all work specified regardless of the type or depth of material removed and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

206.04.01 Removal of existing pavement, sidewalk, paved ditches, curb or combination curb and gutter, and full depth saw cuts within the limits of any class of excavation will not be measured but the cost will be incidental to the Contract unit price for the Class of Excavation in which it occurs.

206.04.02 Saw cuts, removal of existing pavement, sidewalk (except as specified in 603.04), paved ditches, and curb or combination curb and gutter outside the limits of any class of excavation will be measured in the original position and paid for as follows:

(a) Saw Cuts per linear foot when specified in the Contract Documents.

(b) Removal of Existing Pavement, Sidewalk, and Paved Ditches per cubic yard.

(c) Removal of Existing Curb or Combination Curb and Gutter per linear foot.

When any material included in (b) or (c) is removed but not replaced, the area shall be backfilled and landscaped as directed by the Engineer. All cost will be incidental to the Contract unit price for the pertinent items specified in the Contract Documents.

SECTION 207 — REMOVAL OF EXISTING MASONRY

207.01 DESCRIPTION. This work shall consist of removing all or part of existing concrete, concrete block, brick or stone structures (headwalls, toe walls, etc.), including concrete piles as specified in the Contract Documents or as directed by the Engineer. Removal of existing bridge structures shall conform to Section 405.

207.02 MATERIALS. Not applicable.

207.03 CONSTRUCTION.

207.03.01 Removal. All removal shall be to an elevation of at least 1 ft below subgrade or existing ground, unless otherwise specified in the

Contract Documents or as directed by the Engineer. Blasting will not be permitted without the written approval of the Engineer. Piles, grillages, or cribbing under removed masonry shall be cut off and removed to the above limits.

207.03.02 Use of Removed Masonry. Masonry material may be broken and used in the work. The broken material will be considered as rock in conformance with 204.02.01. Material determined to be unsuitable by the Engineer shall be disposed of as excess or unsuitable material at no additional cost to the Administration.

207.03.03 Protection of Retained Masonry. Retained sections that are damaged due to the Contractor's operations as determined by the Engineer shall be repaired or replaced in a manner acceptable to the Engineer at no additional cost to the Administration. Connecting edges and surfaces shall be cut to lines specified in the Contract Documents or as directed by the Engineer.

207.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all excavation, backfill, disposal of excess or unsuitable material, blasting, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

207.04.01 Removal of Existing Masonry will not be measured but will be paid for at the Contract lump sum price.

207.04.02 When specified in the Contract Documents, Removal of Existing Masonry will be measured and paid for at the Contract unit price per cubic yard.

207.04.03 When a new structure is placed in the location of an existing structure, the removal of the existing structure will be incidental to the new structure unless otherwise specified.

SECTION 208 — SUBGRADE PREPARATION

208.01 DESCRIPTION. This work shall consist of the preparation, protection, and maintenance of the subgrade prior to the construction of succeeding courses.

208.02 MATERIALS. Refer to Section 916.

208.03 CONSTRUCTION. After roadway excavation and embankments have been completed and the requirements of Section 204 are in conformance, the subgrade shall be fine graded and compacted to a

minimum density of 97 percent of the maximum dry density as specified in T 180.

208.03.01 Removal and Replacement of Unsuitable Material. All soft and unstable material and any other portions of the subgrade that will not properly compact shall be removed, disposed of, replaced with suitable material and compacted.

208.03.02 Subgrade Control. The subgrade surface shall be brought to line and grade and shaped to the specified cross section. Grade shall be set for subgrade control both longitudinally and transversely with fixed controls not to exceed 25 ft spacing. The finished subgrade shall not deviate more than 1/2 in. from the established grade. It shall be compacted and smoothed over its full width by the use of a smooth faced, steel wheeled roller approved by the Engineer or by mechanical tampers and vibratory compactors if rolling is not feasible.

208.03.03 Bleeder Ditches. The Contractor shall at all times maintain adequate open bleeder ditches along the subgrade to keep it thoroughly drained. Erosion and sediment control practices conforming to Section 308 shall be maintained.

208.03.04 Subgrade Maintenance. Maintenance of the subgrade shall be the responsibility of the Contractor. The Contractor shall take precautionary measures to prevent damage by heavy loads or equipment. Any defects or damage shall be repaired or replaced at no additional cost to the Administration.

208.03.05 Subgrade Approval. No subsequent cover material shall be placed upon a frozen subgrade or any subgrade until it has been checked and approved by the Engineer.

208.04 MEASUREMENT AND PAYMENT. Subgrade preparation, including bleeder ditches and any mechanical tamping will not be measured but the cost will be incidental to the pertinent items specified in the Contract Documents.

SECTION 209 — TRIMMING EXISTING DITCHES

209.01 DESCRIPTION. This work shall consist of trimming, sloping and shaping existing ditches, within the limits and to the lines and grade as specified in the Contract Documents. Clearing and grubbing and the removal and disposal of surplus or unsuitable materials are included in the work.

209.02 MATERIALS. Not applicable.

209.03 CONSTRUCTION. Clearing and grubbing for trimming existing ditches shall conform to Section 101. Existing ditches shall be trimmed, sloped, and shaped to a uniform grade and cross section. The side slopes shall be constant with a maximum slope of 1:1 unless otherwise specified. Excess or unsuitable materials removed shall be disposed of as specified in Section 201.

209.04 MEASUREMENT AND PAYMENT. Trimming Existing Ditches will be measured and paid for at the Contract unit price per linear foot of existing ditches on which work has been completed. Measurement will be along the center line of the ditch.

The payment will be full compensation for all clearing, grubbing, excavation, disposal of surplus and unsuitable materials and for all labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 210 — TAMPED FILL

210.01 DESCRIPTION. This work shall consist of compacting embankment and backfill materials by means of mechanical tampers or vibratory compactors. This method of compaction shall be used wherever materials cannot be adequately compacted by other methods approved by the Engineer.

210.02 MATERIALS. Refer to Section 916.

210.03 CONSTRUCTION. After approval has been given by the Engineer, the areas shall be backfilled with materials approved by the Engineer. The material shall be placed in horizontal layers not to exceed 6 in. loose depth over the entire area to be tamped and uniformly compacted by means of mechanical tampers or vibratory compactors. The moisture and compaction requirements shall conform to 204.03.04.

When backfilling around abutments, retaining walls, culverts, utilities, or other structures, special care shall be taken to prevent any wedging action against the structure by the material being compacted. The existing slopes to be filled against shall be benched or stepped. The backfill shall be constructed in horizontal layers as described above and wide enough that there shall be a horizontal berm of thoroughly compacted material behind the structure at all times for a distance at least equal to the height of the structure remaining to be backfilled, except insofar as undisturbed material protrudes into this space. Tamping may be required over additional widths when the material cannot be adequately compacted by

other methods. When structures are installed below subgrade in embankments, the tamped fill shall be placed to a depth of 1 ft over the top of the structure, while in excavation sections the tamped fill shall extend to the surface of the finished earthwork.

210.04 MEASUREMENT AND PAYMENT. Compacting embankments and backfills by mechanical tampers or vibratory compactors will not be measured but the cost will be incidental to the pertinent items specified in the Contract Documents.

SECTION 211 — GEOSYNTHETIC STABILIZED SUBGRADE USING GRADED AGGREGATE BASE

211.01 DESCRIPTION. This work shall consist of furnishing and installing a layer of geotextile and a minimum of 12 in. of graded aggregate base to bridge unstable material and minimize the use of undercutting. This item shall only be used when specified in the Contract Documents or as directed by the Engineer. In extremely unstable areas, the Engineer may increase the thickness of the graded aggregate base material.

211.02 MATERIALS.

Graded Aggregate Base	901.01
Geotextile for Subgrade Stabilization-Class ST	921.09
Securing Pins or Staples	921.09

211.03 CONSTRUCTION.

211.03.01 Test Strip. In extremely unstable areas, the Engineer may direct that a test strip be constructed to determine the thickness of aggregate layer required to stabilize the area. The test strip shall be a minimum of 100 ft in length and at least one lane wide. The Engineer will determine the depths of aggregate to be used in the test strip. Based on the results of the test strip the Engineer will determine the thickness of aggregate to use in subsequent construction.

211.03.02 Grade Preparation. When geosynthetic stabilized subgrade using graded aggregate base is specified, the area where the geotextile is to be placed shall be cut to the depth shown on the Contract Documents or as directed by the Engineer.

The grade upon which the geotextile is to be placed shall be brought to the line, grade, and cross section specified. The grade shall be as smooth as practical and free of debris. Construction traffic on the grade shall be

minimized. When ruts are formed by construction traffic, they shall be removed by reshaping the affected area. The grade shall not be overworked and shall be approved by the Engineer prior to placement of the geotextile. Adequate surface drainage shall be maintained in conformance with 208.03.03.

Compaction and moisture requirements for the underlying soil on which the geotextile is to be placed may be waived by the Engineer.

211.03.03 Geotextile Placement. Geotextile shall be placed on the prepared surface for the full width of the area to be treated. In areas where longitudinal underdrain is to be placed, the geotextile shall be placed up to the edge of the proposed longitudinal underdrain trench, but shall not be placed where the trench is to be excavated.

The geotextile shall be unrolled on the grade parallel to the base line without dragging it across the grade. Wrinkles and folds in the geotextile shall be removed by stretching and pinning.

The geotextile shall be overlapped a minimum of 30 in. at roll edges and ends. Overlaps at the end of the roll shall be in the direction of aggregate placement with the roll being covered on top of the next roll. Roll ends and roll end overlaps shall be pinned a minimum of 5 ft on center. Roll edges and roll edge overlaps shall be pinned a minimum of 50 ft on center.

For curves the geotextile shall be folded or cut and overlapped in the direction of the turn. Folds in the geotextile shall be pinned a minimum of 5 ft on center. Damaged geotextile shall be repaired or replaced immediately as directed by the Engineer at no additional cost to the Administration. Geotextile patches shall be overlapped a minimum of 3 ft into undamaged geotextile.

Traffic, including construction equipment, is prohibited on the bare geotextile.

211.03.04 Aggregate Placement. Placement of the graded aggregate base shall be in conformance with Section 501 with the following exceptions:

(a) Placement and Spreading. Aggregate shall be placed within three working days of geotextile placement. The graded aggregate base shall be placed as a single lift in the thickness required to provide the specified compacted depth. The graded aggregate base shall be placed by end dumping and spreading. Construction shall be parallel to the base line. Turning of construction equipment on the graded aggregate base shall be kept to a minimum.

(b) Density Requirements. Immediately after placement, the graded aggregate base material shall be compacted to the required density. The top 6 in. of the graded aggregate base shall be compacted to a minimum density of 95 percent of maximum dry density with a moisture content equal to optimum moisture content ± 2 percent, unless otherwise directed by the Engineer. The optimum moisture content and maximum dry density shall be determined in conformance with T 180. In-place density shall be measured as specified in MSMT 350 or 352. Compaction requirements will be waived for the graded aggregate base material below the top 6 in.

(c) Vibration. Graded aggregate base shall not be vibrated unless otherwise specified or directed by the Engineer.

211.04 MEASUREMENT AND PAYMENT. Geosynthetic Stabilized Subgrade Using Graded Aggregate Base will be measured and paid for at the Contract unit price per cubic yard. The payment will be full compensation for furnishing and placing the geotextile and graded aggregate base, compaction, test strip, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Excavation will be measured and paid for in conformance with Section 201.

CATEGORY 300
DRAINAGE

SECTION 301 — CLASS 3 EXCAVATION FOR INCIDENTAL CONSTRUCTION

301.01 DESCRIPTION. This work shall consist of excavation below the planned elevation as specified in the Contract Documents or as directed by the Engineer.

301.02 MATERIALS. Not applicable.

301.03 CONSTRUCTION. The area to be excavated shall be the size, depth and location as authorized by the Engineer. Backfill shall conform to Section 302. Refer to 402.03.01 for excavated material.

301.04 MEASUREMENT AND PAYMENT. Class 3 Excavation for Incidental Construction will be measured and paid for at the Contract unit price per cubic yard. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Backfill. Backfill will be measured and paid for as specified in 302.04.

SECTION 302 — SELECTED BACKFILL

302.01 DESCRIPTION. This work shall consist of placing selected backfill material as specified in the Contract Documents or as directed by the Engineer.

302.02 MATERIALS.

No. 57 Aggregate	901.01
Crusher Run Aggregate CR-6	901.01

302.03 CONSTRUCTION. Unsuitable foundation material shall be replaced as directed by the Engineer. Refer to Section 210 for compaction.

302.04 MEASUREMENT AND PAYMENT. Selected Backfill using No. 57 Aggregate or Selected Backfill using Crusher Run Aggregate CR-6 will be measured and paid for at the Contract unit price per cubic yard. The payment will be full compensation for compaction

and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 303 — PIPE CULVERTS

303.01 DESCRIPTION. This work shall consist of placing the size and type of pipe on a firm bed to the specified line and grade and cleaning the existing pipes as specified in the Contract Documents or as directed by the Engineer.

303.02 MATERIALS.

Selected Backfill	302.02
Concrete Mix No. 2	902.10
Pipe	905

303.03 CONSTRUCTION. Pipe lengths and gradients shall be verified by the Contractor and shall be acceptable to the Engineer before installation.

End walls, when visible from the roadway, shall be constructed parallel to the roadway and askew pipe shall protrude through the end wall. End walls, not visible from the roadway, shall be constructed normal to the center line of the pipe.

The existing pipes shall be cleaned and the material disposed of as directed by the Engineer.

303.03.01 Excavation. When a pipe is to be laid on existing ground, on or under fill, embankment shall be constructed to a height of at least 9 in., but not more than 3 ft above the proposed top of the pipe. The trench shall then be excavated to receive the pipe. The width of trench shall be sufficient to permit thorough tamping of the backfill under the haunches and around the pipe. This width shall be twice the outside diameter of the pipe or the outside diameter plus 18 in. on each side, whichever is less. Refer to 402.03.01 for excavated material.

303.03.02 Bedding. When rock is encountered, it shall be removed and replaced with a minimum 8 in. of selected backfill as directed by the Engineer.

When unsuitable foundation material is encountered, it shall be removed and replaced with selected backfill for the full width of the trench as directed by the Engineer.

Culverts 48 in. or more in nominal horizontal diameter shall be bedded in an approved foundation shaped by means of a template which will support the pipe for at least 10 percent of its overall height.

303.03.03 Installation. Pipes shall be laid with hubs upgrade. A single lay hole through the shell of the pipe will be permitted with an approved lifting device. The lay hole shall be cast in the pipe during fabrication or cored without damaging any reinforcement. After installation, the lay hole shall be permanently sealed by filling with mortar, rubber plug, or other means approved by the Engineer. Wood plugs are prohibited.

303.03.04 Joints. Pipe joints shall be sealed in a manner appropriate to the pipe material.

Reinforced Concrete Pipe. Joints shall be sealed with rubber type gaskets (circular pipe) or resilient type material (elliptical pipe) conforming to M 198. Mortar joints are prohibited.

Metal Pipe. Joints shall be sealed with rubber gaskets and coupling bands conforming to M 36.

Plastic Pipe. Joints shall be integral bell and spigot with rubber or neoprene gaskets conforming to F 477.

303.03.05 Pipe Connections. Pipe connections may be either prefabricated or constructed in the field. Corrugated pipe sections shall be butted together and the sections joined with an approved band. A field pipe connection shall include cutting a hole in one pipe, inserting and trimming the connecting pipe and placing a concrete collar using Concrete Mix No. 2 at the connection. In the case of corrugated pipes, a welded connection may be substituted for the concrete collar.

303.03.06 Pipe Encasement. When specified in the Contract Documents or when directed by the Engineer, pipes shall be encased using Concrete Mix No. 2.

303.03.07 Backfill. Earth for backfill shall be free from large lumps, clods, and rocks and shall be placed along the side of the pipe for the full width of the trench in layers not exceeding 6 in. uncompacted depth. Compaction shall conform to Section 210. Each layer shall be compacted simultaneously on both sides of the pipe by means of an approved mechanical tamper. Special care shall be taken to compact the backfill thoroughly under the haunches of the pipe. This method of filling and compaction shall continue until the backfill is completed to a minimum height of 9 in. above the top of pipe. The Contractor shall protect all pipe from damage due to construction equipment or other vehicular traffic passing over the pipe.

Backfill may be placed immediately after laying the pipe, provided that all joints have been sealed as specified.

303.03.08 Removal of Existing Pipe Culverts. When specified in the Contract Documents, existing pipe culverts shall be removed and become the property of the Contractor. Backfilling of trenches resulting from pipe removal shall conform to Section 210.

303.03.09 Relaying Existing Pipe. When specified in the Contract Documents, removed culverts shall be salvaged and relaid in conformance with these Specifications relating to new pipe.

303.03.10 Abandoned Pipes. When specified in the Contract Documents or when directed by the Engineer, abandoned pipes shall be plugged using Concrete Mix No. 2 or brick masonry.

303.04 MEASUREMENT AND PAYMENT. The payment for the items specified in the Contract Documents will be full compensation for all applicable excavation, sheeting, shoring, dewatering, hauling, invert paving, storing, rehandling of material, removal and disposal of excess and unsuitable material, tamped fill, forming bed or foundation, backfill, compaction and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

303.04.01 New pipe culverts will be measured complete in place and paid for at the Contract unit price per linear foot. When a new pipe is to be installed at the same location as an existing pipe, the cost of removal and disposal of the existing pipe, including end walls and end sections, will not be measured but the cost will be incidental to the Contract price of new pipe.

303.04.02 Pipe Connections and Elbows will be measured and paid for at the Contract unit price per each. No deduction from the pipe measurement will be made for pipe connections.

303.04.03 Excavation required below the planned elevation will be measured and paid for as specified in 301.04.

303.04.04 Removal of Existing Pipe will be measured and paid for per the total number of linear feet removed, regardless of the condition. When a multiple pipe installation is removed, each pipe will be measured and paid for. End walls, end sections, etc. removed with the pipe will not be measured but the cost will be incidental to the Contract price.

303.04.05 Selected backfill will be measured and paid for as specified in Section 302.

303.04.06 Relaid Existing Pipe Culverts-Any Size will be measured and paid for as specified in 303.04.01 unless otherwise specified in the Contract Documents.

303.04.07 New end walls, end sections, etc., will be measured and paid for as specified in Section 305.

303.04.08 Removal of existing headwalls, end sections, etc., that are not incidental to the Contract price for the respective pipe items will be measured and paid for as specified in Section 207.

303.04.09 Encasement concrete, and concrete or brick masonry to plug existing pipes will be measured and paid for at the Contract price for the pertinent Concrete Mix No. 2 for Miscellaneous Structures, or Brick Masonry for Miscellaneous Structures item.

303.04.10 Clean Existing Pipe Any Size will be measured and paid for at the Contract unit price per linear foot.

SECTION 304 — STRUCTURAL PLATE PIPE AND STRUCTURAL PLATE PIPE ARCH CULVERTS

304.01 DESCRIPTION. This work shall consist of furnishing and installing structural plate pipe and structural plate pipe arch culverts that are composed of curved plates bolted together in the field as specified in the Contract Documents or as directed by the Engineer.

304.02 MATERIALS.

Selected Backfill	302.02
Concrete Mix No. 2	902.10
Structural Plate for Pipe and Pipe Arches	905

304.03 CONSTRUCTION.

304.03.01 Fabrication. The plates, including required holes, shall be shop fabricated to the required dimensions. The plates shall be shipped complete with proper markings and include all necessary connection devices such as bolts, nuts and washers. The Contractor shall provide working drawings, including erection diagrams and strutting tables acceptable to the Engineer. Erection diagrams shall include proposed lengths and lifting locations of preassembled sections. Fabrication shall not be performed until working drawings are approved by the Engineer.

The plate configurations shall have radii and curvature conforming to AASHTO Standard Specifications for Highway Bridges. When bottom plates are specified to be thicker than top and side plates, the thicker plates for circular pipes shall cover at least 25 percent of the periphery of the circle. For pipe arches, the thicker plates shall include corner plates as well as bottom plates. These culverts shall be laid on a firm bed true to line and grade as specified in the Contract Documents.

Bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in rows 2 in. apart, with one row in the valley and one in the crest of the corrugations unless otherwise specified in the Contract Documents. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12 in. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than 1/8 in.

Edges shall be shop cut to line and grade and shall be free from oxide and burrs. Connections shall be staggered so that no more than three plates come together at any one point. Plates shall be formed to provide lap joints.

304.03.02 Excavation. When a structural plate pipe or structural plate pipe arch is to be laid on existing ground, on or under fill, embankment shall be constructed to a height of at least 18 in., but not more than 3 ft above the proposed top of the pipe. The trench shall then be excavated to receive the pipe. The width of trench shall be sufficient to permit thorough tamping of the backfill under the haunches and around the pipe. This width shall be twice the outside diameter of the pipe or the outside diameter plus 18 in. on each side, whichever is less. Refer to 402.03.01 for excavated material.

304.03.03 Foundation Preparation. Bedding shall conform to 303.03.02. Rails shall be set and the foundation screeded to be coincidental with the exact shape of the bottom plates, and the screeding shall be done immediately prior to erection.

304.03.04 Erection. When strutting is required, it shall be uniform from end to end. Struts shall be left in place until backfills are completed. Nuts and bolts shall be tightened between 100 and 200 ft·lb of torque.

When washers are specified, they shall be placed under the turned element. Bolts shall first be distributed over the section being assembled and holes made to align by shifting the plates. For bottom plates, the nuts shall be inside the structure. Nuts shall not be drawn tight until the section is assembled. Before backfilling, all nuts shall be finally tightened and tested to ensure compliance with torque requirements.

304.03.05 Backfill. Earth for backfill shall be free from large lumps, clods, and rocks and shall be placed along the side of the pipe for the full width of the trench in layers not exceeding 6 in. uncompacted depth. Compaction shall conform to Section 210. Each layer shall be compacted on both sides of the pipe by means of an approved mechanical tamper. Special care shall be taken to compact the fill thoroughly under the haunches of the pipe.

The backfill shall be elevated uniformly along each side of the structure to a height of not less than 18 in. above the top of the structure. For structures without headwalls, backfill shall start in the center of the structure. If the structure includes headwalls or spandrel walls, backfilling operations shall start at one wall and extend toward the opposite side. When batteries or multicell installations are specified, backfill between cells shall be elevated equally on each side of each cell.

No trucks or construction equipment shall be allowed to pass over any part of a structural plate pipe structure until the backfill has been completed and tamped up to a height of not less than 18 in. above the structure.

304.03.06 Concrete Invert. When specified in the Contract Documents, the invert of structural plate pipe or structural plate pipe arch culverts shall be paved using Concrete Mix No. 2. The concrete shall be placed and cured as specified in Section 420.

304.03.07 End Treatment. Ends of structural plate pipes and structural plate pipe arches shall be shop fabricated on a bevel to fit and be flush with the slope and alignment of the surface through which they protrude, except that where an end wall or masonry slope protection is specified, the ends of the structural plates shall then be shop fabricated to fit that construction. The ends of all structural plate pipes and structural plate pipe arches that require an end treatment (end wall or slope protection) shall contain hook bolts for anchorage into the concrete.

Headwalls for structural plate pipes and pipe arches shall conform to Section 305 and unless otherwise specified, shall be constructed parallel to the proposed outer edge of the roadway shoulder.

304.04 MEASUREMENT AND PAYMENT. The payment for the items specified in the Contract Documents will be full compensation for all applicable fabrication, assembly, excavation, sheeting, shoring, strutting, dewatering, hauling, invert paving, storing, rehandling of material, removal and disposal of excess and unsuitable material, tamped fill, foundation preparation, backfill, compaction and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

304.04.01 Structural Plate Pipe and Structural Plate Pipe Arch Culverts will be measured and paid for at the Contract unit price per linear foot. Measurement will be as follows: measure the top length and the bottom length and average. The average length will be the pay length for each pipe in the structure. For multiple pipes, the length will be totaled to obtain the total pay length.

304.04.02 Excavation required below the planned elevation will be measured and paid for as specified in 301.04.

304.04.03 Selected backfill will be measured and paid for as specified in Section 302.

304.04.04 Headwalls will be measured and paid for as specified in Section 305.

SECTION 305 — MISCELLANEOUS STRUCTURES

305.01 DESCRIPTION. This work shall consist of constructing miscellaneous cast-in-place concrete or masonry structures, installing precast concrete or polyethylene (PE) structures, and cleaning existing inlets as specified in the Contract Documents or as directed by the Engineer.

305.02 MATERIALS.

Mortar Sand	901.01
Curing Materials	902.07
Concrete Mix No. 2, No. 3 or No. 6	902.10
Grout	902.11
Brick	903.02
PVC and PE Pipe	905
Reinforcement Steel	908
Steel	909.02
Castings for Frames, Covers, Gratings and Steps	909.04
Polyethylene (PE) Manholes	921.10
Zinc Coating	A 153
Stone	M 43 Size No. 57
Precast Concrete End walls, Inlets, and Manholes	M 199

305.03 CONSTRUCTION. Refer to Section 420 for portland cement concrete, Section 463 for brick masonry, and 402.03.01 for excavated material.

305.03.01 Construction Sequence. Underground drainage structures shall be completed before roadway surfacing is placed. Manholes, catch basins and inlets shall not be completed to final grade until the grading has been finished and all necessary arrangements have been made to ensure suitable connections and tie-ins at proper grade and alignment with pavements, gutters and curbs.

PE manholes shall be installed as recommended by the manufacturer.

305.03.02 Castings. Frames for grates and covers for inlets and manholes, except PE manholes, shall be set in full beds of mortar and rigidly secured in place to proper grade and alignment as specified in the Contract Documents.

305.03.03 Pipe Connections. Inlet and outlet pipes at drainage structures shall be set or cut flush with the inside faces of the structures and shall extend a sufficient distance beyond the outside faces of these walls to provide ample room for making proper connections. The joint around the pipe in the structure wall shall be completely and neatly closed with mortar or other specified materials.

305.03.04 Inverts. Drainage structures containing two or more pipes shall have channeled inverts conforming to the Contract Documents.

305.03.05 Drainage Structures. Inlets and manholes shall contain two 8 in. minimum diameter blockouts for underdrains. The drainage structures shall be backfilled with No. 57 aggregate for a width of 1.5 ft outside of the structure and extend from the bottom of the structure to the subgrade.

305.03.06 Precast Drainage Structures. Working drawings for structures not detailed in the Contract Documents shall be submitted to the Engineer for approval prior to fabrication.

Certification. Certification from the manufacturer for each shipment of precast units is required. A copy of the certification shall be delivered to the Engineer, the Laboratory, and the Contractor with each shipment. One copy shall remain at the plant. The certification shall contain the name and address of the manufacturer, the type of structure, the identification number, the date of manufacture, the date of shipment, a statement indicating conformance with the Specifications, and the signature of the quality control manager. Noted on the unit shall be the station number and designation, the identification number, the name or

trademark of the manufacturer, the date manufactured, and a stamp indicating conformance with the Specifications.

No precast unit shall be shipped unless it has been tested and is shown to be in full compliance with the Contract Documents.

The placement and consolidation of the required bedding under the unit shall be a minimum 6 in. of No. 57 aggregate unless otherwise directed by the Engineer.

305.03.07 Clean Existing Inlets. The existing inlets shall be cleaned and the material disposed of as directed by the Engineer. If the existing grate has to be removed, it shall be replaced and anchored to the satisfaction of the Engineer.

305.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all excavation, concrete, masonry, special or precast units, reinforcement, ladder rungs, drip stones, No. 57 aggregate, underdrain stubs, frames, grates and covers, grade and slope adjustments, backfill and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

305.04.01 Standard Inlets and Manholes specified in the Contract Documents will be measured and paid for at the Contract unit price per each. When a structure exceeds the standard minimum depth specified in the Contract Documents, an additional payment will be made for the excess depth at the Contract unit price per linear foot for the pertinent Vertical Depth item.

305.04.02 Standard End Walls, Headwalls, End Sections and Special Structures will be measured and paid for at the Contract unit price per each.

305.04.03 Nonstandard End Walls and other miscellaneous structures such as steps, spring boxes, and junction boxes, constructed using brick masonry or concrete will be measured and paid for at the Contract unit price per cubic yard unless otherwise specified in the Contract Documents.

305.04.04 No separate or additional measurement will be made for any precast concrete units, metal or castings used in the construction of any of the items noted above.

305.04.05 Cleaning Existing Inlets will be measured and paid for at the Contract unit price per each, regardless of type, size, or depth of the inlet.

305.04.06 When an existing drainage structure is to be removed and replaced with a new drainage structure in the same location, the cost to remove the existing drainage structure and a section of the existing pipe will be incidental to the cost of the new drainage structure.

SECTION 306 — UNDERDRAINS, SUBGRADE DRAINS, AND SPRING CONTROL

306.01 DESCRIPTION. This work shall consist of constructing underdrains, subgrade drains, underdrain for spring control, underdrain pipe outlets, and blind drains using pipe, geotextile, and granular material as specified in the Contract Documents or as directed by the Engineer. Cleaning existing underdrain outlets is also included in this work.

306.02 MATERIALS.

No 57 Aggregate	901.01
Concrete Mix No. 2	902.10
Pipe	905
Geotextile, Class as specified	921.09
Securing Pins or Staples	921.09
Flexible Delineator Post and Rodent Screens	As approved by the Office of Materials and Technology

306.03 CONSTRUCTION. The Contractor shall coordinate the field installation of traffic barrier, signs, lighting, and landscaping with the Engineer to avoid any damage to the underdrains, subgrade drains, or outlet pipes. Any damage to the underdrains, subgrade drains, or outlet pipes shall be corrected to the satisfaction of the Engineer.

306.03.01 Excavation. Trenches shall be excavated to the dimensions and grade specified in the Contract Documents or as directed by the Engineer. The sides and bottom of trenches shall be smooth and uniform to prevent tearing of the geotextile when backfilling. Refer to 402.03.01 for excavated material.

306.03.02 Geotextile. Geotextile, when specified, shall be placed in conformance with the Contract Documents. The machine direction of the geotextile shall be parallel to the longitudinal direction of the trench. The geotextile shall be of sufficient width to completely enclose the underdrain trench including any specified overlaps.

The geotextile shall be placed tightly against the underdrain trench to eliminate voids beneath the geotextile. Wrinkles and folds in the

geotextile shall be avoided, except when changing trench direction. A minimum 24 in. overlap at the geotextile joint ends or breaks shall be maintained. Geotextile joints and overlaps shall be pinned to securely hold the geotextile in place until placement of the cover material. Longitudinal joints, overlaps, and edges shall be pinned a minimum of 50 ft on center.

Damaged geotextile shall be replaced or repaired as directed by the Engineer at no additional cost to the Administration.

306.03.03 Pipe Placement. Underdrain pipe shall be placed in conformance with the Contract Documents. The slope of the underdrain pipe shall be so that positive drainage toward the underdrain outlet is maintained. Perforated pipes shall be placed with the perforations down and arranged symmetrically about the vertical axis. The ends of trunk lines, wye, tee, or ell laterals shall be plugged as directed by the Engineer. Joints and connections shall be in conformance with the manufacturer's recommendations.

306.03.04 Outlets. Underdrain outlets shall be constructed in conformance with the Contract Documents.

Underdrains shall be outletted into drainage structures whenever possible. Outlets that empty into a drainage structure shall be positioned a minimum of 6 in. above the normal flow level in the structure and shall be constructed of normal underdrain pipe. A minimum of 18 in. of cover over the pipe shall be maintained. A rodent screen is not required when an underdrain is outletted into a drainage structure.

When outletted to a slope or ditch, the outlet pipe shall slope a minimum of three percent unless otherwise directed by the Engineer. Pipe used for outlets shall be plain, rigid polyethylene (PE), or plain, rigid polyvinyl chloride (PVC) as specified in Section 905. Flexible tube type PE or PVC pipe is prohibited. Geotextile is prohibited for underdrain outlets. A sloped concrete headwall with a removable rodent screen shall be constructed at the end of the outlet pipe in conformance with the Contract Documents. A flexible delineator post shall be placed on the slope headwall unless otherwise directed by the Engineer.

Outlets for longitudinal underdrains shall be spaced at 250 ft maximum intervals, unless otherwise directed by the Engineer, and at the lowest elevation on all vertical curves. When changing the direction of the longitudinal underdrain or outlet pipe, all bends in the pipe shall have a minimum radius of 3 ft to facilitate future cleaning.

306.03.05 Backfill. Trenches shall be backfilled to the dimensions and grades specified in the Contract Documents. Underdrain and outlet

trenches shall be backfilled as the work progresses unless otherwise directed by the Engineer.

(a) Underdrain. Aggregate backfill shall be lightly tamped and screened or raked to provide proper thickness and grade.

(b) Outlets. Backfill shall conform to Section 210.

The Contractor shall replace any geotextile, underdrain pipe, or outlet pipe damaged by excessive tamping.

Longitudinal underdrain shall be covered with the next pavement layer within 72 hours. All other underdrain shall be covered within 48 hours. The Contractor shall protect underdrain, including the geotextile, from contamination by soil fines. Any underdrain trench that becomes contaminated, and any geotextile that becomes clogged, shall be replaced or repaired as directed by the Engineer at no additional cost to the Administration.

306.03.06 Video Inspection and Acceptance. All new longitudinal underdrain and outlets shall be video inspected by the Contractor in the presence of the Engineer as part of final acceptance. When any damage is found it shall be corrected to the satisfaction of the Engineer at no additional cost to the Administration.

306.03.07 Cleaning Existing Outlets. Existing underdrain pipe outlets shall be cleaned and the material disposed of as directed by the Engineer. Existing rodent screens shall be removed and replaced and, where there are no screens, rodent screens shall be installed as directed by the Engineer.

Existing rodent screens damaged due to the Contractor's negligence shall be replaced at no additional cost to the Administration.

306.03.08 Permanent Subgrade Drains. Permanent subgrade drains shall be required when specified in the Contract Documents or as directed by the Engineer. Subgrade drains shall consist of trenches excavated through the shoulder and roadside grading from the edges of the road pavement to a side ditch, embankment slope, or other approved outlet and filled with aggregate. Locations, unless otherwise specified, shall be at low points and shall be spaced at 25 ft intervals for a distance of 125 ft on each side of the low point, then at intervals of 100 ft to within 125 ft of the high point. Before placing the road pavement and before completion of the shoulder paving or final roadside grading areas, trenches shall be cut and shaped 24 in. wide, backfilled to underside of shoulder material and to the underside of specified topsoil thickness in the roadside grading area using size No. 57 aggregate. The portion of the trench within the

roadside grading area shall be completely wrapped in geotextile. The bottom of the trench at the end adjacent to the road pavement shall be at least 2 in. below the subgrade unless otherwise directed by the Engineer.

306.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all excavation, pipe, coupling bands, aggregate, backfill, geotextile, video inspection and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

306.04.01 Underdrains, Underdrain Pipe Outlets, Subgrade Drains, and Underdrain Pipe for Spring Control will be measured and paid for at the Contract unit price per linear foot.

Slope headwalls, rodent screens, and marker posts will not be measured but will be incidental to the cost of the Underdrain Outlet.

306.04.02 When an underdrain pipe is not used for spring control, all excavation and backfill for spring control will be measured and paid for at the Contract unit price per cubic yard for Class 3 Excavation for Incidental Construction and Aggregate Backfill for Underdrain.

306.04.03 When directed by the Engineer, excavation for underdrains, subgrade drains, and underdrain for spring control required to lower the trench to an elevation deeper than specified in the Contract Documents will be measured and paid for at the Contract unit price per cubic yard for Class 3 Excavation for Incidental Construction and Aggregate Backfill for Underdrain.

306.04.04 When measuring the length of a manufactured connection (tee, elbows, etc.) other than coupling bands, each actual linear foot will be doubled and payment made at the Contract unit price per linear foot for the appropriate underdrain pipe item specified in the Contract Documents.

306.04.05 Cleaning Existing Underdrain Outlets will be measured and paid for at the Contract unit price per each. The payment will be full compensation for locating outlets, removing and replacing the existing rodent screens, removal and disposal of material removed from the pipe, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 307 — PREFABRICATED EDGE DRAINS

307.01 DESCRIPTION. This work shall consist of constructing a prefabricated edge drain system and underdrain pipe outlets as specified In the Contract Documents.

307.02 MATERIALS.

Outlet Pipe	905
Select Borrow	916
Prefabricated Edge Drain and Fittings	922

307.03 CONSTRUCTION. Prefabricated edge drains shall be installed in conformance with the manufacturer's recommendations. Drains with support on only one side shall have the support side placed away from the pavement edge. Refer to 402.03.01 for excavated material.

307.03.01 Trenches For Prefabricated Edge Drains. Trenches shall be excavated with a trencher and shall be as narrow as possible yet wide enough to allow insertion of the prefabricated edge drains at the required elevation. The maximum width of the trench shall be 10 in. The exposed edge of the pavement shall be free of soil to ensure direct contact between the drain and pavement. The excavation of the trench, placement of the edge drain, and placement of the first lift of backfill shall be accomplished in a single continuous operation, unless otherwise directed by the Engineer.

307.03.02 Splices. Splices shall be made prior to placement of the prefabricated edge drain in the trench and in conformance with the manufacturer's recommendations. All splices shall be as approved by the Engineer.

Solid, Central Cores (unconnected two sided flow). Crossover couplings shall be used at all splices and at 200 ft intervals.

307.03.03 Connections to Outlets. The prefabricated edge drain shall be connected to the outlets using fittings recommended by the manufacturer.

Outlets shall be spaced at 200 ft intervals and at the lowest elevation on all vertical curves. Outlets shall be constructed in conformance with 306.03.04.

307.03.04 Backfilling of Trenches. Unless otherwise specified in the Contract Documents, material for backfilling trenches shall be the

material generated from the trenching operation, as approved by the Engineer. Additional backfill material, if needed, shall conform to Select Borrow.

Backfilling shall be completed in two layers with the first layer being placed simultaneously with the drain, holding the drain flush against the side of the pavement. Backfill material shall be compacted using a vibratory shoe compactor.

307.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for excavation, backfill, compaction, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

307.04.01 Prefabricated Edge Drains and Outlet Pipe will be measured and paid for at the Contract unit price per linear foot.

307.04.02 Additional backfill material authorized by the Engineer will be measured and paid for at the Contract unit price per cubic yard for Select Borrow Excavation.

SECTION 308 — EROSION AND SEDIMENT CONTROL

308.01 DESCRIPTION. This work shall consist of the application of erosion and sediment control measures throughout the life of the project to control erosion and to minimize the sedimentation in rivers, streams, lakes, reservoirs, bays, and coastal waters as specified in the Contract Documents or as directed by the Engineer.

Erosion and sediment control measures shall be applied to all disturbed areas. In addition, the Contractor shall identify all staging and stockpile areas and apply erosion and sediment control measures as approved by the Engineer and the Maryland Department of the Environment (MDE).

The Contractor shall assign an employee to the project to serve in the capacity of Erosion and Sediment Control Manager (ESCM).

308.01.01 Standards and Specifications. The erosion and sediment control measures and devices shall be constructed in conformance with the latest Maryland Standards and Specifications for Soil Erosion and Sediment Control published by the Maryland Department of the Environment, Water Management Administration and all revisions thereof including the additions and modifications specified herein or in the Contract Documents. The Contractor shall keep a copy of the latest

MDE Standards and Specifications for Soil Erosion and Sediment Control on the site at all times.

308.01.02 Quality Assurance Ratings. All Administration projects will be inspected by an independent Quality Assurance Inspector assigned to the Construction Inspection Division to ensure compliance with the approved Erosion and Sediment Control Plan. Projects will be inspected biweekly at a minimum and be given one of the following ratings:

Rating A. All temporary and permanent design controls are properly installed prior to any earth disturbing activities. Stabilization is provided within the period specified. Corrective actions are taken within 24 hours. Maintenance of controls is significantly above the minimum acceptance standards. Project needs no further attention at the time of inspection. Controls functioned as intended during the last storm. Controls are expected to function adequately during the next storm event. The Contractor exhibits initiative in establishing and maintaining the controls.

Rating B. Controls are installed at the proper intervals in conformance with the Contract Documents. Controls are functioning as intended. Stabilization is in conformance with the time specified. Some maintenance may be required. Controls functioned as intended during the last storm, and controls are adequate to handle the next storm event. Corrective actions are taken within 48 hours.

Rating C. Controls are installed in conformance with the Contract Documents. Maintenance of controls is in conformance with minimum requirements. Stabilization requirements are being adhered to only when enforced, placing a burden on the controls. There is a good chance of controls failing during the next storm event. Stabilization of disturbed areas needs improvement. Constant monitoring is necessary. Conditions for a shut down could arise quickly.

Rating D. Controls are installed, but some are not in conformance with the Contract Documents. Maintenance of more than half of the controls is needed. Stabilization is not within the time specified. Little or no stabilization is being done. The controls will likely fail during the next storm event. The Contractor is not responsive to requests for corrective action. Corrective actions begin after five working days, if at all. Grading and related operations will be shut down by the Administration.

Rating F. Some controls have been installed. Installation and stabilization requirements are not in conformance with the Contract Documents. Controls are not maintained. The Contractor does not respond to requests for corrective action. There could easily be a major failure during the next storm event. The entire project will be shut down immediately.

Shutdowns. When the first grade of 'C' is given to a project, the Contractor shall make every effort to have all deficiencies corrected within a maximum of five working days. The project will be reinspected at the end of this period. If it is found that the deficiencies have not been satisfactorily corrected, a grade of 'D' will be given and all grading operations will be shut down until the project receives a 'B' rating.

If a consecutive 'C' rating is given for other deficiencies that arise and the original deficiencies were corrected, the Contractor will be alerted that their overall effort is marginal and a grading shut down is imminent if erosion and sediment control efforts do not substantially improve within five working days.

A third consecutive 'C' rating will result in a shut down of grading activities until the project receives a 'B' rating.

When a disregard for correcting these deficiencies is evident, a rating of 'F' will be given and the entire project will be shut down until the project receives a rating of 'B'.

Noncompliance Penalty. When a 'D' or 'F' is given to the project by the independent Quality Assurance Inspector, a monetary penalty, in addition to a shutdown, will be assessed for each day the project is in noncompliance. A rating of 'B' is required to suspend the daily monetary penalty and shutdown.

In extreme cases, where degradation to a resource could occur, or if the Contractor is unresponsive to direction to take corrective action, the Administration may elect to have these corrective actions taken by another contractor or by Administration maintenance staff. All costs associated with this work will be billed to the original Contractor in addition to the penalty.

The daily penalty specified in the Contract Documents will be assessed when a rating of 'D' is given. If a rating of 'F' is given, the daily penalty assessed for the 'D' rating will be doubled.

This penalty will be imposed until the project is reinspected and receives a 'B' rating. This penalty will run concurrent with the mandatory shutdowns outlined in the rating criteria.

308.02 MATERIALS.

Riprap	901.03
4 to 7 in. Stone	901.05
Hot Mix Asphalt	904
Pipe	905

Gabion Wire	906
Steel Plate	909.02
Welding Material	909.03
Fence Fabric for Super Silt Fence	914.01.01
Seed, Mulch, Fertilizer, Soil Conditioner, Soil Stabilization Matting, and Other Materials for seeding and soil stabilization	920
Straw Bales	921.08
Geotextile, Class as specified	921.09
2 to 3 in. Stone	M 43, No. 2
3/4 to 1-1/2 in. Stone	M 43, No. 4
No. 57 Stone	M 43, No. 57

Soil Stabilization Matting will replace Erosion Control Matting, and Geotextile Class SE will replace Filter Cloth and Geotextile Class C where they appear in the latest Maryland Standards and Specifications for Soil Erosion and Sediment Control.

308.03 CONSTRUCTION. Refer to 403.02.01 for excavated material.

308.03.01 Contractor Responsibilities. The Contractor shall construct all erosion and sediment control measures in conformance with 308.01.01. The Contractor shall have all control measures inspected and approved by the Engineer and MDE prior to beginning any other land disturbances. The Contractor shall ensure that all runoff from disturbed areas is directed to the sediment control measures. The Contractor shall not remove any erosion or sediment control measure without the approval of the Engineer and MDE. Refer to GP-7.12 for unforeseen conditions.

308.03.02 Erosion and Sediment Control Plan (E & S Plan) and Sequence of Construction. The Contractor shall implement the Administration's E & S Plan and Sequence of Construction as approved by MDE. Minor adjustments to the sediment control locations may be made in the field with the approval of the Engineer and MDE. Major revisions, deletions, or substitutions to the E & S Plan will require a formal review and approval by the Administration and MDE. Changes to the approved E & S Plan shall be submitted to the Administration in writing at least 14 days prior to implementing the change. The Contractor shall obtain Administration and MDE approval for changes to the E & S Plan or Sequence of Construction prior to implementing the change.

308.03.03 Erosion and Sediment Control Manager (ESCM). At least 10 days prior to beginning any work, the name and credentials of the ESCM shall be submitted to the Engineer for approval. Any substitutes for the ESCM will be subject to the approval of the Engineer. The

substitution shall be timed to ensure that an ESCM is assigned to the project at all times. The Administration reserves the right to request a reassignment of the ESCM duties to another individual for any reason.

The ESCM shall be thoroughly experienced in all aspects of construction and have satisfactorily completed an Erosion and Sediment Control Training Program either conducted or authorized by MDE pursuant to the appropriate article published in the Annotated Code for the State of Maryland. The ESCM shall have primary responsibility and authority for the implementation of the approved erosion and sediment control plans, schedules and methods of operation for both on-site and off-site activities.

The ESCM's duties shall include:

(a) Inspect the erosion and sediment controls on a daily basis to ensure that all controls are in place at all times and to develop a list of activities and schedules to ensure conformance with the Contract Documents.

(b) Maintain a daily log of these inspections, including actions taken, and submit a written report to the Engineer at the end of the work day.

(c) Conduct after storm inspections with the Engineer both during and beyond normal working hours/days and submit a written report to the Engineer.

(d) Be assigned the authority by the Contractor to mobilize crews to make immediate repairs to the controls during working and nonworking hours.

(e) When requested, accompany the Engineer on Quality Assurance Inspections and inspections made by the regulating agencies.

(f) Coordinate with the Engineer to ensure that all corrections are made immediately and that the project is in compliance with the approved plan at all times.

308.03.04 Schedule. Within 14 days after the Notice of Award, the Contractor shall submit for approval to the Administration and the MDE, an Erosion and Sediment Control Schedule to implement the E & S Plan. The schedule shall indicate the sequence of construction, implementation and maintenance of controls, temporary and permanent stabilization, and the various stages of soil disturbance. After the schedule is approved by the Administration, it will be forwarded to MDE for approval. The schedule shall include the following:

(a) Clearing and grubbing of areas necessary for installation of perimeter controls specified in the Contract Documents.

(b) Construction of perimeter controls specified in the Contract Documents.

(c) Remaining clearing and grubbing.

(d) Roadway grading (including off-site work).

(e) If applicable, utility installation and whether storm drains shall be used or blocked after construction.

(f) Final grading, landscaping, and stabilization.

(g) Removal of perimeter controls.

No work shall be started, on-site or off-site until the Erosion and Sediment Control schedules and methods of operation have been accepted by the Administration and MDE.

308.03.05 Preconstruction Conference. At the Preconstruction Conference, the Contractor shall present a general overview of how erosion and sediment control measures will be implemented on the project.

308.03.06 Meetings. At least seven working days prior to the start of work, the Engineer will initiate and conduct an Erosion and Sediment Control Field Meeting. The meeting shall be attended by the ESCM, and representatives of the Administration and MDE.

In addition to the initial Erosion and Sediment Control Field Meeting, periodic in-field Erosion and Sediment Control Meetings will be held to review and evaluate the effectiveness of measures already installed, and to plan for the implementation of necessary controls proposed for succeeding areas of soil disturbance.

308.03.07 Initial Controls. All perimeter controls such as silt fence, earth dikes/swales, check dams, traps, basins, etc., shall be installed prior to the grubbing operation. Typically no controls are required during the clearing operation.

If the Engineer determines that the clearing area has been disturbed and a potential for sediment runoff or erosion exists, the Engineer will direct the Contractor to install the controls at that time.

308.03.08 Stabilization Requirements. Areas flatter than 3:1 and stockpile areas shall be permanently or temporarily stabilized as soon as possible, but not later than fourteen days after grubbing and grading activities have ceased in the area. Trap embankments and slopes, earth dikes, temporary swales, perimeter dike/swales, ditches, and slopes 3:1 or steeper shall be permanently or temporarily stabilized as soon as possible, but not later than seven days after grubbing and grading activities have ceased in the area. The seven and fourteen day requirements mean that the stabilization operation is complete within the applicable seven or fourteen day time frame.

When the excavation or embankment reaches the bottom of the subgrade, those areas in which paving will be placed are exempt from the stabilization requirements. Areas between temporary berms, except median areas, need not be stabilized during incremental stabilization. When permanently stabilized areas are disturbed by the Contractor's grading operation or other activities not specifically approved by the Engineer, the restabilization will be at no additional cost to the Administration. Stabilization requirements may be reduced to less than seven days for sensitive areas. Maintenance shall be performed as necessary to ensure continued stabilization.

All slopes shall be tracked within five days of establishment with cleated type equipment operating perpendicular to the slope.

308.03.09 Maintenance. All erosion and sediment control devices shall be maintained during the construction season, the winter months, and other times when the project is shut down. Access shall be maintained to all erosion and sediment controls until the controls are removed. Lack of maintenance by the Contractor will be considered as noncompliance with the E & S Plan and grounds for a shutdown of the project.

Controls shall be inspected immediately following storm events. The Contractor shall repair controls when damaged and clean out controls as necessary as the first order of business after a storm event.

Any pumping activity, including dewatering sediment traps and basins, shall be directed through a dewatering device approved by MDE.

308.03.10 Waste Areas. Off-site waste areas on State or Federal property require MDE approval. All other off-site waste areas shall be approved by the appropriate Soil Conservation District for each county or the Baltimore City Department of Public Works. All waste areas and stockpile areas shall be protected by erosion and sediment control measures and stabilized within the seven or fourteen day stabilization requirement.

308.03.11 MDE Inspections. MDE will conduct frequent field inspections relative to erosion and sediment control compliance. If they determine that noncompliance with erosion and sediment control provisions are found, their representative will immediately notify the Engineer relative to corrective action. This corrective action may require a shutdown of construction activities until the noncompliance is satisfactorily corrected, and no claims against the Administration will be considered due to a shutdown of the grading operations or the entire project.

308.03.12 Side or Berm Ditches and Culverts. As a first order of work, the Contractor shall construct the side ditches in fill areas and berm ditches in cuts including lining. These linings shall be protected from sediment deposits. Silt fence shall be placed along the banks of existing streams as shown in the Contract Documents prior to any culverts being placed. To avoid sedimentation during the construction of culverts, the streams shall be diverted around the location of the culvert until the proposed culvert and channel have been stabilized.

308.03.13 Removal of Controls. No erosion and sediment control measures shall be removed until all previously disturbed areas are vegetated with a minimum 3 in. growth of grass, and the removal has been approved by the Engineer and MDE. The sediment controls shall be backfilled, graded, and stabilized as specified in the Contract Documents.

All control devices shall be removed, except where an attempt to remove a particular control may severely disturb an area that has been stabilized. When a sediment trap or stone outlet structure is placed at the bottom of a fill greater than 8 ft, the controls may be left in place as determined by the Engineer. Sediment traps left in place shall be stabilized by placing soil stabilization matting over a permanent seed mix.

308.03.14 Erosion And Sediment Control Original Excavation. The Contractor shall excavate, construct embankments, grade, and backfill for sediment traps, sediment basins, and other sediment controls as specified in the Contract Documents, or as directed by the Engineer.

Excavation and embankments shall be to the dimensions for each sediment control as specified in the Contract Documents. Excavated material shall be stockpiled and used for backfill when the sediment controls are removed.

308.03.15 Erosion and Sediment Control Cleanout Excavation. The Contractor shall remove accumulated sediment from sediment controls or other areas during routine maintenance of sediment controls, or as directed by the Engineer.

Sediment traps shall be cleaned out as necessary to have a minimum of 50 percent of the wet storage capacity available at all times. Riprap outlet sediment traps shall have at least 75 percent of the wet storage capacity available at all times. Silt fence, super silt fence, stone outlet structures, stone check dams, and straw bales shall have sediment removed when it reaches 50 percent of the height of the control device.

Sediment removed from control devices shall be placed in an approved waste site either on or off the project. Material stored on-site may be reused once it is dried and it conforms to Administration requirements for embankment.

308.03.16 Earth Dike. Stabilization using sod is prohibited.

308.03.17 Temporary Swale. Stabilization using sod is prohibited.

308.03.18 Perimeter Dike Swale. Stabilization using sod is prohibited.

308.03.19 Pipe Slope Drain. Interceptor berms shall be constructed to direct flow into the flared end section when slope drains are placed on grade. The geotextile apron shall be keyed into a 4 X 4 in. trench.

308.03.20 Riprap Inflow Protection. Gabions are prohibited.

308.03.21 Gabion Inflow Protection. Construction shall be in conformance with Section 313.

308.03.22 Stone Check Dam. Spacing shall be as specified in the Contract Documents or as directed by the Engineer.

308.03.23 Sediment Traps. Sediment traps shall be located and excavated to the length, width, and depth as specified in the Contract Documents. In areas of limited right-of-way, cut side slopes shall be as steep as soil conditions will allow.

At sites where infiltration devices are used for the control of storm water, every precaution shall be taken to prevent runoff from unstabilized areas from entering the infiltration devices during construction. Sediment control devices placed in infiltration areas shall have bottom elevations at least 2 ft higher than the finish grade bottom elevation of the infiltration device. When converting a sediment trap to an infiltration device, all accumulated sediment shall be removed and disposed of prior to final grading of the device.

When grading and paving operations have been completed and vegetation has been established on the slopes and channels to the satisfaction of the Engineer, the sediment traps shall be refilled with

suitable materials, shaped, and treated as specified in the Contract Documents, or as directed by the Engineer.

308.03.24 Stone Outlet Structure. The area beneath stone outlet structures shall be stabilized immediately after the removal of stone outlet structures.

308.03.25 Removable Pumping Station. The Contractor shall furnish the required standpipe, pump, hoses, and connections necessary to adequately dewater the site for construction activities. A pit shall be excavated to the dimensions required to construct the removable pumping station.

308.03.26 Sump Pit. The Contractor shall furnish the required standpipe, pump, hoses, and connections necessary to adequately dewater the site for construction activities. A pit shall be excavated to the dimensions required to construct the sump pit.

308.03.27 Portable Sediment Tank. The Contractor shall furnish the required pipe, pump, hoses, and connections necessary to adequately dewater the site for construction activities. The dimensions of the portable sediment tank shall be determined by the Contractor to provide the required storage volume per pump discharge.

308.03.28 Silt Fence. The geotextile shall be trenched a minimum of 8 in. into the ground and extend a minimum of 22 in. above ground.

Silt fence shall be removed and reset when and as directed by the Engineer. All of the requirements for the original placement of the silt fence shall be strictly adhered to when the fence is reset.

308.03.29 Inlet Protection. Inlet protection shall consist of the construction of standard inlet protection, at grade inlet protection, curb inlet protection, or median inlet protection.

308.03.30 Stabilized Construction Entrance. Stabilized construction entrances shall be located as specified in the Contract Documents or as directed by the Engineer.

Rehabilitate stabilized construction entrance shall consist of periodic top dressing with additional aggregate, replacement of pipe, or other repairs to the entrance and sediment trapping devices as needed or as directed by the Engineer.

308.03.31 Super Silt Fence. The construction requirements for the placement of the chain link fence shall be as specified in 607.03 with the following exceptions:

(a) Drive anchors shall be used when and as directed by the Engineer.

(b) The lower tension wire, brace and truss rods, post caps, 1 in. ground clearance, and concrete footings shall not be used.

Geotextile shall be embedded a minimum of 8 in. into the ground and extend a minimum of 33 in. above ground.

Super silt fence shall be removed and reset when and as directed by the Engineer. All of the requirements for the original placement of the super silt fence shall be strictly adhered to when the fence is reset.

308.03.32 Temporary Asphalt Berm. When a storm drain system outfall is directed to a sediment trap, or sediment basin, and the system is to be used for temporarily conveying sediment laden water, all storm drain inlets in nonsump areas shall have temporary asphalt berms constructed as directed by the Engineer at the time of base paving to direct gutter flow into the inlets to avoid surcharging and overflow of inlets in sump areas.

308.03.33 Straw Bales For Sediment Control. Straw bales shall be used for temporary control of erosion and sedimentation in side ditches or where the placement of a stone outlet structure is not practical. The use of straw bales in median ditches is prohibited.

Straw bales shall consist of undecayed firmly packed straw, approximate size 14 X 18 X 36 in. as prepared by a standard baling machine, and firmly bound by at least two separate circuits of rope or band material which will withstand weathering for the length of time the bale is functioning as a sediment control device. Binding tension on the baling machine shall be sufficient to produce a bale with voids no greater than the nominal thickness of the straw. The bales shall be embedded in soil to a depth of not less than 4 in. and shall be secured in place with two No. 4 reinforcement bars, steel pickets, or 2 X 2 in. wood stakes, 36 in. length. The bales shall be secured by locating the anchoring devices at approximate third points along the longitudinal center line of each bale and driving the anchoring device through the bale and into the ground to a depth of 1 to 1.5 ft.

308.03.34 Stone for Sediment Control. The Contractor shall place No. 57 stone, 3/4 to 1-1/2 in. stone, 2 to 3 in. stone, 4 to 7 in. stone, and riprap for sediment control as specified in the Contract Documents or as directed by the Engineer.

308.03.35 Maintenance Of Stream Flow. During all operations, the Contractor shall maintain the continuous flow of waterways for the locations indicated in the Contract Documents.

Upon completion of construction, and after temporary drainage devices have served their purpose, the devices shall be removed and disposed of in a manner acceptable to the Engineer.

When the Contract Documents include details for the continuous maintenance of stream flow during construction, a Temporary Stream Crossing Permit will not be required if the Contractor uses the Contract Documents and does no other work in the waterways. The Contractor may develop a different plan for maintenance of stream flow, but approval from the Engineer and a Temporary Stream Crossing Permit will be required in these cases. A Temporary Stream Crossing Permit may be obtained by the Contractor from the Maryland Department of the Environment - Water Management Administration, Permits Services Center.

The application for the permit shall include the following items:

(a) Permit Requirements.

(1) Sequence of construction phases such as channel and structure excavation, structure and embankment construction.

(2) Equipment crossings and storage areas.

(3) Methods of maintaining stream flow.

(4) Control of dewatering discharges.

(5) Control of runoff for various phases preceding permanent stabilization.

(6) Methods for controlling erosion and siltation of the waterway.

The Notice To Proceed with construction on the structures at the waterway will not be issued until all the necessary permits are approved and received.

The Contractor is alerted that the special conditions contained in the permit will control the time construction activity will be permitted in the stream.

The discharge of sediment laden water from newly excavated areas directly into the waterways is prohibited.

(b) Conditions. To minimize the effects of discharges of dredged or fill material, the following provisions required by the Department of the Army Nationwide Permit shall be adhered to:

(1) That the discharge will not be located in the proximity of a public water supply intake.

(2) That the discharges will not destroy a threatened or endangered species as identified under the Endangered Species Act, or destroy or adversely modify the critical habitat of these species. In the case of Federal agencies, it is their responsibility to review its activities to determine if the action may affect any listed species or critical habitat. If so, the Federal agency will consult with the Fish and Wildlife Service and the National Marine Fisheries Service.

(3) That the discharge will consist of suitable material free from toxic pollutants in toxic amounts.

(4) That the fill created by the discharge will be properly maintained to prevent erosion and nonpoint sources of pollutants.

(5) That the discharge will not occur in a component of the National Wild and Scenic River System.

(6) That the Management Practices listed herein shall be followed to the maximum extent practicable.

(c) Management Practices.

(1) Discharges of dredged or fill material into waters of the United States shall be avoided or minimized through the use of other practical alternatives.

(2) Direct discharge in spawning areas during spawning seasons are forbidden.

(3) Discharges shall not restrict or impede the movement of aquatic species indigenous to the waters or the passage of normal or expected high water flows or cause the relocation of the water (unless the primary purpose of the fill is to impound waters).

(4) If the discharge creates an impoundment of water, adverse impacts on the aquatic system caused by the accelerated passage of water or the restriction of its flow shall be minimized.

(5) Discharges in wetlands shall be avoided.

(6) When working in wetlands heavy equipment shall be placed on mats.

(7) Discharges into breeding and nesting areas for migratory waterfowl shall be avoided.

(8) All temporary fills shall be removed in their entirety.

308.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work. The maintenance, repair, resetting, and final removal of all erosion and sediment control devices will not be measured, but the cost will be incidental to the Contract price to construct the device unless otherwise specified in the Contract Documents.

308.04.01 Erosion and sediment control manager will not be measured but the cost will be incidental to Erosion and Sediment Control items specified in the Contract Documents.

308.04.02 The implementation of the Erosion and Sediment Control Plan by the Contractor will not be measured but the cost will be incidental to the Erosion and Sediment Control items specified in the Contract Documents.

308.04.03 Erosion and Sediment Control Original Excavation will be measured and paid for at the Contract unit price per cubic yard. The payment will also include excavation, backfill, and grading.

308.04.04 Erosion and Sediment Control Cleanout Excavation will be measured and paid for at the Contract unit price per cubic yard. The payment will also include excavation and disposal.

308.04.05 Earth Dikes will be measured and paid for at the Contract unit price per linear foot. When 4 to 7 in. stone, temporary seeding, and soil stabilization matting are required, they will be measured and paid for as specified in 308.04.25, 704.04, and 709.04, respectively.

308.04.06 Temporary Swales will be measured and paid for at the Contract unit price per linear foot. When 4 to 7 in. stone, temporary

seeding, and soil stabilization matting are required, they will be measured and paid for as specified in 308.04.25, 704.04, and 709.04, respectively.

308.04.07 Perimeter Dike/Swales will be measured and paid for at the Contract unit price per linear foot. When temporary seeding and soil stabilization matting are required, they will be measured and paid for as specified in 704.04 and 709.04, respectively.

308.04.08 Pipe Slope Drain will be measured and paid for at the Contract unit price per linear foot. The payment will also include excavation, backfill, flared end section, geotextile, anchors, coupling bands, and pipe elbows.

Outlet protection will be measured and paid for as specified in 308.04.25.

308.04.09 Riprap inflow protection as specified in 308.04.25.

308.04.10 Gabion inflow protection as specified in 313.04.

308.04.11 Stone check dam will be measured and paid for at the Contract price as specified in 308.04.25.

308.04.12 Sediment traps will be measured and paid for at the Contract unit price for one or more of the items listed below:

(a) Erosion and Sediment Control Original Excavation as specified in 308.04.04.

(b) Corrugated Metal Pipe per linear foot.

(c) Polyvinyl Chloride Pipe per linear foot.

(d) Stone as specified in 308.04.25.

(e) Inflow protection as specified in 308.04.09 and 308.04.10.

308.04.13 Stone outlet structure will be measured and paid for as specified in 308.04.25. The baffle board and stakes will not be measured but the cost will be incidental to the Contract price.

308.04.14 Removable Pumping Station will be measured and paid for at the Contract unit price per each. The payment will also include excavation, pipe, geotextile, wire mesh, steel plate, hose, pump, and connections.

No. 57 stone will be measured and paid for as specified in 308.04.25.

308.04.15 Sump Pit will be measured and paid for at the Contract unit price per each. The payment will also include excavation, pipe, geotextile, wire mesh, steel plate, hose, pump, and connections.

No. 57 stone will be measured and paid for as specified in 308.04.25.

308.04.16 Portable Sediment Tank will be measured and paid for at the Contract unit price per each. The payment will also include pipe, geotextile, wire mesh, steel plate, hose, pump, and connections.

308.04.17 Silt Fence will be measured and paid for at the Contract unit price per linear foot.

308.04.18 Remove and Reset Silt Fence will be measured and paid for at the Contract unit price per linear foot.

308.04.19 Inlet Protection will be measured and paid for at the Contract unit price per each.

308.04.20 Stabilized Construction Entrance and Rehabilitate Stabilized Construction Entrance will be measured and paid for at the Contract unit price per ton. When pipe is required, it will not be measured but the cost will be incidental to the Contract price.

308.04.21 Super Silt Fence will be measured and paid for at the Contract unit price per linear foot.

308.04.22 Remove and Reset Super Silt Fence will be measured and paid for at the Contract unit price per linear foot.

308.04.23 Temporary asphalt berm will be measured and paid for at the Contract unit price per ton of Hot Mix Asphalt. The removal of the temporary asphalt berm will not be measured but the cost will be incidental to the Contract price.

308.04.24 Straw Bales will be measured and paid for at the Contract unit price per linear foot measured along the approximate center line of the row of bales. Excavation and anchoring the straw bales will not be measured but the cost will be incidental to the Contract price.

308.04.25 Stone for sediment control will be measured and paid for at the Contract unit price per ton for the pertinent Stone for Sediment Control item. Geotextile, excavation, and backfill will not be measured but the cost will be incidental to the Contract price.

308.04.26 Maintenance of Stream Flow will not be measured but will be paid for at the Contract lump sum price. The payment will also include

diversion structures, sandbags, polyethylene sheeting, diversion pipes, pumps, hoses, and connections.

308.04.27 Temporary Wood Cellulose Mulch will be measured and paid for as specified in 704.04.02.

308.04.28 Temporary Seeding will be measured and paid for as specified in 704.04.01.

308.04.29 Seeding Roadside Areas will be measured and paid for as specified in 705.04.01.

308.04.30 Seeding Median Areas will be measured and paid for as specified in 705.04.02.

308.04.31 Overseeding Roadside Areas will be measured and paid for as specified in 705.04.05.

308.04.32 Overseeding Median Areas will be measured and paid for as specified in 705.04.06.

308.04.33 Sodding will be measured and paid for as specified in 708.04.01.

308.04.34 Temporary earth berms and interceptor berms for incremental stabilization will not be measured, but the cost will be incidental to the excavation items specified in the Contract Documents.

SECTION 309 — CONCRETE DITCHES

309.01 DESCRIPTION. This work shall consist of constructing concrete ditches and incidental toe walls as specified in the Contract Documents or as directed by the Engineer.

309.02 MATERIALS.

Crusher Run Aggregate CR-6	901.01
No. 57 Aggregate	901.01
Curing Materials	902.07
Form Release Compounds	902.08
Concrete Mix No. 2	902.10
Joint Sealer	911.01
Preformed Joint Filler	911.02
Borrow	916
Soil Stabilization Matting	920.06

309.03 CONSTRUCTION.

309.03.01 Excavation. Excavation and the preparation of the subgrade shall conform to Section 602. Refer to 402.03.01 for excavated material.

309.03.02 Forms. Forms shall be steel or wooden and shall conform to Section 603.

309.03.03 Concrete. Concrete mixing and placing shall conform to Section 603.

309.03.04 Joints. Maximum joint spacing shall be 15 ft. The joints shall be either bulkhead or weakened plane construction joints. Weakened plane joints shall be either tooled or sawed to a minimum depth of 3/4 in. Expansion joints shall be spaced a maximum of 90 ft and sealed.

309.03.05 Cold Weather Construction and Curing. Refer to 520.03.02 for cold weather construction and to 520.03.12 for concrete curing.

309.03.06 Backfill. After the forms have been removed, backfill shall be placed and compacted as directed by the Engineer.

309.03.07 When the existing concrete ditch is removed but not replaced, the area shall be regraded and stabilized as directed by the Engineer.

309.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all concrete, excavation, forms, backfill, curing, disposal of excess or unsuitable material, toe walls, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

309.04.01 Concrete Ditches will be measured and paid for at the Contract unit price per square yard.

309.04.02 The removal and disposal of unsuitable material below the subgrade will be measured and paid for at the Contract unit price per cubic yard for Class 2 Excavation. The payment will include the cost of replacing the unsuitable material with suitable material acceptable to the Engineer, except as specified in 309.04.03.

309.04.03 When Borrow or Selected Backfill using No. 57 Aggregate or Selected Backfill using Crusher Run Aggregate CR-6 is approved by the Engineer as replacement material for the Class 2 Excavation, it will be measured and paid for at the Contract unit price per cubic yard for the pertinent items as specified in the Contract Documents.

309.04.04 Concrete ditches removed but not replaced will be paid for at the Contract unit price per square yard. The payment will include the cost to dispose of the material, regrading, topsoil, and soil stabilization matting.

SECTION 310 — CONCRETE SLOPE AND CHANNEL PROTECTION

310.01 DESCRIPTION. This work shall consist of protecting slopes and channels with cast-in-place concrete and cutoff walls as specified in the Contract Documents or as directed by the Engineer.

310.02 MATERIALS.

Crusher Run Aggregate CR-6	901.01
No. 57 Aggregate	901.01
Curing Materials	902.07
Form Release Compound	902.08
Concrete Mix No. 2	902.10
Welded Steel Wire Fabric	908.05
Joint Sealer	911.01
Preformed Joint Fillers	911.02
Roofing Paper	911.07
Borrow	916

310.03 CONSTRUCTION.

310.03.01 Excavation. Excavation, including excavation for cutoff walls shall conform to Section 602. Refer to 402.03.01 for excavated material.

310.03.02 Cast-In-Place Concrete. Cast-in-place concrete slope protection shall be constructed in alternate strips so that construction joints are all in one direction and that tooled joints run perpendicular to the construction joints. The result shall be a checkerboard pattern having squares not less than 3 ft nor more than 5 ft. The size of the squares and the size of squares around curved surfaces shall be as directed by the Engineer. Joints and cutoff walls shall be constructed as specified in the Contract Documents or as directed by the Engineer.

310.03.03 Forms. Forms shall conform to Section 603.

310.03.04 Concreting. Concrete mixing shall conform to 915.03.04. Volumetric batching and continuous mixing will be permitted on this work. Areas subject to the infiltration of water shall be dewatered by

methods acceptable to the Engineer prior to placing the concrete. The concrete shall be spread, tamped or otherwise consolidated to secure maximum density as it is placed. It shall be struck off with an approved screed to the elevation of the top of the forms. The surface shall have a broomed finish. Plastering of the surface is prohibited. All edges and joints shall be edged with a 1/4 in. edging tool.

310.03.05 Cold Weather Construction and Curing. Refer to 520.03.02 for cold weather construction and to 520.03.12 for concrete curing.

310.03.06 Backfill. After the forms have been removed, backfill shall be placed and compacted as directed by the Engineer.

310.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all concrete, forms, excavation, curing, joint sealer and filler, backfill, compaction, disposal of excess or unsuitable material, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

310.04.01 Concrete Slope and Channel Protection and Concrete Slope Protection for Streams will be measured and paid for at the Contract unit price per square yard of finished surface.

310.04.02 Cutoff Walls will be measured and paid for at the Contract unit price per linear foot.

310.04.03 The removal and disposal of unsuitable material below the subgrade will be measured and paid for at the Contract unit price per cubic yard for Class 2 Excavation. The payment will include the cost of replacing the unsuitable material with suitable material acceptable to the Engineer except as specified in 310.04.04.

310.04.04 When Borrow or Selected Backfill using No. 57 Aggregate or Selected Backfill using Crusher Run Aggregate CR-6 is approved by the Engineer as replacement material for the Class 2 Excavation, it will be measured and paid for at the Contract unit price per cubic yard for the pertinent item specified in the Contract Documents.

SECTION 311 — RIPRAP DITCHES

311.01 DESCRIPTION. This work shall consist of constructing riprap ditches and riprap ditches with capping as specified in the Contract Documents or as directed by the Engineer.

311.02 MATERIALS.

Riprap	901.02 and 901.03
Geotextile, Class as specified	921.09
2 to 4 in. Stone	M43, No.1

311.03 CONSTRUCTION.

311.03.01 Excavation. Excavation shall conform to the line and grade specified in the Contract Documents. Ditch sides and bottom shall be smooth and firm, free from protruding objects that would damage the geotextile, and constructed in a manner acceptable to the Engineer. Refer to 402.03.01 for excavated material.

311.03.02 Geotextile Placement. The geotextile shall be placed on the prepared subgrade with the adjacent edges overlapped a minimum of 2 ft. Damaged geotextile shall be replaced or repaired at no additional cost to the Administration in a manner acceptable to the Engineer.

311.03.03 Riprap Placement. Stones shall be placed by mechanical or other acceptable methods to produce a reasonably graded mass of stone. Placing the stones by methods that cause extensive segregation is prohibited. The depth of the riprap shall be as specified in the Contract Documents.

311.03.04 Backfill. Any excavation voids existing along the edges and ends of the placed riprap shall be backfilled with suitable material to blend in with contiguous slopes, ditch lines, or existing ground. Riprap placed in the clear recovery area shall be capped with a layer of 2 to 4 in. stone.

311.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all excavation, geotextile, stone, backfill, disposal of excess material, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

311.04.01 Riprap Ditches and Riprap Ditches with Capping will be measured and paid for at the Contract unit price per square yard of finished surface.

311.04.02 Bottom Cutoff Walls and Side Cutoff Walls will be measured and paid for at the Contract unit price per linear foot.

SECTION 312 — RIPRAP SLOPE AND CHANNEL PROTECTION

312.01 DESCRIPTION. This work shall consist of protecting slopes and channels with a covering of geotextile and stone and an aggregate filter blanket as specified in the Contract Documents or as directed by the Engineer.

312.02 MATERIALS.

Aggregate Filter Blanket	
Crusher Run Aggregate CR-6	901.01
Stone	901.02
Geotextile, Class as specified	921.09

312.03 CONSTRUCTION.

312.03.01 Excavation. Excavation for riprap and cutoff walls shall conform to the lines and grades specified in the Contract Documents. The subgrade shall be smooth and firm, free from protruding objects that would damage the geotextile and constructed in a manner acceptable to the Engineer. Refer to 402.03.01 for excavated material.

312.03.02 Geotextile. The geotextile shall be placed on the prepared subgrade with the adjacent edges overlapping a minimum of 2 ft. Damaged geotextile shall be replaced or repaired at no additional cost to the Administration in a manner acceptable to the Engineer.

312.03.03 Aggregate Filter Blanket. When an aggregate filter blanket is specified, it shall conform to the lines and grades specified in the Contract Documents and shall be compacted in a manner acceptable to the Engineer.

312.03.04 Riprap Placement. The ground surface upon which the slope and channel protection is placed shall be free of brush, trees, stumps and shall be acceptable to the Engineer.

The first section of riprap placed shall consist of a minimum of 5 tons and will be inspected by the Engineer for conformance to gradation and placement requirements. This section shall be used to evaluate quality control for the remainder of the project if it is approved by the Engineer. If the material is rejected, it shall be removed from the project and additional sections, each consisting of a minimum of 5 tons, shall be placed.

The placement of the riprap shall begin with the bottom cutoff walls or toe sections. The larger stones shall be placed in the cutoff walls and along the outside edges of the limits of slope and channel protection. The riprap shall be placed with equipment which produces a uniformly graded mass of stones. Placing the stones by methods that cause segregation is prohibited.

The surface elevation of completed riprap installations shall be flush with adjacent channel bed or bank slope elevations, and shall not create an obstacle to the flow. The outer riprap surfaces shall be even and present a generally neat appearance. The plus or minus tolerance of the surface of the finished riprap installation shall be 3 in. for Class I Riprap and 6 in. for Class II and III Riprap from the lines and grades shown on the Contract Documents when measured perpendicular to the exterior surface of the stonework.

Placed material not conforming to the specified limits shall be removed and replaced as directed by the Engineer at no additional cost to the Administration.

The stone shall be placed and distributed so the resulting layer will contain a minimum of voids and there will be no pockets of same size material. The stone shall be placed to its full course thickness in one operation in a manner that the underlying material will not be displaced or worked into the course of riprap being placed. When an aggregate filter blanket is used, placement of the riprap shall proceed in a controlled manner to avoid disruption or damage to the layer of bedding material.

312.03.05 Backfill. Any excavation voids existing along the edges of the completed slope and channel protection shall be backfilled and compacted in a manner acceptable to the Engineer.

312.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all excavation, geotextile, stone, backfill, compaction, disposal of excess material, prewashing when required, preparation of quality control section, and for all material, labor, equipment, tools and incidentals necessary to complete the work.

312.04.01 Riprap Slope and Channel Protection will be measured and paid for at the Contract unit price per square yard. Area measurements will be actual surface measurements.

312.04.02 Cutoff Walls will be measured and paid for at the Contract unit price per linear foot.

312.04.03 Riprap for scour protection will be measured and paid for at the Contract unit price per ton for the item Class II Riprap For Scour Protection.

312.04.04 Aggregate Filter Blanket will be measured and paid for at the Contract unit price per square yard for the depth specified in the Contract Documents.

SECTION 313 — GABIONS

313.01 DESCRIPTION. This work shall consist of protecting slopes and channels with stone filled wire baskets as specified in the Contract Documents or as directed by the Engineer.

313.02 MATERIALS.

Stone	901.05
Wire for Gabions	906.01
Geotextile, Class as specified	921.09

313.03 CONSTRUCTION.

313.03.01 Excavation. Excavation, including excavation for cutoff walls, shall conform to the lines and grades specified in the Contract Documents. The subgrade shall be smooth, firm, and free from protruding objects or voids that would affect the proper placement of the wire baskets or damage the geotextile. Refer to 402.03.01 for excavated material.

313.03.02 Geotextile. Geotextile shall be required for all gabions and shall be placed on the prepared subgrade. Adjacent strips shall be overlapped a minimum of 2 ft. Care shall be exercised in placing and anchoring the empty basket units to ensure proper alignment and to avoid damaging the geotextile. Damaged geotextile shall be replaced or repaired as directed by the Engineer at no additional cost to the Administration.

313.03.03 Wire Baskets. Placement of the units shall begin with the cutoff walls. The empty units shall be set on the geotextile and the vertical ends bound together with wire ties or interlocking fasteners spaced to permit stretching of the units to remove kinks. Stretching methods will be optional with the Contractor. Stakes, pins or other approved methods shall be used to ensure a proper alignment.

313.03.04 Stone. The empty basket units shall be filled carefully with stone placed by hand or machine to ensure good alignment with a

minimum of voids between stones, avoiding bulging of the mesh. The maximum height from which the stone shall be dropped into the units shall be 36 in. The stone shall be placed to provide a minimum of two courses. Care shall be taken in placing the top layer of stone to ensure a uniform surface to avoid any bulging of the lid mesh. After a basket unit has been filled, the lid shall be bent over until it meets the ends of the unit. The lid shall then be secured to the sides and ends with wire ties or interlocking fasteners. When a complete basket unit cannot be installed on slopes or channels because of space limitations, the basket unit shall be cut to fit as directed by the Engineer.

313.03.05 Backfill. Any excavation voids existing along the edges of the completed gabions shall be backfilled and compacted in a manner acceptable to the Engineer.

313.04 MEASUREMENT AND PAYMENT. Gabions, including cutoff walls will be measured and paid for at the Contract unit price per cubic yard of stone filled wire baskets complete in place. The payment will be full compensation for all excavation, geotextile, stone, ties or fasteners, backfill, compaction, disposal of excess material, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 314 — FLOWABLE BACKFILL FOR UTILITY CUTS

314.01 DESCRIPTION. This work shall consist of furnishing, hauling and placing a flowable cement stabilized backfill material as specified in the Contract Documents or as directed by the Engineer. The material shall be used for utility cut backfill and shall set up to a stabilized mass.

314.02 MATERIALS. The flowable backfill shall consist of a mixture of fly ash, cement, and water and shall be certified by the manufacturer.

Cement	902.03
Fly Ash	902.06
Water	921.01

314.02.01 Fillers. Fillers, when required shall be natural aggregates with a maximum size of 3/4 in. and may include sands. Bottom ash shall not be used as a filler.

314.02.02 Components. Toxic or deleterious components shall not be used in the backfill mixture. The mixture shall have a 28 day, unconfined

compressive strength of 100 psi minimum based on the manufacturer's certification. Certification shall include the actual test data for each mixture to be used.

314.02.03 Analysis. Chemical analysis of the fly ash used in the mixture conducted by the Contractor shall conform to U.S. EPA EP Toxicity Standards. An analysis shall be conducted on fly ash from each stockpile whenever the coal source is changed, replenished or when fly ash from a different source is used. The results of the analysis shall be submitted to the Engineer for approval prior to using the mixture.

314.03 CONSTRUCTION. Placement of the flowable backfill material shall conform to the manufacturer's recommendations or as directed by the Engineer. Utility trenches shall be backfilled full depth to the top of the subgrade using the mixture as specified in the Contract Documents or as directed by the Engineer.

The mixture shall fill all voids during the backfill operation.

The backfilled utility cut shall be protected from freezing and traffic for 24 hours. Paving operations shall not begin for at least 24 hours after backfilling is completed and has been approved by the Engineer.

The Contractor shall keep detailed records of all flowable backfill placed. Records shall include the source of the fly ash, date placed, the location, depth, and the quantity used. These records shall be submitted to the Engineer.

314.04 MEASUREMENT AND PAYMENT. Flowable Backfill for Utility Cuts will be measured and paid for at the Contract unit price per cubic yard. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 315 — INFILTRATION TRENCHES

315.01 DESCRIPTION. This work shall consist of installing infiltration trenches as specified in the Contract Documents or as directed by the Engineer.

315.02 MATERIALS.

Class I Riprap	901.02
PVC Pipe, Schedule 40	905
Geotextile, Class as specified	921.09
Stone	M 43 No. 2

315.03 CONSTRUCTION. Infiltration trenches shall not be placed in service until all of the contributing drainage area has been stabilized to the satisfaction of the Engineer. Heavy equipment and traffic shall be restricted from the proposed infiltration trench location.

315.03.01 Excavation. Excavated material shall be removed from the trench site. Trench walls and bottom shall be free of protruding objects that could damage the geotextile. When necessary, the trench walls shall be sloped. The bottom dimensions and stone depth shall be as specified in the Contract Documents. The side walls of the trench shall be roughened. The bottom of the trench shall be graded flat. Refer to 402.03.01 for excavated material.

315.03.02 Installation. Geotextile shall be placed on the sides of the trench and the top of the No. 2 stone. The bottom of the trench shall not be covered with geotextile. The geotextile for the sides of the trench shall overlap the top geotextile by 6 to 8 in. The top geotextile shall extend the full width and length of the trench. All longitudinal joints in the top geotextile shall overlap a minimum of 6 in. The upstream roll shall overlap the downstream roll by a minimum of 2 ft for a shingled effect.

An observation well shall be placed vertically in the longitudinal center of each infiltration trench using 6 in. diameter perforated PVC pipe, Schedule 40. The pipe shall be placed on a base plate at the bottom of the trench. The well shall be capped using a threaded PVC fitting and a vandal proof sewer cap. The cap shall be set 6 in. above ground level with the depth of the trench marked on the cap. The well shall have a plastic collar with ribs to prevent rotation when removing the cap. When soil capping is used, the observation well shall be constructed of perforated PVC pipe within the No. 2 stone and non-perforated pipe through the soil capping.

All stone shall be clean and free of all soil and fines. The No. 2 stone shall be placed in 12 in. lifts with no compaction. Care shall be taken to prevent soil and fines from intermixing with the stone aggregate. All contaminated stone aggregate shall be removed and replaced with uncontaminated stone aggregate at no additional cost to the Administration. The trench shall be capped with a 12 in. minimum depth of stone or soil as specified in the Contract Documents.

315.04 MEASUREMENT AND PAYMENT. Infiltration Trenches will be measured and paid for at the Contract unit price per cubic yard. The payment will be full compensation for all excavation, stone, capping, riprap, geotextile, PVC pipe, fittings, cap, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

CATEGORY 400
STRUCTURES

SECTION 401 — MAINTAINING EXISTING BRIDGE DECK DURING LIFE OF CONTRACT

401.01 DESCRIPTION. This work shall consist of patching the existing bridge deck as specified in the Contract Documents or as directed by the Engineer.

401.02 MATERIALS.

Rapid Hardening Cementitious Material for Concrete Pavement Repairs	902.14

The Contractor shall select the patching material from the prequalified list of rapid hardening cementitious materials maintained by the Office of Materials and Technology.

401.03 CONSTRUCTION. The Engineer and Contractor shall periodically review the existing deck and determine if any patching is necessary. All holes over 1 in. deep having an area greater than 2 ft^2 shall be patched. Locations and limits of all patch areas shall be approved by the Engineer.

Before patching begins, the Contractor's Traffic Manager shall confer with the Engineer to decide on a plan for diverting or detouring traffic during patching operations. All items relating to traffic safety and traffic control requirements shall conform to the Contract Documents.

The areas requiring patches shall be clean and free of loose material and conform to the manufacturer's recommendations.

When working on a full depth patch area, the Contractor shall protect waterways and roadways under the structure from falling debris. No removed material shall be disposed of in any waterway.

The patching material shall be placed full depth to the top of the existing bridge deck surfaces.

New reinforcement will only be required when directed by the Engineer.

When a patch has been made and it has not yet reached sufficient strength to support traffic when this section of the structure is opened to traffic, it shall be covered with a steel plate as specified in 522.03.13. All areas around the plate shall be built up with asphalt material.

401.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

401.04.01 Patching for Maintaining Existing Bridge Deck will be measured and paid for at the Contract unit price per square foot. The payment will also be full compensation for the removal of material required to prepare the patch area, including chipping and hand cleaning, as well as furnishing and placing reinforcement steel, forming, providing protective structures, and furnishing, placing and removing any steel plates. Patches performed day or night will be paid for at the Contract unit price.

401.04.02 All work, materials, sequence of operations and cones required to maintain traffic during each occurrence of patching including removal after patching is complete, will be measured and paid for at the Contract unit price per each for the pertinent Maintenance of Traffic for Bridge Patching Operation item. When more than one patch is made under one movement of traffic for patching, the item will be paid for only once, regardless of the number of patches made or the length of time traffic is rerouted. When traffic must be maintained more than once for a particular patching operation, the work will be measured and paid for only once.

401.04.03 Floodlighting. Floodlighting will not be paid for unless approved by the Engineer in writing. When floodlighting is approved, it will be paid for as specified in 420.04.06.

SECTION 402 — STRUCTURE EXCAVATION (Class 3 and Class 4)

402.01 DESCRIPTION. This work shall consist of excavation and backfill for structures as specified in the Contract Documents or as directed by the Engineer. Classes of structure excavation are:

Class 3 Excavation — Excavation above the water surface elevation specified in the Contract Documents.

Class 4 Excavation — Excavation below the water surface elevation specified in the Contract Documents.

If Class 4 Excavation is not specified in the Contract Documents, all excavation shall be Class 3 Excavation.

402.02 MATERIALS.

Crusher Run Aggregate CR-6	901.01
Subfoundation Concrete	902.10, Mix No. 1

402.03 CONSTRUCTION. All excavation contiguous to existing pavements and structures shall be sheeted, shored, braced, and supported in a substantial manner to prevent settlement, movement, or damage to the pavement or structure. Excavated material shall not be placed in any manner that may endanger any structure and shall be kept out of waterways.

402.03.01 Backfill and Embankment Material. All suitable material removed from the excavation shall be placed in backfill or stored for future use. Excavated material shall not be wasted without permission of the Engineer. Boulders, logs or other unforeseen unsuitable material encountered shall be removed from excavated material prior to placing as backfill. Unsuitable material shall be disposed of in an approved disposal area.

402.03.02 Footing Elevations. The elevation for the bottom of the footing specified in the Contract Documents shall be considered as approximate only, and the Engineer may, during the period of construction, direct changes in dimensions or elevations of footings to secure a satisfactory foundation.

402.03.03 Footing Foundations. Footings for structures shall be on suitable foundations, and no concrete shall be placed or foundation piles driven until the foundations are approved by the Engineer.

All rock or other hard foundation material shall be cleaned of loose material and cut to a firm surface, either level or stepped as directed by the Engineer. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When concrete will rest on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation. Final removal of the foundation material to grade shall not be made until just prior to concrete placement. When the Contract Documents include an item for Subfoundation Investigation (Section 419), the item shall be used to verify the character of the foundation if directed by the Engineer.

Faces of footings shall be placed plumb against either undisturbed material, rock, sheeting, shoring, or forms. Faces of footings in rock shall bear against a minimum 1 ft depth of rock. If the excavation will not

stand plumb, the Contractor shall furnish and install sheeting, shoring, or forms as required. When specified in the Contract Documents, sheeting used to construct spread footings shall be left in place and cut off in conformance with 410.03.10. When not specified, or when sheeting is used to construct pile supported foundations, the sheeting may be removed.

The design of sheeting and shoring shall be the responsibility of the Contractor. When the material retained by the sheeting and shoring is greater than 6 ft high, the detail, procedure, and computations shall be submitted the same as specified for falsework details in TC-4.01 and the Contract Documents. The experience specified in TC-4.01 will be waived.

Forms used for footings shall be removed and the void between the footing and the embankment shall be backfilled with subfoundation concrete or tamped fill utilizing crusher run aggregate CR-6. The material shall be compacted to a minimum of 92 percent of maximum density when tested in conformance with T 180, Method C. Subfoundation concrete shall be used for this backfill when footings are submerged. Footing form working drawings will be required for approval for footings thicker than 6 ft or below the water table or adjacent to railroad tracks.

Where foundation piles are used, the excavation of each pit shall be completed to the as planned bottom of footing elevation before the piles are driven. After the driving is completed, all loose and displaced material shall be removed, without damaging the placed piling, leaving a suitable bed to receive the footing concrete. For tremie seal, the displaced material may remain in place provided the minimum thickness of footing concrete, pile embedment and the required sealing of the foundation seal is maintained.

Where foundation piles are not used on piers, abutments, retaining walls, and wing walls and excavation to suitable bearing must be made below the as planned bottom of the foundation, the additional excavated spaces under these substructure units shall be backfilled with subfoundation concrete or the footing elevation shall be lowered, or the footing deepened as specified in the Contract Documents or as directed by the Engineer. Rock foundations that are to receive footing concrete shall have a rough finish. Where excavation to suitable bearing for box culverts must be made below the as planned bottom of the foundation, additional excavated spaces under the barrels shall be backfilled with selected backfill.

402.03.04 Cofferdams and Foundation Seals. When cofferdams are required, the Contractor shall submit for review, drawings and a complete

description of the process for construction of the cofferdam. Timber or bracing left in the cofferdams or cribs shall not extend into the substructure concrete. Cofferdams shall be constructed to protect the concrete against damage.

(a) Foundation Seal. When the foundation cannot be dewatered, the Engineer may require the construction of a concrete foundation seal. The Contractor shall submit for review drawings and description of the process before placing the seal. If a mud wave is created during the placement of the tremie seal, the displaced material shall be removed in order to preserve the full foundation cross section specified in the Contract Documents. The foundation shall then be pumped out and the footing placed in the dry. When weighted cribs are employed and the crib's weight is utilized to overcome a part of the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib into the foundation seal. When a foundation seal is placed under water, the cofferdam shall be vented or ported at low water level as directed.

(b) Pumping. Pumping is prohibited during the placing of concrete. Pumping to dewater a sealed cofferdam shall not begin until the seal has set sufficiently to withstand the hydrostatic pressure.

(c) Removal of Cofferdams or Cribs. Cofferdams or cribs shall be removed by the Contractor after the completion of, and without damage to the substructure.

(d) Stability of Foundation. The Contractor shall stabilize the foundation area so that the concrete footing can be constructed in the dry and in its proper place.

402.03.05 Backfilling. All excavated spaces resulting from structure excavation not occupied by the portions of the permanent work shall be backfilled with suitable material. The backfilling shall be carried to the surface of the surrounding ground or grade as specified in the Contract Documents. Borrow shall not be used until the available project excavation is exhausted. The top surface of the backfilled areas shall be neatly graded. Backfill compaction shall conform to Sections 204 or 210.

Backfilling Against Structures. Backfilling against various structures shall be performed as follows:

(a) Brick Masonry. Backfilling will not be permitted until seven days after completion of the section.

(b) Concrete Structures. Backfilling will not be permitted until curing is completed and the concrete has achieved 80 percent of the specified compressive strength.

(c) Footings, Culverts and Piers. Fill placed around footings, culverts and piers shall be deposited on both sides to approximately the same elevation at the same time.

(d) Abutments, Retaining Walls, Culverts or Other Structures. The bed for the backfill shall be built up in horizontal layers so that at all times there is a horizontal berm of uniformly compacted material behind the structure for a distance at least equal to the height of the abutment or wall remaining to be backfilled, except where undisturbed material protrudes into this area. Compaction of the berm shall conform to 204.03. Jetting of fills or other hydraulic methods involving liquid or semiliquid pressure within the berm area is prohibited.

402.04 MEASUREMENT AND PAYMENT. Class 3 Excavation and Class 4 Excavation will be measured and paid for at the Contract unit price per cubic yard for the volume of material actually removed from within the limits specified.

No measurement or payment will be made for removing any water or liquids.

Class 3 Excavation and Class 4 Excavation will extend a maximum of 18 in. to vertical planes outside of the structure. Where blasting is required, a maximum of 6 in. will be allowed below the planned elevation.

Class 3 Excavation and Class 4 Excavation will include excavation for bridges, box culverts, and other structures as specified in the Contract Documents.

The upper limits for Class 3 Excavation on existing ground or embankments will be the existing groundline or the lower limit of roadway excavation. The lower limit of the two will control.

The upper limits for Class 3 Excavation on preliminary embankments will be the bottom of the as planned footing elevation. For stepped footings the upper limits will be the bottom of the as planned footing elevation of the highest portion of the footing. If the preliminary embankment has a surcharge, the upper limits will be the lower limit of roadway excavation.

The upper limits for Class 4 Excavation will be the bottom of the stream bed or the water elevation shown on the Contract Documents, whichever is lower.

The payment for Class 3 Excavation and Class 4 Excavation specified in the Contract Documents will be full compensation for all excavation, backfill, filling void around footings due to removing forms, blasting, grout, dewatering, removal and disposal of excess or unsuitable material, and for all material, labor, equipment, tools, and incidentals necessary to complete the work. When an item for Class 3 Excavation and Class 4 Excavation is not included in the Contract Documents, the excavation will not be measured but the cost will be incidental to other items.

Excavation for Pipe Culverts, Culvert End Walls, Inlets, and Manholes is excluded from the Class 3 Excavation or Class 4 Excavation.

402.04.01 Additional excavation required below the elevation specified in the Contract Documents and necessitated by the lowering or deepening of footings, or the placing of subfoundations or underpinning, will be measured and paid for at the Contract unit price for either Class 3 Excavation or Class 4 Excavation as directed by the Engineer.

402.04.02 Sheeting, bracing, and shoring either removed or left in place, will not be measured but the cost will be incidental to other pertinent items unless otherwise specified in the Contract Documents.

402.04.03 Excavation necessary to expose or remove piles, grillages, sheeting, cribbing, masonry, or other obstructions will not be measured nor paid for if the excavation occurs outside the limits of excavation. The removal and disposal of obstructions within the limits of excavation will not be measured separately but the cost will be included in the Contract unit price for either Class 3 Excavation or Class 4 Excavation.

SECTIONS 403 — 404 RESERVED

SECTION 405 — REMOVAL OF EXISTING STRUCTURES

405.01 DESCRIPTION. This work shall consist of the removal and disposal, wholly or in part, of existing structures as specified in the Contract Documents.

405.02 MATERIALS. Not applicable.

405.03 CONSTRUCTION. Before removal operations begin, the Contractor shall submit to the Engineer for approval a list of the equipment to be used and the removal method.

Sheeting and shoring required for the removal of existing structures or portions thereof shall conform to 402.03.03.

Unless otherwise specified in the Contract Documents, the limits of removal for existing structures shall be 1 ft below the proposed groundline or to the limits necessary to avoid conflict with the proposed construction. The material obtained from the removal of the existing structures shall become the property of the Contractor who shall remove and dispose of the material on approved spoil areas.

When portions of an existing structure are to be removed and the remaining portion will be exposed to view in the final structure, a neat 1 in. deep saw cut shall be made to separate the removal operations from the concrete which is to remain. Existing reinforcement steel that will be incorporated into the final structure shall be protected and conform to 421.03.07.

405.03.01 Removal of Bridge Deck Slabs. The Contractor shall protect the public against injury and damage from demolition operations when removing portions of existing bridge deck slabs. When deck removal is performed over or near roadways, railroads or waterways, the Contractor shall furnish and erect temporary protective shields to prevent any material or debris from entering these areas. The Contractor shall adhere to the underclearance restrictions specified in TC-6.12.

Working drawings for the protective shields shall be submitted in conformance with TC-4.01(b). Flooring and siding shall have no cracks or openings through which material particles may pass. The shields shall be able to support over their entire area 150 lb/ft^2 in addition to their own dead weight.

After the Engineer determines that the protective shields have served their purpose, they shall be removed and become the property of the Contractor.

405.03.02 Bridge Deck Slabs to be Replaced. On structures where the existing structural steel will be used in the finished structure and the Contractor elects to support the protective shields from the steel, all connections to the protective shields shall be made by means of clamps or other approved devices. The drilling of holes in the existing steelwork, or welding to the steelwork for this purpose is prohibited.

Before removal operations begin, the outlines of the top flanges or cover plates of all stringers and floor beams shall be drawn on the bridge deck and 1 in. diameter pilot holes made outside these lines to confirm the location of the steel.

Prior to removing the existing slabs, the Contractor shall take elevations at locations along the bottom of the bottom flange or top of the top flange by removing small sections of slabs over stringers using pilot holes at the center and quarter points of all stringers and at other points if necessary, to provide a maximum spacing of 25 ft between elevations. After removing the deck, the Contractor shall take a new set of elevations at the same points and ascertain the rebound. These rebounds shall be used in lieu of dead load deflections to establish grade controls and to produce finished tops of concrete bridge decks that will be true to as planned line and grade. For bridge decks constructed with a longitudinal construction joint between stringers, diaphragms between these stringers shall not be disconnected unless specified in the Contract Documents.

On continuous bridges, the Contractor's proposed sequence of deck removal shall address uplift at the ends of continuous spans.

If damage results from the Contractor's operations, the removal operation shall be modified and the damaged items shall be repaired or replaced by the Contractor in a manner acceptable to the Engineer at no additional cost to the Administration.

405.03.03 Removal of Existing Bridge. Existing bridges, including piles, shall be removed as specified in 207.03.01 and from any area that will interfere with proposed construction.

405.04 MEASUREMENT AND PAYMENT. The removal of existing bridges and structures or portions thereof will be measured and paid for as specified. The payment will be full compensation for all excavation, backfill, saw cuts, professional engineer services, temporary protective shields, temporary sheeting and shoring, hauling, disposal, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

405.04.01 The Removal of Existing Structures will not be measured for payment but will be paid for at the pertinent Contract lump sum price.

405.04.02 The removal of existing traffic barriers (parapets, railings, etc.) from bridges, including end posts and wing walls, and retaining walls will not be measured but will be paid for at the Contract lump sum price for the pertinent Removal of Existing Traffic Barrier item.

405.04.03 Removal of existing structures for which no specific pay item is included in the Contract Documents will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents.

SECTION 406 — DRILLED HOLES IN EXISTING MASONRY

406.01 DESCRIPTION. This work shall consist of drilling holes in existing masonry for grouting of bars, bolts or anchorages, as specified in the Contract Documents or as directed by the Engineer.

406.02 MATERIALS.

Grout	902.11(c)

406.03 CONSTRUCTION. Holes shall be drilled only in the solid portion of the masonry, and are prohibited at points where cracks exist. Drilled holes shall be a minimum of 6 in. from the face of any masonry surface. The minimum size of dowel bars shall be No. 6. The holes shall be drilled at least 1/2 in. larger than the outside diameter of the insert to be grouted. Holes shall be cleaned and then filled two thirds full of grout. The insert shall be placed and allowed to set for 24 hours.

406.04 MEASUREMENT AND PAYMENT. Drilled Holes in Existing Masonry will be measured and paid for at the Contract unit price per linear foot of drilled holes. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Inserts required for insertion in these holes will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents.

Drilled holes for which no specific pay item is included in the Contract Documents will not be measured but the cost will be incidental to the other pertinent items specified in the Contract Documents.

SECTIONS 407 — 409 RESERVED

SECTION 410 — PILING

410.01 DESCRIPTION. This work shall consist of furnishing and installing piling as specified in the Contract Documents or as directed by the Engineer. When drilled shafts (caissons) are specified refer to Section 412.

410.02 MATERIALS.

Sand	901.01
Concrete for Steel Pipe Piles	902.10, Mix No. 3 Slump 4-6 in.
Tremie Concrete for Steel Pipe Piles	902.10, Mix No. 4
Timber Piles	907.01
Timber Sheet Piles	907.01
Resin and Fiberglass Caps	907.01.01
Steel Pipe Piles	907.02
Steel H Piles	907.03
Steel Sheet Piles	907.04
Reinforcement for Steel Pipe Piles	908.01
Hardware	909.10
Water	921.01
Timber Preservatives	921.06

410.03 CONSTRUCTION. The Contractor shall be responsible for ordering and delivering piling of the proper type and length to the structure site.

410.03.01 Storage and Handling. Piling shall be stored and handled to avoid damage. Damaged piling shall be repaired or replaced as directed by the Engineer.

410.03.02 Preparation for Driving. Piling shall not be driven until embankments and excavation have been completed as specified in the Contract Documents or as directed by the Engineer.

The Contractor shall provide templates or other approved means to assure that the piles are properly aligned and positioned.

The heads of all piling shall be equipped with a cap or cushion so that the energy imparted by the hammer can be transmitted to the pile evenly without injury to the top or butt. The top of the pile, irrespective of its type, shall be normal to the axis of the moving parts of the hammer.

410.03.03 Pile Tips.

(a) Timber piles shall be pointed where driving conditions require. The point shall be symmetrical and not less than a 4 in. diameter. Timber piles shall have their tips or bottoms shod with a metal shoe or point when specified in the Contract Documents or as directed by the Engineer.

(b) Timber sheet piling shall be drift sharpened or beveled at the bottom to wedge contiguous piles in tighter contact.

(c) Steel H piles shall be driven without any special tip reinforcement unless otherwise specified in the Contract Documents.

(d) Steel pipe piles shall be driven open ended.

410.03.04 Splicing. Splicing of timber piles is prohibited. In event of an isolated timber pile penetrating below planned tip elevation resulting in the top being below planned elevation, the Engineer will determine when replacement is required, supplemented by an additional pile or when the structure can be changed without detriment.

When splicing of steel H piles and steel pipe piles is necessary, they shall be spliced as specified in the Contract Documents by electric arc welding conforming to AWS Structural Welding Code for the full periphery. The number of splices permitted shall be compatible with driving conditions at the site and the standard lengths of piling produced by manufacturers; however, only one section of each pile shall be less than 20 ft.

When welding is required above a maximum elevation specified in the Contract Documents, it shall be performed in conformance with 430.03 excluding the submerged arc welding requirement. Welders shall be qualified in conformance with 430.03.19(a) or (b) for steel pipe piles 24 in. in diameter or greater, and in conformance with 430.03.19(b) for pipe piles less than 24 in. in diameter.

All welding above these limits shall receive 100 percent Magnetic Particle Inspection (MT) on the root pass and completed weld, and 100 percent Radiographic Inspection (RT), in conformance with AWS D1.5. Inspectors shall be approved by the Office of Materials and Technology, Metals Group as specified for certification testing in conformance with AWS D1.5.

Inspectors certified by an accredited/certified American Society for Non-Destructive Testing (ASNT), Level III in the inspection discipline,

may submit certifications to the Office of Materials and Technology, Metals Group for review.

Where a manufactured pile type is designed to be spliced by screwing two pieces together or by the use of couplings or collars, and the details for the splice are not specified in the Contract Documents, the device shall be submitted to and approved by the Engineer before use.

It is intended, when practical, that piles be driven in a continuous operation, and that splicing be performed prior to approaching the estimated tip elevation.

410.03.05 Test Piling. The depth of penetration and the length of piling for structures will generally be determined by driving test piles. The Contract Documents will specify the test pile locations, minimum penetrations and bearing values and estimated tip elevations. From this information the Contractor shall order and drive the test piling. The actual safe bearing value of the test piling can then be determined as specified in 410.03.09. From the test pile data and observed behavior, the Contractor shall order the permanent piling required to complete the work.

410.03.06 Pile Driving. The Contractor shall submit to the Engineer, a plan of the pile driving method, including type of hammer, for approval prior to driving any piling.

The hammer to be used for driving permanent piles shall be the same hammer that was used to drive the test piles. If the Contractor changes hammers, the Contractor shall drive additional test piles at no additional cost to the Administration, before driving the permanent piles, even if the energy ratings of the hammers are identical.

Hammers shall be operated at speeds recommended by the manufacturer for the bearing value specified. The manufacturer's manual for the hammer employed shall be available to the Engineer at the project site.

Hammer energy is defined for the purpose of these Specifications as the approved rated energy per blow of the power hammer.

Tests will be directed by the Engineer to determine the acceptability and energy rating of power hammers. The Contractor shall pay all costs, including the Administration's expenses, for approval and energy rating of any pile driving hammer.

When considering the hammer for approval, the ratio of the weight of the pile to the weight of the striking unit will be evaluated to determine the adequacy of the hammer.

Leads or spuds shall be constructed to afford freedom of movement of the hammer during the driving phases. The Contractor shall drive the piles within the tolerance as specified without injury to the piles. Any leads that do not produce satisfactory end results in the driving of piling shall be removed from the work.

Driving with the hammer out of the leads is prohibited.

On all special, marine or water projects and pile bents, the leads shall be of sufficient length so that the use of a follower will not be necessary. Long piles and batter piles may require guides at intervals and additional support to prevent excessive bending or buckling under the hammer blow. Piles shall be held in place and alignment by templates or other means approved by the Engineer.

External jetting of any piles is prohibited. If it is necessary to remove material from within a pile shell to advance the pile tip or merely to obtain room for concreting, a minimum of 10 ft soil plug shall be left undisturbed at the tip of the pile. Turbidity curtains shall be installed around the piles being cleaned.

Where piling must perforate strata which resists driving, the Contractor shall auger or drill holes through the strata. The size of the auger or drill to be used shall not be larger than the nominal diameter of a round pile or the minimum diameter of a circle in which an H pile will fit and shall be approved by the Engineer before use. After the hole is completed, the pile shall be inserted and dry sand shall be used to completely fill any voids between the pile and the walls of the hole. Driving shall then be completed, after which any remaining voids shall be completely filled with dry sand.

410.03.07 Pile Driving Tolerances.

(a) General. Foundation piles shall not be used out of the position specified in the Contract Documents by more than 6 in. in any direction after driving, regardless of the length of piles. Variation from the vertical or from the batter shall not be more than 1/4 in./ft.

(b) H Piles. Rotation of the pile in excess of 25 degrees from the as planned axis is prohibited.

(c) **Bents.** Piles shall be driven so that the cap may be placed in its proper location.

410.03.08 Unacceptable Piles. Any pile not in conformance with the Contract Documents shall be corrected by one of the following methods or other methods approved by the Engineer at no additional cost to the Administration:

(a) The pile shall be withdrawn and replaced by a new pile.

(b) A second pile shall be driven adjacent to the unacceptable pile.

(c) The pile shall be spliced or built up (except timber piles).

(d) A sufficient portion of the footing shall be extended to properly embed the pile.

410.03.09 Bearing Value. The determination of the bearing value shall be primarily obtained from observation and reporting of the behavior of the test pile from the time first placed in the leads until it attains practical refusal or reaches a stratum specified in the Contract Documents or as directed by the Engineer. To furnish the Engineer and Contractor with a guide as to the probable supporting value at each position, the Engineer will compute the safe bearing value from the following formula:

$$P = \frac{2WH}{S + 0.1} \quad \text{for single acting power hammers}$$

$$P = \frac{2E}{S + 0.1} \quad \text{for double acting power hammers}$$

where:

P = safe bearing value in pounds.
H = height of fall in feet.
W = weight in pounds of striking parts of hammer.
E = approved hammer energy per blow in foot pounds for double acting, differential acting, and diesel hammers.
S = the average penetration in inches per blow for the last several inches of penetration.

The above formula is applicable only when:

(a) The hammer is operating properly and at the manufacturer's recommended speed in the case of a power hammer.

(b) The head of the pile is not broomed or crushed.

(c) The penetration is reasonably quick and uniform.

(d) There is no discernable bounce after the blow.

(e) A follower is not used.

If the Contract does not provide for test loading, the results of this formula as applied to the test piles shall be used to designate the proposed penetration or lengths of piles. However, each pile shall have its driving record evaluated to assure its ability to carry the intended load.

Test piles shall be driven in permanent vertical pile locations as directed by the Engineer or as specified in the Contract Documents. Test piles found to be satisfactory by the Engineer shall be utilized as permanent piles.

410.03.10 Pile Cutoff and Removal. The tops of all piles and pile casings, except timber piles that support timber caps, shall be cut off at the elevations specified in the Contract Documents and on a true plane perpendicular to the axis of the pile unless otherwise specified. Timber piles that support timber caps shall be cut off to ensure that the plane of the bottom of the cap will bear fully on the pile head. Shimming between the timber cap and pile head is prohibited.

Piles used for sheeting and shoring shall be cut off a minimum of 1 ft below existing grade, channel bottom or mud line as applicable. When specified in the Contract Documents, these piles may be removed. The Contractor shall dispose of all removed material on approved spoil areas.

410.03.11 Steel Pipe Piles. After driving, soil plugs shall be removed to the elevation specified in the Contract Documents. Prior to placing filling (when specified) or reinforcement, steel pipe piles shall be inspected with the aid of a suitable light for illuminating the interiors of the piles for their entire unplugged length. No filling or reinforcement shall be placed until the Engineer approves the pile.

The Contractor shall provide all required equipment for inspection including oxygen, light, boatswain's chair and lift. The Contractor shall comply with federal and local safety regulations while performing this work.

410.03.12 Concreting Steel Pipe Piles. Concrete work shall conform to Section 420. Reinforcement shall conform to Section 421 and shall be securely fastened together to form a cage which shall be positioned and held at a uniform distance from the shell.

Tie bars and bands for reinforcement cages of foundation (footing) piles shall be tie wired. Tack welding may be used, provided an Administration certified welder is used.

Tie bars, bands and spacer lugs for bents or column piles shall not be tack welded to any of the main reinforcement bars except that the Contractor may place a band at the top and bottom of the pile cage and weld all main bars to the band. The remainder of the intersections of ties and main bars shall be fastened by tie wiring.

The top portion of the pile shall be cleaned in the areas to be filled with reinforced concrete and tremie concrete as shown on the Contract Documents. Tremie concrete shall be placed and cured prior to dewatering the top of the pile shell. The reinforcement unit shall be placed in the top portion of the pile prior to filling with Mix No. 3 concrete. All work shall conform to the Contract Documents and as directed by the Engineer.

Concrete shall not be placed in any pile until all driving within a radius of 15 ft has been completed or until all the piles for any unit of the structure (pier, bent or abutment) have been driven to their final penetration and accepted by the Engineer. In the event that this procedure cannot be followed, all driving within the above limits shall be discontinued until the concrete in the last pile placed has set a minimum of 72 hours.

Immediately prior to concreting, water or other foreign substances found in a pile shall be removed. The concrete shall be deposited in one continuous operation. The restriction in Section 420 for dropping concrete more than 5 ft shall not apply.

Reinforcement steel cages shall be set and fastened in proper position in the pile before any concrete filling is placed, except when the reinforcement steel cage extends 6 ft or less below the top of the pile, the concrete filling may be placed before the reinforcement is installed. Concrete deposited in piles shall be thoroughly consolidated with mechanical vibrators from the bottom of the reinforcement steel cages to the tops of piles.

Freshly concreted piles shall not be disturbed in any way nor shall any loads be allowed upon any of them until all concrete has been in place and cured a minimum of 72 hours.

410.03.13 Treatment for Timber Pile Heads. Timber pile heads that are not to be imbedded in concrete shall be painted with an approved asphalt treatment. After the asphalt has sufficiently cured, it shall be covered with a glass resin composite shield. The first coat of resin shall

be applied to the top and down the side a minimum of 1 in. beyond the limits of the woven glass. Precut woven glass cloth shall be applied using a 3 in. grooved aluminum roller to achieve "wet out." Woven glass cloth shall be neatly wrapped over the top of the pile, draped down the side a minimum of 2 in. and nailed with copper nails. When the first coat of resin has taken a tack free set, a second coat of resin shall be applied to seal the entire application.

410.04 MEASUREMENT AND PAYMENT. The payment for the items specified in the Contract Documents will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

410.04.01 Piling (permanent and test) will be measured and paid for at the Contract unit price per linear foot for the pertinent Piling item. The measured length of all piling will be taken from its tip up to final cutoff unless otherwise specified in the Contract Documents. For test piles not utilized as permanent piles, the measurement for cutoff will be at the same elevation as the nearest proposed permanent pile or to actual top of test pile, whichever is lower. Where piling designated as test piles is accepted for use in the permanent structure, measurement will be made as test piles and no additional allowance will be made in other piling items.

410.04.02 Furnishing and setup of pile driving equipment required for driving permanent and test piles will not be measured but the cost will be incidental to the Contract unit price for the pertinent Pile item.

When an item for Setup for Driving Pile is included in the Contract Documents, the furnishing and setup of pile driving equipment required for driving permanent and test piles will be measured and paid for at the Contract unit price per each for the pertinent Setup for Driving Pile item. The unit price per each for the setup required for driving each pile for the proposed structure will be used regardless of the distance that the equipment must be moved for each pile setup. A maximum of one setup will be paid per pile location. No additional compensation will be paid for any setup required for redriving or any additional driving of any pile no matter what reason the particular pile may require redriving or additional driving.

410.04.03 Pile points for steel H piles will be measured and paid for at the Contract unit price per each for the pertinent Pile Point for Steel H Pile item.

410.04.04 Timber sheet piling will be measured and paid for at the Contract unit price per 1000 board foot for the pertinent Timber Sheet Piling item. Computation of quantities will be based on nominal thickness of lumber, the length of the sheet piling, and the average depth

of the sheet piling from cutoff at the top to the tip of the sheet piling in the completed structure. No allowance will be made for waste.

410.04.05 Steel sheet piling will be measured and paid for at the Contract unit price per square foot as measured along the plane of surface for the pertinent Steel Sheet Piling item.

410.04.06 The following will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents:

(a) When specified, tips for steel pipe piles.

(b) Test pieces of sheet piling (timber or steel).

(c) Dewatering, clean out, filler, reinforcement and concrete used in steel pipe piles.

(d) Pile splices.

(e) Augering, including sleeve and backfill when required.

(f) Cleaning, painting, or coating of piling.

(g) Piling or sheet piling for temporary structures, piles or sheet piling driven for the Contractor's convenience, or for any piles or sheet piling not specified in the Contract Documents.

(h) Piling not approved by the Engineer, such as piles not properly driven, piles with questionable safe bearing values, piles damaged during driving, or piles driven below planned cutoff or the removal of any pile rejected by the Engineer as unsatisfactory.

(i) Glass resin composite shield used on timber piles.

SECTION 411 — PILE LOAD TEST

411.01 DESCRIPTION. This work shall consist of applying loads to test piles when the Contract Documents include Load Tests. The load test setup, the measuring system, the loading device, the loading procedure, the frequency of measuring the movement of piles and the record keeping shall conform to D 1143 unless otherwise specified in the Contract Documents or directed by the Engineer.

411.02 MATERIALS. Not applicable.

411.03 CONSTRUCTION. At each load test location, the Engineer will provide driving criteria for the test pile. The pile shall then be driven and load tested to the test load specified in the Contract Documents or as directed by the Engineer. If the pile fails to achieve this capacity, an additional load test shall be performed on a second test pile. This pile shall be located adjacent to the initial test pile and driven according to revised driving criteria provided by the Engineer. The Engineer may elect to have the Contractor redrive piles that do not conform to the required penetration resistance.

The equipment and methodology used for driving the load test piles shall be the same as the equipment and methodology used for driving the permanent piles.

At each load test location, the Contractor shall construct a test enclosure to protect all of the equipment including dial gauges, load cells, loading apparatus and the personnel taking readings. Heat shall be provided, if necessary, so that a minimum temperature of 50 F is maintained within the enclosure. The test enclosure shall be adequately illuminated so that the readings can be taken inside the enclosure at all times of the day. The enclosure shall be ventilated to prevent fogging or frosting of gauges.

The Contractor shall submit drawings to the Engineer showing all details of the proposed load test setup. The submittal shall include the method of applying the load, the reaction frame and reaction pile configuration, if used, and the placement and support of measuring devices. The submittal shall be made at least seven days prior to the start of the first pile load test. The Contractor shall revise the load test setup if directed by the Engineer.

The reaction frame shall be designed by a professional engineer experienced in structural design and registered in the State of Maryland.

The load test setup shall be capable of supporting the test load for the duration of the test.

The clear distance from reaction piles to the test pile shall be at least 10 times the distance from the midpoint of web to end of flange for H piles or 10 times the radius of pile at the top for pipe piles or timber piles.

Where necessary, and if directed by the Engineer, the unsupported length of load test piles shall be braced to prevent buckling and without influencing the test results.

The primary instrument for measuring the movement shall be dial gauges. The dial gauges shall have an accuracy of 0.001 in. and shall have a minimum travel of 2 in. Three dial gauges spaced 120 degrees apart shall be used for measuring the movement of the top of the pile. A secondary system consisting of a scale, mirror and piano wire shall be used to measure the movement of the pile top.

Load apparatus shall conform to D 1143, Apparatus for Applying Loads. The loading apparatus shall have a capacity of 150 percent of the test load. The maximum operating load of all jacks shall be 85 percent of its total capacity. If more than one hydraulic jack is used, the jacks shall be of the same piston diameter, connected to a common manifold and pressure gauge, and operated by a single hydraulic pump.

Loads shall be applied uniformly without impact. If hydraulic jacks are used, they shall be equipped with automatic regulators so that constant pressure can be maintained for the long term test without frequent manual adjustment.

Unless weights of known magnitude are used to load the test piles, the primary method of measuring the test load shall be by a load cell with an accuracy tolerance within plus or minus 2 percent of the applied load. The load cell shall be calibrated prior to the test and a copy of the calibration report supplied to the Engineer. A pressure gauge shall be provided as a secondary system. The pressure gauge, hydraulic ram, and hydraulic pump shall be calibrated as a unit to an accuracy within 5 percent of the applied load. The use of a single high capacity jack is preferred to the use of multiple jacks. When a multiple jacking system is used, each jack shall be fitted with a pressure gauge in addition to the master gauge in order to detect malfunctions.

Load measuring devices shall be recalibrated if required by observed performance.

The load test pile shall be cut off in a manner that ensures a surface that is perpendicular to the longitudinal axis to allow for full bearing of the test pile. A steel plate of 1 in. minimum thickness shall be placed over the cutoff surface in a manner that facilitates axial loading and even bearing on the test pile.

The test procedure for all test piles driven to the embedded depths specified in the Contract Documents shall be the standard loading procedure conforming to D 1143 or as directed by the Engineer. Loading shall be continued to the specified test load or to failure, whichever occurs first.

The Contractor shall provide equipment to determine if reaction piles are moving. A scale attached to the reaction piles that can be monitored with a transit shall be used for this purpose.

If at any stage during the test, the Engineer detects malfunctioning of any apparatus furnished by the Contractor, or the load is being eccentrically applied, or the anchor piles are yielding, the Engineer will order the test abandoned and the Contractor shall replace it with another test at no additional cost to the Administration. The Contractor shall have all necessary personnel present at the site at all times during the performance of the test to maintain the required load.

After the pile test program is complete, anchor (reaction) piles shall be removed or cut off as specified in 410.03.10.

Steel pipe piles shall be load tested before filling.

411.04 MEASUREMENT AND PAYMENT. When the project includes an item for load test, it will be measured and paid for at the Contract unit price per each for the pertinent Load Test item. The payment will be full compensation for furnishing and installing all equipment, drawings, monitoring, recording, removal of all devices at the completion of the tests, and for all material, labor, equipment, tools and incidentals necessary to complete the work. In the event that the properly conducted load test fails to achieve the designated capacity, the additional tests will be measured and paid for at the Contract unit price per each under the Load Test item.

SECTION 412 — DRILLED SHAFTS (CAISSONS)

412.01 DESCRIPTION. This work shall consist of constructing drilled shafts (caissons) as specified in the Contract Documents, or as directed by the Engineer.

412.02 MATERIALS. Materials shall conform to 420.02 except as modified herein.

Concrete Mix No. 4	902.10
Reinforcement Steel	908
Steel Casings	A 252, Grade 2 or A 36

412.03 CONSTRUCTION. Construction shall conform to 402.03, 419.03, and 420.03, except as modified herein.

412.03.01 Subfoundation Investigation. When the Contract includes an item for Subfoundation Investigation, the Contractor shall conduct a subfoundation investigation program prior to ordering or fabricating reinforcement for drilled shafts. This program shall be used to determine the elevation of suitable bearing stratum and the required depth of the drilled shafts. Test holes shall be drilled at approximately a third of the drilled shaft locations, as selected by the Contractor, spread over the number of shaft locations. Test holes shall be drilled a minimum of 10 ft below the estimated drilled shaft length unless otherwise directed by the Engineer. After drilling the test holes, the data obtained will be evaluated by the Engineer to determine the uniformity/variability of the foundation materials. If the evaluation determines that more test holes are required, additional test holes shall be drilled at locations approved by the Engineer.

412.03.02 Shaft Installer. The Contractor shall obtain the services of a shaft installer having a proven record of experience, having successfully completed not less than three projects with similar subsurface conditions, shaft sizes, depths and minimum volumes of work as contained in the project. The Contractor shall submit evidence of pertinent experience to the Engineer for approval before proceeding with drilled shaft work.

The Contractor shall furnish a Certified Drilled Shaft report for each drilled shaft. The report shall record the following:

(a) Top and bottom elevations.

(b) Final center line location at top.

(c) Variation of shaft from plumb.

(d) Results of tests performed.

(e) Levelness of bottom.

(f) Seepage of water.

(g) Top and bottom elevation of any casings left in place.

(h) Any unusual conditions.

(i) Variation of dimensions from planned.

(j) Dates of start and completion of excavation.

(k) Inspection, testing, and placement of concrete (including any delays in concreting and location of construction joints in shafts).

(l) Reinforcement steel.

(m) Any additional information relevant to the as-built drilled installation.

The Contractor shall record and maintain information pertinent to each drilled shaft and shall provide required data to other testing and inspection personnel.

The Contractor shall provide all facilities as are reasonably required for the safe and convenient conduct of the Engineer's inspection and testing procedures.

412.03.03 Geotechnical Engineer. When specified in the Contract Documents, the Contractor shall employ the services of a qualified geotechnical engineer for inspection and testing for installation of drilled shafts. The geotechnical engineer shall be a professional engineer registered in the State of Maryland, have a demonstrated record of experience with similar drilled installations, and shall be approved by the Engineer prior to beginning augering for the drilled shafts.

The geotechnical engineer shall submit a plan containing the proposed methods to be use to inspect the drilled shafts in conformance with this Specification.

The geotechnical engineer shall visually inspect the bottom of each drilled shaft and perform tests as necessary to verify the bearing capacity. Drilled shafts shall be founded in material having a minimum design bearing capacity specified in the Contract Documents. The geotechnical engineer shall provide certification that the drilled shafts were properly drilled to a satisfactory depth and bearing.

412.03.04 Holes. Holes for drilled shafts shall be excavated by auguring, drilling, or hand excavation as necessary to reach the required bearing strata. Casings or slurry shall be installed as excavation proceeds when earth walls cannot be maintained without spilling into the shaft. Casings shall be full-length, watertight, of sufficient thickness to withstand compressive, displacement and withdrawal stresses, and to maintain the shaft walls. Casings shall be withdrawn as concrete is placed unless otherwise specified in the Contract Documents, or directed by the Engineer.

The final bottom elevation of drilled shafts shall be determined by the geotechnical engineer when the services are required. All holes shall be approved by the Engineer.

Holes for successive drilled shafts shall not be excavated until adjacent holes are filled with concrete and allowed to set.

Drilled shafts shall be constructed within the following tolerances:

(a) Maximum permissible variation of center line locations shall be not more than 1/24th of the shaft diameter or 3 in., whichever is less.

(b) Shafts shall not be out of plumb by more than 1.5 percent of the depth, 12.5 percent of the shaft diameter, or 15 in., whichever is less.

(c) The top of the shaft or concrete cut-off elevation shall be within 1 in. of the design elevation.

If the specified tolerances are exceeded, corrective construction shall be provided to compensate for excessive eccentricity at no additional cost to the Administration. Proposed methods of corrective construction shall be submitted to the Engineer for approval before proceeding.

The bottom of drilled shafts shall be excavated to an undisturbed, level plane. All loose material shall be removed prior to placing concrete.

Drilled shafts shall be dewatered as required to facilitate excavation, inspection and concreting.

Each drilled shaft shall be inspected before placing concrete.

Reinforcement Steel. Reinforcement steel cages for each drilled shaft shall be fabricated and erected as one continuous unit. Reinforcement shall be placed accurately and symmetrically about the axis of the hole, and held securely in position during concrete placement.

Exposed ends of extended reinforcement shall be protected from damage.

Concrete. Drilled shafts shall be filled with concrete immediately after inspection and approval by the geotechnical engineer and the Engineer.

Concrete shall be placed in one continuous operation, in a smooth flow without segregating. Mechanical vibration for consolidation shall be provided for at least the top 25 ft of each shaft. Concrete shall be placed by means of bottom discharge bucket, flexible drop chute, elephant trunk hopper, tremie, or pumping. Chutes, tremies or pumping shall be used where a drop of more than 8 ft is required.

Concrete shall be placed in the dry insofar as practicable. If excessive water occurs and it is not feasible to dewater the drilled pier shaft for concreting, then concrete shall be placed by the tremie method in conformance with 420.03.05. Tremie placement operations shall be controlled to ensure that tremie is not broken during continuous placing from bottom to top. Other methods of depositing concrete underwater may be used if approved by the Engineer.

A sufficient head of concrete shall be maintained to prevent any reduction in the diameter of the drilled pier shaft by earth pressure and to prevent extraneous material from mixing with the concrete. The withdrawal of temporary casings shall be coordinated with concrete placement operations to maintain a head of concrete approximately 5 ft above the casing bottom.

Concrete placement shall be stopped at the top cut-off elevations as shown on the Contract Documents. The tops of drilled shafts shall be screeded level and given a roughened surface finish. Where the cut-off elevation is above ground elevation, the top section shall be formed to extend the shaft to the required elevation.

Construction joints will be permitted in drilled shafts if concrete placement operations must be interrupted, as accepted by the Engineer. The surface of any construction joint shall be screeded level and given a roughened surface. An approved bonding compound shall be applied to the construction joint surface prior to placing additional concrete.

The Engineer may require full-depth continuous coring of drilled concrete shafts where observations of temporary casing removal and concrete placement operations indicate cause for suspicion of quality of concrete, presence of voids, segregation or other defects. This work shall be performed at no additional cost to the Administration.

Defective Drilled Shafts. Drilled shafts found to be defective shall be repaired or replaced as directed by the Engineer at no additional cost to the Administration.

412.04 MEASUREMENT AND PAYMENT. The payment for the items specified in the Contract Documents will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

412.04.01 Drilled shafts including furnishing and setup of augering equipment, auguring, drilling, excavating, dewatering, inspection, testing, services of the shaft installer and geotechnical engineer, sleeves, reinforcement, concrete, etc., will be paid for at the Contract unit price per linear foot for the pertinent Drilled Shaft item.

412.04.02 When subfoundation investigation is specified, it will be measured and paid for in conformance with 419.04.

SECTIONS 413 — 417 RESERVED

SECTION 418 — PROTECTIVE JACKETS FOR PILES

418.01 DESCRIPTION. This work shall include cleaning piles, fabricating, furnishing and placing wire fabric, fabricating, furnishing, installing and sealing the protective jackets, and filling the void between pile and jacket with grout as specified in the Contract Documents or as directed by the Engineer.

418.02 MATERIALS.

Fine Aggregate	901.01
Portland Cement	902.03, Type II
Concrete Admixture	902.06
Water	921.01
Welded Wire Fabric	908.08
Fiberglass Protective Pile Jackets	921.11 and 418.02.01
Anchor/Standoff Devices	A 185
Stainless Steel Screws	A 193, Type 303

418.02.01 Jackets. The jackets for new piles shall be fabricated in one solid piece with no longitudinal joint. The closure joint on jackets for existing piles need not be self-locking provided the joint can be field formed with fiberglass and is approved by the Engineer. The field formed closure joint shall conform to the tensile strength of the jacket. All jackets shall be a minimum thickness of 1/4 in. The surfaces of the fiberglass shall be free of bond inhibiting agents.

Jackets for steel and concrete piles shall be provided with noncorrosive standoffs on the inside face to maintain the jackets in the required positions.

418.02.02 Closure Joint Warranty. When closure joints are used for existing piles, the manufacturer and Contractor shall both furnish the Administration a written 5 year warranty against manufacturing and installation defects prior to starting the installations.

418.02.03 Grout. The Contractor shall submit in writing the proposed grout mix design and method of installation to the Engineer for approval before ordering any material.

Steel and Concrete Piles. Grout shall consist of a minimum of 845 lb/yd^3 of cement, 6 ± 1 percent of air entrainment by volume, and be proportioned with fine aggregate and water to provide a pumpable mixture. The minimum 28 day compressive strength shall be 3500 psi.

Ready mixed grout will be permitted by written permission of the Engineer. The ready mixed grout shall be furnished by a manufacturer approved by the Office of Materials and Technology.

Timber Piles. Grout shall consist of water insensitive epoxy and fine aggregate mixed in conformance with the manufacturer's recommendations.

418.03 CONSTRUCTION. Working drawings showing equipment, installation procedure including location of tremie pipes, injection port, method of sealing the bottom of the jacket, and method of support during placement of the grout, shall be prepared by the Contractor and submitted for approval prior to the start of field installations. Jackets shall not be installed until the Engineer approves the procedure and material in writing.

418.03.01 Cleaning Piles. The piles shall be cleaned of all surface contamination such as grease, oil, tar, loose rust, loose coatings, marine organisms, etc. to the satisfaction of the Engineer.

Piles shall be water blast cleaned with a nozzle pressure of 8000 to 20 000 psi, except that timber piles shall be cleaned with a nozzle pressure of 3000 to 3500 psi. The piles shall be cleaned a maximum of 24 hours prior to the placing the grout. Jackets shall not be placed until the Engineer has approved the cleaning of the piles.

418.03.02 Preparation of Protective Jackets. The inside faces of the jackets shall be cleaned and abrasive blasted to remove any agents which will inhibit attachment of anchor devices and bonding of the grout with the inside faces of the jackets. The Engineer may require these procedures to be redone if they are not acceptable at the time of placement.

Protective jackets will be inspected by the Engineer prior to placement. Loose or damaged anchor devices shall be repaired to the satisfaction of the Engineer. Protective jackets deemed unsatisfactory by the Engineer shall be replaced at no additional cost to the Administration.

The space between the pile and the jacket shall be sealed at the bottom. All temporary support devices used to position the protective jackets during installation shall be external and shall be removed before final acceptance.

418.03.03 Filling Void. The void between the pile and the protective jacket shall be filled with grout placed by the tremie method using two tremie pipes or by pumping using an injection port located at the bottom of the protective jacket. Depositing by means of bottom dump buckets is prohibited. Tremie pipes shall be equipped with hopper tops.

Only approved mixing equipment shall be used in preparation and handling of the grout. All oil and other rust inhibitors shall be removed from the mixing drums, stirring mechanisms and other portions of the equipment in contact with the grout before the mixers are used. All materials shall be accurately measured by volume or weight as they are fed into the mixer. Time of mixing shall not be less than one minute. The continuously agitated grout may be held in the mixer or agitator a maximum of one hour, or for 1-1/2 hours when the temperature falls below 70 F.

Grout placement shall be made as one continuous operation for each pile. Special care shall be taken in the placement of grout to obtain a satisfactory flow to ensure proper distribution around and bonding to the pile.

If emergency interruptions of continuous grout pumping become necessary, the Contractor shall stop the operations and remove the grout and the jacket. The pile shall be thoroughly cleaned as described in 418.03.01 prior to continuing the operation. The pile jacket shall not be reused unless it is removed prior to initial setting of the grout and is approved by the Engineer.

All excess grout shall be removed from the outside of the piles and jackets after the jackets are filled.

418.03.04 Protective Jacket Inspection. The Contractor's operations will be carefully observed during all phases of construction. In the presence of the Engineer, the Contractor shall remove the first two protective jackets installed to provide visual evidence that the Contractor's operations are obtaining the desired results. The removal shall not begin until the grout has set sufficiently to maintain its shape when the protective jacket is removed. The Engineer will examine the grout for cavities, honeycombing, and other defects.

(a) If the grout is satisfactory upon removal of the protective jacket, the Contractor's operations will be approved. The Contractor

shall remove all grout as directed by the Engineer, and clean and reinstall a new jacket in conformance with these Specifications. Reuse of the original protective jacket is prohibited.

(b) If the grout on only one of the installations is unsatisfactory upon removal of the protective jacket, the third protective jacket installed shall also be removed and inspected. If this inspection is satisfactory, the Contractor's operations will be approved. Protective jackets shall then be reinstalled as specified in (a).

(c) If the grout is unsatisfactory upon removal of the protective jacket on both of the first two piles inspected, or on two out of the three piles inspected as specified in (b), the Contractor shall submit modifications to the operations to the Engineer for approval before continuing. These procedures shall continue until the Contractor's operations are satisfactory.

(d) Additional inspections will be performed whenever required by the Engineer.

418.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for fabricating, furnishing and installing protective jackets including welded steel wire fabric, grout, excavation, and all material, labor, equipment, tools and incidentals necessary to complete the work.

418.04.01 Protective jackets will be measured and paid for at the Contract unit price per each for the pertinent Protective Jacket for Pile item.

418.04.02 Protective jackets will be measured and paid for at the Contract unit price per linear foot (depth) for the pertinent Protective Jacket for Pile item.

418.04.03 Protective jacket inspections that are satisfactory and accepted by the Engineer will be measured and paid for at the Contract unit price per each for the pertinent Protective Jacket Inspection item. Payment will also be full compensation for removal of the jacket, removal of the grout, cleaning, and reinstalling a protective jacket, welded steel wire fabric, and grout.

418.04.04 Protective jacket inspections that are unsatisfactory and rejected by the Engineer will not be measured or paid for. The Contractor shall remove the protective jacket, grout, and welded steel wire fabric and clean the existing structure at no additional cost to the Administration.

SECTION 419 — SUBFOUNDATION INVESTIGATION

419.01 DESCRIPTION. This work shall consist of drilling test holes in rock or other foundation material as a means of verifying the character and suitability of material for foundation purposes.

419.02 MATERIALS. Not applicable.

419.03 CONSTRUCTION. Test holes shall be drilled in conformance with T 206 and T 225, and shall be drilled at least 10 working days prior to excavation or pile driving in that area. The Contractor shall notify the Engineer at least 10 working days prior to drilling. The locations and minimum depth of the test holes shall be as specified in the Contract Documents or as directed by the Engineer. The Contractor shall record all information on the Administration's boring log Form No. SHA 73.0-46 that is available from the Office of Materials and Technology. The Contractor shall supply a geologist approved by the Engineer or a geotechnical engineer that is a professional engineer registered in the State of Maryland to ensure that the test holes conform to these Specifications.

The geologist/geotechnical engineer shall submit the drilling results to the Engineer within two working days after drilling any given hole or as specified in the Contract Documents. Within five working days after receipt, the Engineer will evaluate the subfoundation investigation to determine if any change in the as-planed excavation is necessary. Foundation excavation will not be permitted until the Contractor receives the Engineer's evaluation for that particular foundation.

419.04 MEASUREMENT AND PAYMENT. Subfoundation Investigation will be measured and paid for at the Contract unit price per linear foot for the actual total length of holes drilled. The payment will be full compensation for the geologist or geotechnical engineer services, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 420 — PORTLAND CEMENT CONCRETE STRUCTURES

420.01 DESCRIPTION. This work shall consist of constructing concrete structures or portions of structures including the furnishing, transporting, mixing, placing, curing, and finishing of the portland cement

concrete and protecting the structures as specified in the Contract Documents or as directed by the Engineer.

420.02 MATERIALS.

Curing Materials	902.07
Form Release Compound	902.08
Concrete Mixes	902.10 and 420.02.04
Grout	902.11
Linseed Oil	902.12
Drains, Downspouts, Weep holes and Pipes	905
Reinforcement	908.01
Cast Iron Scuppers	909.04
Anchor Bolts	909.06
Steel Forms Which Remain In Place	909.11
Joint Sealer	911.01
Preformed Joint Fillers	911.02
Preformed Elastomeric Joint Seals	911.04
Water Stops and Flashing	911.08 and 913.05
Production Plants	915
Fusion Bonded Epoxy	917.02
Water	921.01
Epoxy Bonding Compound	921.04

420.02.01 Admixtures. Calcium chloride or any other admixtures containing chloride salts shall not be used in the concrete placed on steel bridge deck forms which remain in place.

420.02.02 Requirements for Accessories. All accessories such as inserts and ties that will remain in completed superstructures within the top 5 in. of final deck slab concrete shall be either epoxy coated or made of material other than aluminum that will not rust. All accessories that will remain in parapets, sidewalks or any other portion of the structure designated to have epoxy coated reinforcement steel shall also conform to these requirements. Inserts are prohibited in the top half of slabs exposed to vehicular traffic unless specified in the Contract Documents.

420.02.03 Precast Reinforced Concrete Box Sections. Precast reinforced concrete box sections for culverts shall conform to M 259 or M 273 including concrete design strength. All details shall be as specified in the Contract Documents. Construction joints between the walls and the bottom and top slabs will be optional.

Certification. Refer to 305.03.06.

420.02.04 Composition of Concrete Mixes for Slip Form. If the slip form method is used for constructing concrete parapets and concrete median barriers on bridges, the concrete shall conform to Mix No. 6 except that the slump shall be 1 in. maximum. The slump shall be measured at the placement point as the concrete is being charged into the slip form machine. The coarse aggregate shall be crushed stone conforming to M 43, size number 7, and shall not be less than 63 percent of the total aggregate in the mix. Other size coarse aggregate may be used provided the Engineer approves the slip form results.

420.03 CONSTRUCTION. Concrete shall be made either at the work site or away from the work site by an approved central mixing plant, or by approved truck mixing as specified in Section 915.

When the Contract Documents specify the removal of portions of existing parapets or end posts, the removal shall be in conformance with 405.03.

420.03.01 Equipment. The Contractor shall use equipment of sufficient capacity to complete any unit or section of concrete between construction joints, as specified in the Contract Documents, in one continuous operation consistent with placement operations as approved by the Engineer. Hand mixing may be permitted with written approval of the Engineer for small volumes of concrete. However, its intended use is for small isolated areas where structural integrity is not critical and the volume does not exceed 1 yd^3.

420.03.02 Forms.

(a) Design Criteria.

(1) Design Loads. Design loads shall conform to AASHTO Standard Specifications for Highway Bridges, Temporary Works, Loads. The lumber in the forms shall be assumed to weigh 50 lb/ft^3.

(2) Design Stresses.

Timber Design. Timber design for formwork shall conform to ACI Standard Recommended Practice for Concrete Formwork (ACI 347). Unit stresses stipulated in AASHTO for treated timber may be increased by 25 percent but shall not exceed the values listed below. Deflections for form members shall not exceed 1/270 of the span or 1/4 in.

Compression Perpendicular to Grain	450 psi
Compression Parallel to Grain	1600 psi
Flexural Stress	1800 psi
Horizontal Shear	
Beams up to 6 in. deep	200 psi
Beams over 6 in. deep	150 psi
Axial Tension	1200 psi

Plywood. The strength of plywood without backing shall be calculated based on the grain of the face plies running parallel to its span. The plywood shall be installed in this manner.

Steel Members for Forms. Steel design for formwork shall conform to AASHTO Standard Specifications for Highway Bridges. For design where no dynamic loading is involved, the AISC Standard Manual of Steel Construction, Allowable Stress Design may be used as the accepted design code.

Steel Forms Which Remain in Place. The maximum deflection of steel deck forms that remain in place shall not exceed 1/180 of the span and not in excess of 1/2 in.

For steel deck forms that remain in place, camber shall not be used to compensate for deflection in excess of the above limits. The design spans of the form sheets shall be the clear distance between beam or girder flanges less 2 in.

For steel forms which remain in place, the unit working stress in the steel sheet and supporting members shall not be more than 0.725 of the specified minimum yield strength of the material furnished but not to exceed 36 000 psi. Physical design properties shall be computed in conformance with the American Iron and Steel Institute Specification for Design of Cold Formed Steel Structural Members.

(b) Working Drawing Approval. Detail, form, falsework and centering plans and design loads shall be submitted to the Engineer for approval except as specified otherwise in the Contract Documents. Working drawings for forms shall include all members proposed for use as well as form ties and bracing. Details for form ties shall not be submitted separately but shall be incorporated in the general working drawings submittal. The rate of placing concrete shall be noted on the working drawings. Approval of the working drawings will not relieve the Contractor of responsibility as specified in TC-4.01. The provisions of

430.03.28 also apply when working drawings are submitted for falsework and centering.

(c) Forms at Construction Joints and Corners. Ties or bolts shall be provided 3 to 6 in. from each side of concrete construction joints for tightening the forms against the hardened adjacent concrete prior to placing fresh concrete. At joints where forms have been removed and reconstructed, the form surface shall extend over the concrete already in place; and the forms shall be drawn tightly against the previously placed concrete prior to placing the fresh concrete. Forms shall be filleted at all sharp corners, except when otherwise specified in the Contract Documents and shall be given a bevel or draft in the case of all projections. All exposed corners of concrete shall be chamfered with 3/4 x 3/4 in. milled chamfer strips, except on unexposed footings or where specified in the Contract Documents.

(d) Form Scaffolds and Platforms. Form scaffolds and platforms shall be built along the outside of bridge deck fascias during construction of forms for bridge decks. They shall be designed and constructed as an integral part of the form supports. Separate design calculations shall be furnished with the working drawing submission. Approval of the working drawings will not relieve the Contractor of responsibility as specified in TC-4.01.

(e) Forms for Unexposed Surfaces. All sheathing, studs and bracing shall be of sound material. Studs and wales shall be straight and true and surfaced on two edges to a uniform width. The inside face of the forms shall be of sufficiently smooth construction that the resulting concrete surfaces shall be accurately formed.

(f) Forms for Exposed Surfaces. Unless otherwise specified in the Contract Documents, steel forms which remain in place shall be used between stringers to support the bridge deck concrete, except in panels where a longitudinal deck construction joint is located between stringers. Forms to be used on the structure for widening and rehabilitation shall provide that the exposed finished concrete surfaces shall match the existing structure.

(1) Lined Forms for Exposed Surfaces. Contact surfaces of lined forms for surfaces exposed to weather or view shall be approved composition board, sanded plywood or metal. All studs shall be surfaced two edges to a uniform width and shall be of a grade of lumber that is solid, straight and free of defects that could impair its strength. The backing for form lining shall be constructed using a grade of form lumber that

is solid, straight and free of defects that could impair its strength, but need not be of the quality used for contact forms for unexposed surfaces.

All sheathing for form backing shall be surfaced two sides to a uniform minimum of the thickness of at least the dimension approved on the working drawings. Form sheathing shall be built solidly, securely nailed to studs and placed to prevent any bulging of the lining.

(2) Unlined Forms for Exposed Surfaces. Unlined forms in contact with surfaces exposed to weather or view shall be constructed of five ply sanded plywood of the thickness specified in the Contract Documents. Plywood shall be manufactured especially for concrete formwork using waterproof glue. All studs and wales shall be surfaced two edges to a uniform width.

Full size sheets of plywood shall be used except where smaller pieces cover an entire area. All joints shall be backed solidly to prevent leakage and the edges of abutting sheets shall be nailed to the same stud or blocking with sixpenny nails not more than 8 in. apart. Where rustication occurs, horizontal joints in the plywood shall be constructed behind a rustication strip. Otherwise, horizontal joints shall be placed at the same respective elevations in all portions of the structure. Where vertical rustication occurs, vertical joints in the lining shall be constructed behind a rustication strip. Otherwise, vertical joints shall be kept to a minimum and shall be butted tightly together and sealed with a crack filler specified in the Contract Documents, as the plywood is nailed in place.

(g) Steel Forms Which Remain in Place.

(1) Installation. The surface of the steel forms in contact with concrete shall be smooth and free of surface irregularities. Working drawings for steel forms which remain in place shall specify the grade of steel, the physical and sectional properties for all permanent steel bridge deck form sheets and a clear indication of locations where the forms are supported by steel beam flanges subject to tensile stresses.

Form supports shall not be welded to flanges of steel that are not considered weldable or to portions of flanges that are subject to tensile stresses.

Welding and welds shall conform to the provisions of the latest AWS Bridge Welding Code pertaining to fillet welds.

Unless otherwise specified in the Contract Documents, steel forms which remain in place shall be used between stringers to support bridge deck concrete, except in panels where a longitudinal deck construction joint is located between stringers.

(2) Procedure Check and Inspection. The Contractor shall remove at least one section of the forms at a location and time selected by the Engineer from each span of each bridge in the Contract. If the bridge has a longitudinal joint, a form on each side of the joint shall be removed from each span. This should be done as soon after placing the concrete as practical to provide visual evidence that the concrete mix and the Contractor's procedures are obtaining the desired results. An additional section shall be removed if the Engineer determines that there have been any changes in the concrete mix or in the Contractor's procedures warranting additional inspection.

At locations where sections of the forms are removed, the Contractor will not be required to replace the forms, but the adjacent metal forms and supports shall be repaired to present a neat appearance and ensure their satisfactory retention. As soon as the form is removed, the concrete surfaces will be examined for cavities, honeycombing, and other defects. If irregularities are found and the Engineer determines that these irregularities do not justify rejection of the work, the concrete shall be repaired as directed by the Engineer. The concrete shall be given an ordinary surface finish in conformance with 420.03.07(a). If the concrete where the form is removed is unsatisfactory, additional forms, as necessary, shall be removed to inspect and repair the slab. The Contractor's method of construction shall be modified as required to obtain satisfactory concrete in the slab. All unsatisfactory concrete shall be removed and replaced or repaired as directed by the Engineer at no additional cost to the Administration.

The Contractor shall provide all facilities as are reasonably required for the safe and convenient conduct of the Engineer's inspection procedures.

(h) Steel Forms Which Do Not Remain in Place. The surface of the steel forms in contact with the concrete shall be smooth and

free of bolts, bolt heads, nuts, rivet heads, welding seams and surface irregularities. Forms that produce unacceptable concrete surfaces will be rejected and shall not be reused.

(1) For Round Columns and Piers. Steel forms for round columns and piers shall have minimum number of horizontal joints and shall be column height. The minimum thickness of these steel forms shall be 10 gauge.

(2) For Pier Caps and Crash Walls. Prefabricated girder type steel forms may be used for forming pier caps or crash walls. Each element of these forms, including side, bottom and end shall be in one piece where practical. Splices shall be arranged to provide a symmetrical pattern where forms are spliced.

(3) For Reinforced Concrete Box Culverts and Rigid Frames. Steel forms or forms constructed of wood or composition wood panel sheathing set in metal frames may be used. The minimum thickness of steel forms for box culverts and rigid frames shall be 10 gauge.

(i) Fiber Column Forms. Fiber column forms shall only be used for round columns, and shall conform to these Specifications. The forms shall produce columns truly round and straight and shall be protected from dampness before concrete is placed. Fiber forms shall not be spliced.

(j) Release Agents. All forms shall be treated with form release compound immediately before placing concrete.

(k) Temporary Supports. Temporary supports used for centering and falsework shall be built on good firm foundations. Unless otherwise provided, they shall be founded to bear upon strata at or below the frost line unless rock is available, or piling shall be driven for support where required. The strength and bracing of the temporary supports shall ensure that the completed structure will have the shape shown on the Contract Documents. The Contractor shall employ jacks or hardwood wedges in connection with the temporary supports in order to take up settlement either before or during placing of concrete. Temporary supports shall be set to give the structural camber specified on the Contract Documents, plus allowance for shrinkage and settlement. If during the construction any weakness, settlement or distortion develops, the work shall be stopped and any masonry affected thereby removed and the temporary structures strengthened

before work is resumed. Centering shall be constructed to permit its gradual, uniform lowering.

(l) Defective Forms. Removal or modification of steel forms which remain in place shall be performed using a device approved by the Engineer. Burning is prohibited.

(m) Form Ties. Only form ties approved by the Engineer shall be used. Ties shall leave no metal closer than 2 in. from the surface. They shall not be fitted with lugs, cones, washers or other devices which act as spreaders within the form or for any purpose that leaves a hole larger than 7/8 in. diameter. When prefabricated steel girder forms are used, tapered ties up to 1-1/2 in. maximum diameter shall be used. Ties shall be clean and free of rust. When ties are removed, the holes shall be pressure grouted with a nonshrink mortar mixed to match the color and texture of the concrete.

Portions of ties to be removed from the concrete shall be coated with a clear lubricant or other approved material to facilitate removal.

Care shall be exercised during removal of form ties to avoid spalling the concrete on the exposed surface. Cutting back from the face of the is prohibited.

(n) Form Support Brackets or Devices. Devices attached to previously placed concrete may be used, provided all parts are acceptable to the Engineer. No metal part of an insert, threader or anchor that remains in place in the concrete shall be within 2-1/2 in. of the surface. The concrete supporting the brackets or other devices shall be cured and shall have attained a minimum compressive strength of 3000 psi before the brackets or other devices are attached. All voids left in the concrete after brackets or other devices have been removed shall be no greater than 2 in. diameter and shall be completely filled with mortar and the surface finished as specified in 420.03.07(a).

(o) Form Removal. For the purpose of determining the time when falsework and forms may be removed, backfill placed, and when loads may be applied to structures, an adequate number of concrete test specimens shall be made in addition to those required to check the quality of the concrete being produced. All forms for concrete work shall be removed and disposed of by the Contractor after formwork requirements have been conformed to, except those that are specified to remain in place.

Methods of form removal likely to cause overstressing of the concrete shall not be used. Forms and their support shall not be removed without the approval of the Engineer. Supports shall be removed in a manner that permits the concrete to uniformly and gradually take the stresses due to its own weight.

(p) Year Built Marking. The year of completion shall be cast into each structure, as determined by the Engineer. Forms or molds for casting the year built numerals in the structure shall be supplied by the Contractor. The year built numerals shall be the size specified in the Contract Documents.

420.03.03 Anchor Bolt Placement. Anchor bolt placement shall conform to 430.03.31.

420.03.04 Concreting. Before placing concrete, forms shall be cleaned. Struts, stays and braces serving temporarily to hold the forms in correct shape and alignment shall not be buried in the concrete. If faces of completed or proposed excavated footing areas are disturbed prior to concreting, the footings shall be extended at no additional cost to the Administration, to bear on undisturbed faces acceptable to the Engineer.

All concrete except tremie concrete shall be placed in the dry.

(a) Foundations. The Contractor shall be responsible for any reinforcement fabricated prior to approval of foundations. If bearing material varies more than assumed in design, footing may be lowered, raised, deepened, subfoundation placed, piles used or a combination of these methods used to best obtain bearing as directed by the Engineer. If planned footings are changed vertically, reinforcement steel shall be revised as required. Subfoundation concrete for bridges, retaining walls and wing walls of box culverts or rigid frames shall be constructed using plain Concrete Mix No. 1 (no reinforcement). The Concrete Mix No. 1 need not be vibrated, and the usual curing and cold weather requirements may be reduced to three days. Selected backfill using number 57 aggregate may be used for subfoundation for box culvert barrels, headwalls and miscellaneous structures.

(b) Concrete Placement. Concrete shall be placed to avoid segregation of the material and the displacement of the reinforcement. The use of troughs, chutes and pipes for conveying concrete more than 15 ft from the mixer to the forms will be permitted only when acceptable to the Engineer. Open troughs and chutes shall be metal or metal lined. Where segregation occurs due to steep slopes, chutes shall be equipped with baffles.

Where placing operations would involve dropping the concrete more than 5 ft, it shall be deposited through a tube made of sheet metal, canvas or other approved material. Aluminum hoppers or tubes are prohibited. Lower ends shall be kept as close as possible to the newly placed concrete and not more than 3 ft above the concrete. All tubes shall have a minimum diameter of 6 in. unless otherwise directed by the Engineer. After initial set of the concrete, the form shall not be disturbed, and no strain shall be placed on the projecting ends of the reinforcement.

Concrete shall be placed in horizontal layers not more than 12 in. high except as provided herein. When less than the complete area of a layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and vibrated before the preceding layer has taken initial set to prevent injury to the concrete and avoid separation of joints between the layers.

Concrete in columns and walls shall be placed in one continuous operation unless otherwise directed. The concrete shall set at least 12 hours before the caps are placed.

Where walls, piers, columns, struts and posts have horizontal construction joints, succeeding lifts shall not be placed until the lower placement has set for 12 hours.

Prior to subsequent placement, all accumulations of mortar splashed upon the reinforcement shall be cleaned. Care shall be exercised not to injure or break the concrete seal bond near and at the surface of the concrete while cleaning the reinforcement steel.

(c) Superstructure Placement.

(1) Grade Controls for Bridge Deck Slabs. Bridge deck slabs supported by new stringers shall be placed in conformance with the specified line and grade. The Contractor shall take all necessary precautions, including a check on all new bridge seat elevations as the last order of work before setting stringers. Any adjustments resulting from this check shall be completed before additional work is started. After the structural steel is set, a final check of elevations of all the steel stringers at points corresponding to those specified in the Contract Documents for dead load deflection and finished roadway elevations shall be made. Computations shall be made by the Contractor, reviewed by the Engineer, and controls set at proper elevations to produce finished tops of concrete bridge decks that will be true as to planned line and grade of the roadway surface.

Grade control for bridge deck slab replacements shall conform to 405.03.02.

(2) Superstructure Placement Restrictions. The superstructure shall not be erected until the substructure forms have been sufficiently stripped to determine the character of the concrete in the entire substructure, unless otherwise permitted by the Engineer. In all spans, the concrete bridge deck slabs outside of the stringers shall be cast using plywood forms.

Unless otherwise specified in the Contract Documents, concrete for deck slabs shall be pumped whenever the volume of concrete in the pour exceeds 50 yd^3.

The Contractor shall place all superstructure concrete in conformance with the following schedule:

SUPERSTRUCTURE CONCRETE PLACEMENT SCHEDULE		
DATES	BEGIN CONCRETE PLACEMENT AFTER	FINISH BURLAP PLACEMENT BEFORE
May 15 - June 15	7:00 PM	11:00 AM
June 16 - Aug. 14	9:00 PM	7:00 AM
Aug. 15 - Sept. 15	7:00 PM	11:00 AM
Sept. 16 - May 14	No time restrictions	

Superstructure concrete shall not be placed or worked in any manner when the temperature in an unshaded location at the placement site is above 80 F. Floodlighting shall be used when existing light is less than 20 average horizontal ft-c over the construction area.

The Contractor shall submit a Situation Plan to the Engineer showing the locations and aiming of floodlights. After reviewing this plan, the Engineer will witness a test of the floodlighting system at the proposed construction area. The Contractor shall run the floodlighting test. The floodlighting system shall be capable of maintaining 20 ft-c without producing a glare on traffic. Floodlighting systems will be approved by the Engineer. When portable generators are used, an emergency backup system shall be available at all times on the job site.

(3) Rate of Concreting for Bridge Deck Slabs. Provisions shall be made by the Contractor to ensure that the placement

rate of concrete is 35 yd^3/hour minimum. Under special circumstances, the Engineer may give written approval to lower this requirement.

The Contractor shall submit for the Engineer's approval written evidence of an adequate source of concrete, and placing and finishing equipment capable of conforming to the minimum rate of placement of 35 yd^3/hour per crew while providing the intended quality finish. This evidence shall be submitted at least one week prior to the proposed placement of the bridge deck slab.

Concrete in slab spans shall be placed in one continuous operation and in one layer for each span, unless otherwise directed by the Engineer.

Concrete shall not be mounded on concrete slab forms supported by beams, stringers, or girders. When placing, the concrete shall be distributed to a depth not exceeding the planned slab thickness plus 6 in. before spreading, consolidating and finishing.

The placing sequence shall be in the numerical order specified in the Contract Documents and shall not be modified. A minimum of 40 hours shall lapse between the completion of one placement and the start of the next numbered placement.

(d) Box Culverts. Box culverts shall be constructed by casting in place or using precast reinforced concrete box culvert sections. Whenever a particular method is indicated in the Contract Documents, the Contractor may elect to use the alternate method unless otherwise specified. However, all time constraints such as maintenance of traffic, curing, completion dates, etc., shall be met.

If the Contractor elects to use precast reinforced concrete box sections, at least 15 ft of all box culvert ends and all footings, wing walls, headwalls and toe walls shall be cast in place. Additionally, the precast sections shall terminate a minimum of 1 ft from all footings and toe walls. All lifting devices shall be indicated on the working drawings and all lifting holes shall be filled with nonshrink grout after the precast units are in place. The precast reinforced concrete box sections shall be set tightly together and the joints shall be sealed in conformance with the manufacturer's recommendations.

The bottom slabs of cast in place concrete box culverts shall be placed for their full depth in one mass or layer and permitted to set not less than 12 hours before any additional work is done.

Single cell box culverts spanning in excess of 10 ft and multiple cell box culverts shall not have the top slabs placed until the concrete in the sidewalls has set for a minimum of 12 hours. Construction joints at the top of sidewalls may be omitted in some cases provided the top slabs are placed as follows:

(1) For single cell box culverts spanning 10 ft or less, the sidewall construction joint may be omitted and the top slab placed on the sidewalls, provided the concrete in the sidewalls is allowed to set for approximately two hours before starting to place the top slab.

(2) Regardless of size or number of cells, the Contractor may request in writing to place the top slab on the walls of box culverts in conformance with (1) above. The written proposed plan, including rate and method of placement, and type and size of equipment, shall be submitted to the Engineer for approval. If the Contractor receives initial written approval, the first section of the structure shall serve as a demonstration to confirm that there is no excessive cracking or any other detriment, and that satisfactory results will be obtained. After receiving written final approval, the Contractor may continue placing the remainder of the box culvert. If at any time the Engineer decides that the results are no longer satisfactory, the Contractor shall revert to placing the concrete with the 12 hour delay as specified above at no additional cost to the Administration.

(e) Forming Concrete Parapets and Median Barriers on Bridges. The Contractor may construct concrete parapets and median barriers on bridges by either the slip form method or conventional fixed form method. The slip form method is prohibited on bridges maintaining traffic, or on parapets when railing is specified.

Contractors who elect to use the slip form method shall first demonstrate their ability to produce results acceptable to the Engineer. If a Contractor is unable to demonstrate that ability or fails to maintain acceptable results during production, the slip form operation shall be stopped, the unacceptable work shall be removed and the construction methods shall be modified. If construction modifications do not produce acceptable results, the Contractor shall use the fixed form method. No additional

compensation will be permitted, and no increase will be allowed in any Contract price nor will any revisions be made to the amount of time to complete the Contract as a result of any required removals, modifications or changes in the method of placing parapets or barriers.

The Contractor shall notify the Engineer in writing of the proposed method of constructing the parapets and median barriers prior to beginning superstructure work. If slip forming is to be considered, then the following shall apply:

(1) The Contractor shall submit to the Engineer evidence of being capable of producing high quality slip formwork. Prior to beginning any slip form construction, the Contractor shall submit a detailed work plan. The plan shall include the type of equipment, materials and procedures to be used, any subcontractors involved in the construction, key personnel who will be performing the work (names, training, experience, etc.), as well as detailed information on how the Contractor proposes to satisfactorily complete the work.

(2) When possible the work plan shall include reference to at least three other similar projects completed in the State of Maryland or surrounding states using the slip forming method for parapet or median barrier construction. As far as practical, these similar projects shall have been built using the same equipment, personnel, material, and procedures proposed for the project. The Engineer may elect to visit these completed projects to evaluate the acceptability of the finished product.

If the Engineer determines that the Contractor has satisfactorily slip formed parapets or median barriers at the locations submitted in the Contractor's work plan, the requirements of the off bridge test site specified below may be waived and the first 50 ft of slip forming on the bridge will be considered the test section for the structure. This test section shall be completed and approved prior to placing the remaining portions of parapet or bridge median barrier.

(3) The work plan shall be approved in writing prior to beginning any slip forming operation.

Any proposed revisions or deviations to the approved work plan submitted by the Contractor shall be approved by the Engineer in writing prior to making the change.

If the Contractor does not conform to (2) above, an off bridge test section shall be completed and accepted prior to placing any portion of the parapet or bridge median barrier. The Contractor shall place the appropriate test section of parapet or median barrier using the same equipment, sensor line, support spacing, material, personnel and procedures as described in the work plan. This test section shall match the structure's horizontal curve as much as practical, be a minimum of 50 ft long, and be placed at a location selected by the Contractor near the bridge site.

The off bridge test section shall be placed with vertical irregularities varying upward and downward at least 3/4 in. The Contractor shall then prove that the method of slip forming can compensate for this deviation and provide a top of parapet or median barrier that is true to the proposed line and grade and not necessarily parallel to top of bridge deck. This will necessitate that the equipment provide for variations in height of vertical face of parapet where it intersects the top of deck slab.

The sensor line shall be positioned, supported, and spaced in the same manner in the testing operation as will be used on the bridge decks with no stakes, holes, etc., used to support it. Sensor support spacing shall be as recommended by the slip form machine manufacturer and as necessary to maintain the planned line and grade. The rate of slip forming on the test section shall be the same as that proposed for the bridge. Joints shall be saw cut in the test section at the same approximate spacing and in the same manner as proposed for the finished bridge.

The Engineer will evaluate the procedure, material, equipment and appearance of the test section. The Contractor shall take three test cores from the test section at locations directed by the Engineer to determine the concrete quality. Honeycombing, sags, tears or other evidence of poor quality concrete will be cause for rejection of the test section. If the test section is rejected, the Contractor may place additional test sections until approved by the Engineer or may elect to use the fixed form method.

The accepted test section shall remain in place until all parapets or median barriers on the bridges are complete. The slip formed parapets and median barriers on the bridges will be compared to the approved test section to ensure that similar acceptable structures are being achieved on the

bridges. Following completion and acceptance of all bridge parapets and median barriers, the Contractor shall remove and dispose of the off bridge test section.

The entire testing procedure, including removing and disposing of test units, regardless of whether the procedure is approved or rejected, shall be done at no additional cost to the Administration.

When dual bridges are separated by a joint, the two parapets that make up the median barrier shall be constructed in separate operations. Constructing both sections of median barrier simultaneously is prohibited. The first median parapet section shall be allowed to cure for a minimum of 40 hours prior to constructing the second section of median parapet.

Additional reinforcement steel shall be placed to provide bracing for the reinforcement in the parapet to prevent displacement when subjected to the pressure developed in the slip form machine's extruding process. A detail will be included in the Contract Documents. The alignment and rigidity of the reinforcement steel will be strictly enforced by the Engineer to ensure that the minimum clearances shown on the Contract Documents for concrete cover are maintained.

The Contractor shall ensure that a continuous supply of concrete is available at the bridge site during slip forming operations, and that an uninterrupted flow of concrete is provided to the slip form machine. Once the slip form machine is set in motion, it shall keep advancing until it reaches the proposed stopping point. The Contractor shall organize and schedule the operations in a manner that the next concrete truck will be able to move into position at the slip form machine as soon as the previous truck pulls away without interrupting the machine's uniform advancement. Under no circumstances will the Contractor be allowed to operate the slip forming in a manner which requires a concrete truck to be removed from the bridge before another truck can move into place.

Vehicular traffic, except for the slip form machine and its concrete supply trucks, is prohibited on the bridge while slip forming operations are in progress.

When the slip form machine is set up and the sensor wire is placed, a dry run of the equipment shall be made in the presence of the Engineer to ensure that the parapet or median barrier will envelop preset obstacles that are to be embedded or meet with flush surfaces such as pull boxes, expansion joint plates, etc.

The concrete consistency shall maintain the shape of the structure without support after the extrusion. The surface shall be free of surface pits larger than 3/16 in. diameter. The concrete shall require no further finishing, other than light brushing with water only. Finishing with brush applications of grout is prohibited.

If a tear occurs at the top of the parapet or median barrier during the slip forming operation, it shall be repaired immediately. The repair shall be made in a workmanlike manner in conformance with good concrete practices acceptable to the Engineer. The repair shall blend into the barrier to the extent that the naked eye cannot distinguish any difference in the wall face or top.

The rate at which the slip form machine is advanced is crucial to the quality of the finished parapet or median barrier. The Contractor shall ensure that the rate of advancement conforms to the equipment manufacturer's recommended value. The advancement of the slip forming machine on the bridges shall be the same rate as used on the approved test section. A higher or lower rate is prohibited.

The shape of the finished parapet or median barrier shall conform to the dimensions shown on the Contract Documents. The vertical face at the bottom of the concrete safety shaped parapets or median barriers is 3 in. high, and will be unacceptable if this vertical face exceeds 3-1/2 in. The finished parapet or median barrier shall show no deviation from the proposed grade and alignment in excess of 1/4 in./10 ft.

Joints shall be saw cut in the finished parapet or median barrier using a diamond blade. Cuts shall be 1/8 in. wide and 2 in. deep and shall be made in the top, outside and inside faces, stopping 3 in. above the top of deck slab in both faces except where it is impossible for the outside portion of the final placement of back to back median parapets. Joints shall be spaced as shown on the Contract Documents. Reinforcement steel in the parapets and median barriers shall

be terminated at the joint locations. The deck shall be marked to ensure that the saw cuts are made at these locations and do not conflict with the reinforcing steel pattern. The trapezoidal shaped control joints on the outside of parapets will not be required if slip forming is used. Slip form placements shall only be terminated at a parapet control joint. The joints shall be saw cut as soon as possible after initial concrete set and after the concrete has set sufficiently to preclude raveling during the sawing. The sawing shall be completed the same day the concrete is extruded and before any shrinkage cracking has occurred. Concrete shall not be left overnight without saw cutting the joints.

When portions of the bridges are in superelevation with varying rates of slope, the Contractor shall produce the exact configuration of parapets and median barriers as shown on the Contract Documents, i.e., level top surface, wall normal to deck surface, etc.

(f) Temperature Controls. Concrete temperatures shall be as specified in 902.10. Concrete below these temperatures shall be heated by one of the following methods:

(1) When the method of heated mixing water is used, the water shall not be above 170 F when introduced into the mix.

(2) When the method of heated aggregates is used, aggregates containing frozen lumps shall be independently heated and no materials containing frozen lumps, ice, or snow shall be permitted to enter the mixer. Aggregates may be heated by steam coils or other dry heat but not by discharging live steam or hot water into them. Heating by means of a flamethrower or any direct flame is prohibited.

When the ambient air temperature is below 40 F, the temperature of the air in contact with the reinforcement shall be raised to 40 F prior to placing concrete. When the ambient air temperature is above 70 F and the reinforcement is exposed to the direct rays of the sun, the reinforcement shall be cooled to 70 F or less by means of a water spray prior to placing concrete. When the ambient air temperature is above 70 F and the steel forms that remain in place are exposed to the direct rays of the sun, the forms shall be cooled by means of water spray prior to placing concrete.

When abnormal wind or storms are forecast locally by the National Weather Service, superstructure concrete shall not be placed during the period covered by the forecast.

(g) Pumping. Equipment shall be suitable and adequate in capacity for the work and will be acceptable to the Engineer. The equipment shall be arranged so that no vibrations result which might damage freshly placed concrete. No parts of the pump or discharge line shall be made of aluminum.

(h) Use of Conveyors. Concrete may be moved from the mixer to its final position by use of conveyors. Conveyors shall be in sections and concrete shall be deposited from one conveyor belt onto the next through a hopper. The maximum rise on any individual section of the conveyor is 30 degrees from the horizontal. The maximum belt travel speed shall be 900 ft/minute for concrete slumps less than 2 in. This speed shall be decreased for slumps exceeding 2 in. Conveyors used for placement of decks shall be supported by main load carrying members. Polyethylene or other material acceptable to the Engineer shall be placed under the conveyor line to contain any spillage from the belts onto the deck.

420.03.05 Depositing Concrete Under Water. Concrete shall not be deposited in water or exposed to the action of water before setting, unless specified in the Contract Documents or approved by the Engineer in writing. Concrete deposited under water shall be placed by means of a tremie pipe. The tremie pipe shall not be less than 10 in. diameter and shall be equipped with a watertight plug.

The bottom of the pipe shall be equipped with a baffle or deflector plate. The number and location of pipes will be dependent on the size of the pour. After tremie concrete has been placed, it shall not be disturbed nor shall successive layers be placed on top until the previously placed concrete has developed the necessary strength as determined by the Engineer. Concrete shall not be deposited in water where the temperature is less than 35 F. When concrete is deposited in water 36 to 45 F, the concrete shall be heated and placed at a temperature of 60 to 80 F. Pumping of water is prohibited while concrete is being placed. The consistency of the concrete shall be carefully regulated to prevent segregation. Tremie concrete which projects more than 6 in. above the top of the as-planned tremie concrete shall be cut down at no additional cost to the Administration until no portion is more than 6 in. above the as-planned elevation.

(a) Cofferdams. Where cofferdams are used, separate forms shall be constructed within the cofferdams except where footing concrete is to be placed against a base of undisturbed material and where

the cofferdam is to remain in place and act as the concrete form. The water level in the space between form and cofferdam shall be kept below the bottom elevation of concrete for at least 12 hours.

(b) Concrete Seals. When feasible, concrete seals for parts of structures under water shall be placed continuously from start to finish so as to avoid horizontal construction joints. The surface of the concrete shall be kept as nearly horizontal as practicable at all times to ensure thorough bonding. In these cases, each succeeding layer of the seal shall be placed before the preceding layer has taken its initial set. The slump of tremie concrete shall be maintained between 4 and 8 in. and maintained as close to 4 in. as possible. After dewatering and prior to placing any succeeding layers of concrete, the top of the foundation seal (tremie concrete) shall be thoroughly cleaned.

(c) Concrete Exposed to Saline Water. Saline water shall not come in direct contact with the concrete until it has been permitted to harden as required in the following table:

CONCRETE IN SALINE WATER	
SALINE CONTENT OF WATER BY WEIGHT IN PARTS PER THOUSAND	SALINE WATER SHALL NOT CONTACT CONCRETE UNTIL FOLLOWING MINIMUM TIME IN DAYS HAS ELAPSED AFTER INITIAL SET*
0 to 10	0
10+ to 15	7
15+ to 20	14
20+ to 25	21
Over 25	30
* The Engineer may approve a waiver in writing.	

Unless otherwise specified, the concrete shall be wet cured for at least seven days while being maintained at a temperature of 50 F or above.

420.03.06 Consolidation. All concrete except concrete deposited under water shall be consolidated by means of internal vibrators unless otherwise directed by the Engineer. These provisions shall also apply to precast members or units.

Vibration shall be applied at points uniformly spaced and not further apart than twice the radius over which the vibration is visibly effective.

(a) Internal Vibration. Internal vibrators shall be of a type and design approved by the Engineer. The intensity of application shall visibly affect a mass of concrete of 1 in. slump over a radius of at least 18 in. and have frequency of vibration not less than 4500 impulses per minute.

(b) External Vibration. External vibrators shall be of a type and design approved by the Engineer. External vibration shall be used as directed by the Engineer for the following sections: very thin, very heavily reinforced, numerous inserts, or where form surfaces are sharply inclined or battered. Filler concrete for steel grid floors shall be consolidated using external vibrators to the steel grid.

420.03.07 Finishing Concrete Surfaces. Concrete faces shall be finished with one of the following types. All concrete work shall have an ordinary surface finish as described in (a) below unless otherwise specified.

(a) Ordinary Surface. Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces except from those that are not to be exposed or not to be waterproofed. On all surfaces, broken corners or edges and any cavities shall be thoroughly cleaned and, after having been kept moist, shall be carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the grade of the concrete being finished. Any excess mortar at the surface of the concrete shall be removed. The mortar patches shall be cured as specified in 420.03.09. Construction and expansion joints in the completed work shall be carefully tooled and cleaned. Joint filler shall be exposed for its full length with clean and true edges. Resulting surfaces shall be true and uniform. Surfaces that cannot be repaired in a manner acceptable to the Engineer shall be completed as special surface finishes.

(b) Special Surface. Fins and projections shall be removed. The surface of the concrete shall then be saturated with water and kept wet for a minimum of two hours. A grout mix of the same proportions as the concrete shall be thoroughly rubbed onto the surface by section using burlap pads or cork floats completely filling all voids, pits, and irregularities. After this grout has dried sufficiently, the excess shall be wiped off with dry, clean burlap. The surface shall then be cured as specified in 420.03.09(f), except that only colorless liquid curing compound shall be used in

this method. The exterior faces of cast-in-place superstructures and end posts for bridges over highways and all interior faces of cast-in-place parapets, bridge median barriers, and end posts shall receive this type of finish. This finish shall not be applied to members that have been constructed by the slip form method.

(c) Horizontal Surfaces. All upper horizontal surfaces such as the tops of parapets, copings, and bridge seats shall be finished by placing an excess of concrete material in the forms and striking off even with a wood template. Tops of handrail (posts and caps), headwalls, parapets, wing walls, and barriers shall be steel troweled to a smooth, dense surface.

The bridge seat bearing areas of the substructure masonry shall be finished to the elevations shown on the Contract Documents. The Contractor shall check the elevation of each bearing area prior to finishing to ensure conformance. Each area shall be checked for level in all directions using a spirit level and adjustments made prior to the setting of the concrete. The area shall be steel troweled to a dense flat surface. Bearing areas that are not flat after final finishing shall be ground to achieve an acceptable surface.

Bearing areas will be rejected whenever the elevation is below that of the surrounding masonry.

(d) Bridge Deck Slabs. Concrete for bridge decks shall be transversely screeded with a power operated cylinder or roller finishing machine approved by the Engineer. The finishing machine and all transverse construction joints shall be set parallel to the nearest support lines (the abutment or pier) on all bridge deck slabs. When the skew angle changes at supports, the screed angle shall be adjusted accordingly as the finishing machine progresses across the deck slab. The concrete shall be placed so that the front edge of the newly placed concrete is as nearly as possible parallel to the skew of the finishing machine. The concrete shall also be placed uniformly ahead of the finishing machine, and shall not be more than 6 in. above the top elevation of the finished deck slab nor more than 10 ft ahead of the finishing machine.

Under no circumstances shall the finishing machine span a length greater than the manufacturer's recommendation. The Contractor may combine machines or use two machines of which both may use a common rail and any additional rail. The proposed method and the location and anchorage of accessories that will remain in the completed superstructures as a result of this requirement shall

be subject to the approval of the Engineer and conform to 420.02.02.

After the concrete has been struck off, the surface shall be checked with a 10 ft straightedge operated in a position parallel to the center line of the structure by means of long handles.

This straightedge shall progress longitudinally in overlapping 5 ft increments and transversely in 2 ft increments to locate any irregularities in the surface. The width of the working face shall not be greater than 2 in. and the straightedge shall be as light weight as possible to avoid distortion of the slab surface.

The concrete surface shall be finished with a full width strip of burlap mechanically or manually dragged across the surface.

(1) Slab Grooving. Grooving shall be performed on all bridge decks including slab bridges, and box culverts built to grade. The grooving operation shall start after the bridge deck slab has been cured in conformance with 420.03.10, and attained a minimum compressive strength specified in 420.03.15. The bridge deck shall be grooved perpendicular to the center line.

The grooves shall be cut using a mechanical saw device that leaves grooves 1/8 in. wide, 3/16 ± 1/16 in. deep, and variably spaced from 5/8 to 7/8 in. apart. The grooves shall extend across the slab to within 1 ft of the gutter lines. The transverse grooving shall not cut across armored joints or any joint in which an existing joint seal may be damaged, but shall stay clear by 2 ± 1 in. on each side. On joints skewed 70 degrees or less, one pass shall be made parallel to the armored joint unless otherwise directed by the Engineer. The residue resulting from grooving operations shall be removed from all surfaces in a manner acceptable to the Engineer. All surfaces shall be left in a washed, clean condition.

(2) Deck Slab Tolerances. Slab thickness shall not be reduced. Any slabs that are found to have deficient thickness may be rejected. The surface shall not deviate in a transverse or longitudinal direction more than 1/8 in./10 ft from a straight line. For vertical curves the deviation (from the curve specified) shall not exceed 1/8 in./10 ft in a longitudinal direction. The corrective work shall be done prior to grooving at no additional cost to the Administration.

(e) **Sidewalks and Safety Curbs.** The concrete shall be struck off with an approved screed to the elevation and slope specified in the Contract Documents. It shall be wood floated to give a uniformly gritty surface free from depressions or high spots. The joints shall then be edged with the appropriate edging tool. Curbs shall be stripped and finished as soon as possible.

(f) **Culvert Slabs.** The tops of culvert slabs when they are the roadway riding surface shall be finished in conformance with (d). Invert slabs and the tops of culvert slabs when they are not part of the roadway, or when they are to be overlaid with hot mix asphalt shall be screeded either by hand or machine and have a float finish. The allowable surface tolerance shall be within 1/4 in. of the grade specified in the Contract Documents.

Inverts of culverts having a span less than 10 ft need not be straightedged.

420.03.08 Curing. These requirements shall apply to curing of all concrete surfaces except bridge deck slabs or top surfaces of culverts with integral wearing surfaces. Curing for bridge deck slabs and top surfaces of culverts with integral wearing surfaces shall be as specified in 420.03.10.

Curing shall start as soon as the concrete has set sufficiently.

The requirement for keeping the surfaces wet shall be met even in areas where there is no ready water supply.

(a) Culvert invert slabs and all footings shall be cured for five days using the method specified in 420.03.09(a),(b),(c), or (d).

(b) Vertical surfaces shall be cured in the forms for seven days. However, the forms may be removed after 24 hours for structural elements 6 ft or less in height, or after 48 hours for structural elements greater than 6 ft high, with the following provisions. The surface shall be cured as specified in 420.03.09(d) for the remainder of the seven day curing period. The forms shall not be removed when cold weather protection is required. Forms, falsework, centering, etc., carrying loads shall remain in place for a minimum of seven days and until the concrete has attained a compressive strength of 3000 psi. Internal bulkheads used for forming construction joints, etc. may be removed after the concrete has been in place for 24 hours if it is necessary to do so to continue the work without interruption. When a higher strength concrete than specified is used, forms, falsework, centering, etc., carrying loads shall remain in place for three and a

half days and until the concrete has attained a compressive strength of 3000 psi.

Fiber column forms may be removed at times specified above, but no later than 10 days after placing concrete.

When parapets or median barriers on structures are formed by the slip form method, curing shall begin as specified in 420.03.09(f) using a fugitive dye liquid membrane-forming compound immediately after the concrete is finished. Immediately after each joint is saw cut, the concrete surfaces shall be cured for the remainder of the seven days of cure as specified in 420.03.09(d).

(c) Tops of end walls, end support walls, headwalls, etc., shall be cured for three days with burlap or cotton mats as specified in 420.03.09(b) or (d), respectively.

(d) Horizontal surfaces shall be cured for seven days as specified in 420.03.09 using method (b),(c),(d), or (e).

420.03.09 Curing Methods.

(a) **Flooding.** Units of structures that will be below water in the completed structure, i.e., bottom slabs of culverts, footings, struts, etc., may be gradually flooded when approved by the Engineer after the concrete is 12 hours old, provided the curing water conforms to 921.01. The temperature of this water shall be maintained at 35 F or above for the specified curing time.

(b) **Burlap.** Two layers of burlap shall be used. Successive strips of burlap shall be overlapped a minimum of 6 in. The second burlap layer shall be placed not less than 45 degrees to the first layer, or in lieu of this, the 6 in. overlap of the second layer may be placed midway between the first layer. This material shall be thoroughly saturated by immersion in curing water for at least 24 hours prior to placement and shall be kept saturated throughout the time specified for curing.

(c) **White Opaque Polyethylene Backed Nonwoven Fabric.** One layer of white opaque polyethylene backed fabric shall be used. Successive strips shall be overlapped a minimum of 6 in. This material shall be thoroughly saturated by immersion in curing water for at least 24 hours prior to placement and shall be kept saturated throughout the time specified for curing.

(d) **Cotton Mats.** One layer of cotton mat material shall be used and shall be kept thoroughly saturated with curing water prior to

placement and throughout the time specified for curing. The material shall be kept in tight contact with the concrete.

(e) White Opaque Burlap Polyethylene or White Opaque Polyethylene Film. The white opaque burlap polyethylene sheeting shall be placed on no less than one layer of wet burlap with the burlap side of the sheeting facing down. White opaque polyethylene film, if used, shall be placed on no less than two layers of wet burlap. Only one layer of cotton mats is required in any usage. These materials may only be used atop the wet burlap or cotton mats on unobstructed flat and reasonably level surfaces.

Adjacent mats or sheets shall be lapped no less than 1 ft. The ends shall be brought down around the sides of the concrete being cured and securely fastened to make an airtight seal.

The white opaque burlap polyethylene sheeting or the white opaque polyethylene film shall remain in place for the same length of time as required for burlap or cotton mats. These protective coverings need not be wetted down, however, the covered burlap or cotton mats shall be kept wet for the time interval specified.

(f) Liquid Membrane. Liquid membrane forming compound shall be applied in conformance with manufacturer's recommendation or as directed by the Engineer. The material shall be applied by sprayers and shall be thoroughly agitated before and during use.

420.03.10 Bridge Deck Slabs. Bridge deck slabs and culvert top slabs with integral wearing surfaces, including sidewalks, shall be cured as follows:

The Contractor shall have misting equipment available. Prior to placement of any concrete, operation of the misting equipment shall be verified by the Engineer to ensure that the equipment and procedure are capable of misting the entire placement area without damaging the fresh concrete. This shall be done at the location of proposed use each day that a deck placement is to be made. Ample spare parts, water, fuel, etc. shall be readily available. A backup tested unit shall also be available.

The Contractor shall cover the finished concrete with wet burlap as specified in 420.03.09(b). The concrete covering shall progress immediately after the concrete has been finished but no portion of the concrete shall remain uncovered for more than 45 minutes after placement. Mist spraying shall be used when directed by the Engineer, and when the concrete is not covered with wet burlap within 30 minutes

after placement. Once misting is started, it shall continue until wet burlap is complete in place.

Use of the mist spray shall not relieve the Contractor of the responsibility for covering the concrete within the 45 minutes after placement.

After the concrete is covered with wet burlap, it shall be cured in conformance with 420.03.09(b) for the remainder of the seven day period. The two layers of burlap shall be kept continuously and uniformly saturated throughout the curing period. White opaque burlap polyethylene sheeting and white opaque polyethylene film or clear polyethylene film shall not be placed over wet burlap except when approved by the Engineer in writing for cold weather protection. A sufficient quantity of soaker hoses shall be used to conform to these requirements. The Contractor shall take immediate action to remedy improper saturation of any area throughout the entire curing period.

The Contractor shall provide a sufficient number of experienced personnel and necessary equipment to ensure proper placement, protection and curing of the concrete in conformance with these Specifications.

The Contractor shall also provide temporary troughs, dams, etc., necessary to prohibit the runoff water from reaching any traveled roadway, shoulder or sidewalk. The proposed methods of controlling runoff water in these areas shall be submitted to the Engineer for approval before use. The plan shall include locations of all troughs and dams, as well as the proposed methods of attaching them to any portions of the structure. There shall be no welding or drilling holes in any portion of a permanent member of the structure.

After the procedure is underway, it shall be evaluated, and any areas not functioning in a manner acceptable to the Engineer shall be modified by the Contractor to satisfy the requirements for retaining and directing the flow of water.

In rehabilitation construction, where the full use of temporary troughs, dams, etc., is not practical, modifications to the provisions for controlling the runoff water shall be made by the Contractor and approved by the Engineer.

420.03.11 Construction Joints. Construction joints shall be kept to a minimum and will be permitted only where specified in the Contract Documents, or authorized by the Engineer in writing.

The surface of the hardened concrete shall be cleaned and kept moistened until the additional concrete is placed. The top surface of concrete shall be leveled using a grade strip, unless otherwise specified. At chamfers the top surface of the concrete shall be steel troweled adjacent to the chamfer using the top surface for the chamfer strip as a guide.

Where a featheredge might be produced at a construction joint, as in the sloped top surface of a wing wall, an inset form shall be used to produce a blocked in addition to the preceding placement. The inset form shall produce a 6 in. minimum edge thickness of concrete in the succeeding placement.

The Contractor shall place an epoxy bonding compound on the surface areas of existing concrete (concrete that existed prior to the beginning of the Contract) which will be in contact with new concrete. Epoxy bonding compound shall also be applied to the entire face of all bridge deck slab construction joints. The surfaces to be coated shall be clean, sound, and dry and bonding compound shall be mixed and applied in conformance with the manufacturer's recommendations.

420.03.12 Linseed Oil Protective Coating. Linseed oil protective coating shall be applied to the integral concrete bridge deck slabs, box culvert wearing surfaces and sidewalks on bridges and box culverts when the pertinent Linseed Oil Protective Coating item appears in the Contract Documents.

Permanent paint or tape lane markings required on the structures shall be placed prior to the application of the linseed oil protective coating. The concrete surfaces to be treated shall also be cured, dried and thoroughly cleaned of all dust, dirt, and deleterious material prior to placing the first linseed oil protective coating.

If the concrete is wet, it shall be allowed to dry for one to two days at a minimum temperature of 60 F. If the concrete surfaces are extremely dry, the Contractor shall either wet the concrete thoroughly and allow it to dry for one or two days or apply a third protective coating at the same rate per gallon as the second coat, as directed by the Engineer. The ambient temperature at the time of application shall be 50 F minimum. Following the second application, the ambient temperature shall be 40 F minimum. Two coats shall be applied on all top surfaces that are not grooved. The first coat shall be applied at a rate of 40 yd^2/gal. The second coat shall be applied at a rate of 67 yd^2/gal. On bridge decks and top slabs of box culverts that are grooved, the first coat shall be applied at a rate of 25 yd^2/gal. The second coat shall be applied at a rate of 45 yd^2/gal. The second coat shall not be applied until the first coat is dry. If additional coats are required, there shall be a minimum of 24 hours between them.

The drying time may be increased as the ambient temperature falls below 70 F.

420.03.13 Cold Weather Protection. Concrete shall be protected and heated after it has been placed when the air temperature in the shade and away from artificial heat drops to 40 F or lower at the time of placing or at any time within the number of days specified herein. Protection and heating shall be as follows:

(a) Ordinary concrete shall be protected and kept continuously at a temperature not less than 50 F for at least seven days following placement.

(b) In no case shall concrete be heated to more than 100 F. At the end of the heating period, the concrete surfaces shall be cooled to the temperature of the outside air by slowly reducing the artificial heat at a uniform rate until the temperature of the outside air is reached within a 24 hour period.

The Contractor shall have tarpaulins, insulating devices, and other suitable materials at the site to enclose or protect all portions of the concrete requiring protection. Materials shall be installed as close as possible before placing the concrete, and it shall be installed as rapidly as possible to keep exposure to cold weather to a minimum. Where heating is required, the spaces to be heated shall be completely enclosed and the temperature kept at required levels by the use of heaters approved by the Engineer.

The Contractor shall provide a sufficient number of maximum/minimum recording thermometers to record temperatures in each concrete placement undergoing cold weather protection.

The curing period for all structure concrete requiring cold weather protection shall conform to the cold weather protection period except when the normal curing period is longer.

420.03.14 Underpinning Old Foundations. If underpinning is required, the Contractor shall perform the required work as directed by the Engineer. The operation shall consist of the restoring or lowering of the old foundations with concrete. The concrete shall be Mix No. 6. Excavation and the underpinning operations shall be done in part section, so as not to remove more than 10 percent of the supporting area under the old foundation at one time. The concrete shall have a maximum slump of 1-1/2 in. When directed by the Engineer, underpinning shall be installed by hand, pneumatic, or pumping processes. The usual curing and cold weather requirements will be deleted for the underpinning with other

provisions for curing and protection improvised on the job as may be directed.

420.03.15 Loads on Concrete Structures. The erection of structural steel or concrete superstructures on concrete substructures shall not start until the Contractor has completed curing, removed forms, and substructure concrete has reached a minimum compressive strength of 3000 psi.

Loads shall not be applied to any new portion of bridge deck or box culvert built to grade until the final section of that unit of the deck has completed its specified curing period. Vehicles, including the Contractor's, and heavy equipment are not permitted on any new portion of bridge deck or box culvert built to grade until the concrete cylinder breaks for the final section of that unit of the deck has attained a minimum compressive strength of 4500 psi. However, loads such as stored materials, lightweight equipment, concrete safety parapets, sidewalks, median curbs, etc., may be placed upon the concrete slab via cranes or other lifting devices when the concrete in the final section of that unit of the deck has attained a minimum compressive strength of 3000 psi.

Backfill shall not be place on any new portion of box culverts not built to grade until the final section of that unit of the slab has completed its specified curing period and the concrete in that section has attained a minimum compressive strength of 3000 psi.

420.03.16 Prevention and Removal of Stains on Concrete. The Contractor shall prevent rust from structural steel, staining by asphalt materials or any other substance from discoloring any portion of the concrete. The Contractor shall use construction procedures that prevent staining of any of the concrete. Where unpainted structural steel has been specified, the Contractor shall protect the pier caps, columns and abutments with a wrapping of reinforced polyethylene or similar material which shall be left in place to prevent staining until after the structure has been completed. If any portion of the concrete is stained, the stains shall be removed and concrete restored to its original color without damage to the concrete. The work shall be done as directed by the Engineer at no additional cost to the Administration. Chemical solvents shall not be used to remove stains unless approved by the Engineer.

420.03.17 Safety Hazards. The Contractor shall be responsible for gas detection in and ventilation of confined spaces as specified in TC-3.05.

420.03.18 Defective Work. Defective work exposed upon removal of the forms shall be entirely removed or repaired within 24 hours, as directed by the Engineer.

(a) Edges of material remaining in place shall be cut perpendicular to the finished surface to the full depth of the material removed, but not less than 1 in. If the removal of defective concrete affects the structural requirements, the member also shall be removed and replaced as directed by the Engineer.

(b) Defective areas shall be cleaned.

(c) Defective areas shall be coated with an epoxy bonding compound.

(d) Defective areas shall be patched with concrete mortar or epoxy. The color, contour, and texture of surrounding concrete shall be matched as close as possible.

420.04 MEASUREMENT AND PAYMENT. Portland cement concrete structures will be measured and paid for as specified. The payment will be full compensation for all forms and form removal, reinforcement steel, curing and misting, scuppers, grooving, mechanical and electrical work, all cost incidental to the conducting of tests for oxygen content and presence of gases and applying mechanical ventilation to confined spaces, year built markings, and all material, labor, equipment (including safety equipment), tools and incidentals necessary to complete the work.

The construction of drainage and weep holes, any pipe necessary, expansion material, flashing, dampproofing, membrane waterproofing, epoxy bonding compound, joints and their placement will not be measured but the cost will be incidental to the concrete item. No deduction in concrete quantities will be made for pipes or conduits having diameters less than 8 in., reinforcement steel, anchors, or any other appurtenances.

420.04.01 Portland cement concrete for Footing Concrete, Subfoundation Concrete and Tremie Concrete will be measured and paid for at the Contract unit price per cubic yard.

420.04.02 Portland cement concrete for Substructure Concrete for Bridge, Superstructure Concrete for Bridge, and Reinforced Concrete Box Culverts will not be measured but will be paid for at the Contract lump sum price. The cost for epoxy protective coated reinforcement steel shall be excluded from the Contract lump sum price for Superstructure Concrete for Bridge. When a bridge deck rehabilitation project, other than bridge widenings, requires modification to the backwalls and wing walls and there is no substructure concrete item, the concrete will be incidental to the Superstructure Concrete item.

420.04.03 Wing walls and footings for reinforced concrete box culverts will not be measured but the cost will be incidental to the Reinforced Concrete Box Culvert item.

420.04.04 Parapets (including end posts) on bridges, wing walls, reinforced concrete box culverts and retaining walls, or concrete median barriers on bridges and top slabs of reinforced concrete box culverts will not be measured but will be paid for at the Contract lump sum price for the pertinent Concrete Parapet or Concrete Median Barrier items.

420.04.05 Parapet and end post modifications on bridges, wing walls, reinforced concrete box culverts and retaining walls, or concrete median barriers on bridges and top slabs of reinforced concrete box culverts will not be measured but will be paid for at the Contract lump sum price for the pertinent Parapet Modification item. The payment will also include saw cutting, removal of portions of the existing parapet or end post, drilling, and grouting.

420.04.06 Floodlighting will be measured and paid for at the Contract unit price per each night used, including fuel, backup generator, setup, relocation, and removal.

420.04.07 Linseed oil protective coating will be measured and paid for at the Contract unit price per square yard for the pertinent Linseed Oil Protective Coating item.

420.04.08 Temporary supports or piling will not be measured but the cost will be incidental to the formwork.

420.04.09 Retaining walls will be measured and paid for as specified in 450.04

SECTION 421 — REINFORCEMENT FOR CONCRETE STRUCTURES

421.01 DESCRIPTION. This work shall consist of furnishing and placing reinforcement, including deformed steel bars, wire mesh, and plain round steel spiral bars, as specified in the Contract Documents or as directed by the Engineer. Reinforcement shall be uncoated or epoxy coated as specified in the Contract Documents.

421.02 MATERIALS.

Grout	902.11(c)
Deformed Steel Bars	908.01

Plain Round Steel Bars for Column Spirals	908.02
Wire Mesh	908.05 and 908.06
Fusion Bonded Epoxy Powder Coating for Steel and Touch Up System	Section 465 and 917.02
Galvanizing	A 153

421.02.01 Supports. Material for all supports shall be approved coated metal, plastic, plastic tipped, or galvanized. Aluminum is prohibited. All materials shall be acceptable to the Engineer.

The wire supports for epoxy coated steel bars shall be completely covered with 1.5 to 9.0 mils of adherent epoxy coating except for minimum necessary contact marks. The reinforcement steel shall be held in place with plastic coated tie wires fabricated for this purpose.

Steel bars used as supports for epoxy coated steel bars shall be epoxy coated in the same manner as reinforcement steel.

421.03 CONSTRUCTION.

421.03.01 Working Drawings. The Contractor shall submit working drawings to be approved by the Engineer prior to the start of any fabrication unless otherwise specified. Details shall conform to TC-4.01.

421.03.02 Plan Dimensions. All dimensions related to reinforcement steel are out to out measurement except the spacing is measured center to center.

421.03.03 Cutting and Bending. Reinforcement bars shall be cut and bent at the mill or shop to the shapes specified in the Contract Documents before shipment to the job site. Reinforcement bars shall not be bent in the field except to correct errors, damage by handling and shipping, or minor omissions in shop bending.

Epoxy coated reinforcement bars on skewed bridges and in other locations that are specified to be cut in the field shall be either sawed or sheared; flame cutting is prohibited.

All bending shall conform to the Specifications tolerances modified to cover requirements as specified in the Contract Documents.

421.03.04 Shipping, Handling, and Protection of Material. Reinforcement steel bars shall be shipped in standard bundles and tagged and marked in conformance with the provisions of the Code of Standard

Practice of the Concrete Reinforcing Steel Institute. Bundles shall be kept intact and material undamaged and properly identified until ready for use.

Coated steel shall be bundled together for shipment using excelsior or other materials as approved by the Engineer and banded using plastic or padded metal bands. All lifting shall be performed with a strong back and multiple supports consisting of a sufficient quantity of straps or slings to prohibit abrasion within the bundle from excessive bending or distortion.

Regardless of the type of surface the bundles are to be stored upon, all bundles shall be stored at the site on suitable blocking or platforms at least 4 in. above the surface or vegetation. They shall be kept free from vegetation growth, accumulations of dirt, oil, or other foreign material. Blocking shall be sufficiently close to avoid bending and distortion of the bars. Any distortion of the bars or damage to epoxy coating shall be corrected as directed by the Engineer at no additional cost to the Administration. Damage to the epoxy coating shall be touched up in conformance with 465.03. Epoxy coated bars shall be adequately covered for protection from ultraviolet rays from the time of delivery when they are to be stored outside for more than 90 days.

421.03.05 Placing and Fastening. All reinforcement steel, including dowel bars, shall be accurately placed in the position specified in the Contract Documents or working drawings, and firmly held during the depositing and setting of the concrete. Inserting reinforcement steel or dowel bars into plastic concrete is prohibited.

Bars shall be tied at all intersections except alternate intersections need not be tied where spacing is less than 1 ft in each direction. On bridge decks and the top slabs of box culverts, all intersections shall be tied in the top mat of reinforcement. Reinforcement steel bars embedded in concrete shall not be bent after they are in place.

Before any concrete is placed, all mortar shall be cleaned from the reinforcement. Concrete shall not be placed until reinforcement bars are inspected and approved by the Engineer. This shall not relieve the Contractor of the responsibility for any shifting of the bars during the placement of concrete.

Reinforcement bars shall be supported and their distances from faces of forms shall be maintained by means of approved templates, blocks, ties, hangers, or other supports. Bars in the bottom of footings shall be supported on approved precast concrete blocks with embedded tie wires or suspended in place. Bars in the tops of footings shall be supported by supports that are approved by the Engineer.

Metal, metal with plastic tipped legs, or plastic chairs shall not be used against formed surfaces that will be exposed in the finished structure.

A final visual inspection of epoxy coated steel at the construction site will be made by the Engineer after the steel is in place and immediately prior to placing the concrete. Any areas designated by the Engineer that require repair shall be patched with epoxy in conformance with 465.03. Concrete shall not be placed on a patched area until the patching material is cured for one hour. The Contractor shall allow the Engineer four hours of normal working time after the reinforcement and forms are in place to conduct the inspection.

421.03.06 Splicing. Bars shall be furnished in the lengths and spliced as specified in the Contract Documents and approved shop drawings. There shall be no additional splicing of bars without written approval of the Engineer. Lap splices shall be made with the bars in contact and wired together.

Welding of reinforcement steel or attachments thereto is not permitted without written authorization by the Engineer.

421.03.07 Tying New Concrete into Existing Concrete. On all projects where portions of existing structures are to be used in the finished structure and existing concrete is to be removed, the existing reinforcement steel to be incorporated in the final structure shall be straightened and cleaned. Care shall be taken not to damage these bars.

Any exposed existing reinforcement steel that is to be incorporated into the final structure:

(a) That has lost 20 percent or more of its original cross sectional area as determined by the Engineer, shall be cut out. A new bar of the same diameter shall be provided and placed so as to have the minimum required lap at each end of the new bar, or modified as per (c).

(b) Where the required bar lap length is available, it shall be used as a dowel.

(c) Where the required bar lap is not available or limits of concrete removal to achieve bar lap are too great, a welded or approved mechanical splice shall be provided.

All existing reinforcement steel extending into an area in which epoxy coated reinforcement steel is required shall be abrasive blast cleaned and epoxy coated with the touch up system.

If expected reinforcement steel is missing, or a pattern differing from that shown on the existing Contract Documents is uncovered, then the Office of Bridge Development shall be contacted for evaluation.

Where dowel bars are required to tie new concrete into an existing structure, they shall be installed in conformance with 406.03.

421.03.08 Substitution. Substitution of different size bars will be permitted only when approved by the Engineer. No additional compensation will be allowed for substituting larger size bars in lieu of the bars specified.

421.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for cleaning, coating, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

421.04.01 Reinforcement steel bars or epoxy coated reinforcement steel bars will not be measured but the cost will be incidental to other pertinent items specified unless an item for reinforcement steel bars appears in the Contract Documents.

421.04.02 Reinforcement Steel Bars or Epoxy Coated Reinforcement Steel Bars will not be measured but will be paid for at the pertinent Contract lump sum price.

421.04.03 Reinforcement Steel Bars or Epoxy Coated Reinforcement Steel Bars will be measured and paid for at the Contract unit price per pound based on the original approved overall lengths of bars computed on the basis of the nominal unit weight per linear foot.

421.04.04 Incorporating existing reinforcing steel in the final structure including straightening, bending, splicing, and removal and replacement will not be measured but the cost will be included in the pertinent Concrete item.

SECTION 422 — DAMPPROOFING AND MEMBRANE WATERPROOFING

422.01 DESCRIPTION. This work shall consist of dampproofing and waterproofing of concrete surfaces.

422.02 MATERIALS.

Asphaltic Materials	913.01
Asphalt Primer	913.02

Fabric for Use with Asphalt	913.03
Membrane Waterproofing and Dampproofing	913.04

422.03 CONSTRUCTION. Dampproofing and waterproofing shall be applied using asphaltic materials, primers and fabric, or by the roll or sheet method specified in 422.03.07.

422.03.01 Storage. Waterproofing fabrics and membranes shall be stored in a dry protected place. Asphalt materials in containers shall be kept closed when not in use.

422.03.02 Surface Preparation. Dampproofing or membrane waterproofing shall not be applied until curing has been completed and surfaces are protected against cold. All surfaces shall be dry, smooth, and free from projections and holes.

When dampproofing and membrane waterproofing are both specified for application, the membrane waterproofing shall be applied first. Dampproofing or membrane waterproofing shall not be permitted when the temperature is less than 40 F.

422.03.03 Dampproofing. When asphaltic coatings are used for dampproofing, they shall consist of two prime coats and one seal coat. Dampproofing shall be applied to the following concrete surfaces that will be in contact with backfill.

(a) Rear face of abutments and abutment wing wall stems.

(b) Rear faces of headwalls and wing walls for pipes 36 in. in diameter or larger and for culverts.

(c) Rear face of retaining wall stems.

(d) The following areas pertain to reinforced concrete box culverts:

(1) Top of top slabs when not built to grade.

(2) Entire outside surfaces of side walls.

(3) Additionally, bottom of bottom slabs of precast units.

422.03.04 Waterproofing. When asphaltic coatings are used for waterproofing, they shall consist of a prime coat, three mop coats, and two layers of fabric.

Waterproofing shall be applied to all construction joints of a concrete structure that are next to backfill above normal water surface with backfill

on one side and atmosphere on the other side. It shall be applied with a minimum width of 16 in. centered on the joint.

422.03.05 Application of Dampproofing. Care shall be taken to confine all coatings to the areas to be covered to prevent coating of parts of the structure that will be exposed to view in the completed structure. Dampproofing shall be applied to the full face of all contraction joints.

The dampproofing material shall be applied in conformance with the manufacturer's recommendations. When no recommendations are provided, the dampproofing material shall be applied to the cured, cleaned, and dry surfaces as follows:

(a) Paint with two coats of primer for absorptive treatment at a rate of 1/8 gal/yd^2 per coat. The second coat shall not be applied until the first coat has thoroughly dried. The material shall not be heated.

(b) After the second prime coat has thoroughly dried, one seal coat shall be applied by brush or roller at a rate of 1/8 gal/yd^2. When necessary, this material may be heated, but not in excess of 150 F.

422.03.06 Application of Membrane Waterproofing. When membrane waterproofing is applied, the cured, cleaned and dry surfaces shall be coated with a prime coat and covered with mop coats and layers of fabric.

Coating Procedure. The surfaces shall first be coated with a primer at a rate of 1/8 gal/yd^2. The prime coat shall be applied 24 hours in advance of applying any mop coats and shall be dry before the first mopping is applied. The primer shall not be heated.

Asphalt for mop coats shall be heated to a temperature between 300 and 350 F, with frequent stirring to avoid local overheating. The heating kettles shall be equipped with thermometers.

The waterproofing shall begin at the low point of the surface to be waterproofed, so that water will run over and not against or along the laps.

The first strip of fabric shall be half width. The second shall be full width, lapped the full width of the first sheet. The third and each succeeding strip thereafter shall be full width and lapped so that there will be two layers of fabric at all points and three layers with laps not less than 2 in. wide at edges of strips. All laps at ends of strips shall be 12 in. wide.

Beginning at the low point of the surface to be waterproofed, a section 20 in. wide and the full length of the surface shall be mopped with the hot asphalt. Immediately following the mopping, the first strip of fabric shall be pressed into place eliminating all air bubbles. This strip and an adjacent section of the surface of a width equal to slightly more than half the width of the fabric being used shall then be mopped with hot asphalt and a full strip and a full width of the fabric shall be pressed into place as before. The forward or upgrade half of this second strip and an adjacent section of the concrete surface shall then be mopped with hot asphalt and the third strip of fabric shingled on so as to lap the first strip not less than 2 in. This process shall be continued until the entire surface is covered. The entire surface shall then be given a final mopping of hot asphalt. There shall be a complete coating of asphalt between all layers of fabric.

In all cases, the mopping on concrete shall cover the surface so that no gray spots appear, and on cloth it shall be sufficiently heavy to completely conceal the weave. Asphalt shall be applied at the rates of 1.2 gal/yd^2 on horizontal surfaces and 1.4 gal/yd^2 on vertical surfaces. The work shall be regulated so that at the close of a day's work, all cloth that was laid shall have received as many coatings as was required for that stage of completion. Special care shall be taken at all laps to see that the cloth is thoroughly sealed down.

422.03.07 Roll or Sheet Waterproofing Membrane. An alternate system of waterproofing or dampproofing consisting of rolls or sheets of membrane material may be used in lieu of the above coatings. The rolls or sheets shall be applied in conformance with the manufacturer's recommendations.

422.03.08 Membrane Care. At the edges of the membrane and any points where it is punctured by appurtenances such as drains or pipes, it shall be flashed in a manner acceptable to the Engineer to prevent water from getting between the waterproofing and the waterproofed surface. Damage to the membrane shall be repaired. Repairs shall extend beyond the outermost damaged portion, and the second ply shall extend at least 3 in. beyond the first.

422.04 MEASUREMENT AND PAYMENT. Dampproofing and membrane waterproofing will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents.

SECTION 423 — PNEUMATICALLY APPLIED MORTAR

423.01 DESCRIPTION. This work shall consist of removing existing concrete, and furnishing and placing pneumatically applied mortar as specified in the Contract Documents or as directed by the Engineer.

423.02 MATERIALS.

Curing Materials	902.07
Reinforcement Steel	908.01, 908.02, and 908.08
Anchor Bolts	909.06
Water	921.01

Cement shall be Type II conforming to 902.03, and shall be furnished in the original 94 lb paper sacks supplied from the cement manufacturer.

Fine Aggregate. Fine aggregate shall conform to the Fine Aggregate-Portland Cement Concrete requirements of 901.01. Maximum moisture content of fine aggregate shall be 6 percent by weight.

Mortar Mixes. Pneumatically applied mortar shall have a 28 day compressive strength of 5000 to 9000 psi. All mixes shall be approved by the Engineer prior to starting work.

423.02.01 Test Panels. When specified in the Contract Documents, test panels of various mix combinations, admixtures, and materials shall be prepared and cured by the Contractor. One test panel shall be prepared for every 100 ft^3 of mortar in place. Additional test panels shall be prepared as directed by the Engineer. Each panel shall be 36 in. square and 8 in. deep. At least half of each panel shall contain the same reinforcement as the structure. A separate panel shall be fabricated by each application crew using the equipment for each mix design, and in each shooting position encountered.

The Contractor shall be responsible for the preparation and curing of all test panels. The Contractor shall core each test panel and the cores shall be delivered to the Laboratory for testing. Cores shall have a minimum diameter of 4 in. and a minimum length of 8 in. Each core will be tested in compression at 7, 14, and 28 days. Core strength correction will conform to T 24.

The cut surface of each specimen will be examined by the Engineer. Additional surfaces shall be exposed by sawing or breaking the panel when this is considered necessary to check soundness and uniformity of

the material. All cut or broken surfaces shall be dense and free from lamination and sand pockets.

423.03 CONSTRUCTION. The Contractor's proposed methods of protecting the public against injury and damage from demolition operations to remove deteriorated concrete shall be submitted to the Engineer and approved prior to beginning removal operations. Whenever protective shields are required, they shall conform to 405.03.01.

The Contractor shall provide safe access to all areas of the existing structure to be repaired. Prior to the start of any repair work, the Contractor, in the presence of the Engineer, shall conduct a full and thorough inspection of the areas to be repaired. The purpose of this inspection will be to identify the location and extent of each area of concrete deterioration and repair. The extent of removal and the determination of when sound concrete is encountered shall be as established by the Engineer.

Restrictions. The Contractor shall wait 72 hours minimum after completing repairs to a section of a stringer or pier before chipping on any section that has a common side or point.

If at any time an area is identified as having deteriorated concrete beyond the following limits, all work shall immediately stop, and the Engineer will notify the Office of Bridge Development. Work in these areas will not be permitted to resume until approval has been obtained from the Office of Bridge Development:

(a) A maximum depth of 6 in. behind the original finish surface.

(b) A maximum depth of 3 in. behind the reinforcement steel.

(c) A maximum depth of 1 in. under the bearing.

423.03.01 Equipment. All equipment shall be capable of thoroughly mixing all material used and shall be calibrated.

The mixer shall be self-cleaning and capable of discharging all mixed material without any carry over from one batch to the next. Mixing equipment shall be cleaned at least once a day.

The air compressor shall be of ample capacity to maintain a supply of clean, dry air adequate to provide the required nozzle velocity for all parts of the work, while simultaneously operating a blowpipe for cleaning away rebound.

The air and water pressure shall be constant and not pulsate.

423.03.02 Storage. Storage and handling of cement shall conform to 902.01. Sand shall be stored to prevent segregation or contamination of the material.

Regardless of the type of surface the bundles are to be stored upon, all bundles shall be stored at the site on suitable blocking or platforms at least 4 in. above the surface or vegetation. The reinforcement shall be kept free of dirt, oil, grease, paint, and other foreign matter.

423.03.03 Surface Preparation. The deteriorated areas of concrete shall be removed to sound concrete with a 30 lb maximum chipping hammer. Chipping shall continue to a minimum depth of 1 in. behind the reinforcement steel and until there are no sudden changes in the depth of the cavity. The perimeter of the cavity shall consist of a shoulder that is perpendicular to the surface of the structure for a minimum depth of 1 in.

After the Engineer has determined that the cavity surface is sound, it shall be abrasive blasted. Just prior to mortar application, all surfaces shall be thoroughly cleaned, followed by wetting and damp drying.

The Contractor shall contain all blast waste and loose concrete and promptly remove it to an approved disposal site. Blast waste and loose concrete shall be kept out of waterways.

423.03.04 Reinforcement. If sound concrete is encountered before the reinforcement steel is exposed, then sound concrete shall be removed to a depth of 1 in. behind the existing reinforcement steel. If sound concrete is found within 3-1/2 in. of the proposed finished surface, the removal shall stop and additional No. 4 reinforcement bars shall be dowelled and installed at 12 in. center to center horizontally and vertically, 2 in. clear of proposed finished surface. Dowelling shall conform to Section 406 except that the grout shall conform to any type specified in 902.11.

All exposed existing reinforcement steel that will be incorporated in the new work shall be abrasive blasted to a near white finish to remove all rust, dirt, scale, and loose concrete. All deteriorated reinforcement bars that have lost 20 percent or more of their original dimension shall be cut out and new bars welded in their place. Dual bars of equivalent or greater section may be used. New reinforcement steel shall be welded to existing reinforcement steel as specified in the Contract Documents. The Engineer will establish if reinforcement steel is to be reused or replaced.

All areas to be repaired shall be reinforced with wire mesh in addition to the reinforcement steel.

For anchoring reinforcement to masonry surfaces, expansion bolts not less than 3/8 in. in diameter shall be set in drilled holes, or plain round

No. 4 bars shall be set in approved dry packed mortar tightly driven in drilled holes. Drilled holes shall not be less than 3 in. deep. All bolts or bars shall be set in solid masonry (not in mortar, joints, or cracks) and shall have heads or hooks on their outer ends. Where approved by the Engineer, wire mesh reinforcement may be wired to existing reinforcement without the use of expansion bolts.

Mesh shall be cut in sheets of proper size, and the separate sheets shall be bent over templates so as to follow closely the outlines of the member or surface to be covered. It shall be securely held in a uniform position by being tied with 14 gauge black annealed wire to the bolts or bars. Ties shall be spaced at 12 in. maximum.

Where adjacent sheets of mesh join, they shall overlap at least two squares of the mesh and be tied together at intervals not exceeding 18 in. with 14 gauge black annealed wire.

423.03.05 Guides. Sufficient guides shall be provided to obtain the full thickness of mortar specified to ensure uniform and straight lines.

423.03.06 Mixing and Screening. The cement and sand shall be uniformly dry mixed in a batch mixing machine. Mixed materials that are not applied as mortar within one hour after being mixed shall be discarded. After the materials are dry mixed and before being charged into the placing machine, the mixture shall be passed through a 3/8 in. screen.

423.03.07 Application. Each layer shall be built up by several passes of the nozzle over the working area. The mixture shall emerge from the nozzle in a steady, uninterrupted flow. Should the flow become intermittent for any cause, it shall be directed away from the work until it becomes constant. The distance of the nozzle from the work shall be as required to give best results for the conditions, and shall be held perpendicular to the application surface. When shooting through reinforcement, the nozzle shall be held at a slight angle from perpendicular to permit better encasement.

The application of the mixture to vertical surfaces shall begin at the bottom. The first layer shall at least completely embed the reinforcement.

Rebound shall not be worked back into the construction, or be salvaged and included in later batches.

Rebound and overspray shall not be allowed to fall into waterways and shall become the property of the Contractor, who shall dispose of this material in an approved disposal site at no additional cost to the Administration.

When a layer of pneumatically applied mortar is to be covered by a succeeding layer, it shall first be allowed to take its initial set. Then all laitance, loose material, and rebound shall be removed by brooming. Any laitance that has been allowed to take final set shall be removed by abrasive blasting and the surface cleaned with an air water jet. In addition, the surface will be sounded by the Engineer with a hammer for hollow sounding areas resulting from rebound pockets or lack of bond.

423.03.08 Curing and Cold Weather Protection. Curing and cold weather protection shall conform to Section 420. Mortar shall be kept continuously wet for at least seven days after application. The use of a liquid membrane forming compound will be permitted with prior approval of the Engineer.

423.03.09 Finishing. The area of repair on existing structures shall be finished to match the existing structure.

423.04 MEASUREMENT AND PAYMENT. Pneumatically Applied Mortar will be measured and paid for at the Contract unit price per cubic foot of mortar in place. The payment will be full compensation for inspections, removal of existing concrete, abrasive blasting, and furnishing all cement, sand, water, test panels, drilled holes, reinforcement bars and wire mesh, mortar, expansion bolts, cores, storage, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 424 — RESERVED

SECTION 425 — LIGHTWEIGHT SUPERSTRUCTURE CONCRETE

425.01 DESCRIPTION. This work shall consist of constructing the lightweight concrete portions of the structure as specified in the Contract Documents.

425.02 MATERIALS. Materials shall conform to 420.02 except as modified herein.

Control testing for Compression Test and Unit Weight of Cured Concrete shall be two companion cylinders for each 100 yd^3, or fraction thereof, as specified in M 195.

Lightweight concrete shall have a minimum compressive strength of 4500 psi. It shall be composed of Type I portland cement, an approved air entraining admixture, Type A or D chemical admixture, water, lightweight coarse aggregate, fine aggregates and be proportioned as specified in 211.2 of the ACI's Recommended Practices for Selection Proportions for Structural Lightweight Concrete. Fly ash or ground iron blast furnace slag may be substituted for portland cement as specified in 902.06.

Minimum cement content shall be 700 lb/yd^3. The maximum average unit weight of the cured concrete shall be 118 lb/ft^3. Air entrainment shall be determined by volumetric method as specified in T 196, and shall be 6 to 9 percent (entrapped plus entrained). Slump shall be 3 in. maximum when the absorption of the coarse aggregate is greater than 10 percent, but shall be 2 to 5 in. when the absorption of the coarse aggregate does not exceed 10 percent. Water added to the mix using saturated aggregates shall not exceed a water/cement ratio of 0.45. Net water including the absorbed water shall not exceed a water/cement ratio of 0.75.

425.03 CONSTRUCTION. Construction shall conform to 420.03 and the following:

Handling of lightweight aggregates shall be arranged to provide a thorough sprinkling of the aggregates during the stockpiling to produce damp aggregate. Sprinkling shall be done to obtain uniform distribution of moisture. Aggregates shall then be allowed to drain as long as necessary to produce a uniform moisture content, and the moisture content shall be maintained as much as practical until the aggregate is used. The admixtures shall be added to the mix as specified in the manufacturer's recommendations.

425.03.01 Existing Structures. Existing bridge decks shall be removed as specified in 405.03.02. The Contractor is cautioned that the deck replacement material may be lighter than the existing deck and the deflection caused by the lighter material will be less than the material removed. The Contractor shall compute modified rebound figures to be used in lieu of dead load deflections to establish grade controls to produce finished tops of concrete bridge decks that will be true to as planned line and grade.

425.04 MEASUREMENT AND PAYMENT. Lightweight concrete structures will be measured and paid for as specified. The payment will be full compensation for all forms and form removal, reinforcement steel, curing and misting, scuppers, mechanical and electrical work, all cost incidental to the conducting of tests for oxygen content and presence of gases and applying mechanical ventilation to

confined spaces, year built markings, and for all material, labor, equipment (including safety equipment), tools, and incidentals necessary to complete the work.

The construction of drainage and weep holes, any pipe necessary, expansion material, flashing, dampproofing, membrane waterproofing, epoxy bonding compound, joints and their placement will not be paid for but the cost will be incidental to the lightweight concrete item. No deduction in lightweight concrete quantities will be made for pipes or conduits having diameters less than 8 in., reinforcement steel, anchors, or any other appurtenances.

425.04.01 Lightweight Superstructure Concrete will not be measured but will be paid for at the Contract lump sum price unless otherwise specified in the Contract Documents.

425.04.02 Lightweight concrete parapets and median barriers will not be measured but will be paid for at the Contract lump sum price for the pertinent Lightweight Concrete Parapet or Lightweight Concrete Median Barrier items.

425.04.03 Floodlighting will be measured and paid for as specified in 420.04.06.

425.04.04 Linseed Oil Protective Coating will be measured and paid for as specified in 420.04.07.

SECTION 426 — LATEX MODIFIED CONCRETE OVERLAY FOR BRIDGE DECKS

426.01 DESCRIPTION. This work shall consist of removing a specified amount of the existing bridge deck mechanically or through hydromilling, removal of additional areas of deteriorated concrete, cleaning all surface areas to be overlaid, replacing deteriorated reinforcement steel, and placing latex modified concrete (LMC), all as specified in the Contract Documents.

Restrictions. Placement of LMC on bridge decks is prohibited between November 30 and April 30. The Contractor shall not scarify any bridge deck that will not be overlaid and cured prior to this restriction.

426.02 MATERIALS.

Fine Aggregate	901.01
Coarse Aggregate	901.01, Size No. 7

Portland Cement Type I	902.03
Concrete for Patching	902.10
Latex Modified Concrete	902.13
Reinforcement	908
Water	921.01

426.03 CONSTRUCTION. All removed material shall become the property of the Contractor and shall be disposed of at approved spoil areas.

426.03.01 Equipment. All equipment proposed for use by the Contractor shall be approved by the Engineer prior to use and shall conform to the following:

Deck Removal Equipment.

(a) Existing Wearing Surface Removal. This equipment shall only be required when the existing bridge contains a hot mix asphalt wearing surface. It shall be capable of removing the wearing surface without damaging armored joints that are to remain or the existing concrete surfaces beyond the specified minimum removal depth. When pavement breakers are proposed, broad faced chisel blades shall be used and operated at a slight angle with the horizontal to peel the wearing surface off.

(b) Deck Surface Removal. Power operated mechanical type or a high pressure water jet type equipment shall be capable of uniformly removing the specified minimum depth from the existing concrete surface.

(1) Mechanical Type. This equipment shall be limited to depths not closer than 1/2 in. from the top of the existing reinforcement. When additional removal is required, it shall be performed by high pressure water jet, power driven hand tools, or hand tools.

(2) High Pressure Water Jet. This equipment may be used to any depth above and below the reinforcement steel. The runoff water shall be satisfactorily controlled to prevent it from reaching any traveled roadway, waterways, or any other areas designated in the Contract Documents or by the Engineer. Insufficient means of controlling runoff water or the concrete removal depth may be cause for rejection of this equipment. When this is the case, the Contractor shall revert to the mechanical type, power driven hand tools, or handchipping at no additional cost to the Administration. However, the Contractor shall revert only to the mechanical

type equipment for removal of the specified minimum depth when the specified minimum depth is at least 1/2 in. above the existing reinforcement.

(c) **Power Driven Hand Tools.** This equipment shall be used for removal of unsound concrete or to achieve the required depth when deeper than 1/2 in. above the top of existing reinforcement. This equipment will be permitted with the following restrictions:

(1) Pavement breakers heavier than nominal 30 lb class are prohibited.

(2) Pavement breakers or mechanical chipping tools shall not be operated at an angle in excess of 45 degrees measured from the surface of the deck.

(3) Chipping hammers heavier than a nominal 15 lb class shall not be used to remove concrete from beneath any reinforcement bars.

(d) **Hand Tools.** Hand tools such as hammers and chisels shall be provided for removal of remaining particles of unsound concrete from beneath any reinforcement bar or to achieve the required depth.

(e) **Abrasive Blasting.** This equipment shall be capable of removing rust scale and old concrete from reinforcement bars and of removing small chips of concrete partially loosened by the removal operation.

LMC Proportioning and Mixing Equipment. Equipment used for mixing shall be self-contained, mobile, continuous mixing, and subject to the following:

(a) The mixer shall be self-propelled and be capable of carrying sufficient unmixed dry bulk cement, sand, coarse aggregate, latex modifier, and water to produce on the site a minimum of 6 yd^3 of concrete. Storing aggregate in the mixing equipment overnight is prohibited.

(b) The mixer shall be capable of positive measurement of cement being introduced into the mix, have a recording meter visible at all times, and be equipped with a ticket printout which shall indicate the quantities being mixed.

(c) The mixer shall be calibrated to accurately proportion the mix. Certification of the calibration by an approved testing authority

will be accepted as evidence of the accuracy if the yield is shown to be true within a tolerance of 1.0 percent in conformance with MSMT 558.

(d) The mixer shall provide positive control of the flow of water and latex emulsion into the mixing chamber. Water flow shall be indicated by flow meter and be readily adjustable to provide for minor variations in aggregate moisture.

(e) The mixer shall be capable of being calibrated to automatically proportion and blend all components of indicated composition on a continuous or intermittent basis as required by the finishing operation, and shall discharge mixed material through a conventional chute directly in front of the finishing machine.

(f) The mixer shall be capable of spraying water over the entire placement width as it moves ahead to ensure that the surface to be overlaid is wetted to receive the LMC.

Placing and Finishing Equipment. The combination of labor and equipment for proportioning, mixing, placing, and finishing LMC shall conform to the following minimum requirements except when otherwise specified in the Contract Documents:

TOTAL OVERLAY AREA PER BRIDGE yd^2	MINIMUM OVERLAY RATE PER HR yd^3
0-328	1.0
329-492	1.5
493-656	2.0
over 656	2.5

(a) Placing and finishing equipment shall include hand tools for placement and brushing in freshly mixed LMC mortar and for distributing it to approximately the correct level for striking off with the screed.

(b) An approved finishing machine shall be used for finishing all areas of work. The finishing machine shall be self-propelled and capable of forward and reverse movement under positive control. Provisions shall be made for raising all screeds to clear the screeded surface for traveling in reverse. A rotating cylinder type finishing machine shall be used. It shall be equipped with one or

more rotating steel cylinders, augers, and vibratory pans and span the placement transversely.

(c) The finishing machine shall be designed so that when LMC is being mixed and placed under normal operating conditions at the minimum rate, the elapsed time between depositing the LMC on the concrete deck and final screeding shall not exceed 10 minutes.

(d) The construction shall be supervised by a representative of the manufacturer of the LMC mixture or as directed by the Engineer.

426.03.02 Deck Removal and Repairs. Removal shall be performed to the limits shown in the Contract Documents. After removal the Engineer will inspect the entire exposed portion of the deck and indicate if any repairs are required including the type and extent of the repair. Deteriorated areas of deck shall be removed down to sound concrete by use of power driven hand tools, hand tools, or high pressure water jet. After completion of removal of deteriorated concrete, remove all rust, oil or other foreign materials detrimental to achieving bond, followed by abrasive blasting and air blast or vacuum as determined by the Engineer.

The Engineer will determine any extraneous damage to the existing bridge caused by the Contractor's operations, which the Contractor shall repair at no additional cost to the Administration.

Existing reinforcement steel to be utilized in the finished deck shall conform to 421.03.07 except all bars shall be thoroughly cleaned by abrasive blasting. Where the bond between existing concrete and reinforcement steel has been destroyed, or where more than half the diameter of the steel is exposed, the concrete adjacent to the bar shall be removed to a depth that will permit concrete bond to the entire periphery of the exposed bar. This clearance shall be a minimum of 1 in. unless lower bar mats make it impractical. Care shall be exercised to prevent cutting, stretching, or damaging any exposed reinforcement steel.

Areas from which unsound concrete has been removed shall be kept free of slurry produced by hydromilling of concrete in adjacent areas. Work shall be planned so that this slurry will drain away from all open areas. All slurry shall be removed from prepared areas before proceeding with the surface preparation.

Spalled concrete, voids and other defects that are located within the proposed LMC overlay area shall then be repaired in conformance with the methods specified herein. Each repair shall include the removal of the additional deck material, all handchipping, and repairing material. If the Contractor elects to use Mix No. 5/Mix No. 6 concrete to make repairs, the concrete shall be placed even with the top of the remaining deck prior

to placing the overlay material. The top surface of these deck repairs shall be given a final textured finish consisting of 1/8 in. wide by 1/8 in. deep transverse corrugations spaced approximately 1/4 in. apart. The method of texturing shall be approved by the Engineer prior to placing the material for the deck repair. The repaired areas shall be covered with wet burlap or wet cotton mats and shall be kept continuously wet for 120 hours.

(a) Type I Deck Repairs. This repair shall include cavities less than 1 in. deep. The cavity may require handchipping, but the void shall be filled with LMC overlay while applying the overlay.

(b) Type II Deck Repairs. This repair shall include cavities 1 to 3 in. deep which the Contractor has the option of repairing with Mix No. 5 concrete or filling the void with LMC overlay while applying the overlay. Wire fabric shall be placed as specified in 423.03.04. Wire fabric will not be required for repair areas less than 2 ft^2.

(c) Type III Deck Repairs. This repair shall include areas where the depth of deck removal is over 3 in. deep but not full depth. The Contractor may opt to repair with Mix No. 6 concrete or fill the void with LMC overlay while applying the overlay. If the repair crosses a proposed construction joint, a 1-1/2 X 3 in. keyway shall be provided at the vertical joint.

The Contractor shall furnish and erect temporary protective shields as specified in 405.03.01 when the depth of removal reaches half of the original concrete deck thickness and deeper removal is anticipated.

(d) Type IV Deck Repairs. This repair shall include areas where the depth of deck removal is full depth. The option and requirements of (c) shall also apply. In large areas forms supplied to enable placement of the concrete shall be supported by blocking erected from the stringers. In small areas forms supplied to enable placement of the concrete/LMC may be suspended from existing reinforcement bars by wire ties.

The top surface of all deck repairs shall be even with the top of the remaining deck.

426.03.03 Surface Preparation. The entire surface shall be thoroughly cleaned and abrasive blasted before placing the overlay. The abrasive blasting shall clean all reinforcement of visible rust and clinging concrete detached from the deck and all areas of concrete against which the overlay is to be placed. Abrasive blasting may be required on the day the

overlay is to be placed so that reinforcement is free of visible rust. Abrasive blasting shall not be performed more than 24 hours prior to placing the LMC overlay. When the Contractor opts to fill repaired voids with concrete in conformance with 426.03.02, they shall be completely cured prior to performing this surface preparation.

The surface shall be further cleaned by air blast followed by flushing with water. Prior to placing the LMC overlay, the surface shall be wetted and kept wet for at least one hour and puddles of free water shall be removed.

426.03.04 Proportioning and Mixing LMC Materials. Mixers shall be clean and the ingredients accurately proportioned.

LMC materials shall be mixed at the site in conformance with the specified requirements for the equipment used. The LMC discharged from the mixer shall be uniform in composition and consistency. Mixing shall be capable of permitting finishing operations to proceed at a steady pace with final finishing completed before the formation of the plastic surface film.

426.03.05 Placing and Finishing LMC Overlay. The LMC overlay will be the riding surface of the bridge. The top of the LMC overlay shall be placed to the true as planned line and grade of the roadways. The Contractor shall take all necessary precautions to produce a finished top of LMC overlay that shall be smooth riding by placing the LMC overlay in a manner that meets the grade of the proposed adjoining portions of the new bridge decks and adjoining roadways.

Screed rails shall be placed and fastened in position to ensure finishing the new surface to the required profile. Anchorage for supporting rails shall provide horizontal and vertical stability. Screed rails shall not be treated with any compound to facilitate their removal.

The location of longitudinal joints may be shown in the Contract Documents. If not shown, the locations shall be as directed by the Engineer based on avoiding joints in the vehicular wheel path as much as practical.

The Contractor shall take every reasonable precaution to secure a smooth riding bridge deck in conformance with 420.03.07(d). Prior to placement operations, the equipment, procedures, personnel and previous results shall be reviewed with the Engineer, and the inspection procedures will be reviewed to ensure coordination. Precautions shall include the following:

(a) All surfaces shall be completely cleaned as approved by the Engineer prior to placing the LMC overlay.

(b) The LMC mixture shall be brushed onto the wetted, prepared surface. Care shall be exercised to ensure that all vertical and horizontal surfaces receive a thorough, even coating and that the rate of progress is limited so that the brushed material does not become dry before it is covered with additional materials required for the final grade. Brushed material that has dried prior to LMC placement shall be removed and replaced in a manner acceptable to the Engineer. Coarse aggregate that accumulates from the brushing operations shall be disposed.

(c) The LMC mixture shall be placed to approximately 1/4 in. above grade and then screeded with an approved power operated finishing machine to the line and grade specified in the Contract Documents. A suitable portable lightweight or wheeled work bridge shall be used behind the finishing operation. Hand finishing may be required along the edge of placements. Joints shall be edge tooled except next to metal expansion dams, curbs, and previously placed lanes.

(d) Screed rails and construction bulkheads shall be separated from the newly placed material by passing a pointing trowel along their inside face. The trowel cut shall be for the entire depth and length of screed rails and bulkheads after the mixture has stiffened sufficiently. Metal expansion dams shall not be separated from the overlayment.

426.03.06 Curing. The surface of the LMC overlay shall be covered with a single layer of clean, wet burlap or wet cotton mat as soon as the surface will support it without deformation. Immediately following covering with wet burlap or wet cotton mat, a 4 mil layer of polyethylene film shall be placed on the burlap or cotton mat and the surface cured for 24 hours. After 24 hours, the curing material shall be removed and the LMC air cured for an additional 72 hours. White opaque burlap polyethylene sheeting may be substituted for the polyethylene film with approval of the Engineer, but shall not replace the wet burlap or wet cotton mat.

426.03.07 Grooving. The operation shall conform to the applicable portions of 420.03.07(d)(1), but shall start after the LMC has been cured in conformance with 426.03.06.

426.03.08 Limitation of Operations. LMC placement shall conform to the applicable deck placement restrictions specified in 420.03.04.

All traffic (Contractor's or public) is prohibited on the LMC overlay until the curing of the material is completed and the compressive strength test has reached 3000 psi.

LMC and concrete shall not be placed adjacent to an LMC surface course less than 96 hours old. This restriction does not apply to a continuation of placement in a lane or strip beyond a joint in the same lane or strip.

Grinding or chipping the existing concrete pavement within 6 ft of LMC is prohibited until the LMC has cured for a minimum of 48 hours.

LMC shall not be placed at temperatures lower than 45 F. The LMC may be placed at 45 F, if rising temperature is predicted, and anticipated for at least 8 hours.

At temperatures below 55 F, the Engineer will require a longer curing period and conformance with applicable portions of 420.03.13.

LMC that is unsatisfactory shall be removed and replaced at no additional cost to the Administration. Any day during which the curing temperature falls below 50 F shall not be counted as a curing day. When during the curing period the curing temperature falls below 35 F, the work may be considered as being unsatisfactory and rejected.

During minor delays of one hour or less, the end of the placement may be protected from drying with several layers of wet burlap. A construction dam or bulkhead shall be installed when the delay exceeds one hour in duration. Placement operations may proceed after a period of not less than 12 hours. This restriction does not prohibit continuation of placement provided a gap is left in the lane or strip. The gap shall be of sufficient length for the finishing machine to clear the previously placed LMC overlay.

Adequate precautions shall be taken to protect freshly placed LMC overlays from sudden or unexpected rain. All placing operations shall stop when it starts to rain. The Engineer may order the removal and replacement of any material damaged by rainfall at no additional cost to the Administration. The Engineer will determine what material has been damaged.

No linseed oil shall be placed on LMC finished deck surfaces.

426.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all removing and cleaning, abrasive blasting, air blasting, flushing with water, forming, curing, disposal of material

removed, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

426.04.01 Removal and Disposal of Existing Wearing Surface from Bridge will be measured and paid for at the Contract unit price per square yard for the actual surface area removed from the bridge deck.

426.04.02 Removal to the depth specified in the Contract Documents will be measured and paid for at the Contract unit price per square yard for the pertinent Removal of Portions of Existing Concrete Bridge Deck item.

426.04.03 Deck repairs will be measured and paid for at the Contract unit price per square yard for the pertinent Type Deck Repair item. Payment shall also include full compensation for the repair material.

426.04.04 Furnishing, placing, finishing and curing of the LMC overlay, will be measured and paid for at the Contract unit price per square yard for the pertinent Latex Modified Concrete Overlay item. The actual areas placed, finished and cured will be measured, exclusive of areas of metal expansion dams exposed on the finished surface.

426.04.05 Repair Bar for Deck Reinforcement will be measured and paid for at the Contract unit price per linear foot.

426.04.06 When traffic bearing surfaces are required, supplying and removal of them and any repairs of damage to existing deck will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents.

SECTION 427 THRU 429 — RESERVED

SECTION 430 — METAL STRUCTURES

430.01 DESCRIPTION. This work shall consist of furnishing, fabricating, transporting and erecting of steel beams, plate girders, trusses, grillages, columns and bents, shoes, pedestals, castings, miscellaneous steel and all incidental structural steel as specified in the Contract Documents or as directed by the Engineer.

Substitutes for Rolled Members. The Contractor/Fabricator has the option of substituting a fabricated shape for the rolled shape specified in the Contract Documents provided the substitution is at no additional cost

to the Administration and the fabricated shape conforms to the following requirements:

(a) The substitute fabricated shape shall provide a moment of inertia equal to or greater than the rolled shape for the full length of the member.

(b) The substitute fabricated shape shall be of equal depth or greater than the rolled shape and not decrease the underclearance shown in the Contract Documents.

(c) The minimum web or leg thickness for fabricated shapes is 1/2 in.

(d) The minimum flange thickness for fabricated shapes is 1 in. The minimum flange width for fabricated shapes is 12 in. The width to thickness ratio for fabricated flanges shall not exceed 12.

(e) The fabricated shape shall be made of the same material specified for the rolled shape.

(f) All normal criteria for creating a welded member are adhered to.

430.02 MATERIALS.

Grout	902.11(c),(d),(e)
Metals	909
Bolts	A 325
Nuts	A 194
Washers	F 436
Direct Tension Indicating Washers (DTI)	F 959

430.03 CONSTRUCTION. Unless otherwise specified, all welding and dimensional tolerances shall conform to AWS D1.5.

430.03.01 Working Drawings. Working drawings shall be provided by the Contractor as specified in TC-4.01. The Contractor is responsible for the erection of straight and curved girders and if lateral bracing is required for shipping or erection, the details shall be specified on the working drawings.

430.03.02 Work Scheduling. The Contractor shall give a minimum of two weeks notice to the Engineer when and where shop work shall begin to allow for inspection. No materials shall be fabricated until directed by the Engineer.

430.03.03 Facilities for Shop Inspection. The Contractor shall furnish all facilities for the inspection of material and workmanship in the shop. The Inspector shall be allowed free access to the required areas of the premises and shall be provided with an approved office area.

430.03.04 Material Identification. Main member material shall be identified by the Contractor by heat number.

430.03.05 Mill Orders. The Contractor shall furnish the Engineer with copies of mill orders and test reports.

430.03.06 Testing. The Contractor shall furnish, without charge, sample specimens as directed by the Engineer.

430.03.07 Defective Material and Workmanship. The acceptance of any material and workmanship by the Inspector will not deter subsequent rejection. Rejected material and workmanship shall be replaced or repaired as directed by the Engineer.

430.03.08 Marking and Shipping. Each member shall be painted or marked with an erection mark for identification. An erection diagram shall be furnished with erection marks clearly delineating the orientation of diaphragms.

Erection marks for the field identification of members and weight marks for members over 6000 lb in weight shall be painted upon surface areas previously painted with the shop coat. Material shall not be loaded for shipment until the shop coat is thoroughly dry and in any case not less than 24 hours after the paint has been applied.

Where unpainted steel is specified for a finished structure, the Contractor shall not place the Contractor's or any other company's name on any of the structural steel. Mark numbers and inspection stamps shall appear only on the top surface of the top flange of all girders, beams, and diaphragms unless otherwise directed.

Painting is prohibited after loading of materials for transport.

The Contractor shall furnish the Engineer copies of material orders, shipping statements, and erection diagrams. The weight of the individual members shall be shown on the shipping statements.

The loading, transportation, unloading, and storing of structural material shall be conducted so that the metal shall be kept clean and shall not be excessively stressed, deformed, or otherwise damaged.

When handling long steel members, handling devices shall be placed at approximately the quarter points. When storing and shipping members, blocking shall be placed at intervals that prevent sag and distortion. All beams and girders shall be stored, shipped, and handled in an upright position. Members other than beams and girders shall be handled, hauled, and stored with the stronger axis vertical to resist gravity.

All girders having stiffeners the full height of the web on both sides of the web shall be adequately blocked before shipment. This blocking shall be located at the quarter points and midpoint of the girder and at additional locations to ensure that the maximum interval between blocking does not exceed 25 ft.

Members too long to fit inside a truck or trailer shall not cantilever beyond the bed more than one quarter of its length. Members too long to comply with this requirement shall be supported on dollies, additional vehicles, or other vehicles that fully support the long pieces as approved by the Engineer.

430.03.09 Storage of Material. Fabricated material shall be stored off the ground and protected as far as practicable from surface deterioration by exposure to conditions producing rust. These materials shall be kept free of dirt accumulation, oil, or other deleterious matter.

430.03.10 Changes and Substitutions. No changes or substitutions shall be made in any approved drawing unless approved in writing by the Director, Office of Bridge Development.

430.03.11 Fabrication. Fabrication and construction shall be bolted or welded as specified in the Contract Documents or as directed by the Engineer.

When curved girder bridges are to be curved by the heat shrinkage method, the proposed method shall be submitted to the Engineer for approval.

430.03.12 Holes.

(a) Punched Holes. The diameter of the die shall not exceed the diameter of the punch by more than 1/16 in. Holes requiring enlargement shall be reamed. Holes shall be clean cut with no torn or ragged edges. Holes punched full size or subpunched shall be punched so that after the steel is assembled and before any reaming is done, a cylindrical pin 1/8 in. smaller in diameter than the nominal size of the punched hole shall be entered perpendicular to the face of the member, without drifting, in at least 75 percent of the contiguous holes in the same plane. If this

requirement is not met, the nonconforming punched pieces will be rejected. Holes not passing a pin 3/16 in. smaller in diameter than the nominal size of the punched hole will be rejected. Drifting done during assembling shall be only to bring the parts into position and not sufficient to enlarge the holes or distort the material. If the required accuracy cannot be obtained otherwise, holes for connections shall be subpunched and reamed with the members assembled instead of being punched full size.

(b) Reamed or Drilled Holes. Holes shall be cylindrical, perpendicular to the member, and not more than 1/16 in. larger than the nominal diameter of the bolts. Where practical, reamers shall be directed by mechanical means. Burrs on the surface shall be removed. Poor matching of holes will be cause for rejection. Reaming and drilling shall be done with twist drills. If required by the Engineer, assembled parts shall be taken apart for removal of burrs caused by drilling. Connecting parts requiring reamed or drilled holes shall be assembled and securely held while being reamed or drilled and shall be match marked before disassembling. When holes are reamed or drilled, 85 percent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than 1/32 in. between adjacent thicknesses of metal.

(c) Subpunching and Reaming. Holes in all field connections and field splices of main truss or arch members, continuous beams, plate girders, and rigid frames shall be subpunched and reamed while assembled in the shop unless otherwise specified. The assembly, including camber, alignment, accuracy of holes, and milled joints shall be acceptable to the Engineer before reaming is started.

All holes for floor beam and stringer field end connections shall be subpunched and reamed utilizing a template or reamed while assembled.

If additional subpunching and reaming is required, it will be specified in the Contract Documents. The accuracy of subpunched holes shall be the same as required for punched holes.

430.03.13 Shop Assembly. Surfaces of metal that will be in contact after assembling shall be cleaned. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before reaming or tightening of fasteners is started. The member shall be free from twists, bends and other deformations. Material that has been punched full size

shall be reamed, if necessary, prior to tightening of fasteners. Refer to 430.03.12(c).

Parts not completely fastened in the shop shall be secured by bolts as practicable to prevent damage in shipment and handling. Members assembled in the shop for reaming of field connections shall remain assembled until the Engineer's shop inspection.

430.03.14 Camber Diagram. A camber diagram shall be furnished to the Engineer showing the camber at each panel point for each truss, taken from actual measurements during truss assembly. A camber diagram shall be furnished to the Engineer showing the camber at all splice points, points of dead load inflection, and any other points designated by the Engineer for all beams and girders.

Stringers shall be cambered to the dimensions specified in the Contract Documents. The camber specified shall mean the camber as measured after all shop welding has been completed. The maximum tolerance for camber shall be zero under to 3/4 in. over.

Full provisions shall be made for dead load deflections, fabricating tolerances, and irregularities at all points along all stringers so that the superstructure concrete may be placed to match the profile grade line.

430.03.15 Match Marking. Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be matched marked, and a diagram showing these marks shall be furnished to the Engineer.

430.03.16 Use of High Strength Bolts and Lock-Pin and Collar Fasteners. High strength bolts and lock-pin and collar fasteners shall be used unless otherwise specified in the Contract Documents. Unfinished bolts or machine bolts may be used for the temporary erection of structural steel and shall be replaced with high strength bolts, lock-pin and collar fasteners or welding for final erection. Turned bolts shall only be used when specified. The heads, nuts, and washers shall be drawn tightly against the work. Where bolts or lock-pin and collar fasteners are used in beveled surfaces, beveled washers shall be provided to give full bearing to the head, nut, or collar except as otherwise specified in 430.03.17. Where high strength bolt assemblies are used for joint connections, the Contractor shall also perform the additional testing specified in MSMT 211.

430.03.17 High Strength Bolt Joint Requirements.

(a) Only one grade of bolts, nuts, and washers shall be used in a structure. Bolts may be supplied from various manufacturers

provided that each bolt of a given length and diameter shall be made by the same manufacturer. Nuts and washers may be supplied from different manufacturers provided that the same manufacturers make all the respective nuts and washers to be used throughout the structure on all bolts having the same diameter. All bolts, nuts, and washers used with A 709, Grade 50W steel shall conform to A 325, Type 3.

(b) The slope of surfaces of bolted parts in contact with the bolt head and nut shall not exceed 1:20 with respect to a plane normal to the bolt axis. Where an outer face of the bolted parts has a slope of more than 1:20 with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for the lack of parallelism. When assembled, bolted parts shall fit solidly together and shall not be separated by gaskets or any other interposed compressible material. The holes shall be truly cylindrical and at right angles to the surface of the metal so that both head and nut will bear squarely against the metal. When assembled, all joint surfaces including those adjacent to the bolt heads, nuts, or washers, shall be free of scale (except tight mill scale), dirt, burrs, and other deleterious material and defects that would prevent solid seating of the parts. Contact surfaces within joints shall be free of oil, lacquer, or rust inhibitor. Refer to 435.03.04 for contact surfaces to be painted.

(c) When all bolts in the joint are tight, every bolt shall conform to the minimum installation tension specified for its size in MSMT 211. When field conditions prevent tightening at the nut, bolts may be tightened at the head, provided that the nut is prevented from turning. All bolts shall have a washer under the element (nut or bolt head) turned in tightening. Threaded bolt connections shall be tightened by the turn-of-nut method unless the Contractor opts to use DTI's. If impact wrenches are used, they shall be of adequate capacity and have a sufficient supply of air to perform the required tightening of each bolted connection.

(d) To provide the bolt tension specified in 430.03.17(c), there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be additionally tightened with tensioning progressing systematically from the most rigid part of connection to the free edges. During this operation there shall be no rotation of the part not turned by the wrench.

After all bolts in the joint have a snug fit, the joint shall be additionally tightened by the applicable amount of nut rotation specified in the Nut Rotation from Snug Tight Condition table below. All bolt assemblies in the completed structure shall have full thread engagement which is accomplished when the end of the bolt is flush with or extends beyond the outer face of the nut.

NUT ROTATION FROM SNUG TIGHT CONDITION			
DISPOSITION OF OUTER FACES OF BOLTED PARTS			
Bolt length (as measured from underside of head to extreme end of bolt)	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped not more than 1:20 (beveled washer not used)	Both faces sloped not more than 1:20 from normal to bolt axis (beveled washers not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters	2/3 turn	5/6 turn	1 turn

NOTE 1: This table is for coarse thread, heavy hexagon structural bolts of all sizes and lengths and heavy hexagon semifinished nuts.

NOTE 2: Nut rotation is rotation relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation: ±30 degrees for bolts installed by 1/2 turn or less, and ±45 degrees for bolts installed by 2/3 turn or more.

(e) Inspection. The Engineer will be present during the installation and tightening of bolts to determine that the tightening procedure is properly followed and all bolts are properly tightened.

The Contractor shall provide a sufficient number of safe working platforms at splices where high strength bolts will be checked for torque requirements. Platforms shall be maintained at splices until all checking is complete and the splice is acceptable to the Engineer.

Turn of Nut Method. The Contractor shall provide a calibrated torque wrench to be used as the inspection wrench and a calibrated bolt tension calibrator. Both have to be approved by the Engineer.

The Contractor shall conduct the following inspections unless otherwise specified in the Contract Documents. Bolts, nuts, and washers that were previously torqued to installation tension shall not be reused in the structure.

(1) Three bolts of the same size, length, and condition as those under inspection shall be placed individually in the bolt tension calibration device. There shall be a washer under the part turned in tightening each bolt.

(2) Each of the three bolts shall be tightened in the calibration device by any convenient means to the tension specified for its size. The inspecting wrench shall then be applied to the tightened bolt, and the torque necessary to turn the nut or head 5 degrees approximately 1 in. at 12 in. radius in the tightening direction shall be determined. The average torque measured in the tests of three bolts shall be taken as the job inspecting torque to be used in the manner specified in (3).

(3) Bolts represented in the sample above which have been tightened in the structure shall be inspected by applying, in the tightening direction, the inspecting wrench and its job inspecting torque to 10 percent of the bolts but not less than two bolts selected at random in each connection. If no nut or bolt head is turned by this application of the job inspecting torque, the connection will be accepted as properly tightened. If any nut or bolt head is turned by the application of the job inspecting torque, this torque shall be applied to all bolts in the connection; and all bolts whose nut or head is turned by the job inspecting torque shall be tightened and reinspected. Alternatively, the fabricator or erector may opt to retighten all of the bolts in the connection and then resubmit the connection for the specified inspection.

430.03.18 Lock-Pin and Collar Fastener Requirements.

(a) Lock-pin and collar fasteners shall conform to 430.03.17 for one manufacturer, weathering characteristics, sloped surfaces, and applicable inspection.

(b) A representative sample of not less than three sets of lock-pin and collar fasteners of each diameter, length, and grade shall be checked at the job site in a device capable of indicating bolt tension. The test assembly shall include flat hardened washers, if required in the actual connection, arranged as in the actual connections to be tensioned. The calibration test shall demonstrate that each assembly develops a tension not less than 5 percent greater than the tension required for the comparable A 325 or A 490 bolt. Manufacturer's installation procedure shall be followed for installation of bolts in the calibration device and

in all connections. Periodic retesting shall be performed when required by the Engineer.

(c) Fasteners shall be installed in all holes of the connection and initially tightened sufficiently to bring all plies of the joint into firm contact but without yielding or fracturing the control or indicator element of the fasteners. All fasteners shall then be additionally tightened, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. In some cases, proper tensioning of the fasteners may require more than a single cycle of systematic partial tightening prior to final twist off of the control or indicator element of individual fasteners.

430.03.19 Welding. Welding of structures shall conform to the Contract Documents and AASHTO/AWS Bridge Welding Code D1.5 unless otherwise specified.

The provisions contained herein shall apply to both shop and field welding.

All welders, welding machine operators, and tackers employed to work on structures for the Administration shall be approved by the Office of Materials and Technology.

(a) **Qualification Testing.** Welders will be approved based on Qualification Testing conforming to AASHTO/AWS Bridge Welding Code D1.5. Qualification testing will be conducted by the Office of Materials and Technology, Metals Group.

The Contractor shall contact the Metals Group at least 30 days prior to the start of welding operations to schedule welder tests. At the time of test, welders shall have an authorization from the Contractor. This authorization shall contain the welder's name, social security number, Contract number, and the Contractor's name and phone number.

(b) **Qualifications from Outside Sources.** Welders having certifications from outside sources in conformance with the AASHTO/AWS Bridge Welding Code D1.5 may submit that certification for approval to the Metals Group.

All field welders approved by the Metals Group shall have a current Administration Welders Certification card available at all times for inspection by the Engineer.

Unless otherwise specified by the Engineer in writing, only submerged arc welding will be permitted on members carrying primary stress. Members carrying primary stress are as specified in 909.01.

After fabrication, no welding will be permitted on tension flanges for attachments such as metal forms and ty screws, except for steel stud shear developers specified in the Contract Documents.

Welding transversely across the tension flanges of beams or girders will not be permitted and will be cause for rejection unless otherwise specified in the Contract Documents.

430.03.20 Inspection of Fabricated Metal Structures. Fabricated metal structures shall conform to AASHTO/AWS Bridge Welding Code D1.5. Quality control inspection shall be the responsibility of the Contractor.

The Contractor shall have on file with the Office of Materials and Technology a current approved quality control plan prior to receiving source approval. This plan shall specify the frequency, method of inspection and provide for documentation. The inspection frequency shall be at least the minimum specified in AASHTO/AWS Bridge Welding Code D1.5. The Administration requires 30 days to review quality control plans not previously on file.

The Contractor shall also keep complete and current records which shall be available to the Administration's representatives at all times.

When work is completed, the documentation for all quality control tests and inspections shall become the property of the Administration.

430.03.21 Planing. The top and bottom surfaces of steel slabs, base plates, and cap plates of columns and pedestals shall be planed or the plates or slabs shall be heat straightened. Parts of members in contact with them shall be faced. In planing the flat surfaces of expansion bearings, the cut of the tool shall be in the direction of expansion.

430.03.22 Abutting Joints. Abutting joints in compression members and in tension members where specified in the Contract Documents shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed 1/8 in.

430.03.23 End Connection Angles. Floor beams, stringers, and girders having end connection angles shall be built to exact length back-to-back of connection angles. If end connections are faced, the finished thickness of the angles shall not be less than specified in the Contract Documents.

430.03.24 Main Members. Principal portions of main members carrying primary stress (i.e., webs, flanges, girders and trusses) shall be fabricated so that the direction of stress and rolling are the same.

430.03.25 Web Plates. At web splices, the clearance between the ends of the web plates shall not exceed 3/8 in. The clearance at the top and bottom ends of the web splice plates shall not exceed 1/4 in.

430.03.26 Bent Plates. Unwelded, cold bent, load carrying, rolled steel plates shall be taken from the stock plates so that the bend line will be at right angles to the direction of rolling, except that cold bent ribs for orthotropic deck bridges may be bent in the direction of rolling if permitted by the Engineer and shall conform to the following:

(a) Bending shall be so that no cracking of the plate occurs. Minimum bend radii, measured to the concave face of the metal shall conform to the following:

THICKNESS (t) IN INCHES					
Structural Steel	Up to 1/2	Over 1/2 to 1	Over 1 to 1-1/2	Over 1-1/2 to 2-1/2	Over 2-1/2 to 4
A 709, Grades 36, 50 & 50W	2 t	2-1/2 t	3 t	3-1/2 t	4 t

(b) For brake press forming, the lower die span should be at least 16 times the plate thickness. Multiple hits are advisable.

(c) If a shorter radius is essential, the plates shall be bent at a temperature not greater than 1200 F. Hot bent plates shall be taken from stock so that the bend line will be at right angles to the direction of rolling.

(d) Before bending, the corners of the plate shall be rounded to a radius of 1/16 in. throughout the portion of the plate where the bending is to occur.

430.03.27 Erection Plan. The Contractor shall submit for approval, an erection diagram plan outlining erection procedure of the main members. The plan shall conform to TC-4.01 and shall be submitted for approval to the Director, Office of Bridge Development, a minimum of 30 days prior to beginning erection. This plan shall include the numbers and types of equipment to be used including crane capacity, location of crane for lifting, falsework when required, and main member erection sequence and weight.

All wheels and outriggers of a crane or wheels of a structural steel delivery truck shall be at a minimum distance from the rear face of an abutment equal to the vertical distance from the top of a spread footing or to the original groundline if the footing is on piles. No other heavy construction equipment shall be operated within this minimum distance from the rear face of abutments.

The Contractor shall erect bridges with continuous main members in a manner providing the proper reactions, and avoiding overstressing main members.

The Contractor when preparing erection plans and procedures shall take into account the restrictions imposed by the Water Resources Administration relative to pollution or disturbance of existing waterways.

430.03.28 Falsework. The Contractor shall comply with the provisions specified in TC-4.01. The falsework shall be built and maintained in conformance with the approved falsework plans. Any changes subsequent to initial approval which are proposed by the Contractor through the Contractor's professional engineer will be as approved by the Engineer.

Before permitting any loads to be placed on falsework, the Engineer shall receive written certification by the Contractor's professional engineer that the falsework system has been assembled in conformance with the approved falsework drawings. This certification shall be accompanied by a Certificate of Compliance stating that all manufactured materials and assemblies fully comply with the falsework design and plans. The Engineer may either accept the certificate or invoke any provision of GP-5.08. All tests required shall be made by the Contractor at no additional cost to the Administration.

In addition to protective measures shown on the falsework plans, the Engineer may direct the Contractor to provide further protection of falsework against accidental collision by highway or construction traffic and equipment, traffic vibration, flood waters or high winds, etc., that are necessary for public safety and protection of the work.

430.03.29 Damaged or Defective Material. The correction of damaged or defective material shall not begin until a written procedure prepared by the Contractor is approved by the Director, Office of Bridge Development. Correction of damaged or defective material shall be by methods that do not produce fracture or injury. All damaged or defective material will be inspected by the Engineer before and after correction. Corrections shall be conducted in the presence of the Engineer.

430.03.30 Assembling Steel. Material shall be carefully handled and no parts shall be bent, broken, or otherwise damaged. Bearing surfaces and those to be in permanent contact shall be cleaned before the members are assembled. Before beginning the field bolting and welding, the structure shall be adjusted to correct grade and alignment and the elevations of panel points (ends of floor beams) properly regulated. Splices and field connections shall have half the holes filled using bolts and cylindrical erection pins (40 percent bolts and 10 percent pins) before torquing high strength bolts. Splices and connections in members carrying traffic during erection shall have three fourths of the holes filled before torquing. Cylindrical erection pins shall be 1/32 in. larger than the diameter of the fasteners.

430.03.31 Anchor Bolts. No anchor bolts shall be cast in the concrete. The Contractor shall create a template to locate the anchor bolt holes. This template shall be used to shift the reinforcement prior to placing the concrete to eliminate conflicts between the reinforcement and the anchor bolt holes.

Anchor bolts shall be set in round holes drilled or cast in the concrete. Bolts shall be accurately positioned by using templates set to correct location and alignment to ensure proper span lengths, and tops of bolts shall be carefully set to proper elevation. Unless otherwise noted, bolts shall be installed plumb or normal to the finished bearing surface of the masonry.

Bolts set in holes drilled or cast into the concrete shall have the portion below the bridge seat swedged. The drilled or cast holes shall have a diameter at least 1 in. larger than the bolt diameter.

Anchor bolts, nuts, and washers shall not be painted.

After anchor bolts are finally and correctly positioned, the holes shall be completely filled with grout. Grouting of anchor bolts is not permitted until all structural steel is set in its final position. After the masonry plates or shoes are set, the space between the bolts and the round holes through fixed plates or shoes shall be filled with the same material. Slotted holes in expansion devices shall remain unfilled unless otherwise specified in the Contract Documents.

The Contractor shall maintain a minimum air temperature of 40 F around the mortar surface for a period of three days unless otherwise recommended by the manufacturer.

When mortar filling is used for bolts inserted in holes drilled or cast in the concrete, the holes shall first be checked for depth by inserting and withdrawing the bolts. They shall then be partially filled with mortar into

which the bolts shall be forced by uniform pressure or light blows from a hammer (flogging and running is prohibited) so that excess mortar is pushed out at the top of the hole. The excess mortar shall be removed.

Bolts shall be set to project approximately 1/2 in. above the nut and shall be threaded to approximately 1/2 in. below the nut in their final position.

Rockers or expansion plates with slotted holes shall be set with the proper tilt or offset as determined by the temperature prevailing at the time and so that they will be in their midway position at 68 F or as specified in the Contract Documents.

430.03.32 Maintenance of Concrete. The Contractor shall be responsible for keeping all exposed concrete surfaces free from stains and discoloration. The Contractor shall prevent staining of the finished concrete surfaces where unpainted structural steel is specified. Any stains shall be removed and the concrete restored to its original color.

430.03.33 Safety Hazards. The Contractor shall be responsible for gas detection in and ventilation of confined spaces as specified in TC-3.05.

430.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all high strength bolt and lock-pin and collar fastener assembly testing, material, labor, equipment, tools, and incidentals necessary to complete the work.

430.04.01 Fabricated Structural Steel will not be measured but will be paid for at the Contract lump sum price.

430.04.02 Fabricated Structural Steel will be measured and paid for at the Contract unit price per pound computed on the theoretical weight.

Where measurement and payment of Fabricated Structural Steel is based on weight, the weight will be computed on the basis of the net finished dimensions of the parts as shown on the approved working drawings, deducting for copes, cuts, clips, and all open holes.

Computations will be made on the basis of the following:

MATERIAL	POUNDS PER CUBIC FOOT
Aluminum, cast or wrought	173.0
Bronze, cast	536.0
Copper alloy	536.0
Copper, sheet	558.0
Iron, cast	445.0
Iron, malleable	470.0
Lead, sheet	707.0
Steel, rolled, cast, copper bearing, silicone, nickel and stainless	490.0
Zinc	450.0

The weight of rolled shapes will be computed on the basis of their nominal weight per foot as specified in the Contract Documents or listed in the handbooks.

The weight of rolled shapes will be computed on the basis of their nominal weight for their width and thickness as specified in the Contract Documents, plus an estimated overrun computed as half the permissible variation in thickness and weight as tabulated in A 6.

The weight of all shop weld metal (not included in weighed unit) and field weld metal will be computed on the basis of the theoretical volume from dimensions of the welds.

The weight of temporary erection bolts, shop and field paint, boxes, crates and other containers used for shipping, and materials used for supporting members during transportation and erection is excluded from the calculation of weight for payment.

Structural members or materials which fail to conform to requirements of tests and all materials rejected as a result of these tests will not be measured or paid for under any method of payment.

430.04.03 When a pay item for Fabricated Structural Steel is not specified in the Contract Documents, the fabricated structural steel will not be measured but the cost will be incidental to other pertinent items.

430.04.04 Rotational capacity testing for high strength bolt assemblies will not be measured but the cost will be incidental to the Contract price

for the Fabricated Structural Steel item or other pertinent items specified in the Contract Documents.

SECTION 431 — STEEL STUD SHEAR DEVELOPERS

431.01 DESCRIPTION. This work shall consist of furnishing, fabricating and installing, complete in place, steel stud shear developers as specified in the Contract Documents or as directed by the Engineer.

431.02 MATERIALS.

Steel Stud Shear Developers	909.05

431.03 CONSTRUCTION. All structural steel in a particular span of a bridge shall be erected and have forming and decking complete in place in that particular span before shear developers are attached to the structural steel. Shear developers shall be installed as specified in AASHTO/AWS Bridge Welding Code D1.5. After welding is completed, an inspection of all studs will be made by the Engineer prior to placing of concrete. All defects shall be corrected at no additional cost to the Administration.

431.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

431.04.01 Steel Stud Shear Developers will not be measured but will be paid for at the Contract lump sum price.

431.04.02 Steel stud shear developers for which there is no specific pay item included in the Contract Documents will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents.

431.04.03 Steel Stud Shear Developers will be measured and paid for at the Contract unit price per each.

SECTION 432 — BEARINGS

432.01 DESCRIPTION. This work shall consist of furnishing and installing bearings of the type and size specified in the Contract Documents or as directed by the Engineer.

432.02 MATERIALS.

Steel Plates	909.02
Bronze or Copper Alloy	
Bearing and Expansion Plates	910.01
Elastomeric Bearing Pads	910.02
Preformed Fabric Pads	910.02
Epoxy Adhesives	921.04

432.03 CONSTRUCTION.

432.03.01 Storage and Handling. Bearings shall be stored under cover on a platform above the ground surface. They shall be protected from damage at all times and, when placed, shall be dry, clean, free of dirt, oil, grease, or other foreign substances.

432.03.02 Installation. Masonry bearing plates shall be erected on surfaces conforming to 420.03.07(c). The masonry bearing plates shall be placed on a single thickness of preformed fabric bearing pad.

The bearings and pedestals of truss, beam and girder spans, and the center and end bearing of swing spans shall be rigidly and permanently located to correct alignments and elevations.

The attachment of bearings or plates to steel superstructures shall conform to the applicable portions of Section 430.

432.03.03 Steel, Bronze, or Copper Bearings. When steel, bronze, or copper alloy bearings are specified in the Contract Documents, the machined bearing surfaces shall be thoroughly cleaned immediately before erection. As soon as practicable after erection, all unpainted exposed surfaces of the bearings, scheduled for painting, shall be given one prime coat before application of the specified field coats.

432.03.04 Elastomeric Bearing Pads. When elastomeric bearing pads are specified in the Contract Documents, the pads delivered to the bridge sites shall be stored under cover on platforms a minimum of 4 in. above the surface or vegetation. Pads shall be kept dry and protected from damage and contamination from foreign substances at all times.

Prior to installation the pads and abutting surfaces shall be given a final cleaning to assure that they are free of all dust, dirt, oil, grease, moisture, or other foreign substances. Cleaning shall be done with an approved solvent that is compatible with the adhesive prior to application of the epoxy adhesive. The epoxy adhesive shall be mixed and applied in conformance with the manufacturer's recommendations.

When the elastomeric pads are used without masonry bearing plates, the masonry bearing surfaces shall be ground to remove all laitance before the application of the adhesive. The surfaces of the masonry bearing areas that will be in contact with the bearing pads and the full contact area of the bearing pad shall be coated with the epoxy adhesive. After the adhesive is applied and the pads are set in place, blocking or other approved mechanical methods shall be used to secure the pads in their final position until the adhesive has set up.

Surface temperatures and predicted ambient air temperature for the next four hours shall be 50 F or higher at the time of application unless otherwise specified in the Contract Documents or recommended by the epoxy adhesive manufacturer and approved by the Engineer.

432.04 MEASUREMENT AND PAYMENT. Bearings will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents.

SECTION 433 — BRIDGE MOUNTED SIGN SUPPORTS

433.01 DESCRIPTION. This work shall consist of furnishing and constructing bridge mounted sign supports and sign luminaire supports as specified in the Contract Documents. The work does not include sign panels, electrical work, and luminaires.

433.02 MATERIALS.

Epoxy Grout	902.11(d)
Structural Steel	909.01
Anchor Bolts, Nuts and Washers	909.06
High Strength Bolts, Nuts and Washers	909.07
Paint	912.05, Paint System B

On new structures, the structural steel and fasteners for the sign support shall be the same as used for the fabrication of the structure on which it is to be mounted, including the additional requirements for Charpy V-notch testing. When A 709, Grade 50W structural steel is used, the vertical supports shall be made of steel conforming to A 709, Grade 36 or 50.

On existing structures, the structural steel for the sign support shall include the additional requirements for Charpy V-notch testing and conform to A 709, Grade 36 or 50. When the existing structure consists

of A 709, Grade 50W structural steel, the structural steel for the sign support shall conform to A 709, Grade 50W, except that the vertical supports shall be made of steel conforming to A 709, Grade 36 or 50. The fasteners shall conform to 909.07 and shall be Type 3 when used with A 709, Grade 50W structural steel.

Vertical supports to which the sign panels are attached shall be galvanized in conformance with A 123. All bolts, nuts, and similar fasteners in contact with the galvanized material shall be mechanically or hot dipped galvanized. The coating shall conform to the thickness, adherence, and quality requirements of A 153.

433.03 CONSTRUCTION. Construction shall conform to Section 430. Painting shall conform to Section 435, except as otherwise specified herein.

The Contractor shall set the anchor bolts by epoxy grouting or casting in place when applicable.

On new structures the nongalvanized portions of the sign support shall be cleaned and painted in conformance with the system specified for the structure on which it is to be mounted. Portions of the sign support mounted on structures constructed with Grade 50W steel, and attached to areas that are to be painted, shall also be cleaned and painted.

On existing structures not constructed with Grade 50W structural steel, the Contractor may elect to galvanize the entire sign support or paint those areas not designated to be galvanized. The nongalvanized portions of the sign support shall be cleaned and painted as specified in Section 435. They shall be blast cleaned to conform to the surface condition of Near White Sa 2-1/2 prior to painting.

Portions of the sign support mounted on existing structures constructed with Grade 50W steel, and attached to areas that are painted shall also be cleaned and painted.

433.04 MEASUREMENT AND PAYMENT. Bridge Mounted Sign Supports will not be measured but will be paid for at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 434 — RESERVED

SECTION 435 — CLEANING AND PAINTING STRUCTURAL STEEL

435.01 DESCRIPTION. This work shall consist of cleaning and painting new and existing structural steel. The work shall conform to SSPC Standards. Any structural defects including cracks, missing bolts or rivets, deterioration, etc., detected during cleaning and painting shall be brought to the attention of the Engineer. The Contractor shall protect utility pipes, conductors, or conduits from these operations; they shall not be cleaned and painted unless specified in the Contract Documents.

This work shall also include cleaning and painting of all miscellaneous new replacement steel and all surface areas of the coating on the existing steel that are damaged due to structural repairs.

The Contractor shall provide all maintenance of traffic for lane and shoulder closures required to complete the work including inspection of the work. The Contractor shall provide the Engineer with safe and convenient access for the inspection and measurement of the work throughout the course of the project, for final inspection, and final warranty inspections. The Administration will provide all maintenance of traffic and access for the Engineer and Contractor for all intermediate annual inspections. All maintenance of traffic and access required for corrective action resulting from these inspections, and inspections following corrective action, shall be at no additional cost to the Administration. When a railroad is included in the project, all railroad fees shall be as specified in the Contract Documents except that any additional impact on the railroad due to corrective actions or additional inspections shall be at no additional cost to the Administration.

The Contractor shall conform to the requirements of OSHA for lead, arsenic, cadmium, etc., exposure in construction standards; and the applicable Federal and State laws. Existing paint systems may include toxic metals such as lead, arsenic, cadmium, chromium, etc., which may be considered hazardous waste when removed and tested as specified in the Toxicity Characteristic Leaching Procedure (TCLP), EPA Method 1311.

Prior to bidding the Contractor should be familiar with the current environmental regulations and safety procedures. The Administration is considered the "Generator" of all waste associated with the work, however, the Contractor shall be responsible for preventing waste from entering into the environment by containing, collecting, storing, testing, and disposing of all waste in conformance with Federal, State and local regulations.

Failure to Comply. When the Engineer determines that the Contractor has failed to comply with environmental regulations and safety procedures, that portion of the work will be shut down until the Engineer is assured that the Contractor's modified procedures will result in compliance. These procedures include timely submittals from the industrial hygienist; containment, ventilation, and recovery systems working to the required level of efficiency, and other requirements of the Contract Documents. The shut down and corrective action shall be performed at no additional cost to the Administration.

Field Painting Minimum Requirements. All paint contractors/ subcontractors shall be certified as specified in (a) below. When field cleaning to a condition of SSPC-SP 6 or SP 10 is required on rehabilitation or cleaning and painting existing bridge projects, they shall also be certified as specified in (b) below. All certificates shall be effective prior to Award of Contract and shall remain in effect for the duration of the Contract.

Cleaning and painting operations on projects that are primarily for cleaning and painting existing bridges shall be performed by the Contractor. The use of subcontractors for the cleaning and painting operations on these projects is prohibited. This requirement applies regardless of the percentage of the cost of the cleaning and painting items when compared to the total work in the Contract. Subcontractors may be used for traffic control and other work not pertaining to cleaning and painting.

(a) **SSPC-QP1.** Standard Procedure for Evaluating Qualifications of Painting Contractors: Field Application to Complex Structures.

(b) **SSPC-QP2, Category A.** Standard Procedure for Evaluating Qualifications of Painting Contractors to Remove Hazardous Paint.

435.02 MATERIALS.

New Steel (Includes New Structures, Repairs or Widenings)	912.05, Paint System B
Existing Steel (Includes Existing Structures with or without Widenings	912.05, Paint System C
Existing Coatings Damaged During Structural Repairs	435.02.01

All paint within the paint system shall be from the same manufacturer.

435.02.01 Existing Coatings Damaged During Structural Repairs. Existing coatings damaged during structural repairs shall conform to 435.03.15 and 912.05, Paint System E, Coat I and II except that on fascia beams and trusses Coats I, II, and III shall be applied. The color of the final coat shall match the existing finish coat. The requirement for each coat to be tinted to differentiate between coats will be waived for Coats II and III.

435.03 CONSTRUCTION. The definition of the word "Bridge" as defined in TC-1.02 shall not apply to this Specification. Any references to "Bridges" in this Specification, shall mean any structures carrying traffic over water, roadway, railway, etc., regardless of its length.

Paint Inspector Notification. The Contractor shall notify the Bridge Inspection and Remedial Engineering Division a minimum of 72 hours prior to beginning field cleaning and painting of new and existing steel. The Bridge Inspection and Remedial Engineering Division will provide a paint inspector to assist the Engineer during inspection of the cleaning and painting portion of the work. Failure to comply with this notification shall be cause for rejecting the work performed. Paint applied to steel surfaces without this inspection may be required to be removed and reapplied at no additional cost to the Administration.

435.03.01 The Contractor shall provide, for the exclusive use of the Engineer, the following equipment for the inspection of the Contractor's cleaning and painting operations. All equipment shall be maintained by the Contractor in a condition that is satisfactory to the Engineer and shall remain the property of the Contractor at the conclusion of the Contract.

(a) SSPC Vis 1-89 and SSPC-Vis 3 Standards (Latest Edition) or other approved visual standards.

(b) SSPC Painting Manuals (Latest Edition).

(c) SSPC Guides 6 and 7 (Latest Edition).

(d) Spring Micrometer with Surface Profile Replica Tape.

(e) Sling Psychrometer, F.

(f) U.S. Weather Bureau Psychrometric Tables.

(g) Surface Thermometer, 0 to 150 F.

(h) Probe Thermometer for Paint Temperature.

(i) High/Low Thermometer for Paint Storage Area.

(j) Wet Film Thickness Gauge.

(k) Digital Magnetic Dry Film Coating Thickness Gauge (SSPC-PA2).

(l) Plastic Calibration Shims for Digital Magnetic Dry Film Thickness Gauge.

(m) Inspector's Mirror.

(n) Wind Meter.

(o) Clean, White, Lint-Free, Absorbent Rags.

Field Quality Control. The Contractor shall provide daily job quality control in conformance with SSPC-QP1. Copies of the Contractor's daily job quality control records shall be maintained on site and made available for the Engineer at any time. The Contractor shall also give evidence of qualified personnel and proper inspection and recording procedures for job quality control.

(a) **Personnel Qualifications.** Documentation that personnel performing quality control related functions are qualified, including records of training and experience of qualified supervisors and inspectors, and a description of qualification requirements for inspectors.

Competent Person. A competent person as defined in SSPC-QP2 shall perform all quality control related functions. The Contractor shall provide documentation including records of training, experience, etc., of the competent person's qualifications. The competent person shall have a minimum of 2 years industrial field painting experience with a minimum of 90 days of field supervisory or management experience in paint removal projects; and shall hold a SSPC Competent Person Certificate, and a certificate of completion of 29 CFR 1926.62(l) Lead in Construction Training.

(b) **Inspection Procedures and Recording Systems.** The Contractor shall submit a Quality Assurance Plan within 14 days after receiving Award of Contract. The Quality Assurance Plan shall include the following:

(1) Records of standards and specifications for coating inspection work and their utilization.

(2) System for filing inspections reports.

(3) Demonstration that inspection equipment and calibration standards and procedures are available.

(4) Procedures to stop nonconforming work.

(5) Procedures for verifying proper coating application

(6) Procedures to ensure that each major operation (surface preparation, primer, intermediate, and topcoat application) is inspected.

(7) Procedures for calibration of inspection equipment.

435.03.02 Floodlighting. The Contractor shall provide floodlighting, including power source, to supply adequate illumination to the underside and inside of the structure's containment system for all field cleaning and painting operations and inspections. The floodlighting shall be in good working condition and of a design approved by the Engineer. The floodlighting shall be adjusted to avoid glare that may blind marine and vehicular traffic.

435.03.03 Surface Preparation. Surfaces shall be prepared as specified in the pertinent SSPC Specifications and the Contract Documents. Surface conditions shall conform to the pertinent SSPC-Vis Standards.

Should an area of steel that had previously been cleaned become soiled, contaminated, or rusted, the Contractor shall reclean that area to the satisfaction of the Engineer prior to painting at no additional cost to the Administration.

Regardless of the method of cleaning, all surface imperfections such as sharp fins and edges, weld spatter and slag, deep pits, slivers, runs and sags in existing paint, concrete spatter, bird and animal waste, and any other matter which will prohibit a smooth unobstructed surface for the application of paint, shall be removed. Deep pits shall be filled in conformance with the manufacturer's written recommendations and as approved by the Engineer.

Abrasive media used in blast cleaning operations shall result in blasted surfaces having a surface profile height of 1 to 3 mils as determined by a spring micrometer with surface profile replica tape. If the surface profile is greater than 3 mils, the Contractor shall apply additional coating equivalent to the excessive profile height at no additional cost to the Administration.

Methods of Cleaning. Methods shall be in the order shown in the following table:

912.05 PAINT SYSTEM	METHODS OF CLEANING
A,B	(a),(h) Shop, (c)
C, D, G	(a),(c),(f)
E, F, H	(a),[(i) or (j)],(d) and (b)

Method (d) - 40 grit sanding disk recommended
Method (b) - 60 grit sanding paper recommended

(a) Solvent Cleaning. Solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods approved by the Engineer shall be used in conformance with SSPC-SP 1. Soap steam cleaning shall be used in cleaning steel open grid decks and walkways and machinery areas of drawbridges. Contaminated solvent shall be removed before it evaporates by wiping or rinsing with clean solvents to prevent a film of contaminants from remaining on the surface. Solvent wiping may be required between coats. All solvent shall be approved in writing by the paint manufacturer.

(b) Hand Tool Cleaning. Hand tool cleaning shall conform to SSPC-SP 2.

(c) Power Washing. The pressure washer shall be capable of 2000 psi pressure at the nozzle using potable water unless otherwise specified by the Engineer. This method shall be used within 48 hours prior to blast cleaning. This method shall also be used to remove concrete spatter, dirt, debris, salt contaminants, etc., from new structures prior to application of field coats. The nozzle shall be operated at close range of approximately 6 in. using a pattern of overlapping drops followed by cross hatching with the same overlap. Although usually operated with potable water, a detergent wash approved by the paint manufacturer and the Engineer may be required to remove oil, grease residue, and hydrocarbons.

(d) Power Tool Cleaning. Power tool cleaning shall conform to SSPC-SP 3.

(e) Brush Off Blast Cleaning. Steel grit propelled through nozzles or centrifugal wheels conforming to SSPC-SP 7 shall be utilized unless otherwise approved by the Bridge Inspection and Remedial Engineering Division. Abrasives shall be dry and free of oils, grease, and other harmful materials such as lead dust, etc. at the time of use.

(f) Abrasive Blast Cleaning. Steel grit propelled through nozzles or centrifugal wheels conforming to SSPC-SP 10 shall be utilized unless otherwise approved by the Bridge Inspection and Remedial Engineering Division. The end surface condition shall conform to Near White. Abrasives shall be dry and free of oils, grease, and other harmful materials such as lead dust, etc. at the time of use. Cleanliness of the steel grit shall be verified prior to start of work in conformance with SSPC AB-3 and at least one 8 hour shift every month thereafter in conformance with SSPC AB-2.

(g) Power Tool Cleaning to Bare Metal. Power tool cleaning to bare metal shall conform to SSPC-SP 11.

(h) Shotblast Cleaning. Sufficient amounts of steel grit mixed with cast iron, malleable iron, steel, or synthetic shot propelled through nozzles or centrifugal wheels conforming to SSPC-SP 10. The end surface condition shall produce an etched surface texture as opposed to the peened surface texture typical of shotblasting, and shall conform to Near White. Shotblast cleaning is prohibited in the field.

(i) Power Washing (High Pressure). The pressure washer shall be rated at an optimum of 4000 psi as measured on the flow side of the washer pump. This method shall be used prior to hand tool or power tool cleaning. The pressure washer shall be equipped with easily accessible gauges and pressure regulator to ascertain and regulate the water pressure.

The pressure washer shall operate at 3000 to 6000 psi at the nozzle using a turbo dirt rotary tip as approved by the Engineer. The nozzle shall be operated at close range of approximately 6 in. using a pattern of overlapping drops followed by cross hatching with the same overlap. Although usually operated with potable water, a detergent wash approved by the paint manufacturer and the Engineer may be required to remove oil, grease residue, and hydrocarbons.

(j) Power Washing (Ultra High Pressure). The pressure washer shall be rated at an optimum of 10 000 psi as measured on the flow side of the washer pump. Refer to (i) for all other requirements. The pressure washer shall operate at 8000 to 15 000 psi.

435.03.04 Shop Cleaning. All new structural steel shall be cleaned in the shop. All oil, grease, and other substances shall be removed from steel surfaces as specified in 435.03.03(a) prior to blast cleaning. Blast

cleaning of the following areas shall conform to 435.03.03(h) after all shop fabrication is complete:

(a) Nonweathering Steel - All surfaces

(b) Weathering Steel

(1) The outside surfaces of the fascia stringers for bridges. For dual bridges this includes median fascia.

(2) At abutments, the end 10 ft of all stringers and all other structural steel within the 10 ft area, e.g., stiffeners, cross bracing, bearings, etc.

(3) At piers, 10 ft in each direction from the center line of the pier giving a total length at each pier of 20 ft and all other structural steel within the area, e.g., stiffeners, cross bracing, bearings, etc.

(4) At bolted field splices, 12 in. beyond the longest splice plate for each particular splice and all splice material.

435.03.05 Field Cleaning Existing Structures. Vegetation overhanging or fouling the structure shall be removed.

When the structure to be painted has planking (timber or plywood) between the stringers, it shall be carefully removed in the areas of work operations. The Contractor shall be responsible for storing and maintaining the planking in good condition and disposing of all debris on the planking. Unless otherwise directed by the Engineer, the planking will not have to be reinstalled until cleaning and painting operations are complete. The Engineer may direct the Contractor to reinstall the planking prior to opening any restricted lane to traffic during the same working day. The Engineer may also direct the Contractor to reinstall planking during periods of work stoppage.

When abrasive blast cleaning is specified, the Contractor shall furnish two 12 X 12 X 1/4 in. steel test plates, which shall be cleaned by the Contractor in conformance with SSPC Vis Standards and the Contract Documents, and used as a job sample standard for cleaning operations. These standard test plates shall be given a clear protective coating.

Cleaning and painting shall proceed by sections, bays, or other readily identifiable part of the work as may be approved by the Engineer. The work shall start at the top and proceed toward the bottom. Regardless of the method used for cleaning, the Contractor shall feather the edges of old

paint permitted to remain so that the repainted surface can have a reasonably smooth appearance.

Heavy rust and pack rust shall be removed by a combination of cleaning procedures such as hand chipping (using chipping hammers or scaling hammers), blast cleaning, power tool cleaning, etc. without scarring good steel. All dust, puddles, grease, and debris on surfaces adjacent to those being painted shall be removed. Oil and grease shall be removed by solvent cleaning. Portions of paint on previously painted surfaces which are chalky, powdered, cracked, or otherwise unacceptable, including runs and sags, shall be removed.

Included in the cleaning operations shall be the permanent removal of all existing street signs attached to the webs of fascia stringers. These signs shall be removed before cleaning operations begin. Areas exposed as a result of the sign removal including bolt holes, etc. shall be cleaned and painted. The Contractor shall notify the Engineer who will notify the Office of Traffic and Safety's Chief, Traffic Operations Division whenever the sign is removed. Street signs may be reinstalled elsewhere on the structure by the Office of Traffic and Safety utilizing the Contractor's maintenance of traffic. The Office of Traffic and Safety will coordinate this work with the Contractor.

All cleaning operations shall begin with solvent cleaning as specified in 435.03.03(a) followed with washing as specified in 435.03.03(c),(i), or (j). The appropriate cleaning methods will be specified in the Contract Documents. The water shall be potable prior to beginning work operations. Water and debris removed during washing operations shall be contained and collected in conformance with 435.03.06 through 435.03.08. Water shall be contained regardless of the levels of contaminants found therein. If the water is to be recycled, it shall be tested for heavy metals e.g. lead, arsenic, cadmium, etc., before reuse. Water exceeding the threshold value for any heavy metal (e.g. 5 mg/l for lead) shall not be reused.

Field cleaning areas defined as bearings and beam ends shall include all structural steel for a distance of 3.0 ft from the ends of the stringers at the abutments, and 3.0 ft in each direction from the center line of the piers for a total distance of 6.0 ft.

Field cleaning areas defined as fascia beams shall include the underside of the top flange, face of web, the top, bottom and edges of the bottom flange, and the attached bearings.

Residual dust, dirt, and grease shall be removed as the final procedure prior to painting. The Engineer will determine if all methods are required.

Solvent cleaning shall be used as described in SSPC-SP 1. Solvent cleaning may be required between coatings if exhaust from trucks or other foreign matter is present. In the solvent cleaning operations, the contaminated solvent shall be removed before it evaporates by wiping or rinsing with clean solvent to prevent leaving a film of contaminants spread over the surface.

Subsequent to the cleaning operation, the Contractor shall remove and properly dispose of all resultant debris.

435.03.06 Field Cleaning Waste Containment. The Contractor should contact the Department of Environment prior to bidding to determine the latest regulations affecting the project. The Contractor shall also comply with SSPC Guide 6.

Within 14 days after receiving Award of Contract and prior to the Pre-Construction Conference, the Contractor shall submit the following to the Office of Bridge Development, Working Drawing Review Section:

(a) A written Compliance Program for worker protection conforming to OSHA and the MOSH - Lead in Construction Standards, and other applicable toxic metal standards. The industrial hygienist shall conform to the requirements specified below. The Contractor shall retain on site and make available to the Engineer records of biological monitoring, training, etc. The written Compliance Program shall be signed and sealed by the industrial hygienist and address the following:

(1) Activities emitting lead.

(2) Work procedures to achieve compliance.

(3) Personal air monitoring.

(4) Work Practice Program.

(5) Job site inspections by the Contractor.

(6) Regulated areas.

(7) Ambient air quality.

(8) Soil quality.

(9) Water/sediment quality.

(10) Ventilation system performance.

(11) Emission release.

(12) Medical surveillance.

(13) Respiratory Protection Program.

(b) The industrial hygienist's Plan of Action indicating procedures for monitoring air, soil, and water. The Plan of Action shall include a location plan showing the type and location of monitors and soil test samples for each bridge site. The locations of the soil samples shall be permanently marked for the life of the Contract. The Contractor shall retain on site and make available to the Engineer monitoring and sampling results. The site specific Plan of Action shall be signed and sealed by the industrial hygienist and address the following:

(1) Visual emissions observation.

(2) Ambient air monitoring (TSP Monitoring).

(3) Soil sampling.

(4) Personal monitoring.

(5) Waste sampling.

(6) Waste water sampling.

(7) Water/sediment sampling (if applicable).

(c) Working drawings of the proposed containment and ventilation system.

(d) The design of the systems to be employed, including an analysis of the load which will be added to the existing structure by the containment system, blast waste, etc. The load analysis shall be performed and signed and sealed by a licensed professional engineer registered in the State of Maryland and having a minimum of five years experience in bridges. The analysis shall ensure that the system will not induce a load on the bridge which will create an overstress condition or otherwise effect the structural integrity of the bridge. The containment system or equipment shall not encroach upon the minimum bridge clearances shown on the Contract Documents, unless otherwise approved by the Engineer.

(e) Details for the recovery system for recycling steel grit used for blast cleaning. The recovery system shall be capable of keeping the grit dry, and free of oils, grease, and other harmful materials.

Industrial Hygienist. The industrial hygienist shall be certified by the American Board of Industrial Hygiene with field sampling experience in this type of work. The industrial hygienist shall have $1 000 000 errors and omissions insurance coverage for this type of work. All sampling and testing shall be performed by the industrial hygienist or an employee of that firm under the direct supervision of the industrial hygienist. Sampling and testing shall be witnessed by a representative of the Administration. The Contractor shall notify the Bridge Inspection Remedial Engineering Division a minimum of 24 hours prior to sampling and testing.

The industrial hygienist shall review all results of sampling and testing performed on the project, and prepare a written report interpreting these results for compliance to the applicable regulations. The industrial hygienist shall state any corrective actions that should be performed by the Contractor when results indicate noncompliance to the regulations. Additional monitoring shall be performed to ensure the corrective actions taken by the Contractor are sufficient and have corrected the problem.

The Contractor shall submit a copy of all reports, analysis, etc. to the Engineer. All copies shall be signed by the industrial hygienist, and be submitted within five working days after sampling unless otherwise approved by the Engineer. The industrial hygienist shall submit written certification within five days after the end of the month that the Contractor has complied with the Plan of Action and addressed any deficiencies found.

Containment System. The Contractor shall provide for total containment of all removed and spent materials, regardless of the presence of lead or method of removal. This containment shall prohibit dust, water, solvent, and other debris from escaping into the environment. The Containment System Plan shall conform to 435.03.07 for the capture, containment, collection, and storage of the waste generated by the work, which includes blasting residue, spent blasting mediums, rust, paint particles, dust, etc. Applicable portions of these requirements apply to shops when existing steel coated with hazardous material is being cleaned in the shop.

The containment system shall be capable of containing residue and water generated by the work.

The containment system for abrasive blast cleaning shall conform to SSPC, Class 2A Containment. The Contractor shall provide dust

collectors and airflow systems capable of satisfying ambient air and worker exposure requirements established by the Maryland Department of the Environment and MOSH.

The containment for power washing shall conform to SSPC, Class 2W Containment.

The containment system for hand tool and power tool cleaning shall conform to SSPC, Class 2P Containment. The Contractor shall satisfy ambient air and worker exposure requirements established by the Maryland Department of the Environment and MOSH.

The containment system shall be properly maintained while work is in progress and shall not deviate from the approved working drawings without approval of the Engineer. Public access to all rigging, scaffolding, containment systems, and work sites shall be denied at all times.

The review and acceptance of the working drawings by the Administration (and Railroad when applicable) shall in no way relieve the Contractor of any responsibility for obtaining the required degree of capture, containment, and collection.

Depositing or dropping spent materials into water, onto unprotected ground or roadways, or outside or below the containment areas is prohibited. Waterways shall be protected against conveyance of any paint drift and overspray. Dust shall be contained.

All waste discharged and collected from the containment system shall be protected in a manner so as to prevent migration of the waste into the environment. For bridges over water, the containment system shall include a skimming boom for emergency backup consisting of a float with a skirt or other approved system to collect floating debris. The skimming boom shall be cleaned at least once a day.

Methods for Assessing Quantity of Emissions.

(a) Level 1 Emissions. Level 1 Emissions is defined as random visible emissions of a cumulative duration of no more than 1 percent of the work day or approximately five minutes in an eight hour day. Level 1 is required for all bridges. The industrial hygienist shall perform a minimum of two 15 minute observations during each work shift during periods of ambient air monitoring. The Contractor's competent person shall be responsible for observations during other work shifts. Records shall be retained on site and made available to the Engineer.

(b) Ambient Air Monitoring. Daily ambient air monitoring at each structure shall begin three days prior to beginning work, during the first 10 days of productive abrasive blast cleaning operations, and at least 24 hours of monitoring during blast cleaning for every month thereafter at each bridge site unless otherwise directed by the Engineer. Daily ambient air monitoring at each structure shall begin one day prior to beginning work, and during the first five days of hand tool, power tool, and power wash cleaning. If the data measured is acceptable as determined by the industrial hygienist, additional monitoring will only be required when problems appear to be occurring as determined by visual assessments of the Contractor's operations. Visible residue on the ground, in the water, or visible dust will not be acceptable and may require additional monitoring of the cleaning operations at no additional cost to the Administration.

Total suspended particulate (TSP) monitors shall be placed downwind adjacent to homes, businesses, parks, or pedestrian walkways that are within 500 ft of the bridge during blast cleaning operations in conformance with Method D at each bridge site. Monitoring shall be conducted a minimum of seven hours per work shift. All TSP monitoring samples shall be analyzed using Method 40 CFR 50 Appendix B and G by a laboratory approved by the American Board of Industrial Hygiene.

The industrial hygienist shall use an Adjusted Daily Allowance (ADA) as described in SSPC Guide 6 (not an average daily allowance) for the TSP monitoring.

(c) Worker Exposure Monitoring. The industrial hygienist shall monitor worker exposure during cleaning operations at each structure for lead and other toxic metals.

Worker exposure monitoring tests shall be performed within the breathing zone. Worker exposure monitoring for each job classification shall be performed for at least the first three days of cleaning and monthly thereafter, and as work operations change. The number of tests required shall be determined by the Contractor's industrial hygienist and approved by the Engineer. Results of this analysis may require adjustments to the containment system.

The Contractor shall provide a clean up area with a shower, soap, hot and cold potable pressurized water, a change area with a locker for clean clothes, etc., and an approved container for collection and disposing of waste at each work site. This facility

shall be available for the Contractor's and the Administration's personnel. Hygiene facilities shall conform to the requirements specified in 29 CFR 1926.51, Sanitation Standard.

(d) Soil, Water, and Sediment Sampling. Soil, water, and sediment samples shall be analyzed using EPA Method 3050 by a laboratory approved by the American Board of Industrial Hygiene. A soil analysis for hazardous elements conforming to Method E shall be performed as directed by the industrial hygienist. A minimum of four soil samples shall be taken and analyzed, one at each corner of each bridge. The location of the soil samples shall be marked and recorded and their location shall be approved by the Engineer. A test analysis shall be performed prior to work, during, and at the completion of all work at each bridge. If the final test results indicate an increase in lead content exceeding 500 ppm for any test, the Contractor shall clean the site to reduce the lead content to preexisting conditions.

When the bridge is within 500 ft of a stream or other body of water, the water and sediment shall be tested for heavy metal content before work begins, during work operations, and after work operations are completed.

(e) Hazardous Waste Sampling. The industrial hygienist shall take a minimum of four samples of the accumulated residues collected at each bridge or a sample from every third drum, whichever is greater. All sampling shall be random and representative. The samples shall be analyzed for TCLP as outlined in COMAR 26.13.02.25B, Method 1311; and the EPA Test Procedure Manual, SW-846. Waste shall not accumulate for longer than 30 days before sampling. The representative samples collected shall be analyzed by an approved laboratory and the results returned to the Engineer within five working days. Additional samples may be required if the average test results for lead exceed 3.5 mg/l. For allowable concentrations of other heavy metals, refer to COMAR and EPA procedures. The disposal method employed will be based on the results of these analyses.

Waste water from hygiene facilities shall be tested for heavy metals e.g. lead, arsenic, cadmium, etc. Tests shall be performed after work operations are complete using EPA Method 6010 by a laboratory approved by the American Board of Industrial Hygiene.

435.03.07 Field Cleaning Containment System Plan Guidelines. Connections to the steel work of the bridge shall be made with clamps or

other devices approved by the Engineer. Drilling holes anywhere into the existing structure or welding to the existing steel work is prohibited.

(a) All drawings shall be made on standard 22 x 34 in. reproductive sheets with proper lettering. General notes shall be placed in the space above the title box.

(b) Show the containment system in plan and elevation views including details of clips and hangers.

(c) Indicate maximum permissible waste load permitted on the containment system.

(d) Indicate if vehicles with abrasive and waste will be stationed on the bridge; if so, indicate allowable load and location. Vehicle and equipment loads shall not be permitted behind abutments if surcharging results.

(e) Indicate all restrictions on the bridge and if it is posted.

(f) Indicate which bridges are covered by the plans submitted.

(g) Attachments or fasteners to the bridge shall not be permanent.

(h) When the bridge is over water show a skimming boom for emergency backup.

(i) Identify all containment system components on the plan sheets. Indicate the type and size of scaffolding or rigging to be used and clearly state erection procedures. Indicate sizes of the containment areas, the capacity of the dust collectors, and types of airflow systems to be provided including volume of air from ventilation fans and minimum velocity of air movement. Include number of blasters, capacity of blasting equipment, and hose pressure.

(j) All curtains, screens, or tarps used for containment shall be secured.

(k) No load shall be attached to the bridge railings unless details and calculations showing loading have been approved by the Administration.

(l) Submit six copies of each drawing. Each sheet shall be signed and sealed by a professional engineer. The submittal letter shall be on company letterhead. At least one copy of the submittal shall have an original seal.

(m) Include a location plan for the soil samples, a written Compliance Program, and the industrial hygienist's Plan of Action. Submit six copies each signed and sealed by an industrial hygienist. All submittals shall be in writing and on company letterhead. At least one copy of the submittal shall have an original seal.

435.03.08 Field Cleaning Waste Disposal.

The Contractor shall comply with SSPC Guide 7.

Each day the Contractor shall collect the clothing and other waste material in approved containers and seal them. When drums are used they shall be sealed 55 gal open head type drums conforming to I.C.C. Specification 17-H. All containers shall be in new condition and approved for use by the Engineer. Containers shall be labeled with the bridge number, Contract number, Contractor's name, contents, and the date.

Hazardous Waste. Maryland law provides that when samples tested using TCLP exceed the threshold value (e.g. 5 mg/l for lead), they shall be considered hazardous waste and shall be removed under manifest by a licensed hazardous waste transporter to a permitted disposal facility. Waste containing less than the threshold value by the TCLP test may be disposed of as an industrial waste at any landfill permitted to accept this material. When tested waste material is determined to be hazardous waste, the Contractor shall request through the Administration an EPA identification number as specified in COMAR 26.13.03.03.

The Contractor shall prepare a manifest for waste to be transported from the approved temporary storage site. The manifests shall be prepared and shall contain the information stipulated in COMAR 26.13.03.04 and as otherwise required by State regulations. The manifests shall be forwarded to the Bridge Inspection and Remedial Engineering Division.

Drums of other wastes, such as solvent contaminated rags, disposable protective clothing, disposed dust collector filters, and other contaminated substances shall be sampled individually and tested appropriately.

COMAR 26.13.03.05 stipulates the "Pre-Transport" requirements. Waste shall be transported by a certified waste hauler to any landfill permitted to accept this material.

The Contractor can obtain a list of certified haulers and other information regarding handling and disposal of blast waste by contacting the Department of Environment, Hazardous Waste Administration.

Nonhazardous Waste. All waste shall be disposed of in conformance with Federal, State, county and local regulations.

Temporary Waste Storage Site. At the end of each working day the Contractor shall haul the waste material away from the bridge site to an approved temporary storage site which has been obtained by the Contractor, located in the county the waste material was generated, and approved by the Engineer. The storage site shall be capable of preventing the migration of the contaminated material into the environment. The storage area shall provide protection from vandalism and unauthorized access by the general public. The waste shall be removed from the temporary storage site within 75 days from the initial date of accumulation or before the completion of work, whichever comes first. When the Contract Documents specify that the Contractor's waste containers shall be stored at a particular facility owned by the Administration, the Contractor shall contact that facility to schedule delivery.

435.03.09 Paint Storage. Paints and thinners shall be stored in well ventilated areas and not subject to excessive heat, open flames, electrical discharge, and direct rays of the sun. The Contractor shall adhere to all manufacturer's recommendations. Materials susceptible to damage by low temperatures shall be stored in heated areas when necessary. All materials shall be used on a rotating stock basis and remain closed until used. Paints which cannot be stirred to attain normal consistency shall not be used. Paint not in actual use shall be stored in tightly covered containers at not less than an ambient temperature of 45 F. Containers used for storage of coating shall be maintained in a clean condition, free of foreign materials and residue.

Thin skins formed in the container shall be cut loose and discarded. Material which has livered, gelled, thick skinned, or become questionable shall not be used unless reapproved by the Engineer. Waste chemical solutions, oil rags, and other waste shall be removed daily. All necessary precautionary measures shall be taken to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing, and application of materials. Materials shall not be used beyond their pot life or shelf life.

435.03.10 Field Painting Prerequisites. The Contractor shall conform to SSPC-PA 1 for painting application.

Paint shall not be applied between December 15 and April 15 unless approved by the Engineer.

The Contractor shall adequately protect the environment by providing containment for the paint application area, and be fully responsible for any damage resulting from wind or the cleaning and painting operations.

The Contractor shall submit in writing to the Engineer the proposed type and method of protection against paint spatters, overspray, drippings, etc. while painting over roadways, waterways, machinery areas, and areas in the vicinity of abutments and private properties. If at any time during the execution of the work the method of protection fails to function at the required level of efficiency, the Contractor shall immediately suspend all operations except those attendant to minimizing adverse impact to the environment. Operations shall not resume until modifications have been made to correct the cause of the failure.

Paint operations shall stop if the wind velocity exceeds 20 mph unless otherwise approved by the Engineer, or whenever the Engineer determines that the wind has an adverse affect on the work being performed.

All surfaces to be painted shall be sound, properly cleaned, and thoroughly dry. Paint shall not be applied in rain, snow, fog, mist, or when the ambient air temperature in the shade is below 40 F, the surface temperature is less than 45 F, the surface temperature is expected to drop to 32 F or below before the paint has dried, either temperature is less than 5 F above the dew point, the relative humidity exceeds 85 percent, or the steel is hot enough to cause the paint to blister, produce a porous film, or otherwise be detrimental to the life of the paint. The surfaces to be painted shall not be wet, damp, or frosted. Exceptions to temperature and humidity requirements may be allowed for paint conforming to 912.05 Paint System F and G if approved in writing by the paint manufacturer. However, paint shall not be applied if the surface temperature is less than 35 F.

If at any time it is suspected that moisture is condensing upon the surface, the sling psychrometer shall be used to check dew point, etc. The Engineer may allow a well defined area of the surface to be lightly moistened with a damp cloth and observed. If the dampness evaporates and decreases in 15 minutes, the surface shall be considered satisfactory for the application of paint. If fresh paint is damaged by the elements, the paint shall be replaced or repaired by the Contractor at no additional cost to the Administration.

The Contractor's operations shall be scheduled so that all cleaned surfaces are painted within 24 hours. If rust bloom appears or the air or steel temperature falls below five degrees above the dew point after cleaning and prior to application of the primer coat, the Contractor shall

reclean the affected areas to the satisfaction of the Engineer at no additional cost to the Administration.

Prior to the application of paint, the Contractor shall obtain approval from the Engineer that the surfaces to be painted during that day have been cleaned as specified.

All areas adjacent to machinery or mechanical components, etc. shall be painted by brush application unless approved by the Engineer. Areas not approved by the Engineer for spray painting shall be painted by brush application. All dry spray, runs, and mud cracking shall be removed prior to the application of the succeeding coat. The steel shall be kept dust free during painting operations, and care shall be taken to protect newly coated surfaces from cleaning operations. When an area that had previously been cleaned or painted becomes soiled, contaminated, or rusted, the area shall be recleaned to the specified condition and completely recoated at no additional cost to the Administration.

All edges, corners, crevices, rivets, bolts, nuts, and washers shall be stripe coated prior to the full coat application as specified in SSPC-PA 1, Striping. All areas to be stripe coated shall be done prior to each coat. Inorganic zinc shall not be stripe coated. Stripe coats shall be applied by brush or dauber.

After the primer coat has been applied, each subsequent coat shall be applied within 30 days after the previous coat unless otherwise approved in writing by the paint manufacturer. If the recoat window is exceeded, the surface shall be recleaned as approved by the paint manufacturer and the Engineer.

Paint Representative. The paint representative shall be a technical representative of the paint manufacturer. The paint representative shall be present at the Pre-Construction Conference, and during the initial execution of the work to approve with the Engineer the degree of cleanliness prior to painting, and the method of application of the coating system. The Engineer may stop paint operations for failure to conform to this requirement regardless of reasons. Areas that have been cleaned prior to ceasing paint operations shall be recleaned if required. All work shall conform to the manufacturer's recommendations unless otherwise approved by the Engineer. Work stoppage ordered by the Engineer for failure to comply with these requirements shall not be justification for time extensions or any additional cost to the Administration.

435.03.11 Painting New Steel. The primer coat shall be applied in the shop as recommended by the manufacturer in a single application employing multiple spray passes. The specified dry film thickness shall be applied to all surfaces to be painted except a light dust coating shall be

applied within the areas of field welding and to the top and both edges of the top flange where steel stud shear developers are to be attached.

The primer shall be applied from agitated containers. All touch ups shall have the same dry film thickness as the coat being repaired but may be applied by brush. A zinc rich primer or other primer approved by the manufacturer and the Engineer shall be used to touch up the inorganic zinc primer coat.

Bolts for field assembly shall not be shop coated. After field welding and prior to applying Coat II (first field coat), these bolts, field weld areas, and rusted or damaged areas, shall be power tool cleaned or brush off blast cleaned as specified in 435.03.03(d) or (e), respectively, or abrasive blast cleaned as specified in 435.03.03(f) if required by the Engineer. The primer coat shall be applied on these areas the same day they are cleaned. Primer paint stained from rusted bolts shall be wiped before Coat II is applied.

Prior to field coating the surfaces of the steel shall be pressure water blasted with potable water in conformance with 435.03.03(c) to remove dirt and contaminants. Scrubbing the surface or scraping off excess concrete, etc. may also be required.

Coats II and III shall be applied in the field after all field welding has been completed. All paint shall be applied in conformance with the manufacturer's recommendations. Unless otherwise specified in the Contract Documents, Coats II and III shall be sprayed after all welded areas and damaged primer coatings are properly cleaned and primed as specified or as directed by the Engineer.

Areas of structural steel to be painted, after blast cleaning is complete, are:

(a) **Nonweathering Steel.** The primer coat shall be applied in the shop to all structural steel surfaces. The remaining coats shall be applied to all exposed structural steel surfaces in the completed structure.

(b) **Weathering Steel.** The primer coat shall be applied in the shop to all structural steel surfaces listed below. The remaining coats shall be applied to all exposed structural steel surfaces in the completed structure listed below.

(1) The end 10 ft of all stringers at all abutments and the 20 ft section centered over the piers shall be painted and all other structural steel in these areas shall be painted.

(2) If the structure is over a highway or has curb openings, in addition to those areas cited in (1) above, the entire outside surfaces of the fascia stringers shall be painted (includes underside of the top flange, face of web, and the top, bottom and edges of bottom flange). For dual bridges this includes the median fascia.

435.03.12 Painting Existing Steel. Areas of delamination between plates that are 1/8 in. or greater that cannot be cleaned and coated, and gaps between steel members that cannot be sealed during the application of the primer or stripe coat shall be caulked with a material approved by the paint representative and coated with all coats of the specified paint system at no additional cost to the Administration.

All paint shall be properly mixed and applied as specified by the manufacturer and approved by the Engineer. Spray painting will be permitted provided the location and method of application is approved by the Engineer. The Contractor shall adequately protect the environment and take full responsibility for any damage resulting from wind or the painting operations. All dry spray and runs shall be removed prior to the application of the succeeding coat. Surfaces inaccessible for painting by regular means shall have the paint applied by sheepskin daubers or by other means if necessary to ensure coverage of the proper coating thickness. Thinning of paint is not permitted unless authorized by the paint manufacturer and approved by the Engineer. The Engineer shall be present whenever the paint is thinned.

435.03.13 Restrictions. Except for shop coat touch-ups, steel that will be exposed to view in the completed structure shall not be painted until all concrete has been placed. Care shall be taken by the Contractor to protect concrete from being stained by painting operations. Damaged concrete surfaces shall be restored to originally intended color without damage to the concrete.

435.03.14 Defective Work. The Contractor shall be responsible for the satisfactory application of paint and neither conditions during application nor Laboratory acceptance of paint shall relieve the Contractor of responsibility of obtaining a satisfactory paint system. Painting shall be done in a neat and workmanlike manner. If rusting occurs or a paint coat lifts, blisters, wrinkles, or shows evidence of having been applied under unfavorable conditions, the workmanship is poor, impure or unauthorized paint has been used, or for any other reason the painting is unsatisfactory, the affected paint shall be removed and the steel thoroughly cleaned and repainted at no additional cost to the Administration. These areas shall provide a uniform appearance throughout the structure.

435.03.15 Repair of Damaged Coatings. Coatings which are damaged as a result of the Contractor's operations, regardless as to whether or not cleaning or painting is required in the Contract Documents, shall be repaired at no additional cost to the Administration. The Bridge Inspection and Remedial Engineering Division shall be notified to determine the methods of cleaning and painting to be used. Damaged fascia beams shall be repaired so as to provide a uniform appearance and may require total painting as defined in 435.03.05 when required by the Engineer.

435.03.16 Final Identification. When the final coat of paint is dry, the Contractor shall stencil on the structure a legend indicating the type of paint used in each coat and the month and year in which each application was completed. The letters of the stencil shall be 2 to 2-1/2 in. high and shall be applied with black paint inside a fascia stringer near the abutment at a location selected by the Engineer. If more than one paint system is used, additional stencils shall be applied.

435.04 MEASUREMENT AND PAYMENT. The Contract unit price for the item specified in the Contract Documents will be full compensation for all permits, working drawings, daily quality control records, and professional engineer's services used for containment, industrial hygienist services, air monitoring, sampling and testing materials for lead and heavy metal content, including any revisions, resubmissions of the Containment Plan and Systems that may be required during the execution of the work, and all other incidentals necessary to complete all cleaning and painting operations including providing safe access for inspections, floodlighting, test plates, drums, collection and storage at the temporary storage site, hauling and disposal at an approved industrial waste site or hazardous waste site, removing and replacing planking, removal of debris, and all material, labor, equipment (including test equipment), tools, and incidentals necessary to complete the work.

435.04.01 Cleaning and painting new structural steel will not be measured but the cost will be incidental to the pertinent Fabricated Structural Steel item.

435.04.02 Cleaning and painting existing structural steel will not be measured but will be paid for at the Contract lump sum price for the pertinent Cleaning and Painting item.

SECTION 436 THRU 439 — RESERVED

SECTION 440 — PRESTRESSED CONCRETE BEAMS AND SLAB PANELS

440.01 DESCRIPTION. This work shall consist of furnishing and placing all prestressed concrete beams and slab panels, elastomeric bearing pads, bearing plates and embedded items, all steel strands, jacks, and other devices required to provide in place the finished member in conformance with the Contract Documents.

440.02 MATERIALS.

Fine Aggregate	901.01
Coarse Aggregate	901.01
Cement	902.03
Admixtures:	
Air Entraining	902.06.01
Retarding	902.06.02
Water Reducing	902.06.02, 902.06.03
Pozzolans	902.06.04, 902.06.05
Mixing Water	921.01
Shear Key Grout	902.11
Reinforcement Steel	908.01
Welded Steel Wire Fabric	908.05
Prestressing Strand	908.11
Elastomeric Bearing Pads	910.02
Closed Cell Neoprene Sponge Elastomer	911.10
Fusion Bonded Epoxy Powder Coating for Steel	917.02
Epoxy Adhesive	921.04
Anchor Rod Dowel Bars	A 242
Threaded Tie Rods	A 663, Grades 300 thru 410
Concrete Protective Coatings	Contract Documents

440.02.01 Portland Cement Concrete. The composition, proportioning, and mixing of concrete shall produce a homogeneous concrete mixture of a quality that will conform to the materials and design requirements specified in the Contract Documents.

The required cylinder strength of the concrete at transfer of the tensioning load and the minimum required cylinder strength of the concrete at 28 days will be specified in the Contract Documents. The concrete mix shall contain an air entraining admixture and a Type D or G admixture.

Type G high range water reducing admixtures may only be used if the Engineer determines that the producer can design and show by trial mix that the concrete conforms to the strength requirements specified in the Contract Documents and the following:

(a) Maximum slump of 6 in.

(b) Air content of 5-1/2 ± 1-1/2 percent.

(c) Minimum cement factor of 700 lb/yd^3.

(d) Maximum WCM ratio of 0.45.

The Engineer shall be allowed to take six test cylinders from each member or members cast and cured as a unit for the purpose of checking the quality of the concrete being produced, for determining the time when forms may be removed, and for determining the time when prestressing forces may be applied to a member. These cylinders shall be made in metal or plastic molds and cured with the beams. At least three test cylinders shall be made and cured under laboratory conditions as specified in T 126. Test cylinders shall be made and tested at the manufacturing site, by the manufacturer's quality control technician, in conformance with T 22 and shall be witnessed by the Engineer.

440.02.02 Reinforcement Steel and Tie Rod Tubes. All reinforcement steel to extend into the roadway slab shall be epoxy coated.

Tie rod tubes shall consist of corrugated, rigid or semi-rigid type, galvanized steel sheathing or rigid plastic sheathing.

440.02.03 Debonding Material. Material used for debonding of pretensioning steel strands shall be solid or split plastic sheathing having a minimum thickness of 0.025 in.

440.02.04 Joint Sealers. Joint sealers shall conform to the manufacturer's specifications.

440.03 CONSTRUCTION.

440.03.01 Working Drawings. When the Contractor elects to use methods other than specified in the Contract Documents, the Contractor shall provide working drawings to the Engineer for approval. The drawings shall include reinforcement, anchorages, steel strand profiles, lifting inserts, and all other pertinent information required. Whether the Engineer accepts or rejects any of the Contractor's proposed changes, the members shall be constructed at no additional cost to the Administration.

440.03.02 Prestressed Concrete Plants. The prestressed concrete manufacturing plant shall be registered and certified under the Precast/Prestressed Concrete Institute Program and a valid certificate shall be submitted to the Engineer prior to the start of production.

440.03.03 Beds and Forms. Casting beds shall be supported on unyielding foundations. The beds and forms shall be cleaned after each use. Accumulation of coatings used for bond breakers shall be prevented.

Prior to stringing steel strands, the bottom of forms shall be inspected for cleanliness and accuracy of alignment. The contact surfaces of forms shall be coated with bond breaker that dries to a surface hardness. The coating shall be dry before the steel strand comes in contact with it to prevent contamination of the steel strand.

440.03.04 Meetings. A pre-pour meeting, which shall include a representative of the prestress concrete plant, shall be held prior to commencement of any prestress concrete work.

440.03.05 Protection of Prestressing Steel Strand. Prestressing steel strand shall be stored under shelter and kept free of deleterious material such as grease, oil, wax, dirt, paint, loose rust, or other similar contaminants. Steel showing corrosion, etching, pitting, or scaling of the surfaces shall not be used. A light coating of surface rust is acceptable if it can be removed completely from the steel by wiping with a cloth.

Prestressing steel strand shall not be stored on a surface that contributes to galvanic or battery action. Steel strand shall not be used as a ground for electric welding and shall be protected from electric welding sparks.

440.03.06 Reinforcement Steel, Inserts, and Chairs. Reinforcement steel shall be placed within the specified tolerances, and shall be secured to beds and forms using chairs, blocking, or ties. Cages of bars shall be fabricated by tying only. Cages shall not be supported by tensioned strands. Tie wire ends shall be bent into the slab panel. The type and placement of inserts shall be shown on the working drawings.

Form ties, chairs, and inserts shall be recessed in the concrete by at least 1 in. or stainless steel accessories shall be used.

440.03.07 Methods of Force Measurement. Forces shall be measured using one of the following methods as the primary measuring system and checked by using one of the other methods as the secondary measuring system. Methods of force measurement are:

(a) Curves. Current stress-strain or elongation curves furnished by the strand manufacturer may be used. An average modulus may be used if acceptable to the Engineer. Means shall be provided for measuring the elongations of the strands to at least 1/8 in.

(b) Pressure Gauges. Gauges shall be used to measure force by the pressure applied to hydraulic jacks. These gauges shall be furnished with dials calibrated with the jacking system.

(c) Dynamometers. Dynamometers connected in tension to the stressing system for the initial force may be used.

Gauging System. Tensioning systems shall be equipped with accurately calibrated hydraulic gauges, dynamometers, load cells, or other devices for measuring the stressing load to an accuracy of reading within two percent. A qualified testing laboratory shall calibrate and issue a certified calibration curve with each gauge. A gauging system shall be recalibrated whenever it shows erratic results, when directed by the Engineer, and at intervals not greater than six months. Gauges for single strand jacks may be calibrated by an acceptable and calibrated load cell. Calibrate gauges for large multiple strand jacks, acting singly or in parallel, by proving rings or by load cells placed on either side of the movable end carriage. All jacks and gauges shall be calibrated by an independent laboratory at no additional cost to the Administration and documentation forwarded to the Engineer.

Pressure gauges and dynamometers shall be provided preferably with full pressure and load capacities of approximately twice their normal working range. Loads shall be limited to a minimum of 25 percent and a maximum of 75 percent of the total graduated capacity, unless calibration data establishes consistent accuracy over a wider range.

Each gauge shall indicate loads directly in pounds or shall be accompanied by a chart with which the dial reading can be converted into pounds.

Tensioning systems employing hydraulic gauges shall be equipped with appropriate bypass pipes, valves, and fittings so the gauge reading remains steady until the jacking load is released.

Gauge readings, elongation measurements, and calculations for elongation shall include appropriate allowances for operational losses in the tensioning system due to strand slippage, movement of anchorages and abutments, elongation of abutment anchorage rods, strand rotation, temperature variation, friction, bed shorting, and other forces and influences acting on the strand.

Friction in Jacking System. In multiple strand tensioning systems, the sliding surfaces shall be cleaned and lubricated to minimize friction. A force override (compensatory operational loss correction) shall be established for standard strand pattern series.

Thermal Effects. The design prestress force shall be increased by 0.5 percent for each 5 F ambient temperature below 80 F. No adjustment is required when the ambient temperature is above 80 F. Steel strands shall not be stressed when the ambient temperature is below 40 F. After the steel strands are tensioned, the temperature of the air surrounding the steel strands shall be maintained at 40 F or more until the prestress force is transferred to the concrete.

Control of Jacking Force. Either manual or automatic pressure cutoff valves may be used for stopping the jacks at the required load. Automatic cutoffs capable of adjustment shall be used to ensure that the jacking load corresponds to the required load. The setting accuracy for the automatic cutoff valves shall be verified whenever there is reason to suspect improper results and at the beginning of each days operation.

440.03.08 Stringing Steel Strands. Steel strands containing former vise grip points shall not be reused unless the points are outside the new steel strand vise locations. Steel strands that have been draped shall not be reused.

All steel strands shall have the same lay or direction of twist. The ends shall be cut using shears or abrasive cutting wheels. Steel strands shall be positioned over chairs to eliminate sagging of steel strands in the bottom rows.

440.03.09 Steel Strand Splices. There shall only be one splice per steel strand. For single steel strand tensioning, the number of steel strands that may be spliced in each bed is not restricted. For multiple steel strand tensioning, either all strands shall be spliced and the elongation shall be adjusted for average slippage, or no splices are permitted.

440.03.10 Steel Strand Vises. Steel strand vises shall be capable of anchoring stressing loads positively with a minimum of slippage and shall be cleaned, lubricated, and inspected between each use. Grips that become visibly worn or distorted, or that allow slippage in excess of 1/4 in. shall not be used. A full set of steel strand vises shall be cleaned and inspected before starting each prestressing operation.

The maximum permissible time for holding tensioned steel strands in the bed before placing concrete shall be 72 hours.

440.03.11 Wire Failure in Steel Strands. Seven wire steel strand with any broken wire shall be removed and replaced. All steel strands shall be checked for wire breaks before placement of concrete.

440.03.12 Pretensioning. The total load to be applied to each strand shall be as specified in the Contract Documents. The load shall be applied as a total of two loading stages. The initial load shall straighten the steel strand, eliminate slack, and provide a starting or reference point for measuring elongation.

The initial load shall not exceed 10 percent of the specified tensioning force. Any initial loading exceeding 10 percent shall be approved by the Engineer (i.e. multiple bed casting). The initial load shall be measured within a tolerance of ± 100 lb. The initial elongation measurement shall not be used to determine the initial force.

In all stressing operations, the stressing force shall be kept symmetrical about the vertical axis; however, in tensioning single steel strands, the initial and final loads may be applied in immediate succession to each steel strand.

Jack mounted pressure gauges shall be the primary system of force measurement for the final tensioning of straight single steel strands. Elongation shall be checked against pressure gauge readings on all steel strands. Slippage shall be checked at steel strand vises. The computed elongation, including operational losses and equivalent elongation for the initial tensioning force, shall agree with the pressure gauge reading within three percent.

Jack mounted pressure gauges shall be the primary system of force measurement for the final tensioning of multiple steel strands. For uniform application of load to the steel strands, the position of the face of the anchorage at final load shall be parallel to its position under initial load. Parallel movement shall be verified by measurement of equal movement on opposite anchorage sides and by checking the plumb position of the anchorage before and after final load application. Slippage shall be checked at steel strand vises.

After the steel strands are stressed as specified and with all other reinforcement in place, the concrete member shall be cast to the specified lengths. Strand stress shall be maintained between anchorages until the concrete has reached the compressive strength specified in the Contract Documents.

440.03.13 Steel Strand Tensioning. In all methods of tensioning, the stress induced in the steel strands shall be measured both by jacking gauges and by elongation of the steel strands. If any jack or gauge

appears to be giving erratic results or gauge pressures and elongations indicate materially different stresses during manufacturing, recalibration will be required. Means shall be provided for measuring the elongation of the steel strands to at least the nearest 1/8 in.

A difference in indicated stress between jack pressure and elongation of up to five percent may occur. In this event, the difference shall be placed so that the discrepancy will be on the side of a slight overstress rather than understress. In an apparent discrepancy between gauge pressure and elongation in excess of five percent, the entire operation shall be carefully checked and the source of the discrepancy determined before proceeding further.

Split plastic sheathing for debonded steel strands shall be thoroughly sealed with tape prior to placing concrete.

All pretensioned steel strands shall be cut flush with the end of the member. Where the end of the member will not be covered by concrete, the exposed ends of the steel strands and the concrete face at the end of the member shall be cleaned and coated with a protective coating as specified in the Contract Documents. Cleaning shall be by wire brushing or abrasive blast cleaning to remove all dirt and residue that is not firmly bonded to the metal or concrete surfaces. Care shall be taken to work the protective coating into all voids in the prestressing steel strands.

440.03.14 Curing. Initial curing of all members shall be accomplished by fogging, wet burlap, or other approved methods and shall begin as soon as the concrete is hardened sufficiently to withstand surface damage. The initial curing shall continue until the concrete has attained its initial set; however, the minimum initial curing period shall be three hours. When a retarding agent is used, the minimum period shall be five hours. Following the initial curing, curing shall be resumed using an accelerated curing method.

Accelerated Curing. Accelerated curing of the concrete shall be done by one of the following methods:

(a) Low Pressure Steam Curing. Low pressure steam curing shall be done under a suitable enclosure to contain the live steam and minimize moisture and heat loss. The concrete shall be allowed to attain its initial set before application of the live steam.

Application of the live steam shall not be directed on the concrete or the forms so as to cause localized high temperatures. The temperature of the interior of the enclosure shall be 80 to 160 F. During initial application of the steam, the ambient air temperature within the enclosure shall increase at a rate not to

exceed 40 F per hour. The maximum temperature shall be held until the concrete has reached the required release strength. The steam temperature and the curing temperature shall be maintained uniformly throughout the extremities of the prestressed member. At the end of curing, the concrete temperature shall be reduced at an average of 40 F per hour.

The producer shall furnish at least one recording thermometer for each enclosure. If the enclosure is longer than 300 ft, an additional recording thermometer shall be furnished for each additional 300 ft of length or fraction thereof. The temperature at any point within the enclosure shall not vary more than 10 F from that of the recording thermometer or the average of the recording thermometers if more than one is used.

(b) Radiant Heat Curing. Radiant heat may be applied by means of pipes circulating steam, hot oil, or hot water, or by electric heating elements. Radiant heat curing shall be done under a suitable enclosure to contain the heat, and moisture loss shall be minimized by covering all exposed concrete surfaces with a plastic sheeting or applying an approved liquid membrane curing compound to all exposed surfaces. The heat application shall be maintained uniformly throughout the extremities of the member. All temperature constraints shall be the same as outlined for low pressure steam curing.

440.03.15 Detensioning.

(a) Slab Panels. The tension force shall not be transferred to the prestress slab panel until the concrete strength, as indicated by cylinder strengths, conforms to the specified transfer strength. In control of the prestress concrete, the compressive strength cylinders shall be used to satisfy two essential control requirements:

(1) Concrete in the precast slab panel shall attain the specified strength before the stress in the strands may be transferred.

(2) The design strength shall be met before the slab panel may be handled, except to move to storage, or released for shipment.

Forms, ties, inserts, hold downs, or other devices that restrict the slab panel's longitudinal movement along the bed shall be removed or loosened prior to detensioning or a method and sequence to minimize longitudinal movement shall be used.

Prestressing forces shall be released using a method to minimize sudden or shock loading.

Single steel strand detensioning may be accomplished by heat cutting the steel strands. The single steel strand detensioning sequence shall maintain prestressing forces nearly symmetrical around the slab panel's vertical axis. Eccentricity around the vertical axis shall be limited to one steel strand. The steel strand cutting pattern shall be approved by the Engineer prior to its use.

Multiple steel strand detensioning may be accomplished by gradually reducing the force applied to each strand equally and simultaneously.

(b) **Beams.** The schedule for detensioning of beams having deflected steel strands shall incorporate the following:

(1) The manufacturer's sequence of releasing deflected steel strands and uplift points shall be approved by the Engineer.

(2) All hold down devices for deflected steel strands shall be disengaged and all hold down bolts removed from the beams.

(3) The manufacturer's sequence of releasing the remaining straight steel strands shall be approved by the Engineer.

All hold down devices may be released prior to release of tension in deflected steel strands if:

(1) The weight of the prestressed beam is more than twice the total of the forces required to hold the steel strands in the low position.

(2) The weight or other approved vertical restraints are applied directly over the hold down points to counteract the uplifting forces, at least until the release of deflected steel strands has proceeded to a point that the residual uplifting forces are less than half the weight of the beam.

All procedures for releasing prestressing forces of deflected steel strands shall be followed carefully. Failure to follow these procedures may result in the rejection of the beams.

All beams shall be adequately separated in storage immediately following removal from the bed to facilitate the repair of surface blemishes and to allow inspection of the finished surfaces.

440.03.16 Camber. During the beam fabrication period, the Contractor shall select a representative number of beams to be known as "Camber Control Beams", subject to the Engineer's approval. They shall be clearly and permanently identified so that the camber readings taken as indicated below can be associated with the proper beam.

Camber readings shall be taken as follows:

(a) Just prior to prestressing.

(b) Immediately after prestressing.

(c) At weekly intervals thereafter within the three months after casting.

(d) At biweekly intervals, after the three month period expires.

(e) Just prior to shipment from the casting yard to the job site.

(f) Camber determinations shall be continued at these intervals if the beams are stored or stockpiled at the job site.

Two copies of the camber reports shall be furnished to the Engineer prior to the erection of the beam.

440.03.17 Tolerances. The tolerances for each beam or slab panel shall be as shown in Tables 440.03.17 A or B, respectively unless otherwise specified in the Contract Documents:

TABLE 440.03.17 A

PRESTRESSED CONCRETE BEAM	TOLERANCE
Depth (overall)	± 1/4 in.
Width (flanges & fillets)	± 1/4 in.
Width (web)	± 1/4 in.
Length of Beam	± 1/8 in. per 10 ft or 1/2 in. whichever is greater
Exposed Beam Ends (deviation from square or designated skew)	Horizontal ± 1/4 in. Vertical ± 1/8 in. per ft of beam height
Side Inserts (spacing between center of inserts and from the centers of inserts to the ends of the beams)	± 1/2 in.
Bearing Plate (spacing from the centers of bearing plates to the ends of the beams)	± 1/2 in.
Stirrup Bars: Average of all bars Individual bar longitudinal spacing	 ± 1/2 in. ± 1 in.
Horizontal Alignment (deviation from a straight line parallel to the center line of beam)	1/8 in. per 10 ft, max
Camber Differential between adjacent beams of same type and steel strand pattern	1/8 in. per 10 ft at time of erection or 1/2 in. max
Center of Gravity of steel strand group	± 1/4 in.
Center of Gravity of depressed group steel strand at end of beam	± 1/2 in.
Position of hold down points for depressed strand	± 6 in.

TABLE 440.03.17 B

PRESTRESSED CONCRETE SLAB PANEL	TOLERANCE
Depth (overall)	+1/2 in., –1/4 in.
Width (overall)	± 1/4 in.
Slab Panel Length @ center line (based on design length specified)	± 1/2 in.
Horizontal Alignment (deviation from a straight line parallel to the slab panel center line)	1/4 in. max
Horizontal Misalignment of adjacent form sections	1/2 in. max
Camber Deviation from specified camber, as measured at prestress transfer or at the beginning of slab panel storage at the fabrication plant	± 1/2 in.
Location of each strand	± 1/8 in.
Center of Gravity of strand group	± 1/4 in.
Stirrup Bars (longitudinal spacing)	± 1 in.
Longitudinal Position of handling devices	± 3 in.
Concrete Bearing Area (variation from plane surface when tested with a straightedge through middle half of slab panel	± 1/8 in.
Tie Rod Tubes (spacing between the tube centers and from tube centers to slab panel ends)	± 1/2 in.
Tie Rod Tubes (spacing from tube center to slab panel bottom)	± 3/8 in.
Threaded Inserts (spacing between the center of inserts and from center of inserts to ends of slab panels)	± 1/2 in.
Skew Ends (deviation from designated skew)	± 1/2 in.
Vertical Ends (deviation from specified dimension)	± 3/8 in.

440.03.18 Marking, Handling, Shipping, and Storage. Each member shall be marked with an erection mark for identification, weight marks for beams 6000 lb or more, and inspection stamps. The erection marks on beams shall be painted on the top surface of the top flange. Markings of any kind are prohibited on any surface of a beam that will be visible in the completed structure.

Slab panels shall be marked with an individual, consecutive identification mark at a permanently exposed location. The identification mark shall match that shown on the approved working drawings to allow erection as specified in the Contract Documents.

The Contractor shall furnish the Engineer with an erection diagram clearly indicating erection marks that show the position of the member in the structure.

The cast-in-place lifting devices, and a sufficient number of cranes and spreader beams shall be utilized whenever the prestress concrete members are lifted during loading, unloading, storage, erection, etc.

The Contractor shall furnish the Engineer copies of material orders and shipping statements. The weight of each individual prestress concrete member shall be shown on the statements.

When shipping prestress concrete members, blocking shall be placed at intervals that will prevent sag and distortion. All members shall be shipped in their upright position and be adequately supported and braced to dampen vibrations during transport as shown on the working drawings. Any member too long to fit inside of a truck or trailer shall not cantilever beyond the bed more than one quarter of its length. Members too long to comply with this requirement shall be supported on dollies, additional vehicles, or other vehicles that shall support the long pieces as approved by the Engineer.

Load restrictions shall be as specified in GP-5.10. Prestress members shall not be shipped until approved in writing by the Engineer, a minimum of five days have elapsed since the prestress transfer, and they have attained the minimum 28 day compressive strength.

Beams shall be stored off the ground in an upright position, shall be protected as far as practical from surface deterioration, and be kept free of accumulations of dirt, oil, or other deleterious material.

440.03.19 Erection. Erection shall conform to 430.03.27, .28, .29, .31, .32, and .33.

Slab Panels. Immediately prior to erection of slab panels, the abrasive blasted shear key surfaces shall be cleaned with compressed air, stiff bristle fiber brushes, or vacuumed. Slab panels shall be pulled together and field tightened in the transverse direction by tie rods. Field tightening shall be performed with approved impact wrenches. After tightening, all tie rod holes shall be grouted.

After field tightening all slab panels, the joint below the shear keys shall be sealed using a method approved by the Engineer. Shear keys shall then be grouted by overfilling the joints. Grout shall be driven or tamped compactly in to the keyways and not vibrated. After a half hour the excess grout shall be struck off flush with the top of the slab panels. The manufacturer's recommendations shall be followed for grouting in cold or hot weather.

440.03.20 Bearing Pads. Bearing pads delivered to the bridge site shall be stored under cover on a platform above the ground surface. Pads shall be protected from damage at all times and shall be kept dry, clean, and free of dirt, oil, grease, and foreign substances.

The surfaces of the concrete bearing areas that will be in contact with the bearing pads and the full contact area of the bearing pads shall be coated with epoxy adhesive. The Contractor shall strictly adhere to the manufacturer's recommendations for mixing and applying the epoxy adhesive material. The surface temperatures when applying epoxy adhesive shall be a minimum of 50 F with a predicted ambient temperature for the next four hours of 50 F or above. The surfaces to be coated shall be clean, dry, and sound. The Contractor shall be prepared to use water jets, abrasive blasting, air blasting, etc. for cleaning the surfaces to the satisfaction of the Engineer.

The bearing pads shall be accurately set in the epoxy adhesive and secured in place by blocking or other mechanical means until the adhesive sets.

440.04 MEASUREMENT AND PAYMENT. Prestressed concrete members will not be measured but will be paid for at the Contract lump sum price for the pertinent Prestress Concrete Beams or Prestress Concrete Slab Panels item. The payment will be full compensation for all concrete, forms, reinforcement, bearing pads, steel strands, sheathing, steel components, steel rods, inserts, grout, bearing pads, epoxy adhesive, testing, furnishing and applying concrete protective coatings when specified, transporting, storage, erection, and for all material, labor, equipment, tools and incidentals necessary to complete the work.

SECTION 441 THRU 449 — RESERVED

SECTION 450 — RETAINING WALLS

450.01 DESCRIPTION. This work shall consist of the construction of cast-in-place reinforced concrete footings and stems conforming to the AASHTO definitions of rigid retaining walls. The retaining wall shall be constructed as shown in the Contract Documents. Included in the retaining wall shall be all anchorage assemblies for mounting noise barriers when retaining wall mounted noise barriers are specified in the Contract Documents. All components shall be as specified unless prior approval for alternatives is obtained from the Administration.

When piles or drilled shafts (caissons) are specified in the Contract Documents, they shall conform to Sections 410 and 412, respectively.

450.01.01 Preapproved Alternate Retaining Walls. Alternate retaining walls shall only be used when specified in the Contract Documents. When alternate retaining walls are included in the Contract Documents, only those retaining walls specified will be permitted, and only one type retaining wall shall be used throughout the Contract.

Alternate retaining walls are selected from the list of Preapproved Alternate Retaining Walls, which is maintained by the Office of Bridge Development. Procedures for adding products to the prequalified list may be obtained from the Office of Bridge Development.

Contract Documents for Preapproved Alternates. When the Contract Documents permit and the Contractor elects to use preapproved alternate retaining wall systems, substitute Plans, design calculations, and specifications shall be submitted by the Contractor. The Plans shall be similar in size and detail to advertised documents, and shall include drainage details and all revisions required to construct the alternate retaining wall system. All Plans, calculations, and specifications shall be prepared, signed, and sealed by a professional engineer registered in the State of Maryland who has experience in design of the proposed alternate retaining wall system. The substitute Plans shall bear the Administration's title block and be furnished on reproducible linen or plastic. These Plans will be issued as a Contract revision replacing the Administration's Plans and be kept by the Administration as permanent records. All work pertaining to Contract Documents for preapproved alternates shall be done at no additional cost to the Administration.

After substitute Plans are approved and issued as a redline revision, working drawings bearing the fabricator or supplier's title block shall be submitted for review and approval to the Administration or directly to the consulting engineer as directed by Section 499.

450.02 MATERIALS. Refer to 420.02. When retaining wall mounted noise barriers are specified in the Contract Documents, the anchorage materials shall conform to 455.02.

Sample Panel. Whenever the Contract Documents specify that the retaining wall shall include an architectural finish, a sample panel measuring 24 x 24 in. shall be prepared and delivered to the construction site. The panel shall be typical of the architectural finish and stain to be used on the project. The Administration's approval of the panel shall be received before full-size retaining walls are constructed. The sample panel shall remain on the project site and all subsequent retaining wall sections shall be equal in appearance to this approved panel.

Some projects may require a specified surface such as an ashlar stone pattern, or matching a similar structure or stonework in the area. The Contractor may request or the Engineer may direct that the sample of the texture be submitted for approval prior to submission of the sample panel containing the stain specified in the Contract Documents.

450.02.01 Reinforcement. Reinforcement bars and welded wire fabric in retaining walls that are less than 10 ft from the edge of paved surface (includes shoulders) shall be epoxy coated. Supports for epoxy coated reinforcement shall be coated the same as the reinforcing steel.

450.02.02 Backfill for Preapproved Alternates. Size No. 57 stone shall be used for backfill for all preapproved alternate retaining walls regardless of the type backfill recommended or specified by the retaining wall manufacturer. Geotextile shall be used when specified in the Contract Documents.

450.02.03 Concrete Stain. When a color is specified in the Contract Documents for the exposed surfaces of the retaining wall, the stain shall be selected from the Prequalified List of concrete stains maintained by the Office of Materials and Technology. The color number shall conform to Federal Standard 595.

450.02.04 Textures.

(a) Unless otherwise specified in the Contract Documents, the exposed surfaces of the retaining wall shall receive a special surface treatment as specified in 420.03.07(b).

(b) When a special texture is specified in the Contract Documents, it shall be produced by placing an approved form liner in the face of the form.

450.03 CONSTRUCTION. Retaining walls shall be constructed as shown on the Plans, as specified in 420.03, and herein. Contract Documents for construction of alternate retaining walls shall conform to the Policy and Procedures of the Office of Bridge Development. Alternate retaining walls shall be constructed in conformance with the details, specifications, etc. that are on file with the Office of Bridge Development. Should any detail, specification, etc., change, the retaining wall firm shall submit the revision for review and approval prior to using that revision on Administration projects. Revisions shall not be submitted for projects that are already bid.

Loads are not permitted (backfill, noise barriers, concrete traffic barriers, light standards, etc.) on retaining wall concrete until the concrete in that portion has attained a minimum compressive strength of 3000 psi. Retaining walls shall be backfilled prior to placing these loads on them.

450.03.01 Concrete Stain. When specified in the Contract Documents, two coats of concrete stain shall be applied in conformance with the manufacturer's recommendations and as directed by the Engineer. Before application of the stain, all surfaces shall be structurally sound, clean, dry, fully cured, and free from dust, curing agents or form release agents, efflorescence, scale, or other foreign materials.

450.03.02 Galvanizing. When anchorage assemblies are required for mounting noise barriers, light standards, etc., all holes and welding required in the assemblies shall be done before galvanizing. All assemblies shall be free of oil or any mill coating.

450.04 MEASUREMENT AND PAYMENT. Retaining walls will not be measured but will be paid for at the Contract lump sum price for the pertinent Retaining Wall item. The payment will be full compensation for all piles and caissons (unless specific items are included in the Contract Documents), footings, forms and form removal, architectural treatment, reinforcement steel, concrete, curing, anchorage assemblies, stains and coatings, excavation, sheeting and shoring, backfill (including size no. 57 stone and geotextiles for alternate retaining walls) and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

When specific items for Piles for Retaining Walls are included in the Contract Documents, they will be measured and paid for as specified in 410.04.

When specific items for Drilled Shafts (Caissons) for Retaining Walls are included in the Contract Documents, they will be measured and paid for as specified in 412.04.

SECTION 451 THRU 454 — RESERVED

SECTION 455 — NOISE BARRIERS

455.01 DESCRIPTION. The Standard Noise Barrier System shall consist of precast concrete panels, steel or concrete posts, concrete foundations, fire hose connections, doors, and hardware necessary to construct a noise barrier as specified in the Contract Documents. The Contractor has the option of supplying steel or concrete posts, but the same type of post shall be used throughout an entire noise wall. All components shall be as specified unless prior approval for alternatives is obtained from the Administration.

When drilled shafts (caissons) are specified in the Contract Documents, they shall conform to Section 412.

Bidders may view samples of the proposed panel finishes by contacting the Office of Environmental Design, Noise Abatement Team Leader.

455.01.01 Special Bidding Instructions. When the Contract Documents permit optional post spacings, the Contractor shall place the bid in the appropriate items for the post spacing selected. Only the items pertaining to the selected post spacing shall be bid. All remaining items pertaining to the alternate post spacings not selected shall be filled in as "$0.00". Only one alternate post spacing shall be bid per wall.

455.01.02 Preapproved Alternate Noise Barriers. Alternate noise barriers shall only be used when specified in the Contract Documents. When alternate noise barriers are included in the Contract Documents, only those noise barriers specified will be permitted, and only one type noise barrier shall be used per wall.

Alternate noise barriers are selected from the list of Preapproved Alternate Noise Barriers, which is maintained by the Office of Bridge Development. Procedures for adding products to the prequalified list may be obtained from the Office of Bridge Development.

455.01.03 Contract Documents for Preapproved Alternate Systems or Alternate Post Spacing. When the Contract Documents permit and the Contractor elects to use preapproved alternate noise barrier systems or alternate post spacing not shown on the Plans, the Administration will furnish substitute Plans and specifications to the Contractor within 30 days after issuing Notice to Proceed.

The substitute Plans may include other pertinent modifications and aesthetic changes necessitated by the Contractor's selection such as requiring tapered panels, higher panels, etc., if the changes in elevation between adjacent panels are determined to be too severe. No additional compensation will be given to the Contractor due to revisions detailed in the substitute Plans and specifications.

The substitute Plans will be issued as a Contract revision replacing the advertised Plans. All work under this Section including any changes required in grading, drainage, paving, utility locations, permits, etc., which is a direct result of the substitute Plans shall be done at no additional cost to the Administration.

After substitute Plans are issued as a redline revision, working drawings bearing the fabricator or supplier's title block shall be submitted for review and approval to the Administration or directly to the consulting engineer as directed by Section 499.

455.02 MATERIALS.

Reinforcement for Concrete Structures	421.02
Concrete Stain	450.02.03
Concrete	902.10
Pretensioning Strand	908.11, 1/2 in. diameter, seven wire bright
Elastomeric Bearing Pads	910.02.01
Elastomeric Shims	911.13
Fusion Bonded Polyester Coating	917.03, Color shall be as specified for stain on highway side of roadway
Anchor Assembly	
Plate	A 36
Rods	F 1554, Grade 55, S1 (Chemical Composition and Carbon Equivalent)
Nuts	A 563
Washers	F 436
Steel Posts (Including Plates and Shapes)	A 709, Grade 50W

Fire hose connections, fire doors, miscellaneous hardware, etc. shall be as specified in the Contract Documents.

455.02.01 Hardware. No material substitutions will be permitted for anchor rods, nuts, and washers. These items shall be hot dip galvanized in conformance with A 153.

455.02.02 Epoxy Zinc Rich Primer. The polyester coater shall provide an epoxy zinc rich primer to be used prior to the application of the polyester powder coating. The material shall withstand temperatures used for the polyester powder coating process and shall be subject to the approval of the Engineer.

455.02.03 Precast Concrete Panels. Each panel shall be cast with an embossed or impressed, legible and unique identification number located on a portion of the panel that will not be visible in the completed structure. Panels will be rejected at any phase if identification numbers appear to have been tampered with or altered in any manner. The concrete mix shall conform to Mix No. 6, except that the coarse aggregate shall be AASHTO size no. 5 washed quartz gravel and the design compressive strength shall be 5000 psi.

Textures. All panel surfaces shall be considered as having architectural finishes and care shall be taken to produce a consistent, high quality finish. When stacked panel systems are used, the Contractor shall take extreme care to ensure that the panels stacked within a single frame match in quality and appearance. Aesthetic inspections for all panels shall be made in out-door lighting conditions. Panels failing to conform to these requirements may be rejected.

Special care shall be taken to prevent cement laden spray and spatter created from the process of exposing the aggregate from adhering to the finish surfaces of other panels. Surfaces of all panels shall be washed to remove cement laden spray, dust, and all other foreign matter prior to shipping. Abrasive blasting is not an acceptable method for exposing the aggregate.

Unless otherwise specified in the Contract Documents, the finish for the panels shall be as follows:

(a) An exposed aggregate finish shall be produced on the bottom side of each panel in the precast form.

(b) A Double Rake shall be produced on the top side of each panel.

Sample Panels. Two sample panels, each 24 X 24 in. and a maximum of 2 in. thick, shall be prepared and delivered to the construction site. One panel shall represent the residential side (exposed aggregate) and the second panel shall represent the highway side (double rake with stain) except that the stain shall be omitted from the sample. The exposed

aggregate panels shall exhibit the color range and exposure of the gravel. The double rake panels shall display the appropriate finished texture. The Contractor shall notify the Office of Environmental Design, Noise Abatement Team Leader at least one week prior to the delivery of the sample panels. The Administration's approval of these panels shall be received before full-size panels are manufactured. Whenever the original sample panels are rejected, additional sample panels shall be submitted until the finish is approved.

After the sample panels and working drawings are approved by the Administration, a full-size panel shall be prepared for visual inspection and approval by the Administration at the precasting site. This panel shall have the textures specified in (a) and (b) above on the appropriate highway and residential sides. This panel shall be made available outdoors with both sides visible for inspection. Upon approval by the Administration, all subsequent panels shall be equal in appearance to this approved panel. This panel shall be transported to the project site and used as one of the panels in the noise barrier after all other panels have been accepted.

Reinforcement. Reinforcement bars and welded wire fabric in concrete wall panels that are less than 10 ft from the edge of paved surfaces (includes shoulders) shall be epoxy coated. Supports for epoxy coated reinforcement shall be coated the same as the reinforcement steel.

455.02.04 Concrete Posts. Concrete shall conform to Mix No. 6 except that the coarse aggregate shall be AASHTO size no. 5 washed quartz gravel, and the design compressive strength shall be 5000 psi. When concrete posts include base plates, plates and all hardware shall be galvanized in conformance with A 153.

Textures.

Unless otherwise specified in the Contract Documents, the finish for the posts shall be as follows:

(a) An exposed aggregate finish shall be produced on the bottom side of each post in the precast form.

(b) A Double Rake finish shall be produced on the top side of each post.

Sample Posts. When concrete posts are used, the Contractor shall submit a 24 in. long sample of the concrete post to the construction site for approval. The sample shall be submitted with the panel samples as specified in 455.02.03. The sample post shall exhibit the specified finishes. The Administration's approval of the post shall be received prior to manufacturing full size posts.

455.03 CONSTRUCTION. Refer to 450.03 for additional requirements for noise barriers mounted on top of retaining walls. All welding shall conform to AWS D1.1.

455.03.01 Galvanizing. All holes and welding required in the hardware shall be done before galvanizing. All hardware shall be free of oil or any mill coating. All welds shall be ground smooth, all weld spatter removed, and hardware shall be free of burrs, rust, or other surface imperfections.

455.03.02 Anchor Assemblies. Anchor assemblies shall be assembled and placed at the elevation and spacing specified in the Contract Documents. Templates shall be used for proper alignment and spacing of all anchor assemblies prior to concrete placement. The threads of the anchors shall be sufficient to provide for a 1 in. concrete encasement, leveling nuts, washers, base plate, and a 1/2 in. minimum protrusion through the top of the top nut when the noise wall is properly installed.

455.03.03 Posts. All posts shall be erected plumb at the specified alignment, and at the appropriate spacing.

Embedded Concrete Posts. When concrete posts are used, they shall be erected with a temporary support system to ensure the vertical and horizontal alignment and specified elevation. Temporary support systems shall include fixed ties between the post being set and a previously set post. The design of the temporary support systems shall be submitted to the Engineer on the concrete post working drawings for approval prior to erection. Temporary support systems shall remain in place for a minimum of 40 hours after the completion of the concrete placement for the drilled shaft (caissons) which encases the post.

Polyester Coated Steel Posts. Steel posts shall be completely fabricated, including base plates and all holes drilled before applying the polyester coating system.

All steel posts shall be free of oil and any mill coating. All welds shall be ground smooth, and all weld spatter removed. Steel posts shall be free of burrs, pits, rust, or other surface imperfections.

Steel posts and other nongalvanized items shall be abrasive blasted in conformance with SSPC-SP 10 to a surface condition of Near White. The cleaned surfaces shall be protected from conditions of high humidity, rainfall, or surface moisture, and shall not be allowed to flash rust. The epoxy zinc rich primer shall be applied and cured at a minimum dry film thickness of 3 mils prior to the application of the polyester powder coating. The coating process shall ensure that all solvents in the epoxy zinc rich primer are removed prior to the application of the polyester powder coating.

When galvanized surfaces are to be polyester coated, the galvanizing shall be roughened with a brush off blast cleaning conforming to SSPC-SP 7 prior to applying the polyester coating.

The polyester coating shall be applied as an electrostatically charged dry powder sprayed onto the grounded posts using an electrostatic spray system. The polyester coating thickness after cure shall be 6 ± 2 mils.

The total thickness of coating, primer plus polyester coating, shall be 7 to 12 mils when measured as specified in G 12.

After coating, the posts shall be randomly checked for continuity using a 67-1/2 volt wet sponge detector to check for holidays, pinholes, and discontinuities. The coating thickness shall be checked with a properly calibrated magnetic gauge. Posts requiring limited repair for minor defects shall be touched up with a liquid touch-up. All polyester coated posts shall be wrapped to ensure safe arrival at the job site. At the job site and during installation, the utmost care shall be taken to prevent damage to the posts.

455.03.04 Precast Concrete Panels. Precast concrete panels shall be constructed as shown in the Contract Documents.

The working drawings shall provide for all accessories, additional reinforcement steel, materials, and methods which are not specifically indicated, but which are essential for transportation, handling, and installation or construction of the panels.

Working drawings shall show the size, shape, and location of all panels and shall include complete reinforcement and connection details. When specified by the Contract Documents, the method and sequence of erection, method of plumbing panels and adjusting connections, and the loads and movements due to erection shall be shown on the working drawings.

All lifting devices or inserts used externally, or installed in the panel, shall have a factor of safety of four as determined under the loading conditions anticipated during the course of manufacture, storage, delivery, and erection. All inserts shall be included on the working drawings.

Defects and Tolerances. Concrete shall be placed in a manner so that there are no cold joints. Cracked panels or panels determined by the Engineer which cannot be repaired or do not conform to the following tolerances shall be rejected and replaced with acceptable panels at no additional cost to the Administration:

(a) Panel dimensions shall be within 3/16 in. except for panels with an effective thickness of less than 4 in. where the thickness shall be within 1/8 in.

(b) Panel squareness for rectangular panels shall not exceed 1/2 in. as determined by the difference between the two diagonals.

(c) Panel surface defects on textured-finished surfaces shall not exceed 5/16 in. per 5 ft.

(d) Tongue and groove joints shall be constructed within 1/8 in. of the dimensions shown on the details.

Shipping, Handling, and Erection. Panels shall be adequately protected by padding or other means to prevent cracking, staining, chipping, or spalling of the concrete during handling, storage, transporting, erection, etc. Panels shall be adequately supported or braced during installation to ensure safety. The bracing or supports shall be maintained until proper alignment and adequate permanent support have been provided. No panel shall be left in an unsafe support condition.

When a panel is damaged, it will be evaluated by the Engineer to determine whether or not it can be used. If acceptable by the Engineer, damaged panels shall be repaired in a manner approved by the Engineer.

Panels shall be erected centered between posts. Where a panel is not erected within the tolerances assumed in the connection design, the structural adequacy of the installation will be checked by the Office of Bridge Development and the connection design shall be modified as required. Changes, other than adjustments within the specified tolerances, shall be made only after approval by the Engineer.

The Engineer will inspect the panels again after erection to determine if they have been damaged.

455.03.05 Concrete Stain. Concrete stain shall be applied prior to backfilling. Two coats of concrete stain shall be applied in conformance with the manufacturer's recommendations and as directed by the Engineer. Concrete stain shall be applied to the top and full height of the noise wall panels but shall not be applied to exposed aggregate surfaces. Before application of the stain, all surfaces shall be defect free, structurally sound, clean, dry, fully cured, and free from dirt, dust, curing agents or form release agents, efflorescence, scale, or other foreign materials.

455.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all material, labor, equipment, tools and incidentals

necessary to complete the work. Modifications such as an increase or decrease in the size or number of grade beams, drilled shafts (caissons), or retaining walls, special anchorages, conflicts with utilities or other obstructions when the utilities or obstructions were noted in the Contract Documents, or any other modifications required due to the Contractor's selection of an alternate spacing, or a preapproved alternate noise wall when permitted, will be incidental to the item.

455.04.01 Noise Barrier System panels will be measured and paid for at the Contract unit price per square foot of wall including posts, panels, architectural and noise absorptive finishes, stains and coatings, base plates, anchor assemblies (except when noise barriers are mounted on retaining walls), construction templates, temporary supports, doors, fire hose connections, excavation, backfill, and hardware. Measurement will be based on the as-planned dimensions, using the length along the face of the wall times the panel height.

455.04.02 Grade Beams will not be measured but will be paid for at the Contract lump sum price, which shall also include excavation, reinforcement, concrete, and backfill.

455.04.03 Drilled Shafts (Caissons) will be measured and paid for as specified in 412.04.

455.04.04 Retaining walls will be measured and paid for as specified in 450.04.

SECTION 456 THRU 459 — RESERVED

SECTION 460 — EXPANSION JOINTS IN STRUCTURES

460.01 DESCRIPTION. This work shall consist of furnishing, fabricating, and installing preformed joint fillers, preformed elastomeric joint seals, troughs, structural steel and metal plates to be utilized in providing expansion and contraction capabilities in structures as specified in the Contract Documents.

460.02 MATERIALS.

Hardware for Drainage Troughs	909.06
Preformed Joint Fillers	911.02
Preformed Polychloroprene Elastomeric Compression Joint Seals	911.04

Lubricant Adhesive	911.04.03
Troughs	911.11
Structural Steel	A 709, Grade 36

All structural steel for drainage troughs shall be hot-dipped galvanized as specified in A 123.

Troughs shall be 1/4 in. thick. Joints or splices for drainage troughs are prohibited except as indicated on the Contract Documents.

460.02.01 Paint. The color of the finish coat shall conform to Federal Standard 595, Color No. 26440. The Contractor may substitute two coats of epoxy protective coating conforming to 917.01 in lieu of Coats II and III of any of the following paint systems:

(a) New Expansion Joints. Paint shall conform to 912.05, System B.

(b) Existing Expansion Joints and New Portions. Paint shall conform to 912.05, System E. The Contractor may substitute Coat I of System A in lieu of Coat I of System E for new portions of expansion joint widenings.

460.03 CONSTRUCTION. Expansion joint material delivered to the bridge site shall be stored under cover on platforms above the surface of the ground. It shall be protected at all times from damage and when placed it shall be free from dirt, oil, grease, or other foreign substances. All welding shall conform to AWS D1.1 unless otherwise specified in the Contract Documents. The Contractor shall have all material and installation methods approved by the Engineer prior to installation of any expansion joint material.

The preformed material shall consist of the longest length possible with a minimum of joints. Lengths less than 4 ft shall be one piece. The material shall be cut to a clean, true edge with a sharp tool. Care shall be taken to ensure straight lines at the joint.

When installing the seal, the Contractor shall not use any type of equipment that will damage the seal. If the seal is damaged during installation, the Contractor shall remove and replace the seal at no additional cost to the Administration.

New Expansion Joints. Prior to any shop painting operations, all surfaces of the expansion dam and backwall angles shall be cleaned as specified for nonweathering steel in 435.03.04. The prime coat shall be applied in the shop to the entire area of the backwall and expansion dam

angles including those areas in contact with concrete, except the portion which is masked to receive adhesive for the seal.

Existing Expansion Joints. Prior to any painting operations on existing expansion joints and new steel used to modify them, all surfaces of the expansion dam angles and backwall angles to be painted or receive adhesive for the seal shall be thoroughly cleaned to conform to a Near White condition as specified in 435.03.03(f) or (h). The area that will be in contact with the seal shall then be completely masked for full length and depth of seal.

The backwall and expansion dam angles shall have all prime coats applied to the entire area that will be exposed in the finished structure, both above and below the seal. These coatings shall be applied in the shop for new steel members.

Where the Contract Documents specify replacement or modification to existing expansion joints on bridges on which traffic will be maintained, the Contractor shall have available a supply of steel plates having minimum dimensions of 4 × 8 ft and 1 in. thick. These plates shall be placed over the joints if traffic has to be restored before the concrete has cured or at any time the unfinished work will interfere with traffic.

Where the Contract Documents specify modification to existing expansion joints, the concrete shall be removed in conformance with 405.03.

Where the Contract Documents only specify replacement of existing roadway joint seal, the work shall include cleaning and painting the joint.

All angles shall be cut with a saw. All holes and slots shall be drilled. Cutting with a torch is prohibited.

Any areas where the existing steel coating is damaged due to the installation of new troughs shall be power tool cleaned to bare metal and painted.

Paint. If this is the only portion of bridge to be painted, the paint need not be tested by the Laboratory if, prior to use, a copy of the certified test results has been furnished to the Engineer specifying that the paint conforms to Section 912.

The primer shall be applied on the same day that the blast cleaning takes place. The primer shall be spray applied in a single application with dry film thickness of 3 to 5 mils. All touch-ups may be applied by brush and shall have the same dry film thickness as the coat being repaired.

After the joints are complete in place and just prior to placing the compression seal, the masking tape shall be removed and the seal installed. The finish coat shall then be applied to the exposed portion of the angles above the seal.

Joint Seals in Bridge Decks. The transverse compression seals shall be one piece for the entire length of the roadway joint. Shop or field splices in the seal are prohibited. Compression seals for longitudinal bridge joints shall consist of the longest piece practical.

Lubricant adhesives shall be applied in conformance with the manufacturer's recommendations. If stretching of the seal in excess of five percent occurs, the Contractor shall remove and reinstall the seal as directed by the Engineer.

460.03.01 In-Place Testing. The completed joint shall be subjected to a water test to detect any leakage. The test shall be conducted a minimum of five days after completion of the joint. The Contractor shall provide all facilities required for the Engineer's inspections of the underdeck areas at no additional cost to the Administration. The roadway section of the joint from curb to curb, or parapet to parapet, shall be covered with a minimum of 1 in. of water. If this is not possible, the water test may be performed in part section along the joint. When testing subsequent part sections, the test shall overlap a minimum of 1 ft of the joint previously tested.

The ponding shall be maintained for a period of five hours for the entire roadway or each section of joint being tested. During and at the conclusion of the test, the underside of the joint shall be closely examined for leakage. The expansion joint seal shall be considered watertight if no obvious wetness is visible.

If the joint system exhibits evidence of water leakage at any point, the Contractor shall locate and repair all leaks at no additional cost to the Administration.

When repairs are required, a subsequent water test shall be performed.

If the joint leaks after the second test, the Contractor shall remove, replace and retest the seal at no additional cost to the Administration.

460.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for furnishing, fabricating, placing, etc., of structural steel, roadway seals, drainage troughs, catch basins, downspouts, cleaning, painting, and all material, labor, equipment, tools and incidentals necessary to complete the work.

460.04.01 Joints in structures will not be measured but the cost will be incidental to the pertinent Superstructure Concrete item.

460.04.02 When an item for Modifying Existing Bridge Roadway Joints is included in the Contract Documents, the cost of furnishing, fabricating, placing, etc., of new structural steel, new roadway seals, modifying existing joints on bridge roadway including saw cutting and removal of existing concrete, new concrete, steel plates, cutting of existing steel, welding, drainage troughs, catch basins, downspouts, etc., shall also be included in the Contract unit price per linear foot for the item. The measurement will include the horizontal distance from the inside face to inside face of parapets plus the vertical distance of the curb faces and parapets.

460.04.03 When an item for Drainage Trough for Bridge is included in the Contract Documents, the furnishing and placing of drainage troughs including catch basins, downspouts, structural steel and hardware will be measured and paid for at the pertinent Contract unit price per linear foot. This price will include cutting of angles, painting, drilling of concrete, expansion bolts, etc. The measurement will be the center line distance from end to end of the installed drainage trough fabric.

SECTION 461 — METAL RAILING

461.01 DESCRIPTION. This work shall consist of furnishing, fabricating, coating, and erecting of all metal railings as specified in the Contract Documents.

461.02 MATERIALS. Materials shall be as specified in the Contract Documents.

461.03 CONSTRUCTION. All railings shall be fabricated and erected as specified in the Contract Documents.

The Contractor shall furnish working drawings for approval by the Engineer.

461.03.01 Production, Handling and Shipment. Metal railings and incidental parts shall be carefully handled and stored on blocking, racks, or platforms to prohibit contact with the ground and shall be protected from corrosion or damage. Materials shall be kept free from dirt, oil, grease, and other foreign matter. Surfaces to be painted shall be carefully protected both in the shop and in the field. Damaged material shall be repaired or replaced as directed by the Engineer at no additional cost to the Administration.

461.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

461.04.01 Metal Railing will be measured and paid for at the Contract unit price per linear foot.

461.04.02 Metal Railing will not be measured but will be paid for at the Contract lump sum price.

461.04.03 Metal railing for which no specific item is included in the Contract Documents will not be measured but the cost will be incidental to other pertinent items included in the Contract Documents.

SECTION 462 — TIMBER STRUCTURES

462.01 DESCRIPTION. This work shall consist of constructing structures or portions of structures using timber, including fabrication, erecting, treating and coating of the timber elements as specified in the Contract Documents or as directed by the Engineer.

For timber piling refer to Section 410. For structural steel refer to Section 430. For concrete refer to Section 420.

462.02 MATERIALS.

Asphalt Cement	904.01
Structural Steel	909.01
Gray Iron Castings	909.04
Bolts and Hardware	909.10
Structural Timber	921.05
Preservative Treatments for Timber	921.06
Metal Timber Connectors	Per manufacturer & approved by the Engineer
Galvanizing	A 153
Fire Stops and Galvanized Sheet Metal	A 653, Coating Designation G 90

462.03 CONSTRUCTION.

462.03.01 Storage and Handling. Timber shall be open stacked in piles at least 12 in. above the ground surface in a manner to shed water and prevent warping. It shall be protected from weather by a suitable

covering. The storage site shall be cleared of weeds and rubbish before placing material and throughout the storage period. The site selected shall not be subject to flooding. Timber shall be handled with rope or nylon slings to prevent the breaking of outer fibers, bruising, or penetrating the surface.

462.03.02 Cutting and Boring. When practical, cutting and boring of treated timbers shall be done before pressure treatment with preservatives. All cuts in treated timbers and all abrasions (after having been carefully trimmed) shall be brush coated with two applications of an approved wood preservative before installing the timber in the structure. When the Engineer determines that treated timbers are damaged beyond repair, they shall be removed from the project and replaced at no additional cost to the Administration.

When forms or temporary braces are attached to treated timber with nails or spikes, the holes shall be filled by driving galvanized nails or spikes flush with the surface, as directed by the Engineer.

462.03.03 Bolt Holes. Bolt holes bored after treatment shall be filled with asphalt cement applied with a caulking gun or as directed by the Engineer before inserting bolts. Holes that are not to receive bolts shall be plugged with asphalt cement coated plugs.

462.03.04 Coating Untreated Surfaces. In untreated timber structures, all contact surfaces between any members (except adjacent flooring members) shall be coated with two coats of an approved preservative before assembling. The back faces of bulkheads and all surfaces of timber that will come in contact with earth, metal, or other timber shall be similarly coated. The ends of timber members shall be coated in the same manner.

462.03.05 Protection of Ends of Caps, Wales, and Planks. The ends of all caps, wales, and planks shall be covered with resin glass composite shields as approved by the Engineer. The shields shall be applied as follows:

(a) Remove all dirt and other loose material from area to be capped.

(b) Apply the first coat of resin to the top and 4 in. down the side of the member.

(c) Apply precut glass cloth, using a 3 in. grooved aluminum roller to achieve "wet-out" and brass staples for anchorage.

(d) When the initial coat of resin has taken a tack free set, apply a second coat of resin to seal the entire application.

462.03.06 Diameter of Holes. Holes bored in timber structures shall conform to the following:

(a) Round drift bolts, spikes, and dowels - 1/16 in. less than the diameter of the device.

(b) Square drift bolts, spikes, and dowels - equal to the smallest dimension of the device.

(c) Machine bolts - same as the diameter of the bolts.

(d) Rods - 1/16 in. larger than the diameter of the rods.

(e) Lag screws - equal to the diameter of the screw at the base of the thread.

(f) Connector bolts - 1/16 in. larger than the diameter of the connector bolts.

462.03.07 Bolt Assemblies. Bolt heads or nuts, which come in contact with the timber, shall be fitted with a washer of the size and type specified. After all nuts are adequately tightened, the bolt threads shall be burred.

462.03.08 Countersinking. Countersinking shall be done wherever smooth faces are required. In treated timber, recesses formed in horizontal surfaces for countersinking shall be painted with an approved preservative. After the bolt or screw is in place, recesses shall be filled with an approved asphalt coating.

462.03.09 Connectors. Connector holes shall be bored through members to be connected. The bolt hole shall be kept perpendicular to the face of the timber. When spike grids or split ring connectors are specified in the Contract Documents, they shall be installed in conformance with the manufacturer's recommendations.

462.03.10 Framing. All timber shall be accurately cut and framed to provide even bearing over the entire contact surface. When making joints, shimming and open joints are prohibited.

462.03.11 Sills. Sills shall have true and even bearing on mudsills or concrete pedestals. All earth shall be removed from contact with sills.

462.03.12 Timber Caps. Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends. All caps shall be secured by drift

bolts or as specified in the Contract Documents. The drift bolts shall be in the center of the post or pile.

462.03.13 Bracing. The ends of bracing shall be bolted through the pile, post, or cap. Intermediate intersections shall also be bolted. Spikes or nails shall be used in addition to bolts. When bracing intersects, filler blocks shall be used with a bolted connection.

462.03.14 Stringers. Stringers shall be placed in position so that knots near edges will be in the top portions of the stringers. Bottom edges of stringers shall be sized to provide uniform depth at bearings.

Outside stringers may have butt joints with the ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of the floor beam or cap at each end. The lapped ends of untreated stringers shall be separated a minimum 1/2 in. and shall be securely fastened by drift bolts where specified. When stringers are two panels long, the joints shall be staggered.

Cross bridging between stringers shall be toenailed with at least two nails in each end. The lower ends of all bridging and one side of each diaphragm shall be left disconnected and free to move until after the deck above it has been securely fastened to the stringers.

462.03.15 Floor Planking. Floor planking shall, unless otherwise specified, be SIS and SIE, hit or miss, and the planks shall be of uniform thickness with a maximum tolerance of 1/8 in. Where necessary to maintain traffic, planks shall be laid in half-of-bridge width sections. Timber plank floors shall always be accompanied with suitable hold down devices. Planks shall be spiked to every stringer or joist or nailer using not less than two spikes, and the length of the spikes shall be at least equal to twice the thickness or depth of the plank. Where planks will be under wheel guards or hold down devices, care shall be taken while selecting planks of as near equal thickness as possible. Before any hold down or wheel guard is bolted, treated shims or wedges shall be firmly driven between low planks and hold down and low planks and wheel guard so that all planks shall be held down with equal pressure. The shims shall occupy at least 50 percent of the area between the bottom of the hold down and the top of the plank and between the bottom of the wheel guard and the top of the plank.

462.03.16 Bridge Railings and Wheel Guards. Bridge railings shall conform to Performance Level 1 (PL-1) as specified in the AASHTO Guide Specifications for Bridge Railings. All dimensions for timber rail, posts, and spacers shall be the actual dimensions of the timber.

Bridge rail and wheel guard splices shall be located so that rail and guard members are continuous over a minimum of two posts. Bridge railings and wheel guards shall be installed in sections not less than 12 ft long. Splices shall be shiplapped with the lap equal to 8 in. or the greater side of the piece, whichever is larger.

462.04 MEASUREMENT AND PAYMENT. Piles are excluded. The payment will be full compensation for all timber (treated or untreated) storage and handling, preservative, composite shields, asphalt cement, metal components, drilling holes, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

462.04.01 Timber structures will be measured and paid for at the Contract unit price per 1000 board feet "MBM". The computation of quantities will be based on the nominal sizes specified in the Contract Documents and the exact overall net length of pieces remaining in the completed structure. No allowance will be made for waste.

462.04.02 Timber structures will not be measured but will be paid for at the Contract lump sum price.

SECTION 463 — BRICK MASONRY

463.01 DESCRIPTION. This work shall consist of brick laid in full beds of mortar and built to the shapes and dimensions and at the locations specified in the Contract Documents or as directed by the Engineer.

463.02 MATERIALS.

Curing Compound	902.07.03
Brick	903
Mortar	903.06
Fusion Bonded Epoxy Powdered Coatings	917.02
Water	921.01
Dove Tail Anchors	As specified in the Contract Documents

Sample Panel. When specified in the Contract Documents, a sample panel measuring a minimum of 24 X 24 in. shall be prepared and delivered to the construction site. The panel shall be typical of the brickwork to be used on the project. The Administration's approval of the panel shall be received before beginning the brickwork on the project. The sample panel shall remain on the project site and all subsequent brickwork shall be equal in appearance to this approved panel.

463.03 CONSTRUCTION. Unless otherwise specified, all brick masonry shall be laid in level courses with faces plumb, square and true to the dimensions specified. All exposed surfaces shall be smooth. Brick masonry for parapets and end posts shall be laid parallel to the roadway or barrier.

Brick facing shall be constructed as specified in the Contract Documents.

463.03.01 Bond. Unless otherwise specified, brick masonry shall be laid in running bond. Adjoining courses shall be laid to break joints by half brick as nearly as practical.

463.03.02 Bricklaying. All brick shall be sprayed with water to dampen the surface prior to laying. Only fresh plastic mortar shall be used, and it shall be soft and workable when placed on the wall. A layer of mortar shall be spread on the beds and not more than a shallow furrow which can be readily closed by the laying of the brick shall be made in it. All bed and head joints shall be filled solid with mortar. End joints of stretchers and side or cross joints of headers shall be fully buttered with mortar and a shoved joint made so that mortar is squeezed out at the top of the joint. No brick shall be jarred or moved after it has been fully bedded in the mortar. Bricks loosened after the mortar has taken its set shall be removed, cleaned, and relaid with fresh mortar. No broken or chipped brick shall be used in the face. Spalls or bats are not permitted except where necessary to shape around irregular openings or edges. Full bricks shall be placed at ends or corners where possible and the bats used in the interior of the course. In making closures, bricks shorter than the width of a whole brick shall not be used. Whole brick shall be used as headers.

463.03.03 Joints. All joints shall be slushed with mortar at every course, but slushing alone will not be considered adequate for making an acceptable joint. Exterior faces shall be laid up in advance of backing. Exterior faces shall be back plastered or parged with a coat of mortar not less than 3/8 in. thick before the backing is laid up. Prior to parging, all joints on the back of face courses shall be cut flush. Joints shall be 1/4 to 1/2 in. wide. Whatever width is adopted shall be maintained uniformly throughout the work.

463.03.04 Pointing. All exterior head and bed joints shall be tooled with a round tool, slightly larger than the joint, pressed tight against the still plastic mortar so as to provide a concave finish. When nails or line pins are used, the holes shall be immediately plugged with mortar and pointed as soon as the nail or pin is removed.

463.03.05 Cleaning. Upon completion of the work, all exterior surfaces shall be cleaned by scrubbing and washing down with water, or if

necessary, cleaning shall be done with a 5 percent solution of muriatic acid which shall then be rinsed off with liberal quantities of clean fresh water.

463.03.06 Curing. After the work has been laid up and pointed, the exposed surfaces of brick masonry shall be cured by one of the following methods:

(a) Brick shall be covered with two layers of burlap and kept wet for three days.

(b) A nonasphalt colorless liquid curing compound shall be applied by means of an approved hand or motor driven spray operated at a pressure between 40 and 60 psi. The liquid compound shall be uniformly applied at a rate of 27 yd^2/gal. The material shall be applied so that the exposed surface is completely coated and sealed in one application. At points where the work shows evidence of insufficient coating, additional material shall be added as directed by the Engineer.

463.03.07 Cold Weather Protection. Brick masonry work and pointing are not permitted when there is frost in the brick or when the air temperature is below 50 F, unless the Contractor provides suitable housing, covering and tarpaulins, and heating devices necessary to keep the atmosphere surrounding the masonry at a minimum temperature of 50 F for the curing period.

463.03.08 Backfill. Brick masonry shall not be backfilled before seven days after completion of the section.

463.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all sample panels, dove tail anchors, curing and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

463.04.01 Brick Masonry for Structures will be measured and paid for at the Contract unit price per square foot.

463.04.02 Brick Masonry for Structures will be measured and paid for at the Contract unit price per cubic yard.

463.04.03 Brick Masonry for Structures will not be measured but will be paid for at the Contract lump sum price.

463.04.04 Brick Masonry Facing will be measured and paid for at the Contract unit price per square foot.

463.04.05 Brick Masonry Facing will be measured and paid for at the Contract lump sum price.

SECTION 464 — EPOXY PROTECTIVE COATINGS FOR CONCRETE

464.01 DESCRIPTION. This work shall consist of furnishing, and applying epoxy protective coatings as specified in the Contract Documents or as directed by the Engineer.

464.02 MATERIALS.

Sand	901.01
Epoxy Protective Coatings	917.01

464.03 CONSTRUCTION. The epoxy protective coating shall not be applied until at least 30 days after forms are removed. All surfaces to be coated shall be abraded by abrasive blasting, water blasting, or other mechanical means to provide a surface profile for improved adhesion. The surface shall be sound, clean, thoroughly dry and free of oil, grease, curing compound, and other foreign matter before applying the first epoxy protective coating. Two coats shall be applied to the specified areas of the structure. The application of each epoxy protective coating shall follow a dry weather period of at least two consecutive days and within the time frame recommended by the manufacturer. Adjacent areas not to be coated shall be masked or otherwise protected to prevent staining.

464.03.01 Mixing and Application. Mixing and application shall conform to the manufacturer's recommendations. Epoxy coatings shall be applied by brush or roller. Epoxy coatings shall not be applied to piers and abutments until the structural steel masonry plates have been placed.

464.03.02 Coating Requirements. The second epoxy coating on the top surfaces of the piers and abutment bridge seat areas between beams pads shall be sprinkled with an excess of sand while it is still wet. When it has hardened sufficiently to resist marring, the excess sand not adhering to the coatings shall be removed. Areas to be coated are:

(a) Abutments that are under a transverse joint in the deck shall be coated. The coatings shall be applied to the entire horizontal surface of the abutment bridge seat areas (between and around the beam pads) and all exposed surfaces of the beam pads, and the entire contiguous vertical faces of the backwalls and cheek walls.

(b) Piers that are under a transverse joint in the deck shall be coated. The coatings shall be applied to the entire horizontal surface of pier bridge seat areas (between and around the beam pads), and all exposed surfaces of the beam pads.

464.03.03 Material Precautions. The manufacturer's Material Safety Data shall be used in handling and use of the material.

464.03.04 Repairs. Any portion of the structures damaged by the Contractor's operations in applying the protective coatings, including damage to the epoxy protective coating, shall be repaired as directed by the Engineer, at no additional cost to the Administration. Epoxy protective coating repairs shall be performed in conformance with the manufacturer's recommendations.

464.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for both coats and all material, labor, equipment, tools, and incidentals necessary to complete the work.

464.04.01 Epoxy protective coatings for concrete for which no specific item is included in the Contract Documents will not be measured but the cost will be incidental to other pertinent items included in the Contract Documents.

464.04.02 Epoxy protective coatings for concrete will not be measured but will be paid for at the Contract lump sum price for the pertinent Epoxy Protective Coating item.

464.04.03 Epoxy protective coatings for concrete will be measured and paid for at the Contract unit price per square yard for the pertinent Epoxy Protective Coating item.

SECTION 465 — FUSION BONDED POWDER COATINGS FOR METAL

465.01 DESCRIPTION. This work shall consist of furnishing and applying electrostatically applied fusion bonded powder coatings on metal surfaces as specified in the Contract Documents.

465.02 MATERIALS.

Epoxy Powder Coating	917.02 except creep test will not be required
Polyester Powder Coating	917.03

Polyester powder coating shall be used unless otherwise specified.

465.03 CONSTRUCTION. The coating shall be applied in an environmentally controlled plant that is fully enclosed. The coating system shall have the capabilities of preheating and post baking.

All metal surfaces shall be free of oil or any mill coating.

All metal surfaces shall be grit blasted to white metal as specified in SSPC-SP 5 using a mixture of steel shot and grit. Cleaned surfaces shall be protected from conditions of high humidity, rainfall or surface moisture. The metal surfaces shall not flash rust before coating. Blast profile shall be a uniform, angular anchor profile with a height of 2 to 5 mils. Anchor pattern shall be checked with an approved surface profile gauge.

The coating material shall be applied and cured as specified by the coating manufacturer. The metal surfaces and oven temperatures shall not exceed 500 F during any part of the curing process.

The cured coating shall be of uniform color, gloss, and thickness, and shall be free of blisters, fish eyes, sags, runs, and any other irregularities.

The finished coating thickness shall be 10 ± 2 mils when tested as specified in SSPC PA-2 except the balls and sockets on steel sheet piling may have a lesser thickness of coating.

New bolts, nuts, and washers shall be similarly coated with a thickness of 4 to 7 mils. The nuts shall have oversize threads and shall fit the bolts after both are coated. The bolt heads shall be restrained from turning during torquing operations.

The coater shall be responsible for all quality control checking including visual inspection and thickness measurements and shall keep the results of each inspection in a form suitable to the Administration's representative.

The Administration's representative shall have access to each part of the process and shall have the right and opportunity to witness or perform any of the quality control tests on a random sampling basis.

Touch Up. A compatible touch up system shall be provided for repair of defects, all areas damaged during erection, and all visible open areas. Touch up shall be applied by the Contractor as follows:

(a) Surface Preparation. The coating shall be applied directly to the metal surface which shall be clean, dry, and free of rust and

scale. Blast clean to National Association of Corrosion Engineers (NACE) Near White where possible. Grease, oil, etc., shall be removed with suitable solvents. The cleaned surface shall be coated before oxidation occurs.

(b) Mixing. Mix ratio of Part A to Part B shall be as recommended by the manufacturer. The two parts shall be thoroughly mixed until a uniform color is achieved. If thinning is required, each part shall be thinned separately with thinner recommended by the manufacturer. Material not used within the pot life recommended by the manufacturer shall be discarded.

465.03.01 Material Precautions. The manufacturer's Material Safety Data shall be used in handling and use of this material.

465.04 MEASUREMENT AND PAYMENT. Fusion bonded powder coatings for metal will not be measured but the cost will be incidental to the pertinent items specified in the Contract Documents.

SECTION 466 THRU 468 — RESERVED

SECTION 469 — POROUS BACKFILL

469.01 DESCRIPTION. This work shall consist of furnishing and placing of porous backfill material, reinforced concrete base and pipe drains at the rear of abutments, wing walls, retaining walls, and other locations as specified in the Contract Documents or as directed by the Engineer.

469.02 MATERIALS.

Porous Backfill, Size No. 57, Aggregate	901.01
Concrete Mix No. 1	902.10
Pipe Drains	905
Reinforcement Steel	908.01
Geotextile, Class as specified	921.09

469.03 CONSTRUCTION. Porous backfill material shall be placed in layers in conjunction with the adjacent fill. Any fill material removed for placing the porous backfill material shall be at no additional cost to the Administration. When a form is used between the porous backfill material and the earth backfill, the form shall be completely removed from the completed fill.

Concrete base shall be sloped to drain to points of discharge.

469.04 MEASUREMENT AND PAYMENT. Porous backfill will not be measured but will be paid for at the Contract lump sum price for the pertinent Porous Backfill item. The payment will be full compensation for all excavation, concrete, reinforcement, geotextiles, drains, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

If no item for porous backfill appears in the Contract Documents, the work will not be measured but the cost will be incidental to other items specified in the Contract Documents.

SECTION 470 THRU 494 — RESERVED

SECTION 495 — APPLICATION OF BRIDGE/STRUCTURE NUMBERS

495.01 DESCRIPTION. This work shall consist of applying Bridge/Structure Numbers to all completed structures.

495.02 MATERIALS. The paint shall be suitable for the particular application and shall be selected by the Contractor subject to the approval of the Engineer.

495.03 CONSTRUCTION. The Bridge/Structure Number shall be applied to the bridge/structure as a last order of work. The size, location, etc., shall conform to the pertinent details included in the Contract Documents. All work shall be done in a neat workmanlike manner with sharp edges differentiating between all coatings and the previous substrate. Surfaces shall be properly prepared in conformance with the paint manufacturer's recommendations. Paint shall not be applied to wet or moist surfaces.

On rehabilitation projects the Bridge/Structure Number shall be repainted if it is faded, removed, or otherwise deemed necessary by the Engineer.

495.04 MEASUREMENT AND PAYMENT. Application of Bridge/Structure Numbers will not be measured but the cost will be incidental to the pertinent items specified in the Contract Documents.

SECTION 496 THRU 498 — RESERVED

SECTION 499 — WORKING DRAWINGS

499.01 DESCRIPTION. This work includes the scheduling and distribution of working drawings, which are described in TC-1.02 and TC-4.01. Working drawings shall exhibit good drafting practices and represent the original work of the Contractor, fabricator, or supplier. Submitting duplicated portions of the Plans as working drawings is prohibited. The Contractor shall also submit calculations or other information deemed necessary to backup working drawings when requested by the consultant/Administration. Calculations and other backup material shall be signed and sealed by a professional engineer registered in the State of Maryland when specifically requested.

499.02 MATERIALS. Not applicable.

499.03 CONSTRUCTION.

499.03.01 Schedule. As a first order of work, the Contractor shall prepare and submit in conformance with 499.03.02 or 499.03.03 a schedule for the submission of the working drawings. The schedule shall be coordinated with and be in full accord with the Progress Schedule submitted to the procurement officer under GP-8.04 and TC-5.02.

The schedule shall include each type of working drawings (e.g. form plans, structural steel, etc.), approximate number of drawings to be reviewed, estimated date of first submission, and estimated rate of submission of drawings (e.g. 5/wk). Where possible, the most crucial drawings shall be submitted first with sufficient time for review so as to minimize delays during construction.

499.03.02 Consultant Engineering Firm. When the Contract Documents specify that a consultant engineering firm is to review the working drawings for the structure, all working drawings shall be sent to that firm.

To expedite the checking and distribution of working drawings, fabricators or suppliers may send prints directly to the appropriate consultant engineering firm with copies of all correspondence to the Contractor, Director - Office of Bridge Development, and the District Engineer. If the Contractor requests that all plans be routed through the Contractor's office, then the establishment of that procedure should be the first order of work so as to avoid possible misunderstandings as to the processing. The Contractor shall be aware that this plan of action will

delay the turn around time and will not constitute grounds for complaint or a time extension.

The Contractor, fabricator, or supplier shall furnish to the consultant engineering firm six prints each of all working drawings, etc., for primary review.

Once primary review is complete the Contractor, fabricator, or supplier shall furnish to the consultant engineering firm additional prints (number to be furnished by primary reviewer) for stamping and forwarding to the Administration's Office of Bridge Development for secondary review and distribution.

All working drawings for the structures will not be considered accepted until they bear the acceptance stamps of both the consultant engineering firm and the Administration's Office of Bridge Development.

499.03.03 Office of Bridge Development. When no consultant engineering firm is specified in the Contract Documents, all working drawings for the structures shall be sent to the Director - Office of Bridge Development.

To expedite the checking and distribution of working drawings, fabricators or suppliers may send prints directly to the Director with copies of all correspondence to the Contractor and the District Engineer. If the Contractor requests that all drawings be routed through the Contractor's office, then the establishment of that procedure should be the first order of work so as to avoid possible misunderstandings as to the processing. The Contractor shall be aware that this plan of action will delay the turn around time and will not constitute grounds for complaint or a time extension.

The Contractor, fabricator, or supplier shall furnish to the Director three prints each of all working drawings, etc., for primary review.

Once primary review is complete the Contractor, fabricator, or supplier shall furnish to the Director additional prints (number to be furnished by primary reviewer) for final review and distribution.

499.03.04 Revisions and Substitutions. All modifications, regardless of whether or not the Contract includes a consultant engineering firm, shall be sent to the Director - Office of Bridge Development for acceptance. Any modifications implemented, without written acceptance from the Director - Office of Bridge Development, shall be subject to the requirements of GP-5.02.

499.04 MEASUREMENT AND PAYMENT. This work will not be measured but the cost will be incidental to other pertinent items included in the Contract Documents.

CATEGORY 500 PAVING

SECTION 501 — AGGREGATE BASE COURSES

501.01 DESCRIPTION. This work shall consist of constructing base courses using one of the following as specified in the Contract Documents or as directed by the Engineer:

(a) Graded aggregate without a stabilizing agent.

(b) Plant mixed graded aggregate with a portland cement stabilizing agent.

(c) Bank run gravel.

(d) Sand aggregate.

501.02 MATERIALS.

Graded Aggregate for Base Course	901.01
Bank Run Gravel for Base Course	901.01
Sand Aggregate Base Course	
Coarse Aggregate	901.01, Size No. 57
Fine Aggregate	916.01.01
Portland Cement	902 Type I or IA
Emulsified Asphalt	904.03
Production Plant	915
Water	921.01
Moisture and Dust Control Agents	921.02

501.03 CONSTRUCTION. At least 30 days prior to the start of constructing the base course, the Contractor shall submit the proposed plants, equipment, and material sources to the Engineer for approval.

The Contractor shall protect the subgrade and base against damage from all causes. Any part of the subgrade or base that is damaged shall be repaired or replaced by the Contractor in a manner acceptable to the Engineer at no additional cost to the Administration.

Excavation for widening shall be limited to an area which can be backfilled the same working day using graded aggregate base course. Refer to Standard No. MD-104.92 for the area to be backfilled. The temporary graded aggregate base wedge shall be maintained with a 4:1 or flatter fill slope. The material shall be compacted as directed by the

Engineer. The graded aggregate base wedge shall remain in place until placement of the hot mix asphalt base.

501.03.01 Equipment. All equipment, including the production plant and on-site equipment, shall be subject to approval by the Engineer. The plant shall be ready for inspection by the Engineer at least 48 hours prior to the start of construction operations.

501.03.02 Weather Restrictions.

(a) Temperature and Surface Conditions. Graded aggregate stabilized with portland cement shall be placed only when the ambient air and surface temperature is at least 40 F and rising. Graded aggregate, bank run gravel and sand aggregate base shall be placed only when the ambient air and surface temperature is at least 32 F and rising. Placing material on a frozen subgrade is prohibited.

(b) Cold Weather Protection. The plant mixed graded aggregate stabilized base shall be protected from freezing during the seven day curing period.

(c) Precipitation. Construction during precipitation is prohibited. When precipitation has occurred during the previous 24 hours, the Engineer will determine if the subgrade is sufficiently dry. Any material en route from the plant to the job site may be placed at the Contractor's risk.

501.03.03 Subgrade Preparation. The approved subgrade set to final line and grade shall be completed at least 500 ft ahead of the base course or as directed by the Engineer before the base course construction begins. The foundation shall be constructed as specified in Sections 204 and 208, the Contract Documents, and as approved by the Engineer. If traffic, including construction equipment, is allowed to use the subgrade foundation or preceding layer, it shall be distributed over the entire width of the course to aid in obtaining uniform and thorough compaction. If ruts are formed, they shall be removed by reshaping and recompacting the affected area as specified in Section 204.

501.03.04 Stabilized Graded Aggregate Base Mix. The amount of portland cement shall be determined as specified in MSMT 321.

501.03.05 Bank Run Gravel Base Mix. The Contractor will be permitted to mix or blend materials using chemical additives approved by the Engineer.

501.03.06 Sand Aggregate Base Mix. The mixture shall contain 35 to 40 percent coarse material as measured by dry weight of the total mix.

501.03.07 Transportation. Mixed base materials shall be handled and transported in a manner that minimizes segregation and loss of moisture. All loads shall be covered in conformance with State laws unless hauling is off road and is approved by the Engineer. Dumping into piles, hauling over the completed base course, and stockpiling of material on the job site is prohibited unless approved by the Engineer.

501.03.08 Spreading. The base material shall be uniformly spread without segregating the coarse and fine particles, in layers of approximately equal thickness, to provide the specified planned depth. Shoulders or berms not less than 2 ft wide shall be built up on each side of the base to the top elevation of each uncompacted layer unless the base is placed against concrete curbs or gutters.

501.03.09 Grade or Finished Surface Control. The surface of the base material shall be shaped to the required lines, grades and cross section specified in the Contract Documents. Grades shall be set longitudinally and transversely with fixed controls having a maximum spacing of 25 ft. The surface material shall be compacted and smoothed over its full width using a smooth faced steel wheeled roller or, if rolling is not feasible, by mechanical tampers and vibratory compactors as approved by the Engineer. The finished grade shall not deviate more than 1/2 in. from the established grade.

501.03.10 Compaction. Immediately after placement, the base material shall be compacted to the required density. During compaction operations, the moisture content of the material shall be maintained within 2 percent of the materials optimum moisture. The optimum moisture content and maximum dry density shall be determined as follows:

(a) Sand Aggregate Base and Bank Run Gravel Base: T 180

(b) Graded Aggregate Base and Graded Stabilized Aggregate Base: MSMT 321

Graded aggregate for base, bank run gravel base, and sand aggregate base shall be compacted to a minimum density of 97 percent of the maximum dry density. Graded stabilized aggregate base shall be compacted to a minimum dry density of 95 percent of the maximum dry density. In place density shall be measured as specified in MSMT 350 or 352.

Compaction operations, except on superelevated curves, shall begin at the sides of the course, overlap the shoulder or berm at least 1 ft and

progress toward the center parallel to the center line of the roadway. Superelevated curve compaction shall begin at the low side of the superelevation and progress toward the high side. The compaction operation shall continue until all compaction marks are eliminated.

501.03.11 Graded Stabilized Aggregate Base Protection and Curing. When graded stabilized aggregate base is used, the spreading, compacting and shaping shall be completed within three hours after the mixing water, cement and aggregate have come in contact. Any section not conforming to these requirements shall be reconstructed as directed by the Engineer at no additional cost to the Administration. The surface of the stabilized aggregate base course shall be maintained in a moist condition until the emulsified asphalt seal coat is applied. The emulsified asphalt shall be applied by distributing equipment as specified in 503.03.01 at the rate of 0.2 gal/yd^2. Ponding of the emulsified asphalt shall be avoided. If ponding occurs, the Contractor shall use a sand blotter or an equivalent method as approved by the Engineer.

The stabilized aggregate base course shall be allowed to cure for a period of seven days. During this period the base course shall be closed to all traffic. Any portion of the base course seal coat that is damaged shall be repaired at no additional cost to the Administration.

501.03.12 Moisture and Dust Control Agents. When specified in the Contract Documents or as directed by the Engineer, calcium or magnesium chloride shall be added at the plant or applied to the surface of the graded aggregate, bank run gravel, or sand aggregate base at the project site. Calcium chloride shall be applied at the rate of 1 lb/yd^2. Magnesium chloride shall be applied at the rate of 1 lb/yd^2 or as a solution at the rate of 1/2 gal/yd^2.

501.03.13 Maintenance. During construction and after completion of the base course, the base shall be maintained by the Contractor until the surface course is placed. Unacceptable work that cannot be repaired shall be replaced for the full depth of the base at no additional cost to the Administration.

501.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all aggregate, furnishing, hauling, placing, curing, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

501.04.01 Graded Aggregate Base Course, Graded Aggregate Base Course Stabilized with Cement, Bank Run Gravel Base Course, and Sand Aggregate Base Course will be measured and paid for at the Contract unit price per square yard.

Surface area measurements will be based on the width of the base as specified in the Contract Documents and the actual length measured along the center line of the base surface.

The temporary graded aggregate base wedge constructed in conformance with Standard No. MD-104.92, maintaining the 4:1 or flatter slope, compaction, and removal of the material, will not be measured but the cost will be incidental to the Graded Aggregate Base Course item.

501.04.02 The portland cement stabilizing agent and the emulsified asphalt for seal coat will not be measured but the cost will be incidental to the Graded Aggregate Base Course Stabilized with Cement item.

501.04.03 Bank Run Gravel Base. Material manipulation or addition of chemical additives will not be measured but the cost will be incidental to the Bank Run Gravel Base Course item.

501.04.04 Calcium or Magnesium Chloride will be measured and paid for at the Contract unit price per square yard or if specified in the Contract Documents, at the Contract unit price per ton.

SECTION 502 — SOIL-CEMENT BASE COURSE

502.01 DESCRIPTION. This work shall consist of constructing soil-cement base course using a combination of soil and portland cement, uniformly mixed, moistened, compacted, shaped and sealed. Unless otherwise specified in the Contract Documents, the soil, cement and water may be mixed in a plant or mixed in place, at the Contractor's option.

502.02 MATERIALS.

Portland Cement	902
Emulsified Asphalts	904.03
Production Plant	915
Soil	916; Capping shall not contain aggregate retained on 3 in. sieve, nor more than 45 percent retained on a No. 4 sieve
Water	921.01

502.03 CONSTRUCTION. At least 30 days prior to the start of constructing the base course the Contractor shall submit proposed production plants, location of plants with respect to project site, equipment, and material sources to the Engineer for approval.

The Contractor shall protect the subgrade and base against damage from all causes. Any part of the subgrade or base that is damaged shall be repaired or replaced by the Contractor in a manner acceptable to the Engineer at no additional cost to the Administration.

502.03.01 Equipment. All equipment, including the production plant and on-site equipment, shall be subject to approval by the Engineer. The production plant shall be ready for inspection by the Engineer at least 48 hours before the start of construction operations.

502.03.02 Weather Restrictions.

(a) Temperature and Surface Conditions. Soil-cement base course shall be placed only when the ambient air and surface temperature is at least 40 F and rising. Placing material on a frozen subgrade is prohibited.

(b) Cold Weather Protection. The completed base shall be protected from freezing during the seven day curing period.

(c) Precipitation. Construction during precipitation is prohibited. When precipitation has occurred during the previous 24 hours, the Engineer will determine if the subgrade is sufficiently dry. If precipitation occurs during placement, material en route from the plant to the job site may be placed at the Contractor's risk.

502.03.03 Subgrade Preparation. The approved subgrade set to final line and grade shall be completed at least 500 ft ahead of the base course or as directed by the Engineer before the base course construction begins. The foundation shall be constructed as specified in Sections 204 and 208, the Contract Documents, and as approved by the Engineer. If traffic, including construction equipment, is allowed to use the subgrade foundation or preceding layer, it shall be distributed over the entire width of the course to aid in obtaining uniform and thorough compaction. If ruts are formed, they shall be removed by reshaping and recompacting the affected area as specified in Section 204.

502.03.04 Design Mix. At least 45 days prior to the start of constructing the base course, the Contractor shall submit to the Engineer, samples of the soil and portland cement from the proposed material sources. Materials shall be sampled as specified in the Materials Manual. The Engineer shall determine the exact proportions of soil and portland cement, and the optimum moisture content based on these samples. Proportions may be revised during construction to provide for changing conditions as directed by the Engineer. Plant mixed material shall be sampled at the plant. Mixed in place material shall be sampled from a 100 ft long control strip constructed on the site by the Contractor.

502.03.05 Transportation. Mixed materials shall be handled and transported to minimize segregation and loss of moisture. All loads shall be covered in conformance with State laws unless hauling is off road and is approved by the Engineer. Dumping into piles, hauling over the completed base course, and stockpiling of mixed material is prohibited unless approved by the Engineer.

502.03.06 Spreading of Plant Mix Material. The approved soil-cement mix shall be uniformly spread over the subgrade, without segregating the coarse and fine particles, in layers of approximately equal thickness, to provide the specified planned depth. Shoulders or berms not less than 2 ft wide shall be built up on each side of the base to the top elevation of each uncompacted layer unless the base is placed against concrete curbs or gutters.

502.03.07 Mixed In Place Construction. The soil base material shall be pulverized to ensure that, at the completion of moist mixing, 100 percent passes a 1 in. sieve and a minimum of 80 percent passes a No. 4 sieve. Moisture content of soil at the time of cement application shall not vary more than 2 percent from optimum. Portland cement shall then be spread on the soil at the approved spread rate. The Contractor shall use an accurate scale to verify the spread rate in the presence of the Engineer. The pulverized soil and cement shall then be thoroughly mixed. Immediately after the mixing operation is completed, the water shall be sprayed on the mixture at the approved rate using a pressurized distributor. The soil/cement/water combination shall be mixed until it is uniform, as determined by the Engineer.

502.03.08 Grade or Finished Surface Control. The surface of the base material shall be brought to line and grade and shaped to the specified cross section. Grades shall be set longitudinally and transversely with fixed controls having a maximum spacing of 25 ft. The surface material shall be compacted and smoothed over its full width using a smooth faced steel wheeled roller or if rolling is not feasible by mechanical tampers and vibratory compactors as approved by the Engineer. The finished grade shall not deviate more than 1/2 in. from the established grade.

502.03.09 Finishing. The surface of the base material shall be shaped to the required lines, grades and cross section specified in the Contract Documents.

502.03.10 Compaction. Immediately after placement, the soil-cement base shall be compacted to a density of not less than 100 percent of the maximum density as determined by T 134. In place density shall be measured as specified in MSMT 350. The Contractor shall provide a portland cement concrete compaction block as specified in 204.03.04.

At the start of compaction, the moisture in the mixture shall not be more than two percentage points above or below the specified optimum moisture content of the soil-cement mixture. Compaction operations, except on superelevated curves, shall begin at the sides of the course, overlap the shoulder or berm at least 1 ft and progress toward the center parallel to the center line of the roadway. Superelevated curve compaction shall begin at the low side of the superelevation and progress toward the high side. The compaction operation shall continue until all compaction marks are eliminated.

502.03.11 Construction Joints. At the end of each day's construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a vertical face. The base for large, wide areas shall be built in a series of parallel lanes of convenient length and width, complete with longitudinal joints, as approved by the Engineer.

502.03.12 Protection and Curing. All spreading, compacting and shaping shall be completed within three hours after the mixing water, cement and soil have come in contact. Any section not conforming to these requirements shall be reconstructed as directed by the Engineer. The surface of the base course shall be maintained in a moist condition until the emulsified asphalt is applied. The emulsified asphalt shall be applied by distributing equipment as specified in 503.03.01 at the rate of 0.2 gal/yd^2. Ponding of the emulsified asphalt shall be avoided. If ponding occurs, the Contractor shall use a sand blotter or an equivalent method as approved by the Engineer.

The soil cement base course shall be allowed to cure for a period of seven days. During this period the base course shall be closed to all traffic. Any portion of the base course that is damaged shall be repaired at no additional cost to the Administration.

502.03.13 Maintenance. During construction and after completion of the base course, the base shall be maintained by the Contractor until the surface course is placed. Unacceptable work that cannot be repaired shall be replaced for the full depth of the base course at no additional cost to the Administration.

502.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for furnishing, hauling, mixing, placing, compacting, watering, control strip, emulsified asphalt, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

502.04.01 Soil-Cement Base Course will be measured and paid for at the Contract unit price per square yard.

Surface area measurements will be based on the width of the base as specified in the Contract Documents and the actual length measured along the center line of the base surface.

502.04.02 Portland Cement for Soil-Cement Base Course will be measured and paid for at the Contract unit price per ton.

SECTION 503 — CHIP SEAL SURFACE TREATMENT

503.01 DESCRIPTION. This work shall consist of applying one or two seal coats or a prime coat followed by one or two seal coats as specified in the Contract Documents or as directed by the Engineer. The seal coat shall consist of applying an emulsified asphalt followed by an application of aggregate. The prime coat, when required, shall consist of preparing and treating an existing surface with emulsified asphalt.

503.02 MATERIALS.

MATERIAL	SECTION	APPLICATION	SIZE OR GRADE	SPREAD RATE lb/yd^2	SPRAY TEMP F	SPRAY RATE SINGLE COAT OR FIRST COAT gal/yd^2	SPRAY RATE FOR SECOND COAT (Double) gal/yd^2
Aggregate	901	Single or First Coat	No. 7	25-50	—	—	—
		Second (Double Coat)	No. 8	20-35	—	—	—
Emulsified Asphalts	904.03	Seal Coat	CRS-1	—	70-140	0.3-0.5	0.2-0.4
			CRS-2	—	140-160	0.3-0.5	0.2-0.4
			RS-1	—	70-140	0.3-0.5	0.2-0.4
			RS-2	—	140-160	0.3-0.5	0.2-0.4

503.03 CONSTRUCTION. At least 30 days prior to the start of placement of the chip seal surface treatment, the Contractor shall submit a proposed plan, including equipment and material sources to the Engineer for approval.

The Contractor shall protect the treated pavement against damage from all causes. Any part of the pavement that is damaged shall be repaired or replaced by the Contractor in a manner acceptable to the Engineer at no additional cost to the Administration.

503.03.01 Equipment. All equipment shall be subject to approval by the Engineer.

(a) Asphalt Distributing Equipment. Asphalt distributing equipment will be inspected and calibrated by the Administration prior to use and shall bear a current Administration inspection and calibration tag. A calibration chart showing the total capacity, in gallons, of the distributor tank, and the fractional capacity for each 1/4 in. of tank depth shall be carried in the unit. The unit shall be capable of uniformly applying the specified material on variable widths of surface at the rates specified in 503.02. In addition, the equipment shall include the following:

(1) A fifth wheel tachometer for maintaining uniform speed.

(2) A thermometer graduated in 2 F increments to determine the specified temperature ranges.

(3) Heaters for uniformly heating the materials to the proper temperatures.

(4) Full circulation spray bars that are laterally and vertically adjustable, plus a hand spray.

(5) A calibrated tank to determine the quantity of asphalt in each load and the amount used.

(6) A valve or petcock built into the equipment for sampling the asphalt.

(7) A motor driven pump with pressure gauges to deliver the material to the spray bars. When a variable speed pump and metering system is used, the Contractor shall provide the Engineer with charts prepared by the manufacturer for selecting the proper pump speed for each application.

(b) Aggregate Spreader. The aggregate spreader shall be either self-propelled or attached to a truck tailgate.

(c) Rollers. Refer to 504.03.01(c).

503.03.02 Weather Restrictions. The chip seal surface treatment shall be placed only when the ambient air and surface temperature is at least 50 F and rising. Pavement shall be clean and dry. When weather conditions differ from these limits, material en route from the plant to the job site may be used at the Contractor's risk. If placement of the material is stopped by the Engineer, all material en route shall be disposed of at no additional cost to the Administration.

503.03.03 Foundation Preparation. Prior to placement of the chip seal surface treatment material, the foundation for the chip seal shall be constructed as specified in the Contract Documents and as directed by the Engineer. When paving over existing pavement, ruts and pot holes shall be repaired to provide a smooth surface for the application of the chip seal surface treatment.

503.03.04 Prime Coat. Prior to the application of the prime coat, the surface shall be cleaned of all loose and foreign materials. The prime coat shall be uniformly applied to the surface at the application rate specified in 503.02. Excess material in pools shall be removed before the next coat.

503.03.05 First Seal Coat.

(a) A minimum of 24 hours after the application of the prime coat, an emulsified asphalt shall be sprayed on the surface at the application rate specified in 503.02.

(b) Immediately following the asphalt application, a dry, dust free aggregate shall be spread on the surface at the application rate specified in 503.02. Excess aggregate shall be removed and all areas containing insufficient aggregate shall be corrected.

503.03.06 Rolling. Immediately following the aggregate application, the surface shall be rolled until the aggregate is uniformly embedded into the asphalt. The rolling shall be discontinued if the aggregate begins to crush.

503.03.07 Second Seal Coat. When specified, after the first seal coat has cured a minimum of 24 hours, a second seal coat shall be applied to the surface, omitting the prime coat. The application rate for emulsified asphalt and aggregate shall be as specified in 503.02. Excess aggregate shall be removed and all areas containing insufficient aggregate shall be corrected. The surface shall then be rolled as specified in 503.03.06.

503.03.08 Traffic. Completed sections shall be closed to traffic until the final seal coat has completely cured as directed by the Engineer. The Contractor shall maintain the treated surface after it has been opened to traffic until final acceptance.

503.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for the foundation preparation, furnishing, hauling, preparing, removing excess aggregate, placing materials, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Chip Seal Surface Treatment will be measured and paid for at the Contract unit price for one or more of the items listed below as specified in the Contract Documents.

503.04.01 No. 7 Aggregate for Single Coat Chip Seal Surface Treatment per ton.

503.04.02 No. 8 Aggregate for Second Coat Chip Seal Surface Treatment per ton.

503.04.03 Emulsified Asphalt for Seal Coat per gallon.

The actual number of gallons of emulsified asphalt distributed will be corrected to the corresponding volume at 60 F as determined by use of conversion tables furnished by the Administration.

SECTION 504 — HOT MIX ASPHALT PAVEMENT

504.01 DESCRIPTION. This work shall consist of constructing hot mix asphalt (HMA) pavement as specified in the Contract Documents.

504.02 MATERIALS.

Performance Graded Asphalt Binders	904.02
Tack Coat	904.03
Hot Mix Asphalt Mixes	904.04
Crack Filler	911.01
Production Plant	915

504.03 CONSTRUCTION.

Quality Control Plan. At least 30 days prior to the placement of any HMA pavement, the Contractor shall submit in writing a plant Quality Control Plan to the Team Leader of the Asphalt Team and a field Quality Control Plan to the Engineer for approval. The Quality Control Plans shall contain a statistically based procedure of random sampling and shall show how the Contractor proposes to control the equipment, materials, production and paving operations to ensure conformance with these Specifications. A master plant Quality Control Plan may be submitted for this prior approval. If a master plant quality control plan is submitted and approved, an addendum shall be submitted for each specific Contract.

The plan shall contain production plants, location of plants with respect to the project site, personnel qualifications, inspection and record keeping methods, and minimum frequencies of sampling and testing as specified in MSMT 730, Table 3. The plan shall also detail when and how corrective action will be taken for unsatisfactory construction practices and deviations from the material Specifications. Additionally, the plan shall include a Quality Control Plan for the plant which addresses all elements necessary for quality control.

Plan Administrator and Certified Technicians. The Quality Control Plan shall designate a Plan Administrator. The Plan Administrator shall have full authority to institute any action necessary for the successful operation of the Plan. The Plan Administrator may supervise the Quality Control Plan on more than one project if that person can be in contact with the job site within one hour after being notified of a problem.

The Quality Control Plan shall also designate a Certified Plant Control Technician, Field Control Technician and Certified Materials Tester, if used, as specified in MSMT 731.

Records. The Contractor shall maintain complete records of sampling, testing, actions taken to correct problems and quality control inspection results and shall make them available to the Engineer upon request. Copies of the reports shall be provided when requested by the Engineer.

Linear control charts shall be maintained by the Contractor. Control charts shall be maintained in the Quality Control laboratory in a manner satisfactory to the Engineer and shall be current. As a minimum, the control charts shall identify the mix design number, each test result and the upper and lower specification limits applicable to each test.

Acceptance. The Administration will provide acceptance by:

(a) Conducting independent verification sampling and testing separate from the Contractor/producer.

(b) Periodically observing tests performed by the producer.

(c) Monitoring required control charts.

(d) Directing the producer to take additional samples at any time and location.

(e) Monitoring the Contractor's conformance with the Quality Control Plan.

(f) Evaluating quality control sampling and testing by an independent assurance program.

The Contractor shall protect the pavement against damage from all causes. Any part of the pavement that is damaged shall be repaired or replaced by the Contractor at no additional cost to the Administration.

504.03.01 Equipment. All equipment, including the production plant and paving equipment, shall be subject to approval by the Engineer. The plant shall be ready for inspection by the Engineer at least 48 hours prior to the start of construction operations.

(a) Hauling Units. Refer to 915.02(f). Due regard shall be given to the safety and convenience of the public while applying and maintaining the tack coat. Provisions shall be made to minimize hauling trucks from tracking tack coat onto the adjacent pavement.

(b) Pavers. Pavers will be inspected and approved by the Engineer based upon the manufacturer's specification manual (copy to be provided by the Contractor). The paver shall be a self-contained, self-propelled unit capable of spreading the mixture true to line, grade and cross slope. The paver shall be equipped with a screed or strike off assembly that will produce a finished surface of the required smoothness and texture without tearing, shoving or gouging the mixture. The paver shall have automatic controls for transverse slope and grade. Controls shall be capable of sensing grade from an outside reference line or ski and sensing the transverse slope of the screed to maintain the required grade and transverse slope within plus or minus 0.1 of the required slope percentage.

Manual operation will be permitted in the construction of irregularly shaped and minor areas, or where directed by the Engineer.

Whenever a breakdown or malfunction of any automatic control occurs, the equipment may be operated manually for the remainder of the work day as directed by the Engineer.

Reference lines or other suitable markings to control the horizontal alignment shall be provided by the Contractor, subject to the approval of the Engineer.

(c) Rollers. Rollers shall be self-propelled, reversible, and steel wheeled or pneumatic tired. Rollers may be vibratory or nonvibratory, and they may be operated in the vibratory mode as

long as the Engineer determines that the roller is not cracking or damaging the aggregate in the mix. Rollers shall not be used in the vibratory mode on bridge decks. Pneumatic tire rollers shall have multiple tires of equal size with smooth tread. Wheels shall be arranged to oscillate in pairs, or they may be individually sprung. Tires shall be uniformly inflated at the operating pressure approved by the Engineer. The Contractor shall furnish the Engineer a manufacturer's table showing this data. The difference in tire pressure between any two tires shall not be greater than 5 psi. The Contractor shall provide a means for checking the tire pressure on the job at all times.

504.03.02 Weather Restrictions. HMA material shall only be placed on roadway surfaces when the ambient air and surface temperature is at least 40 F and rising for surface mixes and at least 32 F and rising for base mixes. The pavement surfaces shall be clean and dry and approved by the Engineer before HMA paving begins. Placing HMA material on a frozen graded aggregate base is prohibited. When weather conditions differ from these limits, material en route from the plant to the job site may be used at the Contractor's risk. If placement of the material is stopped by the Engineer, all material en route shall be wasted at no additional cost to the Administration.

504.03.03 Foundation Preparation. Prior to placement of paving material, the foundation shall be constructed as specified in the Contract Documents and approved by the Engineer. When paving over existing pavement, all excess crack filling or patch material shall be removed and all spalls and potholes shall be cleaned, tack coated, filled and tamped with HMA before placement. Manholes, valve boxes, inlets, and other appurtenances within the area to be paved shall be adjusted to grade as directed by the Engineer.

504.03.04 Tack Coat. Prior to application of the tack coat, the surface shall be cleaned of all loose and foreign materials. The tack coat shall be uniformly applied to the surface by full circulation spray bars that are laterally and vertically adjustable and provide triple fanning and overlapping action so that the resulting coating shall be residual asphalt applied at a rate of 0.01 to 0.05 gal/yd^2 as directed by the Engineer.

504.03.05 Hot Mix Asphalt Placement. HMA shall be placed by the paver. Delivery of the mixture by the hauling units and placement shall be continuous. The temperature of the mixture shall be a minimum of 225 F at the time of placement. Broadcasting of loose mixture over the new surface is prohibited.

504.03.06 Compaction. Immediately following placement of the HMA, the mixture shall be compacted by rolling to an in place density of 92.0 to

97.0 percent of the maximum density. In place compaction shall be completed before the mixture cools below 185 F, as determined by a probe type surface thermometer, supplied by the Contractor and approved by the Engineer. Price adjustment due to noncompliance with the required density will be as specified in 504.04.02. Probe type surface thermometer shall remain the property of the Contractor at the completion of the project.

Rolling shall consist of six separate operations in the following sequence:

(a) Transverse joint.

(b) Longitudinal joint.

(c) Edges.

(d) Initial breakdown rolling.

(e) Second or intermediate rolling.

(f) Finish rolling.

Steel wheel rollers shall be used for the first rolling of all joints and edges, the initial breakdown rolling, and the finish rolling.

Rollers shall start at the sides and proceed longitudinally toward the center of the pavement, except on superelevated curves. The rolling shall begin at the low side and progress toward the high side. Successive trips of the roller shall overlap by at least half the width of the roller, and alternate trips shall not end at the same point. When base widening is too narrow to permit the use of conventional rollers, a power driven trench roller shall be used. When the trench must be excavated wider than the proposed width of the widening, an earth berm or shoulder shall be formed against the loose HMA as soon as it is placed. The two materials shall be rolled and compacted simultaneously. Roller marks shall not be visible after rolling operations.

After rolling is completed, no traffic of any kind will be permitted on the pavement until the pavement has cooled to less than 140 F or as directed by the Engineer.

504.03.07 Joints. Both longitudinal and transverse joints in successive courses shall be staggered so that one is not above the other. Transverse joints shall be staggered by the length of the paver. Longitudinal joints shall be staggered a minimum of 6 in. and shall be arranged so that the

longitudinal joint in the top course shall be within 6 in. of the line dividing the traffic lanes.

Joints shall be constructed to provide a continuous bond between the old and new surfaces.

Joints shall be coated with tack coat as directed by the Engineer. When placing a surface course, the edge of the existing pavement shall be cut back for its full depth at transverse joints to expose a fresh surface which shall be coated with tack coat material as directed by the Engineer. Before placing the mixture against curbs, gutters, headers, manholes, etc., all contact surfaces shall be coated with tack coat.

504.03.08 Edge Dropoff. Where HMA paving is being applied to highways carrying traffic, all pavement courses exceeding 2-1/2 in. in depth shall be matched with the abutting lane or shoulder on the same working day. Where pavement courses of 2-1/2 in. or less are placed, the Contractor shall have the option of paving the abutting lane or shoulder on alternate days. The abutting lane or shoulder shall be paved regardless of the depth of pavement course prior to weekends and temporary shutdowns. When uneven pavement joints exist, the Contractor shall provide advance warning traffic control devices in conformance with the Contract Documents.

504.03.09 Tie-In. Where HMA paving is being applied to the traveled way carrying traffic, the Contractor shall construct a temporary tie-in a minimum of 4 ft in length for each 1 in. of pavement depth before traffic is allowed to cross the transverse joint.

The final tie-in shall include the removal of a transverse portion of the existing pavement to a depth so the design thickness of the final surface course is maintained. The length of the final tie-in shall be equal to the posted speed per 1 in. depth of the design thickness of the final course with a minimum length of 25 ft per 1 in. depth and a maximum length of 50 ft per 1 in. depth.

504.03.10 Sampling and Testing for Density. Density testing shall be performed before allowing traffic or construction equipment on the in place material and before placement of the next layer.

(a) Compaction for Quality Control. A lot shall not exceed 1000 tons. A sublot shall not exceed 200 tons. Five consecutive 200 ton sublots shall equal one lot. A lot may contain only one sublot that is less than 200 tons.

On any paving day when production does not end in a multiple of 1000 tons, the remaining fraction shall be considered another lot.

A paving day shall begin with a new lot and sublots. Control strips shall be divided into five equal sublots.

On Contracts requiring less than 500 tons of HMA or when HMA is used in nontraffic areas or on bridge decks, acceptance will be determined by the use of a thin layer nuclear density gauge, when tested in conformance with the manufacturer's recommendations. When the HMA courses are compacted to 1 in. or less, a control strip shall be constructed on the first day of paving. Readings shall be taken with a thin layer nuclear density gauge to determine roller patterns and the number of coverages to obtain optimum density. Optimum density is defined as when the average density does not change by more than 1.0 percent between successive coverages of a 400 to 500 ft area. This optimum density shall be used to determine HMA acceptance after approval by the Engineer. Any lot average 2.0 percent or more below optimum density shall require a new control strip be constructed and tested before paving continues.

The Contractor may use the core or the combined nuclear/core method of testing on Contracts requiring 500 tons or more.

The Contractor shall secure samples and perform tests as follows:

(1) Core Method. When the core method is used, the Contractor shall take samples as specified in MSMT 451, Method B, for each sublot of material placed. Core sample locations will be randomly determined by the Engineer in conformance with MSMT 418.

Two core samples shall be taken from each sublot no later than the next day after compaction. The size diameter cores shall be 4 or 6 in. cores for 9.5 mm, 12.5 mm, and 19.0 mm mixes; and 6 in. cores for 25.0 mm and 37.5 mm mixes. These cores shall represent the day's production and shall be taken prior to placement of the next layer.

Core samples shall be tested in conformance with MSMT 452. The specific gravity of the samples shall be expressed as a percentage of the maximum specific gravity determined for each lot of material. The in place density of each mixture in each lot shall be 92.0 to 97.0 percent. The two core results from each sublot shall be averaged and compliance will be determined on the basis of all sublots tested for each material. Results shall be made available by the Contractor no later than the following work day.

(2) Nuclear/Core Method. The nuclear gauge shall be calibrated in conformance with MSMT 417. A daily validation and standard count shall be performed as specified in the manufacturer's recommendations. A log of these validations and counts shall be with the gauge at all times.

Two one-minute special calibration nuclear tests shall be conducted on each sublot as specified in MSMT 418 no later than the next work day after compaction. A special calibration nuclear test is defined as an average of a minimum of two special calibration readings taken at the same location after rotating the gauge 180 degrees. Two tests per sublot; a minimum of four readings (2 tests x 2 readings/test = 4) shall be taken. Likewise, a 1000 ton lot shall have a minimum of 20 readings (5 sublots x 2 tests/sublot x 2 readings/test = 20).

The results of the two nuclear tests in each sublot shall be averaged and conformance will be determined on the basis of all sublots tested for each material.

Three cores for each lot of material shall be sampled; one at each of three different nuclear test locations determined by the Engineer. The average of the three core results and the average of the three corresponding nuclear tests shall be within 3.0 lb/ft^3. When the difference between nuclear test results and core test results is greater than 3.0 lb/ft^3, the Contractor shall use the core method of testing. The Contractor may return to the nuclear/core method of testing when all calibration criteria are met. If the Contractor's nuclear test results again fail to conform to the 3.0 lb/ft^3 maximum requirement, the core method of density determination shall be used for the remainder of the project.

(b) Acceptance Testing.

(1) Core Method. Acceptance testing will be performed on a minimum of three cores per 6000 tons when the core method of control is used. If the specific gravity difference on each of the three cores is within 0.030, all the lots will be evaluated individually using the test results of quality control samples as specified in 504.04.02. If the difference is greater than 0.030, the Engineer will conduct tests on the remainder of the quality control samples since the last acceptance and all the lots will be evaluated individually using the Engineer's test results.

(2) Nuclear/Core Method. When the nuclear/core method is used, the Engineer will witness the Contractor's testing and coring and will perform acceptance testing on three verification cores from any one lot since the last acceptance. If the density difference between the average of three verification cores and the average of three corresponding nuclear tests is within 3.0 lb/ft^3, all the lots will be evaluated individually using nuclear quality control test results as specified in 504.04.02.

If the difference is greater than 3.0 lb/ft^3, the Engineer will test the remainder of the verification cores since the last acceptance. All lots will be evaluated for the 3.0 lb/ft^3 difference. Lots not conforming to the 3.0 lb/ft^3 difference will be evaluated individually as specified in 504.04.02 using verification core test results. Lots conforming to the 3.0 lb/ft^3 difference will be evaluated individually.

504.03.11 Control Strip. The Contractor may opt to construct a control strip for guidance in determining roller patterns to achieve optimum density. When a control strip is constructed, it shall be placed on the first workday in which HMA is placed and shall be between 400 and 500 ft in length. Based on the Contractor's evaluation of the initial control strip, paving may continue at the Contractor's risk.

The Contractor will not be assessed a density pay adjustment for the amount of material required for construction of the control strips. Should the removal of any control strip be necessary, it shall be removed by the Contractor at no additional cost to the Administration.

The Engineer may require the Contractor to construct a control strip any time during placement of HMA based on the evaluation of compaction results.

504.03.12 Pavement Surface Checks. The Contractor shall have available, at all times, a 10 ft straightedge approved by the Engineer. After final compaction of each course, the surface of each pavement course shall be true to the established line and grade and shall be sufficiently smooth so that when tested with a 10 ft straightedge placed upon the surface parallel with the center line, the surface shall not deviate more than 1/8 in. The transverse slope of the finished surface of each course when tested with a 10 ft straightedge placed perpendicular to the center line, the surface shall not deviate more than 3/16 in.

Transverse joints on each course shall be checked with a 10 ft straightedge immediately after the initial rolling. If the surface of each course varies more than 1/8 in. from true, the Contractor shall make

immediate corrections acceptable to the Engineer so that the finished joint surface shall comply.

504.03.13 Curbs, Gutters, Etc. Where permanent curbs, gutters, edges, and other supports are planned, they shall be constructed and backfilled prior to placing the HMA, which shall then be placed and compacted against them.

504.03.14 Shoulders. Shoulders abutting the HMA surface course of any two lane pavement that is being used by traffic shall be completed as soon as possible after completion of the surface course on that lane. Shoulder construction shall be as specified in the applicable portions of the Specifications and the Contact Documents.

504.03.15 Pavement Profile. Refer to the Pavement Surface Profile requirements specified in the Contract Documents.

504.04 MEASUREMENT AND PAYMENT. Hot Mix Asphalt Pavement will be measured and paid for at the Contract unit price per ton. The payment will be full compensation for furnishing, hauling, placing all materials including antistripping additive, tack coat, control strip, pot hole and spall repairs, setting of lines and grades where specified, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Placement and removal of the temporary tie-in where hot mix asphalt is being applied to the traveled way carrying traffic will not be measured but the cost will be incidental to the pertinent Hot Mix Asphalt item.

Removal of the existing pavement or structure for the final tie-in will be measured and paid for at the Contract unit price for the pertinent items used. The hot mix asphalt for the final tie-in will be measured and paid for at the Contract unit price for pertinent Hot Mix Asphalt item.

Adjustment of existing visible manholes, valve boxes, inlets or other structures will not be measured but the cost will be incidental to the Hot Mix Asphalt item.

Adjustment of existing manholes, valve boxes, inlets or other structures that are encountered below the existing grade will be considered for payment in conformance with GP-4.07.

Removal of existing raised pavement markers will not be measured but the cost will be incidental to the Hot Mix Asphalt item.

Removal of existing raised pavement markers that are encountered below the existing pavement will be considered for payment in conformance with GP-4.07.

504.04.01 Price Adjustment for Asphalt Binder. An adjustment will be made to the final Contract unit price of Hot Mix Asphalt if the price of asphalt binder fluctuates significantly from the prevailing price as quoted in the Contract Documents to the date of placement. This includes HMA patching material converted to tons. The Contract unit price will be adjusted by the amount of fluctuation above 5 percent for Contracts scheduled to be paved during more than one construction season or having an estimated mix quantity of 10 000 tons or more. For Contracts completed within one construction season and having an estimated mix quantity of less than 10 000 tons, the adjustment will be based upon the amount of fluctuation above 15 percent. Only the differential percent change beyond the above noted 5 and 15 percent will be used.

For the purpose of making these calculations, a monthly price index will be maintained by the Administration. This index will be the average F.O.B. selling price of asphalt binder at the supplier's terminal in the State of Maryland.

The adjusted Contract unit price of Hot Mix Asphalt will be computed monthly by using the following formula:

$$F = (PP - Pb)/ Pb \times 100$$

where:

F = percent price increase/decrease of asphalt binder.
PP = index price of asphalt binder per ton at placement date, and
Pb = prevailing index price of asphalt binder per ton as specified in the Invitation for Bids.

Adjusted Contract unit price due Contractor when price of asphalt binder increases:

$$A = B + (D \times T \times Pb)$$

Adjusted Contract unit price due Administration when price of asphalt binder decreases:

$$A = B - (D \times T \times Pb)$$

where:

A = adjusted Contract unit price per ton of Hot Mix Asphalt.
B = Contract unit price per ton of Hot Mix Asphalt.
D = differential percentage expressed as a decimal (F – 5 percent or F – 15 percent as defined above).
T = design target asphalt content expressed as a decimal, and
Pb = prevailing index price of asphalt binder per ton as specified in the Invitation for Bids.

504.04.02 Price Adjustment for Hot Mix Asphalt Properties and Pavement Density. A price adjustment may be made as specified in GP-5.02, when the hot mix asphalt properties or pavement density does not conform to Specifications. The Contract unit price will be adjusted in conformance with these procedures. Acceptance and payment factors of specified mixes will be based on density, binder content and gradation. A pay factor for density and a composite pay factor for binder content and gradation will be computed using the Quality Level Analysis - Standard Deviation Method specified in MSMT 730 to determine the total estimated percent of the lot that is within Specification limits. The Lot Payment for density and the Lot Payment for binder content, and gradation shall be computed as follows:

Lot Payment = (Contract Unit Price) x (Pay Factor) x (Tonnage).

A lot containing material with a pay factor of less than 1.0 may be accepted at the reduced pay factor, provided the pay factor for density and the composite pay factor for binder content and grading are both at least 0.75 and there are no isolated defects identified by the Engineer. A lot containing material not conforming to the Specifications may be terminated by the Engineer, and the material in the shortened lot paid for at the reduced pay factor or the Engineer may order removal of the nonconforming material. A lot containing nonconforming material that fails to obtain at least a 0.75 pay factor for density or a 0.75 composite pay factor for binder content and gradation, will be rejected and shall be replaced at no additional cost to the Administration.

If less than three samples have been obtained at the time of the verification sampling or at the time a lot is terminated, the material in the shortened lot will be considered a part of the previous lot, or will be accepted based on the individual test data at the Engineer's discretion.

504.04.03 Control Strip Price Adjustment. The cost of the control strip, if constructed, will not be measured but will be incidental to the pertinent Hot Mix Asphalt item.

SECTION 505 — HOT MIX ASPHALT PATCHES

505.01 DESCRIPTION. This work shall consist of repairing rigid, flexible, or composite pavements by removing part or all of the section of the existing pavement and replacing the removed materials using hot mix asphalt (HMA) paving material. The locations of the repairs will be as specified in the Contract Documents or as directed by the Engineer.

Partial Depth Patching (PDP). PDP shall consist of the removal of areas of unsound pavement material, up to a 50 percent maximum of the pavement thickness in depth, and replace with HMA as specified in the Contract Documents or as directed by the Engineer. The pavement thickness is defined as the thickness of all bound materials in the pavement structure including HMA, portland cement concrete (PCC), and any other asphalt or cement modified materials.

Full Depth Patching (FDP). FDP shall consist of the removal of specified areas of the full thickness of the pavement sections to the top of the aggregate base material and replace with HMA as specified in the Contract Documents or as directed by the Engineer. FDP shall be used whenever the 50 percent maximum pavement thickness for PDP has to be exceeded.

505.02 MATERIALS.

Graded Aggregate Base	901.01
Aggregates for HMA	901.01
Aggregates for Superpave Mixes	901.01 and MP2
Performance Graded Asphalt Binders and Hot Mix Asphalt	904
Crack Filler	911.01
Production Plant	915

505.03 CONSTRUCTION. The existing pavement shall be removed with a minimum disturbance to the base material and the faces of the remaining pavement shall be plane without ragged edges. The use of equipment that could damage the existing pavement is prohibited.

505.03.01 Weather Restrictions. Refer to Section 504.

505.03.02 Existing Pavement. Each day the Contractor shall complete all repairs for which excavation has been completed. Open excavated areas at the end of the work day are prohibited.

Removal of Pavement for PDP. For PDP the existing pavement shall be removed by milling, grinding, or saw cutting and removal to the specified

depth for the full perimeter of the designated area. Where concrete is encountered prior to reaching the specified depth, the depth of the patch shall then be limited to the top elevation of the PCC. Prior to application of the patch, the bottom of the excavation of all PDP shall be inspected and cleaned of all loose and foreign materials. For PDP of composite pavements, the PCC shall not be damaged during removal of the existing HMA and all spalled cracks and joints shall be tack coated, filled, and tamped with HMA before the patch is to be placed. When the material at the bottom of the PDP is determined to be unsuitable and not structurally adequate, additional material shall be removed until sound material is encountered. When PCC is encountered in a composite pavement and determined to be unsuitable, the removal and replacement of the patch shall follow the description and specification of a FDP.

Removal of Pavement for FDP. For FDP the existing pavement shall be removed by making a perpendicular saw cut full depth for the full perimeter of the designated area. The repair shall be excavated to the top of the aggregate base material. Refer to the applicable portions of 522.03.03 for the concrete portion of a composite pavement. The boundaries of the patch shall have square vertical faces after saw cutting.

505.03.03 Base and Subgrade Preparation. The Engineer will evaluate the aggregate base of the FDP area to determine if it is suitable as a foundation for the repair. When the Engineer determines that the aggregate base material is not stable, it shall be compacted as specified in 501.03.10 to the satisfaction of the Engineer. When no aggregate base is present under the pavement, the subgrade foundation shall be constructed as specified in Section 208, and as directed by the Engineer. When the Engineer determines that the aggregate base or subgrade material is unsuitable, the material shall be replaced with graded aggregate base conforming to Section 501. This operation is defined as removal and replacement of unsuitable material. The replacement aggregate material shall be compacted in layers of 4 in. maximum depth. The existing pavement materials that are removed shall be disposed of site immediately by the Contractor.

The Contractor shall protect the aggregate base or subgrade after preparation. No payment will be made for removal and replacement of subgrade that was not protected.

505.03.04 Subgrade Drains. The Engineer may direct that subgrade drains be constructed in areas of wet underlying subgrade or areas where there may be a future drainage problem as determined by the Engineer.

505.03.05 Emergency Filler. The Contractor shall have readily available sufficient cold patch material to completely fill the void of the repair area. This material shall be subject to the approval of the Engineer

and shall be placed and compacted in the void when directed by the Engineer. At the beginning of the next day's work, this material shall be completely removed as directed by the Engineer.

505.03.06 Steel Plates. The Contractor shall have an ample supply of 12 X 14 ft by 1 in. thick steel plates available on the project to cover the emergency filler.

505.03.07 Patch Construction. Patch construction shall conform to the applicable portions of Section 504. Manual operation will be permitted for placement of the HMA. Cores, control strip, and pavement profile measurements are waived. Equipment, placement, compaction, and quality control procedures shall be as approved by the Engineer.

505.03.08 Patch Placement. Prior to placing the HMA, the exposed vertical surface of all adjacent pavement shall be thoroughly cleaned and all vertical surfaces shall be tack coated in conformance with 504.03.04. The HMA mixture may be spread by shovel, rake or other method approved by the Engineer. Placing HMA on a frozen base is prohibited.

Minimum and maximum lift thickness for HMA Superpave mixes shall be maintained during patching in conformance with the following:

HMA SUPERPAVE LIFT THICKNESS		
MIX DESIGNATION (mm)	**MINIMUM (in.)**	**MAXIMUM (in.)**
9.5	1.0	2.0
12.5	1.5	2.5
19.0	2.0	3.0
25.0	3.0	4.0
37.5	4.0	5.0

505.03.09 Testing and Acceptance. Acceptance shall be determined by nuclear in place density test data and witnessed by the Engineer. The nuclear gauge shall be calibrated in conformance with MSMT 417 except that only five randomly selected locations shall be chosen in the first patch. The Contractor shall take one, one minute special calibration nuclear test from each lift of each patch. Test locations shall be randomly selected from within the patch. A special calibration nuclear test is defined as an average of two (minimum) special calibration readings taken at the same location after rotating the nuclear gauge 180 degrees.

Nuclear in place density test data shall be expressed as a percentage of the maximum specific gravity determined for each day's production. The in place density of each patch shall be 92.0 to 97.0 percent.

The results of all nuclear density tests from each patch shall be averaged and compliance will be determined on the basis of each patch tested.

505.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for saw cutting, milling, grinding, removal, disposal, trimming of the existing pavement, subgrade preparation, placing all materials including tack coat, steel plates, emergency filler, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

All steel plates and emergency filler after removal shall remain the property of the Contractor.

505.04.01 Partial Depth Patching and Full Depth Patching will be measured and paid for at the Contract unit price per square yard or per ton as specified in the Contract Documents. The payment will be full compensation for furnishing, hauling, placing all material, additional removal of pavement above the aggregate base, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

505.04.02 Removal of Unsuitable Material and Refill will be measured and paid for at the Contract unit price per cubic yard. The payment will also include excavation and disposal of unsuitable material, backfilling with aggregate, and compaction.

SECTION 506 — GAP-GRADED HOT MIX ASPHALT

506.01 DESCRIPTION. This work shall consist of the placement of a gap-graded hot mix asphalt surface (GGHMA) as specified in the Contract Documents. GGHMA shall conform to Section 504, except as specified herein.

506.02 MATERIALS.

Gap-Graded Hot Mix Asphalt	904.05
Production Plant	915

506.03 CONSTRUCTION.

506.03.01 Demonstration. Before proceeding with the actual work, the Contractor shall demonstrate to the Engineer that a satisfactory mix can be produced, placed, and the compactive effort determined. A minimum of 100 tons of GGHMA shall be placed outside the project limits for the demonstration. A Material Transfer Vehicle may be used as part of the paving operations.

506.03.02 Hauling Units. Dry soap powder, as approved by the Engineer, may be used with the release agent specified in 915.02(f). Truck beds shall be raised to drain excess water before being loaded with GGHMA.

A light dusting of No. 10 aggregate coated with 1 percent asphalt may be used in lieu of the liquid release agent.

The time between plant mixing and shipment shall not exceed one hour (storage time may vary depending upon gradation, type of binder and/or stabilizer. Storage material shall consistently have results of no less quality than mixtures discharged directly into hauling vehicles). Each load shall be completely covered with a full tarp extending a minimum of 6 in. over each side of the truck body and securely fastened.

506.03.03 Weather Restrictions. Placement of GGHMA will be permitted only when the ambient and surface temperatures are at least 50 F.

506.03.04 Material Transfer Vehicle (MTV). When the Contractor elects to use an MTV for paving, the MTV shall be capable of performing additional mixing of the GGHMA and depositing the mixture into the paver at a uniform temperature and consistency. The MTV shall have a system to continuously mix the mixture prior to discharge into the paving equipment.

506.03.05 Mix Temperature. The minimum temperature of the mixture at the time of placement shall be established during the mix design procedure.

506.03.06 Pavement Thickness. The thickness of the pavement shall be as specified in the Contract Documents.

506.03.07 Tack Coat. Refer to 504.03.04 except that the resulting coating shall be residual asphalt applied at a rate of 0.03 to 0.05 gal/yd^2.

506.03.08 Compaction. Compaction shall be performed using a minimum of three static steel-wheeled rollers, each weighing 10 to

12 tons. The rollers shall follow the paver within 500 ft. Rolling shall start immediately after placement. In place density shall conform to 504.03.06, except that the density shall be 94 to 97 percent of maximum density. Sampling and testing shall be performed as specified in 504.03.10.

The rollers shall be equipped with a watering or soapy watering system that prevents material from sticking to the rollers.

Rollers shall not be used in a vibratory mode. Pneumatic wheeled rollers shall not be used on GGHMA. Roller speed shall be between 1.0 and 3.0 mph. Compaction shall be completed before the mix cools below 230 F.

506.03.09 Control Strip. A full lane width control strip having a minimum length of 500 ft shall be constructed on the finished grade prior to paving start up. The control strip will be used by the Engineer to evaluate the application of the tack coat and to determine the compactive effort. Density requirements are not waived.

506.03.10 Pavement Profile. Refer to the Pavement Surface Profile requirements specified in the Contract Documents.

506.04 MEASUREMENT AND PAYMENT. Hot Mix Asphalt Gap-Graded will be measured and paid for at the Contract unit price per ton, complete and in place. The payment will be full compensation for furnishing, hauling, preparing tack coat, placing all materials, material transfer vehicle, antistripping additive, tack coat, control strips, and for all material, labor, equipment, tools, setting of lines and guides where specified, and incidentals necessary to complete the work. The paid tonnage will be based on the combined bulk specific gravity of the aggregate (Gsb) mixture used. When the Gsb is within 2.70 – 2.80 the paid tonnage is the tonnage used; when outside this range use the following formula to determine the pay tonnage.

$$PT = T\,((AC + (AGG \times 2.75/Gsb) + Y)/100)$$

where:

PT = Pay tonnage,

T = Actual tonnage weighed,

AC = Percent by weight of binder,

AGG = Percent by weight of total mixture of mineral aggregates,

Gsb = Calculated combined bulk specific gravity of various mineral aggregates used in mixture, and

Y = Percent by weight of fiber.

Material produced for the demonstration will not be paid for but the cost will be incidental to the item GGHMA.

506.04.01 Price Adjustment. Refer to 504.04 except as follows:

DENSITY PRICE ADJUSTMENT	
PERCENT OF MAXIMUM DENSITY, LOT AVERAGE	**PAY FACTOR %**
Above 97.0	97
94.0 - 97.0	100
92.0 - 93.9	97
90.0 - 91.9	95
Below 90.0	80 or Rejected at Engineer's Discretion

Note: Any sublot below 89.0 percent will be cause for rejection of the entire lot at the Engineer's discretion.

SECTION 507 — SLURRY SEAL

507.01 DESCRIPTION. This work shall consist of constructing a slurry seal course using a slurry seal (SS), or a latex modified slurry seal (LMSS) as specified in the Contract Documents or as directed by the Engineer.

507.02 MATERIALS.

Mineral Filler	901.01
Water	921.01
Aggregate	923.01
Emulsified Asphalt	923.03
Latex Modified Emulsion	923.04

507.03 CONSTRUCTION.

507.03.01 Weather Restrictions. The slurry seal shall only be placed when the air and surface temperatures are a minimum of 50 F, when it is not raining, and when the local weather forecast does not predict

precipitation or the temperature to fall below 40 F within 24 hours from the time the mixture is placed.

When the surface or air temperature falls below the specified limits, placement of the mix shall cease. Material en route may be placed at the Contractor's risk.

507.03.02 Mixing Equipment. Slurry seal shall be produced in a self-propelled, front feed, continuous loading mixing machine. The unit shall proportion and deliver the materials to a revolving, multiblade, shafted mixer and discharge it continuously and uniformly.

The mixer shall have devices that control the proportioning of each material at all times. The mixer shall be calibrated for the mix design in the presence of an Administration representative, or certified calibration documents may be accepted by the Engineer. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, additives, and water to maintain an adequate supply of the materials for the proportioning controls.

Mixing machines shall be equipped with water pressure systems and nozzle spray bars to provide a water spray ahead of and outside the spreader box when required. Mineral filler shall be added to the aggregate in the proper amount before introduction into the mixer.

Truck mounted machines with positive, nonslipping aggregate delivery systems, but without a front feed continuous loading feature, may be used on project segments of less than 15 000 yd^2 or for spot repair projects.

When truck mixing machines are used, a minimum of two shall be on the project prior to construction.

507.03.03 Spreading Equipment. Slurry seal shall be spread uniformly by means of a mechanical squeegee box attached to the mixer and equipped with paddles mounted on an adjustable shaft to continuously agitate and distribute the materials. The equipment shall provide sufficient turbulence to prevent the mix from setting in the box or causing excessive side buildup or lumps. The Contractor shall attach flexible seals to the box in contact with the road, front and rear, to prevent loss of the mixture. Spraying of additional water into the spreader box is prohibited.

507.03.04 Surface Preparation. The surface shall be clean, dry and free of all objectionable materials prior to applying the tack coat and slurry seal.

A tack coat consisting of one part asphalt emulsion to three parts water shall be applied to all surfaces unless otherwise directed by the Engineer. The tack coat shall be the same emulsion type and grade as used in the slurry seal. The application rate shall be 0.05 to 0.10 gal/yd^2 or as determined by the Engineer.

507.03.05 Application. Slurry seal shall be spread to repair slight irregularities and achieve a uniform, skid resistant surface without skips, lumps or tears, as determined by the Engineer.

The Contractor shall use squeegees and lutes to spread the mixture in areas inaccessible to the spreader box and areas requiring hand spreading.

When hand spreading is necessary, additives may be used to provide slower setting time. The SS and LMSS shall be poured in a small windrow along one edge of the surface to be covered and then spread uniformly. A smooth, neat seam shall be constructed where two passes meet. Excess material shall be removed immediately from the ends of each run.

(a) Slurry Seal. The SS shall be applied at the rate of 16 ±2 lb/yd^2 for Type II Mix and 20 ± 2 lb/yd^2 for Type III Mix, based on the dry aggregate weight, unless otherwise specified in the Contract Documents.

(b) Latex Modified Slurry Seal. The LMSS shall be applied in one or two lifts as directed by the Engineer.

For roadways specified to receive one application, the LMSS shall be applied at the rate of 16 ± 2 lb/yd^2 for Type II Mix and 22 ± 2 lb/yd^2 for Type III Mix, based on the dry aggregate weight, unless otherwise specified in the Contract Documents.

When two applications are specified, the material shall be applied at the combined rate of 28 ± 2 lb/yd^2 for Type II Mix and 32 ± 2 lb/yd^2 for Type III Mix.

507.03.06 Certification. Certified weight tickets shall be furnished to the Engineer for the emulsion, latex emulsion, aggregate, and mineral filler used to ensure specified application rates.

507.03.07 Sampling and Testing. The Contractor shall sample the mixtures at least once daily during paving. Each sample shall be placed in a 1 gal container. Samples shall be submitted to the Regional Laboratory for testing. Residual asphalt content, gradation, stability and

flow shall be determined for SS and LMSS in conformance with T 30, T 164 and T 245, Modified.

507.03.08 Tie-Ins for Entrances and Connecting Roads. Tie-ins shall be made at entrances and connecting roads as directed by the Engineer.

507.03.09 Traffic. SS and LMSS shall be capable of curing at rates that will permit traffic on the pavement within two hours and one hour, respectively after application, without damaging the surface. Any damage to the SS or LMSS caused by traffic shall be repaired by the Contractor at no additional cost to the Administration.

507.04 MEASUREMENT AND PAYMENT. Slurry Seal and Latex Modified Slurry Seal will be measured and paid for at the Contract unit price per square yard for one or more of the pertinent items listed below. The payment will be full compensation for furnishing and placing the aggregate, tack coat, tie-ins to entrances and connecting roads, mineral filler, emulsion, latex emulsion and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

507.04.01 Slurry Seal Using Type II Mix (One Coat).

507.04.02 Slurry Seal Using Type III Mix (One Coat).

507.04.03 Latex Modified Slurry Seal Using Type II Mix (One Coat).

507.04.04 Latex Modified Slurry Seal Using Type III Mix (One Coat).

507.04.05 Latex Modified Slurry Seal Using Type II Mix (First Coat).

507.04.06 Latex Modified Slurry Seal Using Type III Mix (Second Coat).

507.04.07 Price Adjustment. Material not conforming to these Specifications may be accepted at a reduced price if the Engineer determines that it is not detrimental to the work. The following price adjustment will apply:

(a) The residual asphalt content of samples will be averaged for each day's production per lift and will be compared to the mix design submitted by the Contractor. A one percent reduction in Contract unit price per square yard will be applied for each 0.10 percent the asphalt content is out of tolerance.

(b) The Contract unit price per square yard will be reduced 0.5 percent for each gram per square foot of Wet Track Abrasion Test loss between 75 and 100 grams in conformance with

MSMT 403. Material having a loss greater than 100 grams will be rejected.

(c) For applications less than the specified rate, the Contract unit price per square yard will be reduced three percent for each pound per square yard below the specified rate. This adjustment will be determined by comparing the certified delivery tickets with the project Specifications. Material applied at more than the specified rate will not be considered for payment.

SECTION 508 — MILLING HOT MIX ASPHALT PAVEMENT

508.01 DESCRIPTION. This work shall consist of milling the hot mix asphalt (HMA) pavement to the depth and at the locations specified in the Contract Documents or as directed by the Engineer.

508.02 MATERIALS.

Hot Mix Asphalt (HMA)	904

508.03 CONSTRUCTION. Roadway patching shall be performed before the milling operation. Additional roadway patching may be required after the milling operation to correct pavement defects made visible by the milling operation. Refer to Section 505 for HMA Patches.

508.03.01 Equipment. The machine for removing the asphalt pavement shall be a power operated planing machine or grinder capable of removing, in one pass, a layer of asphalt pavement not less than half the lane width to be removed. The machine shall be capable of accurately establishing profile grade control and shall have positive means for controlling slope elevation. The resultant surface shall be true to the established grade and shall be skid resistant. Unless otherwise directed by the Engineer, a tolerance of ± 1/8 in. when using a 10 ft straightedge supplied by the Contractor shall be maintained. The machine shall be capable of preventing dust from escaping into the atmosphere.

508.03.02 Pavement Milling. The milling operation shall be performed in only one lane at a time. When milling highways carrying traffic, all milling exceeding 2-1/2 in. shall have the abutting lane or shoulder milled on the same day. When milling to a depth of 2-1/2 in. or less, the Contractor has the option of milling the abutting lane or shoulder on alternate days. The abutting lane or shoulder shall be milled regardless of depth prior to weekends or temporary shutdowns. Where uneven pavement joints exist, the Contractor shall provide adequate advance

warning traffic control devices in conformance with the Contract Documents.

Temporary pavement tie-ins shall be constructed a minimum of 4 ft in length for each 1 in. of milling depth.

In addition to any other equipment required to remove debris from behind the milling operation, a street sweeper equipped with a vacuum shall be used to remove the dust prior to returning the area to traffic.

After the milling operation is complete, all depressions, potholes, and other irregularities shall be filled and any existing water valves, meters, manhole covers, etc., shall be wedged using HMA.

508.04 MEASUREMENT AND PAYMENT.

508.04.01 Milling Hot Mix Asphalt Pavement will be measured and paid for at the Contract unit price per square yard. The square yard measurement will be computed from the actual width and length measurements of the area that has been milled. The payment will be full compensation for milling, the disposal of milled material, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

508.04.02 Filling depressions and potholes, and wedging manholes, valves boxes, inlets, or other structures, using hot mix asphalt will be measured and paid for as specified in 106.04.

508.04.03 Hot Mix Asphalt Patches will be measured and paid for as specified in 505.04.

SECTION 509 — GRINDING HOT MIX ASPHALT PAVEMENT

509.01 DESCRIPTION. This work shall consist of grinding the hot mix asphalt (HMA) pavement to the depth and at the locations specified in the Contract Documents or as directed by the Engineer.

509.02 MATERIALS.

Hot Mix Asphalt (HMA)	904

509.03 CONSTRUCTION. Roadway patching shall be performed before the grinding operation. Additional roadway patching may be

required to correct pavement defects made visible by the grinding operation. Refer to Section 505 for HMA Patches.

509.03.01 Equipment. The grinding equipment shall have a cutting mandrel with carbide tipped cutting teeth and shall be designed specifically for grinding asphalt surfaces to close tolerances. The equipment shall accurately establish slope elevations and profile grade controls.

A vacuum equipped street sweeper, capable of removing all loose material from the roadway without causing dust to escape into the air, shall follow immediately behind the grinding machine.

509.03.02 Control Strip. The Contractor shall grind a control strip. The strip shall be 500 ft minimum in length with a uniformly textured surface and cross section as approved by the Engineer.

The final pavement surface shall have a transverse pattern of 0.2 in. center to center of each strike area. The difference between the high and low of the matted surface shall not exceed 1/16 in.

509.03.03 Pavement Grinding. The designated area shall be ground using the same procedures, settings, and speed, and conform to the same requirements as those used in the control strip.

When necessary, the existing pavement adjacent to the ground pavement areas shall be ground, to maintain an adequate cross slope for drainage. Grinding will not be required on bridge decks.

The grinding operation shall be performed in only one lane at a time. When grinding highways carrying traffic, all grinding exceeding 2-1/2 in. shall have the abutting lane or shoulder ground on the same day. When grinding to a depth of 2-1/2 in. or less, the Contractor has the option of grinding the abutting lane or shoulder on alternate days. The abutting lane or shoulder shall be ground regardless of depth prior to weekends and temporary shutdowns. Where uneven pavement joints exist, the Contractor shall provide adequate advance warning traffic control devices in conformance with the Contract Documents.

Temporary pavement tie-ins shall be constructed a minimum of 4 ft in length for each 1 in. of grinding depth.

After the grinding operation, the pavement surface shall be tested transversely and longitudinally with a 10 ft straightedge furnished by the Contractor. The difference between the bottom of the straightedge and the matted surface shall not exceed 1/8 in. All areas with high spots greater than 1/8 in. within 10 ft shall be corrected by additional grinding

at no additional cost to the Administration. Straightedge requirements apply to areas across joints and repaired cracks but are not applicable to areas outside the ground area.

After the grinding operation is complete, all depressions, potholes, and other irregularities shall be filled and any existing manholes, valve boxes, inlets, or other structures shall be wedged using HMA conforming to Section 504.

509.04 MEASUREMENT AND PAYMENT. Grinding Hot Mix Asphalt Pavement with Carbide Cutting Bits will be measured and paid for at the pertinent Contract unit price per square yard. The square yard measurement will be computed from the actual width and length measurements of the area that has been ground. The payment will be full compensation for grinding, removal and disposal of ground material, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

509.04.01 Filling depressions and potholes, and wedging manholes, valve boxes, inlets, or other structures using hot mix asphalt will be measured and paid for as specified in 106.04.

509.04.02 Hot Mix Asphalt Patches will be measured and paid for as specified in 505.04.

SECTION 510 — FILLING CRACKS IN HOT MIX ASPHALT PAVEMENTS

510.01 DESCRIPTION. This work shall consist of cleaning and filling cracks 1/8 to 1-3/4 in. wide in hot mix asphalt (HMA) pavement as specified in the Contract Documents or as directed by the Engineer. Cracks less than 1/8 in. wide shall not be filled. Distressed areas shall be repaired as specified herein and as directed by the Engineer. Cracks more than 1-3/4 in. wide; and map, edge or alligator cracks requiring major repairs are not included in this Specification (refer to Section 505).

510.02 MATERIALS.

Performance Graded Asphalt Binders and Hot Mix Asphalt (HMA)	904.04
Crack Filler	911.01
Aggregate	M 43, No. 10
Tack Coat	M 140

All materials for crack filling will be inspected, tested and as approved by the Engineer before being incorporated into the work.

510.03 CONSTRUCTION. All cracks to be filled will be designated by the Engineer.

Crack Cleaning and Preparation. Existing filler that has deteriorated shall be removed using equipment capable of removing the material to the required depth without damaging the sides of the pavement within the crack. Equipment which causes a "V" shaped groove is prohibited. The Contractor shall be responsible for all damage to sound pavement as a result of construction operations.

Cracks shall be cleaned by high pressure water blasting, abrasive blasting, oil free air blowing, by use of a heat lance, or a combination thereof as approved by the Engineer. Any operation may be suspended by the Engineer when weather conditions might create a hazard to the traveling public.

Cracks shall be completely dry before filling using methods approved by the Engineer.

Prepared cracks will be inspected by the Engineer for debris, adherent dust, and dryness prior to filling. Cracks rejected by the Engineer shall be recleaned and dried until satisfactory.

Cracks varying in width up to 1-3/4 in. shall be divided into segments. Portions of cracks having widths ranging from over 1 in. and up to 1- 3/4 in. shall be sawn the full depth of the crack and 1/8 in. wider than the maximum width of the crack The crack shall be cleaned of all debris as specified above. A tack coat shall be applied to the sides of the crack. The crack shall be repaired as specified in Section 505 using a surface mix approved by the Engineer. An appropriate asphalt content and mixing temperature shall be selected by the Contractor.

Crack Filling. Both the ambient and pavement surface temperature shall be at least 45 F and rising at the time of filler application, unless otherwise recommended by the manufacturer.

Hot applied filler materials for cracks from 1/8 to 1 in. in width shall be heated as recommended by the manufacturer, in a double boiler, indirect heating kettle using oil as a heat transfer medium, or other equipment approved by the Engineer. The kettle shall have a mechanically operated agitator, recirculation pumps, and a positive thermostatic temperature control. The applicator wand and all connecting hoses shall be insulated. Overheating or direct heating of the filler is prohibited.

Filler that has been overheated, heated more than four hours, or any amount of filler that remains in the applicator at the end of the day's operation shall be withdrawn and wasted. Prior to the start of each day's operation, the Contractor shall withdraw a minimum of 1 gal of filler from the applicator wand to be considered as waste material.

Prepared cracks that have been approved by the Engineer shall be filled until the material is level to 1/16 in. below the pavement surface. Any filled crack not in conformance with this requirement two hours after filling shall be refilled as directed by the Engineer.

Cracks that cannot be filled due to filler drainage into a large void shall be repaired by plugging the void with HMA Superpave 4.75 mm, or other suitable material approved by the Engineer, then filling the crack as specified above.

The Contractor shall remove excess filler from the surface of the pavement.

Field prepared flow panels of hot applied crack filler shall be submitted to the Office of Materials and Technology for the flow test a minimum of twice daily, or as directed by the Engineer.

Cracks shall be filled the same day they are prepared. Cracks that are not filled on the same day they are prepared shall be recleaned, dried, and filled.

Traffic shall not be permitted on the pavement surface until the crack filler has cured.

Filler that pulls loose within 96 hours after opening the pavement to traffic shall be repaired by the Contractor at no additional cost to the Administration.

510.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for furnishing, hauling, and placing of all materials, crack shaping, crack filling, the removal and disposal of old filler and debris, and for all material, labor, equipment, tools, and incidentals necessary to complete the work. Payment will not be made for wasted material.

510.04.01 Filler Removal, Saw Cutting, Crack Shaping, and Crack Filler will be measured and paid for at the Contract unit price per linear foot.

510.04.02 Patching Material for Cracks will be measured and paid for per linear foot regardless of the width or depth of the crack.

SECTION 511 THRU 519 — RESERVED

SECTION 520 — PLAIN AND REINFORCED PORTLAND CEMENT CONCRETE PAVEMENTS

520.01 DESCRIPTION. This work shall consist of constructing plain and reinforced portland cement concrete pavements as specified in the Contract Documents or as directed by the Engineer.

520.02 MATERIALS.

Portland Cement Concrete and Related Products	902
Reinforcement Steel	908
Joint Materials	911
Portland Cement Concrete Plant	915.03
Epoxy Coating for Reinforcement	917.02

Reinforcement, including load transfer assemblies, tie bars, deformed steel bars and longitudinal tie devices shall conform to Section 908 and shall be epoxy coated.

520.03 CONSTRUCTION. At least 30 days prior to the start of paving operations, the Contractor shall submit for approval, a proposed paving plan, including production plants, location of plants with respect to project site, equipment, proposed material sources, and whether the fixed or slip form method shall be used.

The Contractor shall protect the pavement against damage from all causes. Any part of the pavement that is damaged shall be repaired or replaced by the Contractor at no additional cost to the Administration.

Concrete shall be mixed, placed, or finished when natural light is sufficient, or an adequate artificial lighting system approved by the Engineer is operated.

520.03.01 Equipment. All equipment, including the production plant and paving equipment, shall be approved by the Engineer. The plant, including central mixers, batching plant, truck mixers, and hauling equipment shall conform to Section 915. The plant shall be ready for inspection by the Engineer at least 48 hours prior to the start of construction operations. Paving equipment shall be on the job site, ready for inspection, at least 24 hours prior to the start of construction operations.

Slip form pavers shall be self-propelled on crawler tracks, and no other tractive force other than that which is provided and controlled by the paving machine itself shall be applied. The paver shall be capable of being automatically controlled for both alignment and grade.

The equipment and methods used shall provide a means of obtaining the prescribed weights within the allowable tolerances to achieve the consistency specified with a minimum amount of water to achieve proper placement of the mixture in a condition of maximum density with no segregation, and to finish and cure the pavement as specified herein.

520.03.02 Weather Restrictions.

(a) Temperature and Surface Conditions. Concrete placement shall begin only when the ambient air and surface temperature is at least 40 F and rising and discontinued anytime the temperature falls below 40 F. These requirements may be waived for incidental concrete construction. Placing concrete on a frozen base is prohibited.

(b) Precipitation. The Contractor shall have on hand sufficient material, approved by the Engineer, to cover freshly placed concrete as protection against precipitation.

(c) Wind. Concrete shall not be placed when the Engineer determines that the wind would have a detrimental effect on the work.

When weather conditions differ from these limits, material en route from the plant to the job site may be used at the Contractor's risk.

If placement of the material is stopped by the Engineer for any other reason, all material en route shall be disposed of at no additional cost to the Administration.

520.03.03 Foundation. Prior to the installation of fixed forms or the use of slip forms on the foundation, the foundation shall be constructed as specified in the Contract Documents and approved by the Engineer. The total width of the foundation shall be the width of the pavement to be placed, and extend a minimum of 4 in. outside the base of the fixed form or the outermost edge of the slip form paver track or wheel. No additional payment will be made for the extended width.

520.03.04 Forms. Side forms shall be made of steel not less than 7/32 in. thick with a depth equal to the edge thickness of the pavement. Built up forms and warped forms are prohibited. Forms shall be of sufficient strength to resist all loads applied in the paving process. Forms

shall have a base equal to their height and a flat flanged tread or top surface not less than 2 in. wide. Forms shall be a minimum of 10 ft long except for installation along curves with a radius of less than 200 ft. When the curve radius is less than 200 ft, the forms shall be a maximum of 6 ft long or the forms shall be curved. Stake sockets to accommodate a 1 in. diameter steel stake shall be provided at the minimum rate of three in each section of the form except forms less than 10 ft long shall have at least two in each section.

Forms for keyways shall be rigidly fastened to the road form. Holes shall be provided through both forms and keyways to accommodate tie bars or dowels that may be required.

The forms shall be constructed to a tolerance that will ensure proper concrete placement. Tolerances for forms shall be 1/8 in. in 10 ft for the top, and 1/4 in. in 10 ft for the face. The forms shall provide means for locking the ends of abutting sections. Forms shall be clean and coated with an approved form release compound. Forms that are bent, deformed, or broken shall be removed or repaired as directed by the Engineer.

Grade controls shall be set at intervals not to exceed 25 ft. Forms shall be set a minimum of 400 ft prior to concrete placement. When the foundation has been disturbed after the forms have been set to the correct grade, it shall be corrected by the Contractor and approved by the Engineer. The Contractor shall check the alignment and grade for conformance with the Contract Documents. The foundation surface shall be checked using an approved device such as a scratchboard and correction shall be made by the Contractor before concrete placement.

Wooden forms may be approved for use in exceptional cases, such as on curves of very short radius or when a nonstandard length of straight form is required.

520.03.05 Slip Form Paving. Minimum width of slip form paving shall be 24 ft. If 24 ft width is impractical, written approval is required from the Deputy Chief Engineer, Construction. The total foundation width shall be graded using machine methods.

Grade controls shall be set by string lines at intervals not to exceed 25 ft. The foundation shall be constructed as specified in 520.03.03 and completed at least 1000 ft ahead of the paver before paving begins. Paving shall be stopped and a bulkhead construction joint installed whenever the paving machine comes to within 200 ft from the end of the approved foundation. When paving adjacent to an existing pavement, the paver shall have wheels with rubber tires or protective pads on crawler treads. A minimum clearance of 1 ft shall be maintained from the

outermost edge of the paver track or wheel to the edge of the existing pavement.

Slip forms shall be of a length sufficient to prevent slumping or sagging of the sides and top edges of the pavement slab. They shall be spaced and braced to a uniform and constant width and shall also be held vertical. Slip form equipment shall be capable of placing and securing embedded tie bars and keyways in proper position in the plastic concrete before the edge of the pavement slab is free of the slip form.

520.03.06 Reinforcement. Reinforcement shall be as specified in the Contract Documents. Reinforcement shall be kept clean and free from foreign material that may prevent proper bonding of the concrete.

(a) Dowel bars at joints shall be installed on the approved foundation parallel to the foundation grade, sufficiently ahead of the placement of slab reinforcement and concrete. Each dowel bar shall be coated with a water insoluble lubricant acceptable to the Engineer. Dowel bars may be machine placed or set on chairs or prefabricated assemblies approved by the Engineer, providing proper alignment, depth and spacing.

(b) Tie bars for longitudinal construction joints may be placed on chairs or machine placed so that upon the initial set of the concrete they shall be at proper alignment, depth and spacing, and shall be at right angles to the center line of the pavement. Chairs or machine placement devices shall be submitted to the Engineer for approval prior to use.

(c) Fabric and mat reinforcement shall be furnished in flat sheets and shall be kept flat during placement. Reinforcement clearance shall be as specified in the Contract Documents.

(d) When using slip forms, tied reinforcement bars or prefabricated mats may also be installed ahead of the placement of concrete by being supported on chairs set upon the underlying material. Reinforcement installed in this manner shall be in place for a distance ahead of the paver equal to at least 500 ft or a two hour run of the paver before any paving may begin. Paving shall be stopped and a bulkhead construction joint shall be installed whenever it comes to within 100 ft of the end of the steel placement. All reinforcement shall be adequately secured against displacement or movement.

520.03.07 Concrete Placement. Before concrete is placed on the foundation, the foundation shall be in a moist condition. In addition, if the concrete is exposed to the direct rays of the sun and the ambient

temperature is 70 F and rising, the forms and reinforcement shall be sprinkled with cool water just before placement of the concrete. Concrete shall be deposited on the foundation within the forms and rehandling shall be minimized.

Where concrete is to be placed adjoining a previously constructed lane of pavement, mechanical spreading and finishing equipment may be operated upon the existing lane of pavement only after the existing concrete has reached a compressive strength of 3000 psi in conformance with 902.10.03. Wheels that rest on the previously completed concrete shall be flat without flanges, and operated far enough from the edge of the slab to preclude spalling or damage. The tread of the wheels shall not be less than 3 in. wide. Sampling for control testing shall be done at the time of concrete placement and shall conform to 902.10.08.

The total depth of the slab shall be deposited in a single layer except as otherwise specified herein or approved by the Engineer. Two layer placement shall be used for pavement using bar mat or wire fabric reinforcement unless the Contractor demonstrates that the bar mat or wire fabric can be properly supported on devices approved by the Engineer.

Single Layer Placement. Reinforcement shall be set on chairs to maintain the stability and proper elevation of the reinforcement. Welding of reinforcement to the chairs in lieu of wire ties will be permitted, except for epoxy coated reinforcement, welding will be permitted only if the epoxy coating is applied after the welding. Any damage to epoxy coating shall be repaired as directed by the Engineer using materials specified in 917.02.

Two Layer Placement. The placing of concrete and bar mats or wire fabric reinforcement shall be a continuous operation. Concrete shall first be placed to the specified depth of reinforcement; the reinforcement shall then be immediately placed on the freshly deposited concrete. The second layer of concrete shall be placed immediately after the reinforcement is set in place.

520.03.08 Consolidation of Concrete.

Fixed Form Paving. Concrete shall be consolidated by means of immersion type vibrators. The vibrators shall advance with the paving equipment. Vibrator spacing, amplitude and depth shall ensure proper consolidation, clear reinforcement by 1/2 in., and shall be subject to approval by the Engineer. Special care shall be taken to ensure thorough consolidation along the faces of all forms and joint assemblies. Vibrators shall not come in contact with the side forms, joint assemblies, or underlying material. Excessive vibration which results in segregation shall be avoided.

Slip Form Paving. Concrete consolidation systems shall be incorporated in the paving equipment, and shall be submitted to the Engineer for approval.

520.03.09 Finishing.

Machine Finishing. The machine shall be equipped with two transverse screeds with provision for adjustment to ensure that the concrete is placed to the specified crown and grade. Following the transverse screeds, the concrete shall be screeded longitudinally. The width of the working face of the screeds shall not be less than 6 in. A chevron ("V" type) nonreciprocating finishing float or other type as approved by the Engineer shall be used. The float shall be suspended from a frame that does not ride directly on the forms. Following the finishing float, a scraping straightedge 10 ft long, equipped with a long handle shall be used to bring the pavement to the correct grade. When the finishing machine is operated over concrete which has partially set, provisions shall be made to prevent damage to the concrete by the machine wheels.

Hand Finishing. Where approved by the Engineer, hand finishing may be substituted for machine finishing. Rakes are prohibited for handling concrete.

520.03.10 Slab Surface and Thickness Checks.

Surface Check. After finishing, and before texturing of the concrete, the entire surface of the pavement shall be checked with a 10 ft long metal straightedge approved by the Engineer. The surface shall not deviate from a straight line or vertical curve transversely or longitudinally more than 1/8 in. in 10 ft.

Thickness Check. After the pavement is placed and before final acceptance, the thickness will be checked by the Engineer from cores cut by the Contractor. Coring shall be as specified in MSMT 552. Cores shall be spaced every 1000 ft for each lane unless otherwise specified or directed by the Engineer. Core holes shall be filled by the Contractor, at no additional cost to the Administration. When the thickness of pavement is deficient by more than 1 in., the full section of deficient pavement shall be removed and replaced by the Contractor at no additional cost to the Administration. Deficiencies up to 1 in. will be subject to reduced payment as specified in 520.04.

520.03.11 Texturing and Edging.

Texturing. Following concrete finishing and surface check, the roadway surface shall be given a textured finish using a texturing device which produces transverse corrugations 1/8 in. wide by 1/8 in. deep spaced

between 5/8 and 7/8 in. A 2 in. space shall be provided between passes of the texturing device and a 3 in. space provided between the last corrugation and the center line of all transverse joints. Texturing shall begin when the concrete surface is plastic enough to allow texturing to the depth specified but dry enough to prevent the plastic concrete from flowing back into the grooves being formed. Care shall be exercised to avoid overlaps and the tearing of the concrete in the texturing operation. Texturing on open sections shall be uniform for the full width of pavement. On closed sections, the last 12 in. of the roadway adjacent to the curb shall be left untextured to facilitate drainage. The completed textured finish shall be uniform in appearance.

Edging. After texturing the surface, and when the concrete has taken its initial set, transverse and longitudinal slabs shall be edged using a tool with a 1/4 in. radius.

520.03.12 Curing. Following texturing and edging, the concrete shall be cured for a minimum of 72 hours. Whenever the ambient air temperature falls below 40 F during the curing period, insulated blankets shall be used to maintain the concrete temperature above 40 F. Insulated blankets shall be used in addition to of the curing material. The Contractor shall provide a sufficient number of high/low thermometers to monitor the temperature of the concrete. The concrete shall be cured using one of the following methods:

(a) Liquid Membrane Forming Compound. A liquid membrane forming compound used for curing shall conform to 902.07.03 and shall be applied to the surface as soon as the free water has disappeared from the surface. The compound shall be applied using an approved spraying machine having drive wheels that straddle the freshly placed concrete. Standby equipment shall be on site in the event of failure of the spraying machine. The spraying machine shall be equipped with an adequate wind guard and shall produce a fine spray of material that covers the surface with a uniform continuous film. The film shall be free of pin holes and other imperfections and shall be free of checks, cracks or peelings. Discontinuities in the film shall be corrected by application of an additional coat to the affected area within 30 minutes of the original coat. The compound shall be applied in two applications at a rate of 1 gal/200 ft^2 for both coats. Sprayed surfaces subjected to damaging rainfall within three hours after the second application shall be resprayed at no additional cost to the Administration.

Vertical surfaces of longitudinal and transverse joints shall be kept free of curing compound by the use of rope or other masking methods approved by the Engineer. Sprayed surfaces shall be

protected to prevent disruption of the continuity of the membrane. Application of compound by hand operated spraying equipment in irregular areas shall be as directed by the Engineer.

(b) **Burlap Curing.** Burlap conforming to 902.07.01 shall be placed on the freshly placed concrete as soon as practical, without damaging the concrete. Burlap shall be overlapped to provide a double thickness on the entire surface. The burlap shall be saturated with water before placement and kept continuously wet during the curing period.

(c) **Cotton Mat Curing.** Cotton mats conforming to 902.07.04 shall be placed on the freshly placed concrete as soon as practical, without damaging the concrete. Mats shall be saturated with water prior to placement and kept continuously wet during the curing period.

(d) **Sheet Materials.** Sheet materials conforming to 902.07.02 shall be placed on the freshly placed concrete as soon as practical without damaging the concrete. Sheets shall be lapped at least 1 ft and extend outside the slab. Laps and edges shall be held securely in place to provide continuous contact of the sheet with the pavement surface.

520.03.13 Form Removal of Fixed Form Paving. Unless otherwise directed by the Engineer, forms shall remain until the concrete has set at least 12 hours. The sides of slabs that are not damaged shall be cured for the remaining 60 hours of the 72 hour curing period. Damaged or honeycombed areas shall be repaired and cured for an additional 72 hours.

520.03.14 Joints. Joints shall conform to the details specified in the Contract Documents, be perpendicular to the finished grade of the pavement and be sealed as specified in Section 523. Transverse expansion and contraction joints shall be straight and continuous from edge to edge of the pavement.

(a) **Transverse Construction Joints.** Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for 30 minutes or longer. These joints shall be located at a planned joint except in case of equipment breakdown. When concrete placement cannot be continued, the transverse construction joint may be installed within the slab unit but not less than 10 ft from a planned transverse joint. Transverse construction joints shall be doweled as specified in the Contract Documents, and sawed as specified in (c)(1).

(b) Expansion Joints. Expansion joints shall be formed by means of a preformed filler material conforming to 911.02. The filler shall be securely held in position by means of metal supports, as approved by the Engineer, which shall remain in the pavement. A removable metal channel cap bar shall be used to hold the parts of the joint in proper position and protect the filler from damage during concreting operations. The cap bar shall be removable without damage to the pavement to provide a space for sealing of the joint. Adjacent sections of filler shall be fitted tightly together, and shall extend across the full width of the paving lane to prevent entrance of concrete into the expansion space. Expansion joints shall be formed around structures and features that project through, into, or against the pavement, using joint filler of the type, thickness, and width specified in the Contract Documents or as directed by the Engineer.

(c) Contraction Joints. Longitudinal and transverse contraction joints shall be constructed by sawing. If gravel aggregate is used, joints shall be tooled or formed by using an insert approved by the Engineer.

(1) Sawed Joints. Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8 in. blade to the depth as specified in the Contract Documents. The time of sawing shall vary depending on existing and anticipated weather conditions and shall prevent uncontrolled cracking of the pavement. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit cutting the concrete without chipping, spalling, or tearing. Any membrane cured surface damaged during the sawing operations shall be resprayed as soon as the surface becomes dry. After completion of the curing period, the upper portion of the groove shall be widened by sawing to the width and depth specified. The saw blades may be single or gang type, with one or more blades mounted in tandem. Saw cutting into load transfer devices is prohibited. Immediately after the joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly flushed with water until all waste from sawing is removed from the joint.

(2) Insert Type Contraction Joints. Insert type contraction joints shall be constructed by installing a preformed insert in the plastic concrete to form a weakened plane to induce cracking. The equipment for installing inserts shall be a machine equipped with a vibratory bar for cutting a groove in the plastic concrete for placement of the insert or for vibrating the insert into place at the prescribed joint location.

Installation of the insert shall be to the required depth throughout the full width of the paving lane. Vibration units shall be arranged so that the vibration will be uniformly distributed throughout the bar. The intensity of vibration shall be adjustable as necessary to form a groove of proper size for the filler or for forcing the insert into the plastic concrete and consolidating the concrete around the in place insert. For concrete placed by slip form pavers, the edges of the plastic concrete shall be supported to prevent slumping during the vibration and placement of inserts. The vibratory float shall be used following placement of the insert material in lieu of hand floating or troweling the finish. The insert shall be installed in the plastic concrete immediately following the final machine finishing with a maximum of two joint spacings between the finishing machine and the inserter. Additional straightedge and texturing operations shall be accomplished without disturbing the installed insert. Adjacent sections of the joint inserts within each slab unit shall be securely joined together, and the insert shall be thoroughly consolidated against the full depth of the insert. The insert shall be perpendicular to the finished grade of the pavement and shall be straight in alignment at the joint locations specified, with the top of the insert flush or not more than 1/8 in. below the pavement surface.

After the completion of the curing period, the top portion of fiberboard fillers or sawable preformed inserts shall be removed by sawing with a power saw as approved by the Engineer.

520.03.15 Pavement Profile. Refer to Pavement Surface Profile requirements specified in the Contract Documents.

520.03.16 Opening to Traffic. The pavement may be opened to vehicular traffic after having attained a compressive strength of 3000 psi. Tests of field samples shall conform to T 23.

520.04 MEASUREMENT AND PAYMENT. Plain and reinforced portland cement concrete pavements will be measured and paid for at the Contract unit price per square yard for the pertinent Portland Cement Concrete Pavement item. The square yard measurement will be computed on the basis of plan width and as-built length measured along the pavement center line. The payment will be full compensation for all concrete, forms, reinforcement steel, chairs, epoxy coating, finishing, curing, joints, joint construction, saw cutting, and joint sealing and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

520.04.01 Pavement Thickness Price Adjustment. Payment for areas that are accepted at a reduced price for deficient thickness will be adjusted by the factors shown in the following table. Deficiencies will be determined by procedures specified in 520.03.10. There will be no additional payment for excess thickness.

PAVEMENT THICKNESS PRICE ADJUSTMENT	
DEFICIENCY IN INCHES	PERCENT OF PAYMENT CONTRACT UNIT PRICE
0.00 to 0.20	100
0.21 to 0.30	80
0.31 to 0.40	72
0.41 to 0.50	68
0.51 to 0.75	57
0.76 to 1.00	50
Greater than 1.00 *See 520.03.10	0*

SECTION 521 — CONTINUOUSLY REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT

521.01 DESCRIPTION. This work shall consist of constructing continuously reinforced portland cement concrete pavement on a prepared subgrade as specified in the Contract Documents.

521.02 MATERIALS. Refer to 520.02 and the following:

Reinforcement. Reinforcement, including load transfer assemblies, tie bars, deformed steel bars and longitudinal tie devices shall conform to Section 908 and shall be epoxy coated. The Contractor shall select the type of reinforcement from one of the following:

(a) Deformed steel bar mats conforming to 908.07. The longitudinal bars shall be No. 5, Grade 60, and the transverse bars shall be No. 4, Grade 60.

(b) Loose deformed steel bars conforming to 908.01. The longitudinal bars shall be No. 5, Grade 60 with a minimum length

of 40 ft, and the transverse bars shall be No. 4, Grade 60. The longitudinal bars shall have a minimum length of 40 ft.

(c) Welded deformed steel wire fabric conforming to 908.06.

521.03 CONSTRUCTION. Refer to 520.03 except as modified herein.

521.03.01 Placing Reinforcement. The reinforcement shall be preset on chairs or chair bars with the transverse members placed down. Placement of the longitudinal bars shall be within the tolerances specified in the Contract Documents when measured from the top of the pavement to the bottom of the bar.

Rust, mud, oil or other detrimental coatings shall be removed before placing the concrete. The mat or fabric reinforcement shall be flat and free from distortions. Loose steel bars shall be free from kinks or bends that may prevent them from being properly assembled or installed.

Chairs or chair bars shall be designed to support the reinforcement in position without deflection or displacement during the placing and consolidation of the concrete. Chair bases shall have sufficient bearing to prevent overturning or penetration into the subgrade. The design of the chairs shall not impede the placing of the concrete. The Contractor shall obtain the Engineer's approval for the type of chair or chair bar to be used. Welding of chairs to the transverse bars prior to epoxy coating will be permitted.

If the support system does not hold the reinforcement within the specified tolerances, the Contractor shall increase the number of chairs or take other steps to ensure proper positioning of the steel.

521.03.02 Placing Concrete. Concrete shall be placed in one lift, and be internally vibrated over its full width and depth by immersion vibrators mounted at intervals not to exceed 30 in. center to center, across the full width of the slab being placed. The vibrators shall be operated at a frequency and an amplitude sufficient to be perceptible on the surface of the concrete more than 1 ft in any direction and shall be equipped to provide variable controlled frequencies. The battery of vibrators shall advance longitudinally with the paving machinery. The vibrators shall be hinge mounted to facilitate riding over any obstruction and shall be set to clear the reinforcement by approximately 1/2 in.

All screeding and vibrating operations shall stop immediately whenever forward motion of the paving machinery is stopped.

521.03.03 Joints. Transverse expansion or contraction joints are prohibited in continuously reinforced portland cement concrete pavement. Transverse construction of bulkhead joints shall be formed only at the end of any working period or when necessary to stop concreting operations for more than 30 minutes. They shall be formed with an approved header board in conformance with the cross section of the pavement, placed at right angles to the center line, and perpendicular to the surface. Additional bars shall be furnished and installed as specified in the Contract Documents. The pavement shall be finished to the header board without edging. These joints shall be made with extreme care and the bulkhead kept clean. The roadway reinforcement shall extend continuously through the joint. The reinforcement extending through the joint shall be securely supported on chairs or wooden sills to prevent it from deflecting.

Paving operations shall resume when the Engineer determines that the concrete has sufficiently set. The bulkheads and all debris shall be removed, and the joint shall be cleaned before placing concrete against it.

All joints shall be sealed as specified in Section 523.

521.03.04 Terminal Joints. Terminal joints shall be constructed as specified in the Contract Documents.

521.03.05 Thickness Check. Refer to 520.03.10

521.03.06 Pavement Profile. Refer to the Pavement Surface Profile requirements in the Contract Documents.

521.04 MEASUREMENT AND PAYMENT. Continuously Reinforced Portland Cement Concrete Pavement will be measured and paid for at the Contract unit price per square yard. The square yard measurement will conform to 520.04. The payment will be full compensation for all concrete, forms, reinforcement steel, chairs, epoxy coating, finishing, curing, joints, joint construction, saw cutting, and joint sealing, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

521.04.01 Pavement Thickness Price Adjustment. Refer to 520.04.01.

521.04.02 Terminal Joints. Terminal Joints will be measured and paid for at the Contract unit price per linear foot. The payment will be full compensation for all steel beams, stiffener plates, end plates, drilled holes, welding, cutting, styrofoam, joint filler, concrete, reinforcement, bond breaker, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 522 — PORTLAND CEMENT CONCRETE PAVEMENT REPAIRS

522.01 DESCRIPTION. This work shall consist of repairing plain, conventionally reinforced, or continuously reinforced portland cement concrete pavement as specified in the Contract Documents or as directed by the Engineer. Repairs are either Type I, 6 ft to less than 15 ft in length or Type II, 15 ft and greater in length. The minimum repair length shall be 6 ft.

522.02 MATERIALS. Refer to 520.02 except as follows:

Graded Aggregate for Base Course	901.01
Crusher Run Aggregate CR-6	901.01
High Range Water Reducing Admixture	902.06.03
Nonshrink Grout	902.11(c)
Epoxy Grout	902.11(d)
Epoxy Adhesive	921.04

522.02.01 Concrete Mix Design (Modified Mix No. 6). Concrete shall be Mix No. 6 as specified in 902.10.03 except that the minimum cement factor shall be 800 lb/yd^3, contain a high range water reducing admixture and have a minimum compressive strength of 2500 psi in 12 hours. Testing shall conform to 902.10.08 except that cylinders shall remain in the molds until tests are conducted.

522.02.02 Field Control. Field control will be by compressive strength, cement content, slump, water/cement ratio and air entrainment. Acceptance will be based on a minimum compressive strength of 3000 psi in 24 hours. If test results fall below the specified value, a new mix design shall be prepared by the Contractor as directed by the Engineer.

522.02.03 Polyester Grout. The Contractor may substitute polyester grout in lieu of epoxy grout providing the grout conforms to 902.11(d). Cartridge type systems shall be identified with a batch or lot number.

522.02.04 Epoxy Adhesives. Epoxy adhesives shall conform to 921.04 and shall be Type IV, Grade 3, Class B and C, and shall be water insensitive.

522.02.05 Reinforcement. Reinforcement, including load transfer assemblies, tie bars, deformed steel bars and longitudinal tie devices shall conform to Section 908 and shall be epoxy coated.

522.03 CONSTRUCTION. Areas to be repaired and type of repair will be determined by the Engineer. Prior to the start of repairs, the

Contractor shall submit for approval, a proposed repair plan, including equipment, methods and procedures. The Contractor shall protect the repair area against damage from all causes. If any part of the repaired pavement is damaged, it shall be repaired or replaced by the Contractor at no additional cost to the Administration. Repairs shall be made in only one lane at a time for each roadway.

522.03.01 Equipment. Refer to 520.03.01.

522.03.02 Weather Restrictions. Weather restrictions shall be as specified in 520.03.02 except that the work shall be performed during the months of April through October, unless otherwise permitted in writing by the Engineer. When the range in daily temperature is expected to exceed 15 F, concrete placement will be permitted in the late afternoon after the existing pavement has achieved its maximum expansion, unless otherwise directed by the Engineer.

Cold weather protection shall conform to 520.03.12 except that insulated blankets shall be used when the ambient air temperature is less than 70 F.

522.03.03 Saw Cuts and Removal of Existing Pavement. Concrete slabs shall be removed by the lift out method in large sections. No other method of slab removal shall be used unless permitted by the Engineer. All areas where the pavement has been removed shall be repaired in the same working day.

If any portion of adjacent slabs are damaged due to the Contractor's operations, the damaged portions shall be repaired by the Contractor at no additional cost to the Administration.

Saw cuts and pavement removal procedures are as follows:

(a) Plain and Conventionally Reinforced Portland Cement Concrete Pavement. Existing pavement shall be removed by making a perpendicular saw cut, full depth, for the full slab width using a diamond saw blade. Full depth saw cuts shall be spaced a minimum of 2 in. from and parallel to, longitudinal joints between pavement slabs. When repairs are to be made on only one side of an existing transverse joint, the removal shall extend into the adjacent slab a sufficient distance to ensure that existing dowels are removed. The concrete slab shall be removed within one week after the saw cuts have been made. Repairs shall be completed in a continuous operation.

(b) Continuously Reinforced Portland Cement Concrete Pavement. Existing pavement shall be removed by making a

perpendicular saw cut for the full slab width using a diamond saw blade. The concrete slab shall be removed within 72 hours after the saw cuts have been made. This saw cut shall be 2 in. minimum depth, for the full width of the lane at the boundaries of the repair without cutting the steel reinforcement. The boundaries shall be a minimum of 18 in. from the nearest transverse tight crack for normally spaced tight cracks and at least 6 in. from the nearest transverse crack when they are closely spaced. The Contractor shall saw cut, full depth, across the full width of the slab a minimum of 22 in. inside each boundary saw cut. Additional full depth saw cuts shall be made along all longitudinal edges not bounded by construction joints. Concrete shall be removed to its full depth within the boundaries of the repair area. Bending existing reinforcement bars is prohibited.

The equipment used to remove concrete in the areas between each 2 in. and full depth saw cut shall be restricted to a maximum jackhammer size of 60 lb and hand tools only. The existing pavement edge shall be neatly trimmed and vertical. A minimum of 22 in. of reinforcement shall remain exposed on each side of the repair. The Engineer will require the removal of any pavement breaking equipment from the project that could damage the adjacent concrete pavement.

When the saw cuts close due to temperature prior to removal of the existing slab, narrowly spaced, full depth, full width saw cuts shall be made to relieve pressure. The material between the narrowly spaced saw cuts or the longitudinal joint and the 2 in. minimum offset longitudinal cut shall be removed. Removal equipment shall be as specified above. Tie bars protruding from the longitudinal offset cut shall be cut flush with the existing concrete. All waste material shall be immediately removed from the repair site.

Any saw cuts that extend into adjacent slabs, curbs or gutter shall be sealed as specified in Section 523.

522.03.04 Base and Subgrade Preparation. Refer to 505.03.03 except that the subgrade for all types of repairs shall be moistened with water.

522.03.05 Subgrade Drains. The Engineer may direct that subgrade drains be constructed. The work shall conform to Section 306. Additional work shall be as directed by the Engineer.

522.03.06 Forms. The forms used shall conform to 520.03.04, or shall be as directed by the Engineer. Forms shall overlap the existing pavement on each side of the patch a minimum of 1 ft and be securely

fastened to prevent movement when concrete is placed. The Contractor shall excavate the adjacent shoulder the width of the form plus 6 in. to provide space for the forms. After removal of the form, the excavated shoulder area shall be repaired using the same type of material as used in the original shoulder.

522.03.07 Reinforcement. Reinforcement shall conform to the Contract Documents and 520.03.06. Doweled joints shall be located at the slab face closest to the original doweled joint location.

Holes having a diameter 1/4 in. larger than the dowels, load transfer tie bars and longitudinal tie devices shall be drilled into the face of the existing slab at mid depth. After drilling, the hole shall be blown out and allowed to dry. The dowels, load transfer tie bars and longitudinal tie devices shall be grouted or epoxied into place. The alignment of the reinforcement shall be in the direction of the pavement and parallel to the plane of the surface.

A plastic grout retention disk conforming to the Contract Documents shall be placed on each dowel to prevent loss of the bonding material.

Reinforcement steel bars for continuously reinforced portland cement concrete pavement shall be the same size and spacing as the existing steel and shall be spliced to the exposed steel of the existing pavement by lapping, welding or using a mechanical device that is approved by the Engineer. For lap splices, the steel reinforcement shall be lapped a minimum of 22 in. and secured with tie wires. Longitudinal steel reinforcement bars shall be continuous for the full length of the repair and the amount of steel in the repair area shall be at least equal to the amount of steel in the existing pavement. The reinforcement steel bars shall be supported by chairs or as approved by the Engineer.

For plain and conventionally reinforced pavement, the protruding ends of the dowel bars shall be coated with a water insoluble lubricant approved by the Engineer.

522.03.08 Joints. Joints shall conform to 520.03.14 and the Contract Documents.

All joints shall be sealed as specified in Section 523.

522.03.09 Concrete Placement. Concrete placement shall conform to 520.03.07. Prior to placing concrete, the exposed vertical surfaces of all adjacent concrete shall be cleaned.

Refer to 520.03.02 for weather requirements. The temperature of the concrete at placement shall be 50 to 90 F.

Concrete for continuously reinforced portland cement concrete pavement shall be placed when the air temperature is a minimum 40 F and rising. When the range in daily temperature is expected to exceed 15 F, placement of concrete will be permitted in the late afternoon after the existing pavement has achieved maximum expansion unless otherwise directed by the Engineer.

Plain and continuously reinforced concrete pavement repairs shall be cast in one full depth operation. Conventionally reinforced concrete pavement repairs shall be placed in two equal lifts with the wire mesh laid on the surface of the first lift.

All concrete shall be vibrated.

522.03.10 Finishing. Following the concrete placement, the surface shall be struck off to the finished grade by means of an adjustable steel or wooden template and floated to a smooth finish. The repair shall be screeded longitudinally to provide uniformity of ride to adjacent pavement. The final surface shall match the contour of the existing roadway. The Contractor shall provide a metal straightedge and perform surface checks as specified in 520.03.10.

522.03.11 Curing. The concrete shall be cured as specified in 520.03.12 except that the curing shall continue for 12 hours after placement of the concrete or until the repair is put into service.

522.03.12 Emergency Filler. The Contractor shall have readily available sufficient crusher run aggregate CR-6 to completely fill the void of the repair area. The material shall be placed and compacted in the void and covered with a steel plate when directed by the Engineer. At the beginning of the next day's work, this material shall be completely removed using procedures which shall not disturb the subgrade, dowels, load transfer tie bars, load transfer assemblies or reinforcement that has been previously placed.

522.03.13 Steel Plates. The Contractor shall have an ample supply of 12 X 14 ft by 1 in. thick steel plates available on the project to cover emergency filler or be placed over the patch area until the concrete has developed sufficient strength to carry traffic.

522.03.14 Unacceptable Repairs. Pavement repairs that have been damaged by traffic or other causes or are not in conformance with the Contract Documents shall be removed and replaced by the Contractor at no additional cost to the Administration.

522.04 MEASUREMENT AND PAYMENT. Portland Cement Concrete Pavement Repairs will be measured in place and paid for at the

Contract unit price for one or more of the items listed below as specified in the Contract Documents. The payment will be full compensation for saw cuts, furnishing, hauling, placing of all materials, removal and disposal of old concrete, grout, drilled holes, chairs, all tie devices, reinforcement, epoxy coating, steel plates, emergency filler, joint sealing, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Steel plates and emergency filler shall remain the property of the Contractor at the completion of the project.

522.04.01 Plain Portland Cement Concrete Pavement Type I Repairs per square yard.

522.04.02 Plain Portland Cement Concrete Pavement Type II Repairs per square yard.

522.04.03 Conventionally Reinforced Portland Cement Concrete Pavement Type I Repairs per square yard.

522.04.04 Conventionally Reinforced Portland Cement Concrete Pavement Type II Repairs per square yard.

522.04.05 Continuously Reinforced Portland Cement Concrete Pavement Type I Repairs per square yard.

522.04.06 Continuously Reinforced Portland Cement Concrete Pavement Type II Repairs per square yard.

522.04.07 Removal of Unsuitable Material and Refill per cubic yard. The payment will also include excavation and disposal of unsuitable material, backfilling with aggregate, and compaction.

522.04.08 Subgrade Drains will be measured and paid for as specified in the applicable portions of Section 306.

522.04.09 Shoulder Repairs per square yard. Repairs to existing shoulders necessitated by the placement of forms are also included.

SECTION 523 — JOINT SEALING OF PORTLAND CEMENT CONCRETE PAVEMENTS

523.01 DESCRIPTION. This work shall consist of cleaning and sealing portland cement concrete pavement joints as specified in the Contract Documents or as directed by the Engineer.

523.02 MATERIALS.

Joint Sealers	911.01
Preformed Joint Fillers	911.02

Backer Rod. Backer rod used with joint sealer shall be flexible, compressible, nonshrinkable, have a surface that will prohibit bond with the joint sealer, and be capable of uniformly containing the joint sealer within the desired shape factor. Hard rubber and materials that deform at sealer application temperatures or swell when wet are prohibited.

523.03 CONSTRUCTION. Joints shall be sealed the same day they are shaped and prepared, and shall be completed prior to opening the roadway to traffic, unless otherwise directed by the Engineer. Joints not sealed the same working day shall be recleaned and dried as specified in 523.03.02.

523.03.01 Joint Construction. Joint construction shall be as specified in 520.03.14. When the joint is tooled, preformed joint fillers are prohibited.

523.03.02 Joint Preparation. Joints shall be cleaned by one of the following methods as approved by the Engineer:

(a) High pressure water blasting.

(b) Abrasive blasting.

(c) Oil free air blowing at a minimum of 90 psi.

All joint walls and surfaces to which the joint material is to adhere shall be dry prior to installing the joint filler.

All prepared joints will be inspected and approved by the Engineer prior to sealing.

523.03.03 Sealing. Preformed joint filler shall be installed in conformance with the manufacturer's recommendations and the Contract Documents. The Contractor shall insert the backer rod as specified in the Contract Documents.

Silicone sealer shall be installed in conformance with the manufacturer's recommendations.

Backer rods are not required in longitudinal joints.

The ambient air and pavement temperatures shall both be a minimum of 45 F and rising at the time of sealer application.

Sealer that is hot applied shall be heated as specified in the manufacturer's recommendations in a kettle or other equipment acceptable to the Engineer. The kettle shall have a mechanically operated agitator, recirculation pumps, and a positive thermostatic temperature control. The applicator wand and all connecting hoses shall be insulated. Overheating or direct heating of the sealer is prohibited.

Sealer that has been overheated, subjected to heating for more than four hours, or any amount that remains in the applicator wand at the end of the day's operation shall be withdrawn and disposed of. Prior to the start of each day's operation, the Contractor shall withdraw and dispose of a minimum of 1 gal of sealer drawn from the container through the applicator wand.

All joints shall be filled with sufficient material that will result in the final surface of the sealer being recessed 1/4 in. below the surface of the pavement. Any joint with the sealer recessed more than 5/16 in. below the surface of the pavement two hours after sealing shall be resealed.

Silicone sealer shall be tooled so that the final surface of the sealer will have a parabolic shape in the surface cross sectional area. The deepest point at the center of the joint shall be 5/16 in. below the pavement surface. The Contractor shall use a tool approved by the Engineer that is capable of obtaining the parabolic shape at the surface of the sealer.

Curing time for silicone material varies with temperature and humidity and therefore may delay opening the pavement to traffic. The Contractor is advised to consult the manufacturer's recommendations for curing time.

The Contractor shall remove any excess sealer from the surface of the pavement.

All traffic shall be kept off the pavement surface until the sealer has cured.

Any sealer that pulls loose from the joints or shows excessive bubbling within one week after opening the pavement to traffic shall be replaced by the Contractor at no additional cost to the Administration.

523.04 MEASUREMENT AND PAYMENT. Joint Sealing of Portland Cement Concrete Pavement will be measured and paid for at the Contract unit price per linear foot of joint unless otherwise specified in the Contract Documents. The payment will be full compensation for cleaning existing joints, furnishing, hauling, placing all materials including preformed joint filler, joint sealer, backer rod, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Joint construction and sealing will not be measured but the cost will be incidental to the Contract unit price for the pertinent Portland Cement Concrete Pavement item.

SECTION 524 THRU 548 — RESERVED

SECTION 549 — PERMANENT PAVEMENT MARKINGS

549.01 DESCRIPTION. This work shall consist of furnishing and applying permanent pavement markings to various surfaces at locations and patterns as specified in the Contract Documents or as directed by the Engineer. This includes line markings, letters, numbers, arrows, and symbols.

549.02 MATERIALS.

Permanent Pavement Markings	Refer to Contract Documents

All pavement marking material shall be evaluated on the National Transportation Product Evaluation Program (NTPEP) North Regional Facility test deck. The Contractor shall provide the Engineer with a printed copy of the manufacturer's recommendations for use and installation of pavement markings. All pertinent material safety data sheets (MSDS) shall also be included with the manufacturer's information sheets.

549.03 CONSTRUCTION.

549.03.01 Quality Assurance/Quality Control. The Contractor shall submit in writing, a proposed Quality Control Plan, conforming to the Quality Control Plan requirements. This plan shall be submitted to the Engineer for approval before the prestriping meeting and at least two weeks prior to the start of work. The plan shall contain procedures for random sampling as specified in MSMT 729, and shall show how the Contractor proposes to control the equipment and material to ensure conformance with the Specifications. The plan shall contain personnel certifications, inspection, and record keeping procedures, and minimum frequencies of sampling and testing as specified in MSMT 729. The plan shall also detail when and how corrective action will be taken for unsatisfactory construction practices and deviations from the Specifications. Any deviation from the Quality Control Plan shall be cause for immediate suspension of the marking operation and a meeting

between the Contractor and the Administration will be required prior to restarting of pavement marking.

(a) Placement. Permanent pavement marking placement operations shall not begin until the Engineer has approved the Contractor's Quality Control Plan.

(b) Certified Technicians. Quality control technicians shall have a current Administration certification document to be presented to the Engineer.

(c) Records. The Contractor shall maintain complete records of quality control inspection results, including any action taken to correct problems, and shall submit copies to the Engineer daily. The Contractor shall identify where the quality control tests were performed.

(d) Quality Assurance. The Administration will provide quality assurance by:

(1) Conducting independent sampling and testing separate from the Contractor.

(2) Periodically observing testing performed by the Contractor.

(3) Directing the Contractor to take additional samples and perform additional tests at any time and at any location.

(4) Monitoring the Contractor's conformance with the Quality Control Plan.

Certified Technicians. The Contractor shall provide Administration certified technicians to perform quality control testing and sampling. The technicians shall demonstrate to the Engineer that they have a thorough knowledge of sampling and testing procedures as specified in MSMT 729. Quality control shall be performed during the marking operations in conformance with the approved Quality Control Plan. The Contractor shall identify where quality control tests were performed. Quality control test results shall be submitted to the Engineer at the end of each work day for that day's work. Should a certified technician become delinquent in any of their duties (i.e., failed to have all the proper test equipment on the site, failed to perform tests, failed to submit documents to the Engineer at the end of the day, reported information that varies substantially from the Administration's results), then the technician's certification shall become invalid and a recertification shall be required. All pavement marking operations shall be suspended until the Contractor provides a certified replacement technician.

Evaluation of quality control results and testing performed by the Administration will provide the basis for final acceptance.

Independent assurance audits will be performed by the Administration to confirm and assure that both the quality control personnel's test methods and quality control test equipment are in reasonable conformity with Administration specifications.

549.03.02 Cleaning Pavement Surfaces. Pavement surfaces shall be dry and free of oil, dirt, grease, and other contaminants prior to application of pavement markings. Surfaces not in conformance shall be cleaned by the Contractor to a width 4 to 6 in. wider than the marking to be applied.

Existing pavement markings that conflict with new or altered traffic patterns shall be completely removed by the Contractor. The method used by the Contractor for removal shall not damage the pavement surface and shall be approved by the Engineer. Any pavement damaged shall be repaired or replaced as determined by the Engineer at no additional cost to the Administration.

549.03.03 Application. Before any pavement marking work is begun, a schedule of operations shall be submitted to and approved by the Engineer. All pavement markings shall be applied in conformance with the manufacturer's recommendations.

When permanent pavement markings are applied under traffic, the Contractor shall provide all traffic control necessary to maintain and protect traffic in conformance with the MUTCD and the Contract Documents. The Contractor shall secure the pavement marking operations and protect the markings until they are thoroughly set. All longitudinal pavement markings shall be applied in the direction of traffic. Placing pavement marking material over longitudinal joints is prohibited.

Pavement markings shall conform to the following:

(a) Temperature. Material shall be applied as specified at the manufacturer's recommended ambient, surface and material temperatures.

(b) Thickness. Refer to the Contract Documents for the type of material being applied.

(c) Glass Beads. Refer to the Contract Documents.

(d) Color. Refer to the Contract Documents for the proper color.

(e) Widths. The traveled way lane widths and the width of longitudinal lines shall be as specified in the Contract Documents. Lane widths shall be measured from the center of the line to the center of the line once a control line is established for the lane configuration of the roadway. When measurements are taken from existing longitudinal lines, the point of reference shall be the center of the single line or the center of the space between dual lines. The traveled way lane widths shall be in compliance when they have an acceptable appearance and do not deviate more than 2 in. from the proposed lane width.

(f) Alignment. Markings shall be placed in a straight and uniform manner. Lane lines shall be in compliance when they have an acceptable appearance, and are visually in alignment, with no more than a 3/8 in. variation in any 40 ft section of traveled way.

Longitudinal alignment shall be maintained through all intersections and breaks, even though the lines themselves may discontinue.

(g) Curing. Refer to the Contract Documents.

(h) Retroreflectance. The minimum retroreflectance of the permanent pavement markings shall be the millicandellas/ lux/square meter values specified in the Contract Documents. The retroreflectance of the pavement markings shall be determined using a calibrated 15 m or 30 m geometry retroreflectometer supplied by the Contractor and tested as specified in MSMT 729. An average of five readings shall be used at each site to determine conformance with the Contract Documents and as specified in MSMT 729. The retroreflectometer shall be calibrated annually by the manufacturer and a copy of the calibration certification shall be submitted to the Engineer for that project. The instrument shall be standardized daily in conformance with the manufacturer's recommendations.

(i) Layout Markings. Any layout markings that detract from the overall appearance or function of the final markings as determined by the Engineer shall be removed at no additional cost to the Administration.

(j) Empty Containers. The Contractor shall remove and dispose of all empty containers and other debris related to the pavement marking operation from the project site.

Noncompliance with the Contract Documents during the pavement marking operation shall be just cause to suspend the operation. A

meeting shall be held to review the Quality Control Plan to assure that continued operations will be in compliance. Areas of noncompliance will be identified by the Engineer and correction will be as defined in the Quality Control Plan. Any incorrect markings shall be completely removed by corrective actions.

549.03.04 Quality Control Test Strip. Before beginning work with each color, the Contractor shall place a 200 to 300 foot cumulative quality control test strip of pavement marking material that conforms to the Contract Documents at a location to be determined by the Engineer. Additional control strips may be required at the Engineer's discretion. Authorization to proceed will be given when the Contractor demonstrates to the Engineer that the quality control test strip conforms to the Contract Documents.

549.03.05 Curing. The Contractor shall protect the markings until dry or cured by placing warning devices as specified in the MUTCD and as approved by the Engineer. In the event that the uncured marking is damaged by a vehicle, the marking shall be reapplied, and marks left on the pavement by the vehicle shall be removed. This work shall be performed at no additional cost to the Administration.

549.03.06 Observation Period. The Contractor shall be responsible for any defects in materials and workmanship of the pavement markings for a period of 180 days for durable materials and 60 days for nondurable materials from the date the pavement is opened to traffic.

During the observation period, the permanent pavement marking material shall show no signs of failure due to blistering, excessive cracking, bleeding, staining, discoloration, oil content of the pavement materials, smearing or spreading under heat, deterioration due to contact with grease deposits, oil, diesel fuel, or gasoline drippings, chipping, spalling, poor adhesion to the pavement, or loss of reflective beads.

A minimum of 95 percent of the applied markings shall remain intact during the observation period as determined by the Engineer.

When required, removal of pavement markings shall be performed by the Contractor with no damage to the pavement surface. Any damage incurred shall be the responsibility of the Contractor to repair or replace the pavement surface as determined by the Engineer.

549.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all pavement preparation, furnishing and placing of markings, testing, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Permanent pavement markings and the removal of existing pavement markings will be measured and paid for at the Contract unit price for one or more of the following items:

(a) Permanent Pavement Markings will be measured and paid for at the Contract unit price per linear foot for the color and width specified.

(b) Permanent Pavement Marking Letters, Symbols, Arrows, and Numbers will be measured and paid for at the Contract unit price per each.

(c) Removal of Existing Permanent Pavement Markings will be measured and paid for per stripe at the Contract unit price per linear foot, regardless of width.

(d) Removal of Existing Permanent Pavement Marking Letters, Symbols, Arrows, and Numbers will be measured and paid for at the Contract unit price per each.

549.04.01 Removal, Replacement, or Corrective Actions. Any additional cost (including Maintenance of Traffic) for the removal of markings that are incorrectly or inaccurately installed or failed the observation period, shall be at no additional cost to the Administration. In addition, the current road users fee will be applied when traffic disruption occurs during corrective actions.

CATEGORY 600
SHOULDERS

SECTION 601 — EARTH SHOULDERS

601.01 DESCRIPTION. This work shall consist of constructing shoulders using earth as specified in the Contract Documents.

601.02 MATERIALS. Refer to Section 204.

601.03 CONSTRUCTION. Refer to 204.03 and 208.03.

601.04 MEASUREMENT AND PAYMENT. Earth shoulders will not be measured but the cost will be incidental to the Contract unit price for the pertinent Excavation item.

SECTION 602 — CURB, COMBINATION CURB AND GUTTER, AND MONOLITHIC MEDIAN

602.01 DESCRIPTION. This work shall consist of constructing concrete curb, concrete combination curb and gutter, concrete curb openings, concrete monolithic median, and hot mix asphalt (HMA) curb as specified in the Contract Documents or as directed by the Engineer.

602.02 MATERIALS.

Crusher Run Aggregate CR-6	901.01
Aggregate	901.01, Size No. 57
Curing Materials	902.07
Form Release Compound	902.08
Concrete Mix No. 2	902.10
Hot Mix Asphalt	904
Tack Coat	904.03
Reinforcement Steel	908.01
Joint Sealer	911.01
Preformed Joint Filler	911.02
Borrow Excavation	916.01

602.03 CONSTRUCTION.

602.03.01 Concrete Curb, Combination Curb and Gutter, and Monolithic Median.

(a) Excavation. Excavation shall be to the specified depth and to a width that permits installation and bracing of the forms. The subgrade shall be compacted to 92 percent density in conformance with T 180, Method A, and trimmed to the proper shape and required grade. All soft and unsuitable material shall be removed and replaced with suitable material approved by the Engineer.

(b) Forms.

(1) Fixed Form Method. Fixed forms shall be steel of an approved design, securely fastened and braced to prevent any movement during the placing of concrete. Forms shall extend to the full depth of the concrete and be a minimum of 10 ft long. When installation is made along curves where the radius of the curb face is less than 200 ft, flexible or curved steel or wooden forms a maximum of 6 ft long shall be used. Both wooden and steel forms shall be properly designed, acceptable to the Engineer, and installed to prevent buckling or warping. The tolerance shall not exceed 1/4 in. in 10 ft in either the grade or alignment. Forms shall be thoroughly cleaned and coated with a form release compound each time they are used.

(2) Slip-Form Method. Refer to 603.03.01(b).

(c) Concreting. Concrete shall be mixed in conformance with 915.03.04. Volumetric batching and continuous mixing will be permitted. When the subgrade is dry, it shall be moistened with as much water as it can absorb. Consolidation of concrete placed in the forms shall be by spading or other methods approved by the Engineer. Except for curb face forms, the forms shall remain in place for a minimum of 12 hours and precautions taken to avoid damaging the concrete. Curb face forms shall be stripped as soon as the concrete will retain its shape.

(d) Depressed Curbs. Curbs shall be depressed at entrances and sidewalk ramps as specified in the Contract Documents or as directed by the Engineer.

(e) Openings. Drainage openings for the purpose of outletting rain spout water or other drainage shall be provided by constructing insert openings within the curb as directed by the Engineer.

Curb openings shall be provided as specified in the Contract Documents.

(f) Finishing. Concrete shall be struck off to the cross section specified after which it shall be finished, floated smooth and followed with a broom type textured finish. The Engineer may permit other methods of finishing for the purpose of matching adjacent concrete finishes. Plastering is prohibited. All exposed edges shall be edged with a 1/4 in. edging tool except the face edge of curb shall have a 1 in. radius. When finished, the top surface of curbs and medians as well as the faces shall show no deviation from grade and alignment in excess of 1/4 in. per 10 ft. All honeycombed and damaged areas shall be repaired immediately after the removal of the forms in a manner acceptable to the Engineer.

(g) Joints.

(1) Fixed Form Method. Spacing between joints shall be 10 ft except where shorter spacing is necessary for closures and conformity to expansion and contraction joints in contiguous concrete pavements. No joint spacing shall be shorter than 4 ft. The joints shall be formed by using plate steel templates 1/8 to 3/16 in. thick and shall have a width and depth equal to the unit cross section. The templates shall be set perpendicular to the grade and line of the unit. Intermediate templates or sections of templates are prohibited. Where stationary structures such as bridges and inlets are encountered, an expansion joint shall be constructed for the full depth using 1/2 in. preformed expansion joint filler. Expansion joints shall be constructed at points of curves, tangents, at locations coinciding with adjoining pavement joints and as specified in the Contract Documents or as directed by the Engineer. Only the joints in the gutter portion of the combination curb and gutter and 1 in. up the face of all joints and expansion joints of monolithic medians shall be sealed. Expansion joints are not required when adjacent to a flexible pavement or away from any pavement.

(2) Slip-Form Method. Joint construction shall be as specified in 604.03.01(b), except that joint spacing shall be as specified in 602.03.01(g)(1).

(h) Cold Weather Construction and Curing. Refer to 520.03.02 for cold weather construction and to 520.03.12 for concrete curing.

(i) Backfill. After the forms have been stripped and any necessary repairs are satisfactorily completed, the spaces in front and back of the curb, combination curb and gutter, and median shall be backfilled to the required elevations using material approved by the Engineer prior to any adjacent roadway rolling.

602.03.02 HMA Curb. HMA curb shall be placed by a self-propelled machine. The machine shall form curbing that is uniform in texture, shape, density and to a template as specified in the Contract Documents unless otherwise approved by the Engineer.

The base upon which the curb is to be placed shall be clean, dry and stable. It shall be tack coated with asphalt of the type and amount as directed by the Engineer.

When required, the curb shall be backfilled after it has sufficiently hardened to prevent damage. The backfill shall be consolidated by tamping or rolling.

602.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all concrete, hot mix asphalt, forms, excavation, backfill, disposal of excess material, drainage openings, joint sealer, tack coat, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

The removal and disposal of unsuitable material will be measured and paid for at the Contract unit price for Class 2 Excavation, which price shall include the cost of using suitable excavation as replacement material. When Borrow or Selected Backfill is authorized as replacement material, payment will be made at the Contract unit price bid for the respective items.

When existing curb or combination curb and gutter is removed and replaced with new curb or combination curb and gutter, the cost of the removal will be incidental to the Contract unit price for the new item.

602.04.01 Curb, Combination Curb and Gutter and Monolithic Median will be measured and paid for at the Contract unit price per linear foot. Hot Mix Asphalt Curbs, Concrete Curbs, and Concrete Combination Curb and Gutter will be measured along the front face of the curb. Concrete Monolithic Median will be measured along the center line of the finished top of median.

602.04.02 Concrete Curb or Concrete Combination Curb and Gutter Openings will be measured and paid for at the Contract unit price per each.

SECTION 603 — SIDEWALKS

603.01 DESCRIPTION. This work shall consist of constructing hot mix asphalt (HMA) or concrete sidewalks and sidewalk ramps as specified in the Contract Documents or as directed by the Engineer.

603.02 MATERIALS.

Curing Materials	902.07
Form Release Compound	902.08
Concrete Mix No. 2	902.10
Hot Mix Asphalt (HMA)	904
Welded Wire Fabric	908.05
Joint Sealer	911.01
Preformed Joint Fillers	911.02

603.03 CONSTRUCTION.

603.03.01 Concrete Sidewalks.

(a) Excavation. Refer to 602.03.01(a).

(b) Forms.

(1) Fixed Form Method. Fixed forms shall be of steel or wood and shall extend to the full depth of the concrete. All forms shall be straight, free from warp and of sufficient strength to resist the pressure of the concrete without displacement. Bracing and staking of forms shall be so that the forms remain in both horizontal and vertical alignment until their removal. The forms shall be thoroughly cleaned and coated with form release compound each time they are used. The concrete shall be set for a minimum of 12 hours before the forms are removed and every precaution shall be taken to avoid damaging the concrete.

(2) Slip-Form Method. Slip-form construction shall conform to the method specified in 604.03.01(b) except that joint construction shall conform to 603.03.01(e).

(c) Concreting. Before placing concrete the subgrade shall be moistened with as much water as it can absorb. The concrete

shall be mixed in conformance with 915.03.04. Volumetric batching and continuous mixing will be permitted. Concrete shall be deposited on the prepared subgrade in successive batches to the full width of the sidewalk. It shall be thoroughly spaded along the edges and shall be tamped to eliminate voids. It shall be struck off, screeded to the elevation of the top of the forms and finished.

(d) Finishing. The surface shall be floated and broom finished. Plastering of the surface is prohibited. All outside edges and all joints shall be edged with a 1/4 in. edging tool.

(e) Joints. Joints shall be placed as specified in the Contract Documents. Dummy joints shall be tooled or sawed a minimum of 3/4 in. deep.

Joints shall match adjacent joints in curb or pavement. Expansion joint material shall extend the full depth of the concrete.

(f) Cold Weather Protection and Curing. Refer to 520.03.02 for cold weather protection and to 520.03.12 for concrete curing. During the curing period, all pedestrian and vehicular traffic is prohibited.

(g) Joint Sealing. Expansion joints shall be cleaned of dirt or other foreign material prior to placement of the joint sealing compound. Joint walls and all surfaces to which the sealing material is to adhere shall be surface dry for at least three hours prior to sealing. No sealing material shall be used until the joints are acceptable to the Engineer. The surface of the sealing compound shall be a maximum of 1/8 in. below the level of the sidewalk surface.

603.03.02 HMA Sidewalks.

(a) Excavation. Excavation, subgrade and forms when required shall conform to 603.03.01(a) and (b).

(b) Placement. HMA sidewalk shall conform to 504.03.05. When the sidewalk is not formed, backfill material acceptable to the Engineer shall be used to form an 18 in. wide earth shoulder for the HMA or as specified in the Contract Documents.

(c) Compaction. Compaction shall be accomplished by means of a roller approved by the Engineer. In areas inaccessible to the roller, a vibrating plate compactor or hand tamping may be used. In any case, the HMA shall be uniformly compacted. Compactive effort shall start as soon as the HMA can be

compacted without displacement and shall continue until the material is thoroughly compacted and all marks have been removed.

603.03.03 Backfill. After the forms have been stripped and any necessary repairs are satisfactorily completed, the spaces in front and back of the sidewalk shall be backfilled to the required elevations using material approved by the Engineer.

603.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all excavation, backfill, disposal of excess or unsuitable material, forms, reinforcement when specified, joints, sealer, compaction, curing, finishing, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

The removal and disposal of unsuitable material will be measured and paid for at the Contract unit price for Class 2 Excavation, which price shall include the cost of using suitable excavation as replacement material. When Borrow or Selected Backfill is authorized as replacement material, payment will be made at the Contract unit price bid for the respective items.

When the existing sidewalk is removed and replaced with a new sidewalk, the cost to remove the existing sidewalk will be incidental to the Contract unit price for sidewalk.

603.04.01 Concrete Sidewalks will be measured and paid for at the Contract unit price per square foot of finished surface including sidewalk ramps.

603.04.02 Hot Mix Asphalt Sidewalks will be measured and paid for at the Contract unit price per ton for the mixture placed.

SECTION 604 — CONCRETE TRAFFIC BARRIERS

604.01 DESCRIPTION. This work shall consist of constructing concrete traffic barriers as specified in the Contract Documents or as directed by the Engineer.

604.02 MATERIALS.

Crusher Run Aggregate CR-6	901.01
Aggregate	901.01, Size No. 57
Curing Materials	902.07

Form Release Compound	902.08
Concrete Mix No. 2	902.10
Concrete Mix No. 6	902.10
PVC Pipe	905
Reinforcement Steel	908
Preformed Joint Fillers	911.02
Borrow Excavation	916.01
Geotextile	921.09
Reflective Delineators	As approved by the Office of Traffic and Safety

All concrete traffic barriers, end transitions, and footers shall be constructed using concrete mix No. 6 unless otherwise specified in the Contract Documents. Before beginning work the Contractor shall construct a sample panel approximately 2 ft x 2 ft x 3 in. using the proposed concrete mix design. After 28 days, the concrete shall match Federal Standard No. 595, Color 37722 or lighter. The Contractor shall submit the panel and mix design to the Regional Engineer for approval. The approved sample panel shall remain at the construction site to be used by the Engineer to compare the color of the concrete barrier to the sample panel for adjustments and approval.

A sample panel for each source of supply shall be submitted for approval prior to use.

604.03 CONSTRUCTION. Concrete barriers shall be cast-in-place. Excavation for concrete barriers shall be made to the required depth and to a width that will permit the installation and bracing of forms where necessary. The Contractor shall remove all soft and unsuitable material and replace it with suitable material as directed by the Engineer. The subgrade shall be properly shaped and compacted in conformance with Section 208.

604.03.01 Concrete Barriers. Forming for the footer or concrete barrier may be either the fixed form or the slip-form method. Constructing the footer and the barrier section monolithically is prohibited.

(a) Fixed Form Method. Forms shall be steel with a tolerance not to exceed 1/4 in. in 10 ft in either grade or alignment. For bifurcated and transition sections, other forming materials may be used as directed by the Engineer.

Before concrete is placed against the forms, they shall be thoroughly cleaned and coated with form release compound each time they are used.

Concrete mixing shall conform to 915.03.04 and placing to Section 420. Volumetric batching and continuous mixing will be permitted. Concrete shall be vibrated by means of an approved immersion type mechanical vibrator.

Construction or contraction joints shall be sawed or formed at 20 ft intervals with a minimum of 10 ft. The time of sawing shall be as specified in 520.03.14(c)(1). Expansion joints shall be placed where specified in the Contract Documents or as directed by the Engineer. All joints in footers and walls shall align.

Concrete finishing shall conform to 604.03.03 except that the surface shall be broom finished when forms are stripped in less than 24 hours. Face forms shall be removed for finishing as soon as the concrete can retain its shape.

All honeycombed and damaged areas shall be repaired immediately after the removal of the forms in a manner acceptable to the Engineer.

(b) Slip-form Method. Slip-form equipment shall be approved by the Engineer and include the incorporation of automatic guidance controls to follow the line and grade references. On vertical and horizontal curves, an additional intermediate support shall be set in the field to establish a reference line acceptable to the Engineer. The use of ski or shoe sensors reflecting variations in the grade of the existing roadway surface is prohibited.

Concrete mixing shall conform to 915.03.04. The consistency of the concrete shall be so that after extrusion it shall maintain the shape of the barrier without support. Slip form equipment shall include internal vibrating capability. The surface shall be free of surface pits larger than 3/16 in. diameter. The concrete shall require no further finishing other than broomed finish.

Whenever a tear occurs during the operation of the slip-form equipment, it shall be repaired immediately or removed and replaced as directed by the Engineer.

Construction or contraction joints shall be sawed or formed at 20 ft intervals in the barrier and footer with a minimum of 10 ft, except in the area of miscellaneous structures 6 ft will be permitted. Sawed joints shall be a minimum of 2 in. deep and 1/8 in. wide. Expansion joints shall be as specified in the Contract Documents or as directed by the Engineer.

604.03.02 Curing. Concrete curing and protection shall conform to Section 420.

604.03.03 Finished Surface. Finishing concrete shall conform to Section 420. The completed barrier shall be within 1/4 in. in 10 ft from the horizontal and vertical lines specified in the Contract Documents or as approved by the Engineer. It shall present a smooth, uniform appearance.

604.03.04 Reflective Delineators. Reflective delineators shall be installed on the concrete traffic barrier as specified in the Contract Documents.

604.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all concrete, test panels, excavation, removal of existing hot mix asphalt, disposal of excess or unsuitable material, concrete footer, forms, reinforcement, drilled holes, drainage appurtenances, geotextile, No. 57 aggregate, conduit, boxes and fittings, backfilling, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

The removal and disposal of unsuitable material will be measured and paid for at the Contract unit price for Class 2 Excavation, which price shall include the cost of using suitable excavation as replacement material. When Borrow or Selected Backfill is authorized as replacement material, payment will be made at the Contract unit price for the respective items.

Removal of existing concrete traffic barriers will not be measured unless specified elsewhere in the Contract Documents.

604.04.01 Concrete Traffic Barriers will be measured and paid for at the Contract unit price per linear foot. Measurement will be along the center line of the top of the barrier.

604.04.02 Concrete Traffic Barrier End Transitions will be measured and paid for at the Contract unit price per each.

604.04.03 Reflective Delineators will be measured and paid for at the Contract unit price per each.

SECTION 605 — METAL TRAFFIC BARRIERS

605.01 DESCRIPTION. This work shall consist of constructing metal traffic barriers as specified in the Contract Documents or as directed by the Engineer.

605.02 MATERIALS.

Concrete Mix No. 2	902.10
Brown Polyester Coating	917.03
W Beam	918.01
Metal Posts	918.02
Traffic Barrier Hardware	918.03
Timber Posts	918.04
Wood Offset Blocks	918.04
Wire Rope	918.05
Rub Rail	A 36, Galvanized, A 123
Thrie Beam	M 180, Class A, Type 2
Reflective Delineators	As approved by the Office of Traffic and Safety

605.03 CONSTRUCTION.

605.03.01 Post Erection. Posts shall be driven unless otherwise permitted by the Engineer. The method of driving shall avoid battering or distorting the posts. Posts not driven shall be set in holes of sufficient diameter to allow tamping of the backfill. Postholes shall be backfilled with materials approved by the Engineer and placed in horizontal layers not to exceed 6 in. loose depth, then thoroughly compacted. When it is necessary to place posts in existing paving, all loose material shall be removed and the paving replaced. Prior to erection of the rail or cable elements, the post shall be properly aligned and be within a 1/4 in. tolerance of line and grade. Posts shall be plumb.

If rock is encountered, construction shall conform to 607.03.02.

605.03.02 Rail Assembly. Rail elements shall conform to the Contract Documents and be erected in a manner resulting in a smooth, continuous installation with laps in the direction of traffic flow. All bolts shall be drawn tight.

605.03.03 Offset Blocks. New traffic barrier W beam shall be installed with wood offset blocks. The wood offset blocks shall be routed to prevent the blockouts from rotating.

When an existing steel offset bracket is damaged, it shall be replaced with a steel bracket.

605.03.04 Concrete Curing. Concrete curing and protection shall conform to Section 420.

605.03.05 Brown Polyester Coated Traffic Barrier. All components shall be padded and handled with nylon slings during loading, unloading and installation.

The Contractor shall preserve the integrity of the polyester coating. If the polyester coating is chipped, scratched, blistered or otherwise separated from the base metal, the Contractor shall repair the damaged areas using the repair kit supplied by the manufacturer. All repairs shall be completed to the satisfaction of the Engineer or be replaced at no additional cost to the Administration.

605.03.06 Reflective Delineators. Reflective delineators shall be installed on the traffic barrier W beam as specified in the Contract Documents.

605.03.07 Remove and Reset Existing Traffic Barrier. When the entire run of traffic barrier is removed and reset, the metal offset brackets shall be replaced with 8 in. wood offset blocks. When only a portion of a run is removed and reset, the metal offset brackets shall be replaced with 6 in. wood blocks. The wood block shall match the existing post holes. The posts shall be moved a minimum of 1 ft in either direction from the existing location. When resetting the rail, the height of the rail shall be measured to ensure it conforms to the current Standards. The offset distance from the edge of the roadway shall be maintained unless otherwise directed by the Engineer.

605.03.08 End Treatments. Refer to Section 606.

605.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all rock excavation, components, restoration of grassed or paved areas, drilled post holes, concrete, assembly and erection of all component parts, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

605.04.01 Traffic Barrier W Beam will be measured and paid for at the Contract unit price per linear foot. Thrie Beam Traffic Barrier will be measured and paid for as specified in the Contract Documents. The application of fusion bonded brown polyester coating, as well as all special handling and touch up, will not be measured but the cost will be incidental to the item to which the coating is applied.

605.04.02 Replacing and installing additional posts, splice joints and W beam panels will be measured and paid for at the pertinent Contract unit price.

605.04.03 Removal and Disposal of Existing Traffic Barrier will be measured and paid for at the Contract unit price per linear foot.

605.04.04 Remove and Reset Existing Traffic Barrier will be measured and paid for at the Contract unit price per linear foot. Wood offset blocks will not be measured, but the cost will be incidental to the item.

605.04.05 Reflective Delineators will be measured and paid for at the Contract unit price per each.

SECTION 606 — PERMANENT TRAFFIC BARRIER END TREATMENTS

606.01 DESCRIPTION. This work shall consist of furnishing, and installing permanent traffic barrier end treatments as specified in the Contract Documents or as directed by the Engineer.

606.02 MATERIALS. Refer to 605.02 and the following:

End Treatments and Spare Parts Packages	As specified by the manufacturer
Hazard Marker	As approved by the Office of Traffic and Safety (OOTS)
Plastic Barrels	As approved by OOTS
Sand	901.01
Graded Aggregate Base	901.01
Bank Run Gravel Base	901.01
Common Borrow	916.01.04
Topsoil	920.01

606.03 CONSTRUCTION.

606.03.01 End Treatments.

(a) Type A System. The Type A Systems (single and double rail) shall have the ends of the traffic barrier, the end anchorage terminal, and the rub rail when required, buried in a cut slope. The slope shall be excavated to install these components. Upon installation the area shall be backfilled to match the adjacent slope, compacted, seeded, mulched, and soil stabilization matting installed as directed by the Engineer. The single rail system shall use 6 ft posts throughout the entire end treatment. The double rail system shall use 8 ft posts throughout the entire end treatment except for the last three posts buried in the cut slope.

The Contractor shall select Option 1 or 2 from the Standard for constructing the end anchorage terminal.

Installation of traffic barrier W beam shall conform to 605.03.

(b) Type B System. This system shall be installed in conformance with the manufacturer's recommendations.

(c) Type C, D, E, and F. These systems are not designed to be curved, and shall be installed in a straight line unless otherwise specified by the manufacturer and approved by the Engineer. For installation methods and procedures, refer to the manufacturer's recommendations.

(d) Nose Section. The nose section on the traffic barrier end treatment shall be reflectorized as approved by OOTS.

(e) Finish Coat. Traffic barrier end treatments attached to W beam traffic barrier shall have the same finish coat. Refer to 605.03.05.

(f) Sand Filled Plastic Barrels (SFPB). The components, assembly, placing configuration, and filling of the individual standard yellow plastic barrels with varying weights of sand shall conform to the manufacturer's recommendations or as specified in the Contract Documents. Each SFPB shall be watertight and separated from all other SFPB by a distance of 3 in. The distance between the last row of SFPB and the object being shielded shall be 12 in.

The first barrel of the SFPB configuration shall be reflectorized as specified in the Contract Documents.

All sand to be placed in the barrels shall be dry and loose. Bags of sand are prohibited. An antifreeze agent shall be added to the sand in conformance with the manufacturer's recommendations.

606.03.02 Surface Adjustment. When surface adjustment is required for installation of Type B, C, D, E, and F end treatments as specified on the Standards or in the Contract Documents, the Contractor shall use any class of excavation available on the project. When excavation is not available on the project site, the surface adjustment for end treatments shall be constructed using bank run gravel base, graded aggregate base, common borrow, or topsoil. The surface adjustment shall be completed within 48 hours.

606.03.03 Transitions to Existing Structures. When transitions to existing structures or traffic barriers are required, the work shall be as recommended by the manufacturer of the specified end treatment.

606.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all excavation, fabrication of all component parts, transitions to barriers, reflectorization, backfill, restoration of grassed or paved areas, seed and mulch, soil stabilization matting, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Traffic Barrier End Treatments will be measured and paid for at the Contract unit price for the pertinent end treatments listed below.

Removal of the existing end treatment to be replaced will not be measured but the cost will be incidental to the Contract unit price for the respective end treatments.

606.04.01 Type A Traffic Barrier End Treatments (Single and Double Rail) will be measured and paid for as follows:

(a) Traffic Barrier W Beam per linear foot for the actual number of linear feet measured to centers of posts. When a double rail installation is required, each rail will be measured and paid for at the Contract unit price per linear foot for Traffic Barrier W Beam.

(b) End Anchorage Terminals will be measured and paid for at the Contract unit price per each.

606.04.02 Type B through J Traffic Barrier End Treatments per each.

606.04.03 Surface adjustment for Types B, C, D, E, and F end treatments will be measured and paid for at the Contract unit price per cubic yard for the Surface Adjustment for Traffic Barrier End Treatment item. The payment will be full compensation for furnishing, adjusting embankment or aggregate material, compaction, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

606.04.04 Permanent Crash Cushion Sand Filled Plastic Barrels will be measured and paid for at the Contract unit price per barrel. The payment will be full compensation for all furnishing, placing, excavation, sand, antifreeze agent, machinery, labor, equipment, tools, and incidentals necessary to complete the work.

606.04.05 Repairs.

(a) Traffic Barrier End Treatment Spare Parts Package furnished and installed will be measured and paid for at the Contract unit price per each for the type specified in the Contract Documents. The payment will be full compensation for the complete furnishing and installation of the spare parts package, complete clearing and removal of debris and damaged unsalvageable parts, and for all material, labor, equipment, tools, and incidentals necessary to construct the end treatment to the configuration specified in the Contract Documents or as directed by the Engineer.

(b) When spare parts packages are furnished by the Administration, Repairing Traffic Barrier End Treatments will be measured and

paid for at the Contract unit price per each for the type specified in the Contract Documents. The payment will be full compensation for all transportation, installation, reconnection to fixed objects where necessary, complete clearing and removal of debris and damaged unsalvageable parts, and for all material, labor, equipment, tools, and incidentals necessary to construct the end treatment to the configuration specified in the Contract Documents or as directed by the Engineer.

(c) Payment will not be made for spare parts packages used for end treatments damaged due to the Contractor's operations as determined by the Engineer.

606.04.06 The application of fusion bonded brown polyester coating, as well as all special handling, will not be measured but the cost will be incidental to the item to which the coating is applied.

SECTION 607 — CHAIN LINK FENCE

607.01 DESCRIPTION. This work shall consist of furnishing and erecting chain link fence as specified in the Contract Documents or as directed by the Engineer.

607.02 MATERIALS.

Concrete Mix No. 2	902.10
Fence Fabric	914.01
Tie Wires, Line Post Clips, Tension Wires and Tension Wire Clips	914.02
Posts, Braces, Fittings and Hardware	914.03
Gates	914.04
Barbed Wire	914.05

607.02.01 Type. The height and type of fence shall be as specified in the Contract Documents. When the type of fence is not specified, one of the following types may be used:

(a) Galvanized steel and malleable iron components.

(b) Galvanized steel fabric utilizing galvanized steel posts or aluminum line posts.

(c) Aluminum coated steel fabric utilizing galvanized steel line posts.

(d) Aluminum coated steel fabric utilizing aluminum line posts.

(e) Bonded vinyl coated fabric utilizing galvanized steel or galvanized bonded vinyl coated steel line posts and fittings.

(f) Bonded vinyl coated fabric utilizing aluminum line posts.

607.03 CONSTRUCTION.

607.03.01 General Requirements. The Contractor's activities and operations shall be confined to the area immediately adjacent to the right-of-way lines and within the right-of-way except that permission may be granted by the Engineer for normal construction activities through lands owned by or under control of the Administration.

In areas where any privately owned fence or other property is within the Administration's right-of-way, the Contractor shall remove the items and place them on the owner's property as directed by the Engineer. The Contractor shall be held responsible for any damage to privately owned items removed.

Fence lines specified in the Contract Documents are only a guide and the exact location of the fence shall be determined in the field by the Engineer.

The bottom of the fabric shall be placed a nominal distance of 1 in. above the groundline. A maximum clearance of 6 in. will be permitted for a maximum horizontal distance of 8 ft except for special conditions as specified in the Contract Documents.

Any excavation or backfill required to comply with the above clearance shall be as approved by the Engineer. Fence fabric shall be placed on the roadside of the posts. For storm water management ponds, the fabric shall be placed on the outside of the posts or the side farthest from the pond.

The fence shall be true and taut.

All posts shall be plumbed and spaced as uniform as practicable to the spacing specified in the Contract Documents with a tolerance of minus 2 ft.

Terminal posts shall be installed at all ends, abrupt changes in grade and at changes in the horizontal alignment over 15 degrees. The maximum distance between terminal posts shall be 500 ft.

Post lengths shall accommodate the fabricated width of the fence fabric without stretching or compressing the fabric and provide the required spacing below the bottom of the fabric.

Post caps are required for all round line, terminal, and corner posts.

A tension wire shall run continuously between terminal posts near the top and bottom of the fabric and attached to the fabric with hog ring fasteners at 18 in. intervals.

Horizontal brace rails with diagonal truss rods and turn buckles shall be installed at all terminal posts. Sufficient braces shall be supplied to permit complete bracing from each terminal post to all adjacent line posts.

Fabric shall be tied to brace rails at 2 ft maximum intervals and to posts at 12 in. maximum spacing. Stretcher bars shall be attached to terminal posts by connectors equally spaced at 16 in. maximum centers. Top and bottom connectors shall be as close as possible to the ends of the fabric.

607.03.02 Anchorage for Line Posts and Terminal Posts. All posts shall be plumb. The Contractor shall select the type of anchorage system from the following except when rock is encountered only the concrete method shall be used.

Rock. Where rock is encountered at a depth less than that specified for the footing, a hole 1 in. larger than the greatest dimension of the post shall be drilled to a depth of 12 in. or the planned footing depth, whichever is less. After the post has been set, the remainder of the drilled hole shall be filled with grout composed of one part portland cement and two parts mortar sand by dry loose volume. The space above the rock shall be filled with concrete. The anchor unit method is prohibited in rock areas, where all posts shall be set in concrete.

Concrete Method. Posts shall be centered in the concrete footings. The concrete shall be thoroughly compacted around the post by rodding or vibrating. The finished top surface shall be troweled to a smooth finish slightly above the groundline and uniformly sloped to drain away from the post. The post shall not be disturbed within the 72 hours after the individual post footing is completed.

Hand mixed concrete shall not be used unless otherwise approved by the Engineer. When permitted, the maximum size of the hand mixed batch shall be 1/2 yd^3.

Drive Anchor Blade Method. Drive anchor blades consist of two steel blades driven diagonally through galvanized steel fittings attached to opposite sides of the posts. After being driven into the ground, the post shall be held rigidly upright by means of a drive anchor blade unit. The approximate spread of the blades at their full depth shall be 39 in. The top of the device shall be a minimum of 3 in. below the finished grade.

The anchor unit device and procedure shall be as approved by the Engineer.

Each line post shall be anchored by one of these units and each terminal post shall be anchored by two units spaced approximately 6 in. apart. Each drive anchor blade unit for the terminal post shall be driven in a direction to offset the stresses caused by the tension of the fence.

607.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

The removal of privately owned fence or other property from within the Administration's right-of-way will not be measured but the cost will be incidental to the Contract lump sum price for Clearing and Grubbing.

When an item for Clearing and Grubbing is not specified in the Contract Documents, clearing and grubbing will not be measured but the cost will be incidental to the Contract unit price for the pertinent Chain Link Fence item.

607.04.01 Chain Link Fence will be measured and paid for at the Contract unit price per linear foot for the actual number of linear feet measured to centers of end posts.

607.04.02 Terminal Posts (End, Pull and Corner Post) will be measured and paid for at the Contract unit price per each for the size and type specified.

607.04.03 Gates will be measured and paid for at the Contract unit price per each as complete units of the size and type specified.

SECTION 608 — WHEEL STOPS

608.01 DESCRIPTION. This work shall consist of furnishing, placing, and anchoring preformed wheel stops as specified in the Contract Documents or as directed by the Engineer.

608.02 MATERIALS.

Concrete Mix No. 2	902.10
Reinforcement Steel	908.01
Recycled Composite Material Wheel Stops	As specified by the manufacturer

Recycled Composite Material. Wheel stops manufactured of recycled composite material shall be as specified by the manufacturer and shall be insect resistant.

The manufacturer shall furnish certification as specified in TC-1.02.

608.03 CONSTRUCTION. Wheel stops shall be located and secured in place as specified in the Contract Documents. Only one type of wheel stop will be permitted for each project.

608.04 MEASUREMENT AND PAYMENT. Wheel Stops will be measured and paid for at the Contract unit price per each. The payment will be full compensation for all anchors, material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 609 — SHOULDER EDGE DROP OFF GRADING ADJUSTMENT

609.01 DESCRIPTION. This work shall consist of constructing the area adjacent to the outside edge of the shoulder to eliminate the shoulder edge drop off.

609.02 MATERIALS.

Crusher Run Aggregate CR-6	901.01
Bank Run Gravel Subbase	901.01
Select Borrow	916.01.01
Common Borrow	916.01.04
Topsoil	920.01
Hot Mix Asphalt Millings or Grindings	Size of individual particles shall be less than 2 in. as determined visually.

609.03 CONSTRUCTION. When the outside edge of the shoulder exceeds 2-1/2 in. in height above the existing groundline, the wedge shaped area shall be filled and graded to a slope of 4:1 or flatter. The material shall be compacted as specified in the Contract Documents or as directed by the Engineer. The grading adjustment shall be completed by the end of the day that the drop off is created and prior to opening to traffic.

The material, lines and grades, and the cross section shall be as specified in the Contract Documents.

609.04 MEASUREMENT AND PAYMENT. Crusher Run Aggregate CR-6, Bank Run Gravel Subbase, Select Borrow, Common Borrow, Topsoil, and Hot Mix Asphalt Millings or Grindings for Shoulder Edge Drop Off will be measured and paid for at the Contract unit price per ton, cubic yard or square yard, as specified in the Contract Documents. The payment will be full compensation for furnishing, hauling, placing, compacting, maintaining, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

CATEGORY 700
LANDSCAPING

SECTION 701 — TOPSOIL AND SUBSOIL

701.01 DESCRIPTION. This work shall consist of salvaging topsoil and subsoil, placing salvaged topsoil and subsoil, and placing furnished topsoil and subsoil as specified in the Contract Documents or as directed by the Engineer.

701.02 MATERIALS.

Salvaged Topsoil	920.01.01
Furnished Topsoil	920.01.02
Salvaged Subsoil	920.01.03
Furnished Subsoil	920.01.04
Agricultural Limestone	920.02
Miscellaneous Landscaping Items	920.08

701.03 CONSTRUCTION. When soil or weather conditions are unsuitable, the Contractor shall cease topsoil and subsoil operations until directed by the Engineer to resume.

701.03.01 Salvaging Topsoil and Subsoil.

(a) Evaluation. Topsoil and subsoil infested with any parts (seed, rhizomes, stolons, roots, etc.) of Johnsongrass, Canada Thistle, or Phragmites will be evaluated by the Administration prior to the salvaging operations to determine the severity of the infestation. The evaluation will determine how the topsoil and subsoil are to be used and to establish a means of preventing the spread of these weeds.

(b) Removal. Topsoil and subsoil shall be removed from selected areas specified in the Contract Documents or as directed by the Engineer. Prior to removing topsoil and subsoil, the Contractor shall mow or remove all vegetation over the areas where topsoil and subsoil are to be salvaged. Topsoil and subsoil shall be removed to the depth as directed by the Engineer. The topsoil and subsoil shall be transported and stockpiled in separate storage piles and kept separated from other materials.

(c) Storage. Storage areas for topsoil and subsoil shall be constructed on well drained land, away from live streams, and in conformance with Section 308. Prior to placing piles, the

Contractor shall install silt fence around the perimeter of the stockpile area and maintain the silt fence until vegetation is established. Topsoil and subsoil shall be kept in neat and separate piles separated from other excavated material. The piles shall be seeded with temporary seed immediately after final shaping of the pile. Temporary seeding shall conform to Section 704.

(d) **Excess.** Excess topsoil and subsoil will become the property of the Administration and any removal will require written approval from the Engineer.

701.03.02 Placing Salvaged Topsoil and Subsoil.

(a) **Evaluation.** The Administration will reevaluate salvaged topsoil and subsoil infested with any parts (seed, rhizomes, stolons, roots, etc.) of Johnsongrass, Canada Thistle, or Phragmites prior to placing, to establish a means of preventing the spread of these noxious weeds.

(b) **Surface Preparation.** The Contractor shall completely prepare and finish the surface of all areas to be covered with topsoil and subsoil as specified in the Contract Documents. Immediately prior to being covered with topsoil, the prepared surface shall be in a loose condition and be free from stones or other foreign material 3 in. or greater. When topsoil is placed on a prepared surface material that blends with the topsoil or subsoil, the Contractor shall work the topsoil or subsoil into that material by means acceptable to the Engineer. When topsoil or subsoil will not blend with the prepared surface material, the Contractor shall roughen the surface to provide a bond for the topsoil or subsoil.

(c) **Loading and Hauling.** Prior to the start of the hauling operations, all grass, weeds, brush, stumps, and other objectionable material shall be removed from the surface of stockpiles.

(d) **Placing and Spreading Topsoil.** Topsoil shall be placed, spread, and maintained over the areas designated to the depth, that after settlement, the completed work shall be in conformance with the thickness, lines, grades, and elevations specified in the Contract Documents. Stones and other foreign material larger than 3 in. shall be removed and disposed of by the Contractor. Slopes 4:1 to 2:1 shall be tracked with cleated tract type equipment operating perpendicular to the slope.

(e) **Placing, Spreading, and Compacting Subsoil.** Subsoil shall be placed, spread, and compacted in maximum layers of 8 in. to

produce a uniform firm layer of subsoil. The completed work shall be in conformance with the thickness, lines, grades, and elevations specified in the Contract Documents. Stones and other foreign material larger than 4 in. shall be removed and disposed by the Contractor. Slopes 4:1 to 2:1 shall be tracked with cleated tract type equipment operating perpendicular to the slope.

701.03.03 Placing Furnished Topsoil and Subsoil. Refer to 701.03.02 and the following:

(a) Contractor Responsibility. The Contractor shall make all arrangements and assume all responsibility for consents, agreements, and payments with property owners involved in topsoil and subsoil operations.

(b) Administration's Soil Test Reports. Limestone and soil amendments shall be added as specified in the Administration's soil test reports and 705.03.01(d) or 705.03.02(b).

(c) Storage. If the material is stockpiled upon delivery for future use on the project, the stockpiling shall conform to 701.03.01(c).

701.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for the preparation of surfaces, loading, hauling, placing, supplying, and spreading limestone and soil amendments, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

701.04.01 Salvaged topsoil will not be measured but the cost will be incidental to the Contract price for Class I Excavation.

701.04.02 Salvaged subsoil will not be measured but the cost will be incidental to the Contract price for Class 1 Excavation.

701.04.03 Placing Salvaged Topsoil will be measured and paid for at the Contract unit price per square yard for the depth specified.

701.04.04 Placing Salvaged Topsoil for Grading Adjustment will be measured and paid for at the Contract unit price specified in the Contract Documents.

701.04.05 Placing Salvaged Subsoil will be measured and paid for at the Contract unit price per cubic yard.

701.04.06 Placing Furnished Topsoil will be measured and paid for at the Contract unit price per square yard for the depth specified.

701.04.07 Placing Furnished Topsoil for Grading Adjustment will be measured and paid for at the Contract unit price specified in the Contract Documents.

701.04.08 Placing Furnished Subsoil will be measured and paid for at the Contract unit price per cubic yard.

SECTIONS 702 — 703 RESERVED

SECTION 704 — TEMPORARY SEEDING AND TEMPORARY WOOD CELLULOSE MULCHING

704.01 DESCRIPTION. This work shall consist of furnishing and placing fertilizer, temporary seed, mulch and wood cellulose fiber on cuts, fills, and other soil areas, which cannot be shaped and permanently vegetated for an extended period of time as specified in the Contract Documents or as directed by the Engineer.

704.02 MATERIALS.

Fertilizer	920.03.01
Seed	920.04.01 and 920.04.02
Mulch	920.05.03
Wood Cellulose Fiber	920.05.04
Water	920.08.01

704.03 CONSTRUCTION. Temporary seeding and temporary wood cellulose mulching shall be done any time of the year, as directed by the Engineer. Grading and shaping operations may be required before temporary seeding.

704.03.01 Temporary Seeding. Temporary seeding shall consist of preparing soil, seeding, fertilizing, mulching and applying wood cellulose fiber binder. Temporary seeding shall be done to areas that will remain undisturbed for one month or more.

(a) Soil Preparation. Soil shall be loosened from the grading operation. Compacted soil surfaces shall be loosened as approved by the Engineer before seed is applied.

(b) Seeding, Fertilizing, and Mulching. Seeding, fertilizing and mulching shall conform to 705.03.01 and 705.03.02.

(c) Application Rates.

TEMPORARY SEEDING		
MATERIAL	**LB PER 1000 FT^2**	**LB PER ACRE**
Temporary Seed Mix	2.9	125
Fertilizer (10-20-10)	17.2	750
Mulch (Straw or Hay)	91.8	4000
Wood Cellulose Fiber (Mulch Binder)	17.2	750

704.03.02 Temporary Wood Cellulose Mulching. Temporary wood cellulose mulching shall consist of applying wood cellulose fiber to those areas that will be disturbed in less than one month.

(a) Soil Preparation. Soil shall be left in the condition from the grading operation.

(b) Mulching. Wood cellulose fiber shall be mixed with water in a hydroseeder and applied uniformly. Temporary wood cellulose mulching shall consist of wood cellulose fiber applied at the rate of 34.4 to 45.8 lb per 1000 ft^2 or 1500 to 2000 lb per acre.

704.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work. Repairs due to the Contractor's negligence as determined by the Engineer shall be done at no additional expense to the Administration. After acceptance, mulch requiring replacement, as directed by the Engineer, will be paid for as additional work.

704.04.01 Temporary Seeding will be measured and paid for at the Contract unit price per pound of seed.

704.04.02 Temporary Wood Cellulose Mulching will be measured and paid for at the Contract unit price per ton of wood cellulose fiber.

SECTION 705 — TURF ESTABLISHMENT

705.01 DESCRIPTION. This work shall consist of soil preparation, seeding, fertilizing, liming as required, mulching, overseeding, refertilizing, and mowing all areas designated for turf establishment as specified in the Contract Documents or as directed by the Engineer.

705.01.01 Regional Areas. Maryland is divided into regions by counties as follows:

REGION 1 — Garrett, Allegany and Washington (West of Clear Spring, MD);

REGION 2 — Washington (East of Clear Spring, MD), Frederick, Carroll, Baltimore, Harford, Cecil, Howard, Montgomery, and Baltimore City.

REGION 3 — Anne Arundel, Prince Georges, Calvert, Charles, St. Marys, Kent, Queen Anne's, Talbot, Caroline, Dorchester, Wicomico, Worcester and Somerset.

705.01.02 Seeding Seasons and Seed Mixes.

SEEDING SEASONS AND SEED MIXES						
REGIONS	**SPRING AND FALL MONTH/DAY**		**SUMMER MONTH/DAY**		**LATE FALL MONTH/DAY**	
1	4/1 to 6/15 and 8/1 to 10/1		6/16 to 7/31		10/2 to 11/1	
2	3/1 to 5/15 and 8/1 to 10/20		5/16 to 7/31		10/21 to 11/20	
3	3/3 to 5/1 and 8/1 to 10/31		5/2 to 7/31		11/1 to 11/30	
REGIONS	**ROADSIDES SEED MIX WITH ADDITIVE**	**MEDIANS SEED MIX**	**ROADSIDES SEED MIX WITH ADDITIVE**	**MEDIANS SEED MIX WITH ADDITIVE**	**ROADSIDES SEED MIX WITH ADDITIVE**	**MEDIANS SEED MIX WITH ADDITIVE**
1	1c	2	1ac	2a	1bc	2b
2	1c	2	1ac	2a	1bc	2b
3	1c	1	1ac	1a	1bc	1b
Seed Mix contents refer to 920.04.02 1 = SHA Seed Mix No.1 2 = SHA Seed Mix No.2			ADDITIVES a = Lovegrass or Foxtail Millet b = Rye Grain c = Serecia Lespedeza			

NOTE: All regions shall have Serecia Lespedeza added to the seed mixes which are to be sown on rippable rock.

Roadside areas are outside the edge of the roadbed, interchanges, and median areas with a slope of 3:1 and steeper.

Median areas are between divided highways flatter than 3:1 and at Administration facilities.

705.02 MATERIALS.

Mulch Binder	904.03 or 920.05.04
Agricultural Limestone	920.02

Fertilizer	920.03.01
Seed	920.04.01 and 920.04.02
Mulch	920.05.03 and 920.05.04
Miscellaneous	920.08

705.03 CONSTRUCTION. Seeding shall be performed when the temperature is above 32 F and the ground is not frozen.

705.03.01 Seeding Roadside Areas. Seeding shall consist of soil preparation, liming, seeding, fertilizing, and applying and securing mulch.

(a) Preparing Soil. Areas to be seeded shall conform to the specified finish grades and be free of any weed or plant growth. All areas (except serrated cut slopes) shall be loosened by discing, harrowing, raking or by other approved methods immediately prior to seeding, unless otherwise directed by the Engineer. The area shall be free of all clods, stones and other foreign materials larger than 3 in. On and adjacent to commercial and residential properties, the size of stones and other foreign material shall not be larger than 1-1/2 in. All gullies, washes or disturbed areas that develop subsequent to final dressing shall be repaired prior to seeding. On slopes less than 3:1 and on flat areas, the final seedbed shall be prepared so there is an even and uniform germination of seed and final stand of turf. To conserve moisture, a cultipacker may be run over the seedbed before or after seeding, but before mulching. The seed beds shall be as follows:

(1) Slopes less than 3:1:

The topsoil shall be loosened to a depth of 2 in. and all track marks shall be removed.

(2) Slopes 3:1 and steeper:

The subsoil shall be loosened to a depth of 1 in.

(3) Serrated cut slopes:

The subsoil shall not be loosened. The areas shall be seeded and mulched in 50 ft maximum vertical increments.

(b) Application Equipment. Equipment shall consist of spreaders, drills, hydroseeders or other equipment approved by the Engineer for applying materials either in a wet or dry form. All equipment shall be calibrated before application to the satisfaction of the

Engineer so that materials are applied accurately and evenly to avoid misses and overlaps.

Hydroseeders shall display maximum capacity in gallons and be equipped with an agitation system capable of keeping all the solids in a state of suspension.

The mixture shall be directed upward into the air so droplets will fall in a uniform spray to avoid erosion or runoff.

Mechanical seeders shall be capable of placing seed at the specified rate.

Use of hydroseeders and spinner spreaders is prohibited during periods of high winds when the materials could land on sensitive areas or on sensitive structures.

(c) Application Rates.

MATERIAL	LB PER ACRE
AGRICULTURAL LIMESTONE	
(1) Salvaged Topsoil Areas	Refer to Contract Documents.
(2) Furnished Topsoil Areas	Refer to Soil Reports
(3) Nontopsoil Areas and Serrated Cut Slopes	
Region 1 Limestone	6000
Region 2 Limestone	5000
Region 3 Dolomitic Limestone	4000
Seed Mix No. 1 Roadside Areas	
Areas flatter than 2:1	100
Areas 2:1 and steeper with legumes	75
Seed Mix No. 1 or No. 2 Median Areas	100
Serecia Lespedeza	20
Lovegrass	2
Foxtail Millet	10
Rye Grain	22
FERTILIZER AT SEEDING	
Topsoiled and Nontopsoiled Areas	
10-22-22 (50% UF N_2)	1000
Nontopsoiled Areas 38-0-0 (UF)	200
REFERTILIZING	
Topsoiled Areas	
0-20-20	100
38-0-0 (UF)	400
Nontopsoiled Areas	
0-20-20	400
38-0-0 (UF)	600
MULCH	
(1) Straw or Hay	
(a) Secured with Wood Cellulose Fiber	4000
(b) Secured with Mulch Anchoring Tool	5000
(c) Secured with Tracking Method	3000
(2) Wood Cellulose Fiber	1500
MULCH BINDER	
Wood Cellulose Fiber	750

UF = Ureaform
N_2 = Nitrogen

(d) Liming. Agricultural limestone where required on topsoiled areas flatter than 3:1, shall be incorporated 2 in. into the topsoil before seed and fertilizer are applied. Agricultural limestone where required on all areas 3:1 and steeper, may be mixed with the seed and fertilizer.

(e) Seeding and Fertilizing. Seed and fertilizer shall only be applied to previously prepared seedbeds.

When seed is applied with hydraulic seeders, all mixtures shall be used within eight hours after mixing.

When seed is sown with mechanical seeders, seed and fertilizer shall be incorporated to a depth not more than 1/4 in.

All leguminous seeds shall be inoculated as specified on the inoculant package label. The inoculant shall be stored at room temperatures, out of direct sunlight and away from heating units.

When leguminous seed is sown by hydraulic seeders, 10 times the quantity of inoculant required for dry leguminous seed application shall be used. Seed not used within one hour shall be reinoculated.

When leguminous seed is sown by mechanical seeders, the seed shall be dampened with water and mixed with the inoculant. The inoculated seed shall then be mixed with the other seed to be used. Inoculated seed not used within 24 hours shall be reinoculated.

(f) **Mulching.** Within 48 hours after seeding, mulch shall be applied as follows:

(1) **Straw or Hay Mulch.** Material shall be applied so no more than 10 percent of the soil surface is exposed. Mulch applied by blowers shall provide a loose depth of 1/2 in. to 2 in. The length of 95 percent of the mulch shall be 6 in. or more in length. Mulch applied by hand shall provide a loose depth of 1-1/2 in. to 3 in.

(2) **Wood Cellulose Fiber Mulch.** Wood cellulose fiber will only be permitted on those areas where steep or high slopes prohibit the use of straw or hay application equipment or when approved by the Engineer. During summer seeding at least 70 percent of the hydromulch shall be applied after and separately from the seed and fertilizer.

(g) **Securing Straw or Hay Mulch.** Mulch shall be secured by any of the following methods:

(1) **Mulch Anchoring Tool Method.** This method shall be used for the summer seeding season on slopes 3:1 and flatter and all median areas on highways under traffic. Mulch shall be incorporated into the soil to a minimum depth of 2 in.

(2) Tracking Method. The mulch shall be incorporated into the soil with track type equipment having steel cleats with a minimum depth of 1-1/2 in. The tracking shall be performed perpendicular to the slopes. The equipment used and the method of tracking shall be acceptable to the Engineer. Upon completion of tracking, the mulch shall be further secured as described for the mulch binding method in 705.03.01(g)(3).

(3) Mulch Binding Method. Mulch binder material shall be uniformly applied without displacing the mulch.

705.03.02 Seeding Median Areas. Seeding shall consist of soil preparation, liming, seeding, fertilizing, and applying and securing mulch in conformance with 705.03.01 with the following exceptions:

(a) The soil shall be loosened to a depth of 3 in.

(b) Agricultural limestone, if required, shall be applied separately and incorporated 3 in. into the seedbed.

705.03.03 Nontopsoiled Areas. All nontopsoiled areas to be seeded shall have limestone and 38-0-0 (UF) fertilizer applied.

705.03.04 Overseeding. Overseeding roadside and median areas consists of applying seed and fertilizer to previously seeded and mulched areas where turf establishment has not been successful and where remulching is not required due to mulch remaining from the previous mulch application. Work shall be as directed by the Engineer and conform to 705.03.01 for roadside areas and to 705.03.02 for median areas. Soil preparation and mulch will not be required.

705.03.05 Refertilizing. Refertilizing shall consist of applying 0-20-20 and 38-0-0 (UF) fertilizer to topsoiled, nontopsoiled and serrated cut slope areas and other areas as directed by the Engineer as follows:

AREAS	REGIONS	NUMBER OF APPLICATIONS	MONTHS/WEEKS AFTER SEEDING
Topsoiled	1 and 2	1	4 to 6 weeks
Nontopsoiled and serrated cut slopes	1 and 2	1	April or September
	3	2	April and September

705.03.06 Tractor Mowing. Mowing shall consist of using a minimum 5 ft flail or rotary tractor mower as directed by the Engineer, and shall

conform to the Administration's Mowing Guidelines. The vegetation shall be cut to 5 in. high before it reaches 20 in. high.

705.03.07 Hand Mowing. Mowing shall consist of using a minimum 19 in. hand mower as directed by the Engineer. Vegetation shall be cut to 3 to 4 in. high before it reaches 15 in. high.

705.03.08 Repairing Damaged Areas. Before final acceptance, the Contractor shall repair or replace any seeding or mulching that is defective or damaged due to the Contractor's negligence at no additional cost to the Administration. When the Contractor elects to perform out of season work, the Contractor shall establish a good stand of grass of uniform color and density as approved by the Engineer. When it is not possible to make an adequate determination of the color, density and uniformity of the stand of grass, acceptance of the areas will be delayed until seeding requirements are in conformance.

705.04 MEASUREMENT AND PAYMENT. Turf Establishment will be measured and paid for at the Contract unit price for the items as specified in the Contract Documents. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

705.04.01 Seeding Roadside Areas per square yard. Other seed such as leguminous and out of season seed will not be measured but the cost will be incidental to this item.

705.04.02 Seeding Median Areas per square yard. Other seed such as leguminous and out of season seed will not be measured but the cost will be incidental to this item.

705.04.03 Liming Nontopsoiled Areas per ton.

705.04.04 Applying 38-0-0 (UF) Fertilizer per pound.

705.04.05 Overseeding Roadside Areas per pound of seed.

705.04.06 Overseeding Median Areas per pound of seed.

705.04.07 Refertilizing Topsoiled Areas and Refertilizing Nontopsoiled Areas [0-20-20 and 38-0-0 (UF)] per pound for the combined weight of both fertilizers.

705.04.08 Tractor Mowing per hour.

705.04.09 Hand Mowing per hour.

705.04.10 Repairing Damaged Areas. Except when the defect or damage is due to the Contractor's negligence, once the Contractor has completed the seeding and mulching of any area as determined by the Engineer, no additional work at the Contractor's expense will be required. Subsequent repairs and replacements as required by the Engineer shall be made by the Contractor and will be paid for as additional work.

SECTION 706 — WOODY SHRUB SEEDING

706.01 DESCRIPTION. This work shall consist of soil preparation, seeding, fertilizing, mulching, liming as required and refertilizing all areas designated for woody shrub seeding as specified in the Contract Documents, Section 705, or as directed by the Engineer.

706.01.01 Seeding Season. Seeding shall be done during any seeding season specified in 705.01.02.

706.02 MATERIALS.

Mulch Binder	904.03 and 920.05.04
Agricultural Limestone	920.02
Fertilizer	920.03.01
Seed	920.04.01, 920.04.02(d) and (e)
Mulch	920.05.03
Water	920.08.01

706.03 CONSTRUCTION. Refer to 705.03.

706.03.01 Seeding. Seeding shall consist of soil preparation, liming, seeding, fertilizer and applying and securing mulch in conformance with 705.03.01 with the following exceptions:

(a) Cover Companion Seed Mix. The contractor shall provide the cover companion seed mix.

(b) Woody Seed Mix. The Administration will provide the woody seed mix.

(c) Application Rates.

MATERIALS	LB PER ACRE
Agricultural Limestone	Refer to 705.03.01(c)
Woody Shrub Mix	50
Cover Companion Mix	35
Lovegrass or Foxtail Millet	2 10
Rye Grain	22
Fertilizer: 5-20-20 38-0-0 (UF)	 1000 650
Refertilizing: 0-20-20 38-0-0 (UF)	 400 650
Mulch	5000
Mulch Binder Wood Cellulose Fiber	750

706.03.02 Nontopsoiled Areas. Refer to 705.03.03.

706.03.03 Refertilizing. Refertilizing shall be performed not less than three months after seeding. Refertilizing shall consist of applying 0-20-20 and 38-0-0 (UF) fertilizer to nontopsoiled and serrated cut slope areas and other areas as directed by the Engineer, as follows:

REGIONS	NUMBER OF APPLICATIONS	MONTHS AFTER SEEDING
1 and 2	1	April or September
3	2	April and September

Refer to 705.01.01 for Regional Areas.

706.04 MEASUREMENT AND PAYMENT. Woody shrub seeding will be measured and paid for at the Contract unit price for the items listed below as specified in the Contract Documents. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

706.04.01 Cover Companion Seed Mix per pound. Administration furnished woody shrub seed mix, the Contractor furnished companion

seed, out of season seed, 5-20-20 fertilizer and mulch will not be measured but the cost will be incidental to this item.

706.04.02 Liming Nontopsoiled Areas per ton.

706.04.03 Applying 38-0-0 (UF) Fertilizer per pound.

706.04.04 Refertilizing 0-20-20 and 38-0-0 (UF) per pound for the combined weight of both fertilizers.

SECTION 707 — WILDFLOWER SEEDING

707.01 DESCRIPTION. This work shall consist of wildflower seeding as specified in the Contract Documents or as directed by the Engineer.

707.02 MATERIALS.

Water	920.08.01
Herbicide	920.08.07
Marking Dye	920.08.08
Wildflower Seed Mix and Companion Seed Mix	Furnished by the Administration

707.03 CONSTRUCTION.

707.03.01 Seeding Seasons. Seeding shall be done in each Region during the time listed when the ground is not frozen. Refer to Section 705 for Regions:

REGIONS	SEEDING DATES
1	Sept. 1 to May 1
2	Oct. 1 to April 15
3	Oct. 15 to April 15

Refer to 705.01.01 for Regional Areas.

707.03.02 Pesticide Application. All pesticide applications shall be as specified in the Maryland Pesticide Applicator's Law and in conformance with the manufacturer's recommendations. All pesticide applications shall be performed under the supervision of a Certified Applicator of Pesticides (Category III A or VI).

Herbicide. All vegetation in the seeding area shall be eradicated prior to seeding by use of a herbicide. The herbicide shall be glyphosate with a wetting agent mixed with water and a water soluble marking dye, applied at the following rates:

Herbicide — 5 lb per acre of active ingredient
Marking Dye — 6 to 15 oz per acre
Water — 40 to 50 gal per acre

Reports. The Contractor shall submit daily herbicide application reports to the Engineer using Administration forms.

707.03.03 Mowing. A minimum of two weeks after herbicide treatment, the area to be seeded shall be mowed to a maximum height of 1 in. Clippings shall be removed prior to seeding.

707.03.04 Seeding. Seeding shall consist of soil preparation and sowing seed.

(a) Soil Preparation.

(1) Soil preparation is not required when using a drill seeder.

(2) Seeding area shall be rototilled to a depth of 1 in. prior to seeding when using a broadcast seeder.

(b) Equipment. Seeding equipment shall be approved by the Engineer. Seeds shall be planted using a drill or broadcast seeder. If a drill seeder is used, it shall be equipped with three seed boxes.

(c) Methods.

(1) Drill Seeding. Seed shall be premixed and placed in the seed boxes A, B, and C as noted in (d). Seed mix shall be drilled through the dead turf and thatch into the soil to a depth of 1/4 in.

(2) Broadcast Seeding. All seed listed in (d) for boxes A, B, and C shall be combined and uniformly mixed with calcine clay carrier (cat litter). Seed mix shall be spread in a criss-cross pattern. After spreading the mixture shall be lightly raked or dragged to a maximum depth of 1/8 in.

(d) Mixes and Seeding Rates.

MATERIAL	LB PER ACRE
BOX A – WILDFLOWER and COMPANION SEED	
Spurred Snapdragon	0.50
Plains Coreopsis	1.00
Corn Poppy	1.00
Black Eyed Susan	1.00
Scarlet Sage	0.50
Lemon Mint	0.50
Shasta Daisy	0.20
New England Aster	0.20
Siberian Wallflower	0.50
Evening Primrose	0.10
White Yarrow	0.20
California Poppy	1.00
Hard or Sheep Fescue	10.00
BOX B – WILDFLOWER SEED	
Dames Rocket	1.00
Rocket Larkspur	0.50
Tall Cornflower	1.25
Purple Coneflower	2.00
Lance-Leaf Coreopsis	1.00
Yellow Cosmos	0.25
Purple Cosmos	0.25
Sweet William	0.50
Crimson Clover	1.00
BOX C – FLUFFY WILDFLOWER SEED	
Firewheel	0.20
Blanket Flower	1.00
Calendula	0.50
Sunflower Autumn Beauty	0.20

707.04 MEASUREMENT AND PAYMENT. Wildflower Seeding will be measured and paid for at the Contract unit price per square yard. The payment will be full compensation for herbicide, marking dye, mowing, soil preparation, and seeding (excluding the cost of wildflower and companion seed) and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 708 — SODDING

708.01 DESCRIPTION. This work shall consist of soil preparation, liming, fertilizing, watering, and placing grass sod on prepared areas, as specified in the Contract Documents or as directed by the Engineer.

708.01.01 Regional Area. Regional areas shall conform to 705.01.01.

708.01.02 Regional Requirements.

(a) Bluegrass sod shall be used in Region 1.

(b) Tall fescue sod shall be used in Regions 2 and 3.

(c) Bermudagrass sod shall be used as directed by the Office of Environmental Design.

708.02 MATERIALS.

Agricultural Limestone	920.02
Fertilizer	920.03
Grass Sod	920.04.03
Staples	920.06.01
Water	920.08.01
Pegs	920.08.21

708.03 CONSTRUCTION.

708.03.01 Sodding Season. Sod shall be placed between the dates of August 15 and May 31. Sod shall not be placed on frozen soil and frozen sod is prohibited.

708.03.02 General. Sod shall be transported and installed without breaking, tearing, or loss of soil. All sod shall be transplanted within 48 hours from the time it is harvested.

708.03.03 Final Grading. The areas to be sodded shall present a smooth, uniform surface true to line and cross section, and any raking required to accomplish this shall be done immediately prior to the placing of the sod at no additional cost to the Administration.

708.03.04 Liming and Fertilizing. All areas to be sodded shall be limed and fertilized.

APPLICATION RATES	
MATERIAL	**LB PER ACRE**
Agricultural Limestone	4000
Fertilizer 10-10-10 38-0-0 (UF)	 900 200

After the above materials have been applied, they shall be worked into the top 3 in. of soil.

708.03.05 Placing. Sod shall be placed with close joints and no overlapping. Cracks are prohibited between sod pieces. All sod shall be tamped or rolled after placing to close the seams between the sod pieces and to press the sod tight against the ground. A hand tamper shall weigh approximately 15 lb and have a flat surface of approximately 100 in^2. A roller shall weigh 40 lb/ft of width. Any slipping of sod shall be corrected by the Contractor at no additional cost to the Administration.

On slopes of 2:1 and steeper, sod shall be placed with the long edges parallel to the contour starting at the bottom of the slope. Successive strips shall be neatly matched and all joints staggered or broken. When placing sod in drainage ditches, the length of the strip shall be laid parallel to the direction of the flow of the water. Each strip or section of sod placed on slopes of 2:1 and steeper and surface drainage V-shaped or flat bottom ditches or gutters shall be staked securely with at least two staples or wooden pegs spaced not more than 2 ft apart and driven flush with the top of the sod.

708.03.06 Initial Watering. Each section of sod shall be thoroughly watered a minimum of three times after placement. The first watering shall be within four hours after the sod is placed and shall wet the soil to a depth of 3 in. below the sod. The second and third waterings shall be within 10 days after the sod is placed. A minimum of 24 hours shall elapse between the second and third watering.

708.03.07 Refertilizing. After the sod has been watered three times, and no later than three weeks after placing, it shall be refertilized with 38-0-0 (UF) fertilizer at the rate of 200 lb/acre.

708.03.08 Acceptance. At the time of acceptance all sod shall be firmly knitted, show signs of good health, and have received initial watering and refertilization.

708.03.09 Additional Watering of Sod. The Contractor shall monitor the water needs of the sod to maintain adequate moisture in the upper 4 in. of soil. When additional watering is necessary, the Engineer shall be notified, and if the Engineer concurs, the Contractor shall begin watering immediately.

708.04 MEASUREMENT AND PAYMENT.

708.04.01 Sodding will be measured and paid for at the Contract unit price per square yard. The payment will be full compensation for all sod, initial waterings, staking, liming, fertilizing, refertilizing, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

708.04.02 Additional Watering of Sod. Additional Watering of Sod will be measured and paid for at the Contract unit price per 1000 gal of water applied to the sod. Water will be measured by means of satisfactorily installed meters, or by measurements of tank capacities, or by acceptable documentation of tanks of predetermined capacity. The Contractor shall furnish the Engineer's representative with measurement and capacities to provide a complete and accurate record of the quantity of water furnished and applied. The payment will be full compensation for all water, material, labor, equipment, tools, and incidentals necessary to complete the work. No compensation will be allowed for water wasted or excess watering as determined by the Engineer.

SECTION 709 — SOIL STABILIZATION MATTING

709.01 DESCRIPTION. This work shall consist of furnishing, placing and securing matting on seeded areas, as specified in the Contract Documents or as directed by the Engineer.

709.02 MATERIALS.

Type A Soil Stabilization Matting	920.06
Type B Soil Stabilization Matting	920.06
Staples for Type A Soil Stabilization Matting	920.06.01
Staples and Wood Stakes for Type B Soil Stabilization Matting	920.06.02

The Contractor shall select the soil stabilization matting from the prequalified list of soil stabilization matting maintained by the Office of Materials and Technology.

709.03 CONSTRUCTION. When topsoil is specified for areas where matting is to be placed, the work shall be completed before the soil stabilization matting operation is started. The matting shall be placed within 48 hours after seeding operations have been completed. Matting shall be laid smoothly and firmly upon the seeded surface in the direction of water flow. Stretching shall be avoided.

709.03.01 Placing and Securing Type A Soil Stabilization Matting. Where more than one width of matting is required, the strips shall overlap at least 2 in. Ends shall overlap at least 6 in. The upgrade end of each strip of matting shall be turned down and buried to a depth of not less than 6 in. with the soil firmly tamped against it. Overlapping shall be done with the upgrade section on top. The Engineer may require any other edge exposed to more than normal flow of water to be buried in a similar manner. Edges of matting shall be similarly buried around the edges of catch basins and other structures.

Matting shall be securely fastened in place with staples driven vertically into the soil and flush with the surface. Staples shall be placed on 2 ft centers throughout the mat. Staples shall be placed no more than 18 in. apart in the center of the ditch and along the outside edge of the last mat installed. On all overlapping edges, staples shall be placed 18 in. apart. At all ends of the matting, staples shall be placed 6 in. apart. Mats constructed of wood and hydromulch shall also be watered immediately after stapling to bond the mat with the soil. Water shall be applied so it falls on the mat like a normal rainfall. At no time shall the water be directed from a water or a hydroseeder spray gun in a direct straight line to the mat.

709.03.02 Placing and Securing Type B Soil Stabilization Matting. Matting shall be installed to preclude a longitudinal joint. A longitudinal joint may be installed if approved by the Engineer. Matting shall be securely fastened in place with either staples or wood stakes (fasteners) driven vertically into the soil. Staples shall be driven flush with the matting and wood stakes shall be driven so 3 in. is left above the matting. Staples shall be placed on 2 ft centers throughout the mat. Staples shall be placed no more than 18 in. apart in the center of the ditch and along the outside edge of the last mat installed. On all overlapping edges, fasteners shall be placed 18 in. apart. At all ends of the matting fasteners shall be placed 6 in. apart.

709.03.03 Staple and Fastener Lengths.

TYPES	REGIONS	
	1 and 2	**3**
	Length in. (min.)	**Length in. (min.)**
U Staple	12	18
T Staple	18 Main Leg 2 Secondary Leg	24 Main Leg 2 Secondary Leg
Wood Stakes	12	18

709.04 MEASUREMENT AND PAYMENT. The matting will be measured and paid for at the Contract unit price for the area actually covered. If the top netting on the Type A matting degrades before the disturbed area is fully stabilized the Contractor shall replace the matting and reseed the affected area at no additional cost to the Administration. The payment will be full compensation for all matting furnished and placed, staples, fasteners, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

709.04.01 Type A Soil Stabilization Matting per square yard.

709.04.02 Type B Soil Stabilization Matting per square yard.

709.04.03 Where required, placing salvaged topsoil, placing furnished topsoil, seeding and mulching, and overseeding will be measured and paid for separately at the Contract unit price for the respective item specified in the Contract Documents.

SECTION 710 — PLANTING TREES, SHRUBS, VINES, AND SEEDLING STOCK

710.01 DESCRIPTION. This work shall consist of furnishing and planting trees, shrubs, vines, and seedling stock and all plant establishment operations to complete the work as specified in the Contract Documents or as directed by the Engineer.

710.01.01 Planting Schedule.

DECIDUOUS MATERIAL				EVERGREEN MATERIAL		
SEASON	BALLED AND BURLAPPED AND BARE ROOT	CONTAINER GROWN	SEEDLING STOCK	BALLED AND BURLAPPED	CONTAINER GROWN	SEEDLING STOCK
Spring	3/1 – 4/30	3/1 – 6/15	3/15 – 4/15	3/15 – 4/30	3/15 – 6/15	3/15 – 4/15
Fall	10/15 – 12/15	8/15 – 12/15	—	9/1 – 11/15	8/15 – 11/15	10/1 – 10/31

Bare root plants shall not be planted while in leaf or during periods of freezing weather. No container grown plant material shall be planted if not acclimated to the current weather conditions. No planting will be allowed out of season without written permission of the Engineer.

710.01.02 Pesticide Application. All pesticide applications shall be as specified in the Maryland Pesticide Applicator's Law and in conformance with the manufacturer's recommendations. All pesticide application work shall be conducted under the supervision of a Certified Applicator of Pesticides (Category III A or VI). Daily pesticide application reports shall be maintained by the Contractor. A completed copy for each day of application shall be provided to the Engineer.

The Contractor shall replace any plant material which is killed and prune any plant material which is damaged through any act of negligence by the Contractor in applying and handling of any pesticides on the project.

710.02 MATERIALS.

Fertilizer	920.03.02 and 920.03.03
Wood Chips	920.05.02
Plant Materials	920.07
Miscellaneous	920.08

710.03 CONSTRUCTION.

710.03.01 Plant Storage and Handling. The Contractor shall provide adequate facilities for the protection, watering and temporary storage of plant material.

(a) Bare Root (BR) Material. Following delivery and inspection at the storage area, all bare root plant material shall be healed-in and maintained in moist soil or other suitable material until planted, as directed by the Engineer. Plants being transported to and from the healed-in area shall have their roots protected from drying by

means of covering with canvas, burlap, or straw and shall be kept moist.

(b) Balled and Burlapped (B and B). Root balls shall be kept moist at all times. If not planted within seven days after delivery, the root balls shall be covered with mulch or straw and kept watered until removed for planting. Care shall be taken to prevent damage to trunks, branches and roots. The integrity of the root balls shall be carefully preserved.

710.03.02 Preparation for Planting. The Contractor shall perform all layout, bed preparation, and soil amending as follows:

(a) Layout. The Contractor shall provide the stakes, and stake out the locations of all plants and the outlines of all seedling areas and plant beds as specified in the Contract Documents. No work shall be started until the locations and outlines are approved by the Engineer.

Outline stakes for seedling areas shall be spaced 30 ft apart or as directed by the Engineer. They shall be driven approximately 1 ft into the ground and remain as a permanent means of outline identification through the life of the Contract.

(b) Plant Bed Preparation. Existing weed growth in planting beds shall be sprayed with glyphosate with wetting agent conforming to the Maryland Pesticide Applicator's Law and to the manufacturer's recommendations.

After a minimum of seven days following herbicide application and prior to secondary weed growth, all planting beds shall be mowed to a height of 1 in. After mowing, woody material and debris shall be removed.

On flat areas and slopes less than 4:1, 1 in. of compost, peat moss or other approved organic soil amendments shall be spread over the entire surface of the planting bed and rototilled to provide a depth of 6 in. of loose soil. After rototilling, plant beds shall be raked to provide an even planting surface, removing stones greater than 3 in. and other foreign material.

Plant beds on slopes 4:1 and steeper do not require surface application of sludge or rototilling.

(c) Plant Pit Soil Amendments. All plants shall be planted in planting pits. Soil amending shall be confined to the plant pit and

the immediate surrounding area. Soil shall not be mixed while in a muddy or frozen condition.

Soil clods 2 in. or greater shall be pulverized before mixing.

(1) Soil for plants in the Heath Family (Ericaceous plants, i.e., Azaleas, Mountain Laurel, Sourwood, etc.) shall consist of existing soil into which the Contractor shall thoroughly incorporate 20 percent peat moss by volume. Based on Administration Soil Test Reports, the pH of soil shall be corrected by mixing iron sulfate or other soil pH modifiers approved by the Engineer to provide a pH range from 4.0 to 5.0.

(2) Soil for other plants except members of the Heath Family shall consist of existing soil at each planting pit location into which the Contractor shall thoroughly incorporate 20 percent by volume of compost or other approved organic soil amendments.

(d) Plant Pit Dimensions. Plant pit dimensions are based on standard ball and container sizes established by the Administration. All plant pit dimensions shall be as specified in the Contract Documents and as follows:

STOCK	HEIGHT	SPREAD	PIT DIMENSIONS	
			DIAMETER in.	DEPTH in.
Deciduous & Evergreen Shrubs & Trees B & B	—	—	2 times the ball diameter	Equal to ball depth
Deciduous & Evergreen Shrubs & Trees Container Grown	—	—	3 times the container diameter	Equal to container depth
Deciduous Bare Root Trees	18 in.	2 ft	22	10
	3 ft	4 ft	26	10
	5 ft	6 ft	30	12
	7 ft	8 ft	32	12
Deciduous & Evergreen Seedling Stock	6 in.	12 in.	18	8
Deciduous Bare Root Shrubs	18 in.	—	18	10
	2 ft	—	20	10
	3 ft	—	24	12
	4 ft	—.	28	12
Vines	SIZE			
	2-1/4 in. Peat Pot		12	6
	3 in. Peat Pot or Container		18	6
	4 in. Container		18	8
	No. 1 Container		18	8

710.03.03 Plantings. The Contractor shall perform all planting, fertilizing, supporting, pruning, mulching, and initial watering operations conforming to the following:

(a) General. Plants shall be placed in planting pits in a vertical position with the root collars at the proper height. Amended soil shall be placed under and around roots to stabilize them in position. The root collars shall be placed at the following levels:

TYPE OF SOIL	COLLAR HEIGHT
Well Drained	Same level as the existing grade
Compacted	1 to 2 in. above the existing grade
Wet, Poorly Drained	25 percent of root mass above the existing grade

For wet, poorly drained soils, approved topsoil mixed with 20 percent by volume of compost or other approved organic soil amendments, shall be placed on top of the planting pit and

tapered to the existing grade at the edge of the planting pit as specified in the Contract Documents.

The burlap on the tops of plant balls shall be loosened and spread away or cut away from the entire top portion of the plant ball. When wire baskets are used, fold down or cut off the top of the baskets to below soil level. The roots of bare root plants shall be spread carefully in a natural position and amended soil shall be worked around roots. Containers shall be removed from the root mass of container grown plants and the fibrous roots loosened around the perimeter of the ball. Amended soil for all plants shall be lightly compressed to eliminate major air pockets. Planting soil shall be thoroughly saturated with water during the planting process to settle soil, eliminate air pockets and to provide for initial water needs of the plants.

During the planting process, fertilizer tablets or other approved slow release fertilizers shall be placed around plant roots in conformance with the manufacturer's recommendations.

Care shall be taken during the backfilling, soil compressing and watering to avoid injuring the roots.

Individually planted trees and shrubs shall have a 4 in. high berm of excavated soil placed outside the rim of the pit to form a saucer. Plants on slopes 4:1 and steeper shall have soil excavated from the uphill rim of the pit and a berm built on the downhill rim.

Plants in beds, except trees, will not require berms. A 4 in. high shoulder of excavated soil shall be placed at the lower edge of all beds on slopes 4:1 and steeper.

Berms and shoulders for planting shall be compacted and graded to the satisfaction of the Engineer.

(b) Tree Staking and Guying. Shade trees specified at 6 ft high, flowering trees specified at 3/4 in. in caliper and evergreen trees specified at 5 ft high or greater sizes shall require supports. Other trees shall be supported as specified in the Contract Documents and as follows:

STOCK	CALIPER in.	HEIGHT ft	SUPPORT REQUIRED
Shade Trees	—	6	2 stakes 6 ft length
	3/4 to 2	—	2 stakes 8 ft length
	2-1/2 to 3-1/2	—	3 stakes 10 ft length
	4 and over	—	3 guy wires attached to approved tree anchors
Flowering Trees	3/4 to 2-1/2	—	2 stakes 5 to 8 ft length as required
	3 and over	—	3 guy wires attached to approved tree anchors
Evergreen Trees	—	5 and 6	2 stakes 5 to 6 ft length as required
	—	7, 8 and 9	3 stakes 7 to 8 ft length as required
	—	10 and over	3 guy wires attached to approved tree anchors

When driving stakes and installing anchors, trees shall not damaged. Each stake shall be positioned 5 to 8 in. away from the edge of the ball and driven into solid bearing ground to a minimum depth of 10 in. or more below the bottom of the pit to support the plant. After stakes are driven, they shall be vertical. Stakes and guys shall support trees in a vertical position. All tree staking and guying shall be completed the same day as planting.

Staking and guying shall be performed as specified in the Contract Documents or as directed by the Engineer.

(c) **Mulching.** All plant beds and pits shall be mulched with an approved composted wood mulch or other approved mulches to a minimum thickness of 3 in., including soil berms and shoulders. The mulch shall be raked to an even surface to the limits specified in the Contract Documents or as directed by the Engineer.

(d) **Pruning.** All deciduous trees under 6 ft high and shrubs shall be pruned after inspection on the site as approved by the Engineer, with care being taken to preserve the natural appearance of the plant. Deciduous trees greater than 6 ft high shall be pruned before planting.

(e) **Cleanup.** During the course of planting, excess and waste materials shall be promptly removed, the turf areas kept clean and all reasonable precautions taken to avoid damage to existing structures, plants and grass.

710.03.04 Plant Care During Construction. Plant care shall begin immediately after each plant is installed and shall continue through the landscape construction phase as specified in 710.03.06(b) and (c).

710.03.05 Construction Phase Acceptance. The Contractor shall submit a request to the Engineer in writing for acceptance of the Construction Phase. The Engineer will grant acceptance when the landscape project has been substantially completed and the following requirements are in conformance:

(a) Plant materials show evidence of having been successfully transplanted.

(b) Unacceptable plants have been replaced.

(c) Planting pits and planting beds are weed free.

(d) Damaging pests have been controlled.

(e) Dead wood has been pruned.

(f) Trees have been straightened.

(g) Staking and guying have been repaired.

(h) Washouts in and around planting pits and beds have been repaired and mulch has been replaced as required.

(i) Plants have been watered as necessary.

(j) All other required work has been completed.

710.03.06 Plant Establishment. The Contractor shall maintain and establish the plants for a period of one year.

(a) **Beginning.** The one year period of establishment will begin upon the Engineer's acceptance of the Construction Phase.

(b) **Maintenance.** The Contractor shall maintain all plants in conformance with the original Specifications and as follows:

(1) **Additional Watering of Plants.** The Contractor shall monitor the water needs of all plants. When the Contractor feels watering is necessary, the Engineer shall be notified. If the Engineer concurs, the Contractor shall begin watering immediately.

If the Contractor fails to water when and as required, the Engineer will notify the Contractor and watering shall begin within 24 hours. The Contractor shall continue to water daily until all plant pits in the Contract have been watered unless otherwise directed by the Engineer. Each watering shall be completed within seven calendar days of the day on which watering was designated to begin.

All watering shall be accomplished using a hose with nozzle end breaker or watering probe. Water shall be applied at low water pressure directly to each planting pit, allowing water to be absorbed into the planting pit soil until saturated, but without runoff.

(2) Weed Control. All undesirable vegetation growing within mulched areas shall be eradicated using glyphosate with a wetting agent in conformance with the manufacturer's recommendations. During each growing season, the Engineer and the Contractor shall inspect the site on or about May 30, July 15 and August 30 to determine if weed control is acceptable. Eradication shall be performed prior to these inspections.

All weeds greater than 6 in. high shall be cut down and removed from the project. Any remaining live weed growth shall be treated with herbicide until eradicated.

All herbicide applications shall be as specified in the Maryland Pesticide Applicator's Law and in conformance with the manufacturer's recommendations. The Contractor shall provide a Certified Applicator of Pesticides (Category III A or VI). Daily herbicide application reports shall be provided to the Engineer.

The Contractor shall be responsible for replacing and pruning any plant material which is killed or damaged through any act of negligence by the Contractor in applying and handling of the herbicide on the project.

(3) Pest Management. The Contractor shall institute an Integrated Pest Management (IPM) Program. The Contractor shall periodically inspect the project for plant pests during each growing season. When potential damaging levels of plant pests are observed, they shall be controlled to prevent damage to the plants.

All pesticide applications shall be as specified in the Maryland Pesticide Applicator's Law and in conformance with the manufacturer's recommendations. The Contractor shall provide a Certified Applicator of Pesticides (Category III A or VI). Daily pesticide application reports shall be provided to the Engineer.

If the Contractor fails to monitor and control plant pests prior to damage, the Contractor will be notified to begin pest control operations within 24 hours, until all damaging pests have been controlled.

(4) Refertilization. When required, and as directed by the Engineer, plants shall be fertilized with a solution of 20-20-20 or other approved analysis water soluble fertilizer designed for the liquid fertilization of plants as specified in the manufacturer's recommendations.

(5) Tree Support Removal. The Contractor shall remove all tree supports to ground level in conformance with the Contract Documents. Stakes shall be removed by cutting or pulling. All stakes, hoses, wires and guys shall be completely removed from the job site and disposed of by the Contractor. Tree support removal shall be performed in the last 30 days of the Plant Establishment period and prior to final acceptance of the project.

(c) Removal and Replacement. The Contractor shall promptly remove from the project all unacceptable plants. Plant replacement shall be made as originally specified. All unacceptable plants shall be replaced during each planting season. When between planting seasons, they shall be replaced during the next proper planting season.

(d) Final Acceptance. The Contractor shall submit a written request to the Engineer for a final acceptance of the landscaping on the project.

710.03.07 Plant Relocation. If the Engineer determines that selected locations of plants installed on the project are undesirable, the plants shall be relocated as directed by the Engineer. When directed, the Contractor shall begin removing plants within five working days and continue daily relocation operations until work is complete. Backfilling of abandoned planting pits shall conform to 710.03.08.

710.03.08 Abandoned Planting Pits. When the Engineer directs that an excavated plant pit be abandoned, the Contractor shall backfill the pit

with the excavated soil or approved backfill. The backfill shall be compacted in 8 in. layers to the finished grade. Preparation and seeding of the disturbed area shall conform to Section 705.

710.04 MEASUREMENT AND PAYMENT.

710.04.01 Planting trees, shrubs, vines & seedling stock will be measured and paid for at the Contract unit price per each item specified in the Contract Documents. The payment will be full compensation for all tree supports, watering during the construction period and for all material, labor, equipment, tools, and incidentals necessary to complete the work. If at any time during the Contract period any plants become unacceptable, they shall be replaced at no additional cost to the Administration.

710.04.02 Mulching. Composted Wood Chips or other approved mulching materials within the planting beds will be measured and paid for at the Contract unit price per square yard. The measurement will be computed on the surface area of the specified thickness before settling or as directed by the Engineer. The payment will be full compensation for all mulch, material, labor, equipment, tools, and incidentals necessary to complete the work.

710.04.03 Additional Watering of Plants. Additional Watering of Plants will be measured and paid for during the plant establishment period at the Contract unit price per 1000 gallons of water applied to the plants.

710.04.04 Plant Relocation. Plant Relocation will be measured and paid for at the Contract unit price per cubic foot for the specified planting pit. The payment will be full compensation for plant relocating, placing all backfill, seeding of damaged turf, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

710.04.05 Abandoned Planting Pits. Abandoned Planting Pits will be measured and paid for at the Contract unit price per cubic foot measured prior to backfilling. The payment will be full compensation for placing all backfill, seeding of damaged turf, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

710.04.06 Plant Refertilization. Plant Refertilization will be measured and paid for at the Contract unit price per 1000 gallons of liquid fertilizer mixture applied to the plants in conformance with 710.04.03. The payment will be full compensation for furnishing fertilizer, water, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 711 — PLANTING ANNUALS, PERENNIALS, FALL PLANTED BULBS, AND ORNAMENTAL GRASSES

711.01 DESCRIPTION. This work shall consist of furnishing and planting annuals, perennials, fall planted bulbs, ornamental grasses, and all plant establishment operations to complete the work as specified in the Contract Documents or as directed by the Engineer.

711.01.01 Planting Schedule.

PLANTS	PLANTING DATES
Container Grown Summer Annuals	May 10 – June 1
Container Grown Winter Annuals	September 15 – October 15
Container Field Grown Perennials and Ornamental Grasses	April 15 – June 30 or September 1 – October 30
Fall Planted Bulbs	October 1 – November 30

711.01.02 Pesticide Application. Refer to 710.01.02.

711.02 MATERIALS.

Agricultural Limestone	920.02
Fertilizer	920.03
Shredded Hardwood Bark	920.05.01
Miscellaneous	920.08

711.03 CONSTRUCTION.

711.03.01 Storage and Handling. The Contractor shall provide adequate facilities for the protection, watering and temporary storage of all plant material.

711.03.02 Preparation for Planting.

(a) Layout. The Contractor shall lay out the location of all beds in the field prior to performing any planting operations as approved by the Engineer.

(b) Planting Bed Preparation. Two weeks prior to planting, all weeds and grass located within planting bed areas shall be eradicated using glyphosate with a wetting agent in conformance with the Maryland Pesticide Applicator's Law and the

manufacturer's recommendations. After the weeds have died, the planting bed areas shall be mowed to a height of 1 in. and the debris shall be removed prior to tilling as directed by the Engineer. Prior to rototilling, the following soil amendments shall be evenly spread over the planting bed:

(1) 2 in. composted biosolids or other approved composted materials.

(2) 15 lb/1000 ft^2 of 5-10-10 fertilizer.

(3) The required amount of dolomitic agricultural limestone or other pH modifiers as determined by the Administration's Soil Tests Reports.

After spreading the soil amendments, the planting bed shall be rototilled to provide a depth of 6 in. of loose soil with a rototiller approved by the Engineer. Working soil in a wet or frozen condition is prohibited. After tilling, the planting bed shall be raked to provide an even planting surface and to remove debris and stones larger than 1 in. All debris shall be removed from the site and disposed of by the Contractor.

711.03.03 Planting. Plants shall not be installed until inspected as specified in 920.07.03. When planting in existing beds, the mulch and existing plants shall not be disturbed.

(a) **Annuals and Perennials**. Prior to planting, plants shall be removed from pots without damaging plants. Annuals and perennials shall be planted through premulched cultivated beds with the mulch carefully pulled back and replaced to avoid mixing soil and mulch. When planted, the top of the root mass shall be at ground level and the plant shall be in a vertical position.

(b) **Fall Planted Bulbs.** Prior to planting, all annuals shall be removed. Fall planted bulbs shall be planted at the depth recommended by the supplier for each specified variety of bulb. Bulbs shall be carefully handled to avoid bruising.

(c) **Initial Watering.** Plants shall be watered immediately after planting and as required until the plants roots have knitted into the planting bed soil. The waterings shall provide full and thorough saturation of the soil in the planting bed. A sprinkler or breaker nozzle shall be used to prevent damage to the plants and disturbance of mulch during the watering operation.

(d) Fertilizing. After the initial watering, a water soluble 20-20-20 fertilizer shall be applied to each plant as specified in the manufacturer's recommendations.

(e) Mulching.

(1) Annuals and Perennials. Prior to planting, a 1-1/2 in. layer of shredded hardwood bark mulch shall be spread over the prepared planting bed. After planting, an additional 1/2 in. shall be evenly spread over the bed.

(2) Fall Planted Bulbs. After planting, a 2 in. layer of shredded hardwood bark mulch shall be spread over the planting bed.

(3) Edging. Upon completion of planting, mulch beds shall be neatly edged to a depth of 3 in. with a vertical cut, tapered back to the area to be mulched.

(f) Refertilization. Refertilization shall conform to 710.03.06(b)(4).

711.03.04 Plant Care During Construction. Plant care shall begin immediately after each plant is installed and shall continue through the landscape Construction Phase and as specified in 711.03.05.

711.03.05 Plant Establishment. Plant establishment shall conform to 710.03.06 modified as follows:

(a) After the initial watering has been completed, plants shall be watered as required at the rate of 60 gal/100 ft^2 of planting bed. This amount of watering is equivalent to 1 in. of rainfall.

(b) During the normal growing season, annuals that die shall be replaced immediately when directed by the Engineer.

(c) Annuals shall be removed after they have declined in the late summer or fall. The dead leaves and flower stems of most perennials shall be removed in the fall. The leaves and flower stems of fall planted bulbs shall be removed in the summer after they have died back. All removal and maintenance of plants shall be as directed by the Engineer.

711.04 MEASUREMENT AND PAYMENT.

711.04.01 Installation of annuals, perennials, fall planted bulbs, and ornamental grasses will be measured and paid for at the Contract unit price per each item as specified in the Contract Documents. The payment will be full compensation for all plants, bulbs, initial waterings,

fertilizing, replacements, seasonal maintenance, and for all material, labor, equipment, tools, and incidentals necessary to complete the work. If at any time during the Contract period any plants become unacceptable, they shall be replaced at no additional cost to the Administration.

711.04.02 Mulching. Shredded Hardwood Bark Mulch within the planting beds will be measured and paid for at the Contract unit price per square yard. The measurement will be computed on the surface area of the specified thickness before settling or as directed by the Engineer. The payment will be full compensation for all mulch, material, labor, equipment, tools, and incidentals necessary to complete the work.

711.04.03 Additional Watering of Plants. Additional Watering of Plants will be measured and paid for at the Contract unit price per 1000 gallons of water applied to the planting beds. Water will be measured as specified in 708.04.02.

711.04.04 Plant Refertilization. Plant Refertilization will be measured and paid for at the Contract unit price per 1000 gallons of liquid fertilizer mixture applied to the plant beds in conformance with 711.04.03. The payment will be full compensation for furnishing fertilizer, water, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 712 — SELECTIVE TREE TRIMMING

712.01 DESCRIPTION. This work shall consist of selective tree trimming as specified in the Contract Documents or as directed by the Engineer and in conformance with the Maryland Department of Natural Resources Roadside Tree Law.

712.02 MATERIALS.

Tree Wound Dressing	920.08.20

712.03 CONSTRUCTION.

712.03.01 Equipment. All pruning tools used shall conform to the accepted arboricultural practices and as approved by the Engineer.

712.03.02 Operation. All work shall be performed by personnel under the supervision of a Maryland Licensed Tree Expert. A Roadside Tree Care Permit shall be obtained from the Maryland Department of Natural Resources prior to performing any tree pruning.

712.03.03 All pruning shall conform to the current edition of the National Arborist Association Pruning Standards For Shade Trees. The class of tree trimming to be performed will be identified in the Contract Documents. Pruning and the application of tree wound dressing shall be performed to the satisfaction of the Engineer.

712.03.04 All wood, branches and debris shall be removed as directed by the Engineer and disposed of by the Contractor.

712.04 MEASUREMENT AND PAYMENT. Selective Tree Trimming will not be measured but will be paid for at the Contract lump sum price. In the event of a change in the number of trees included under this item, payment will be adjusted on the basis of the Contractor's breakdown of the lump sum price. This breakdown shall be submitted by the Contractor to the Engineer within 10 days after the Notice to Proceed. The Contractor's breakdown shall list each class of selective tree trimming specified in the Contract Documents with a tabulation of the numbers and sizes of trees included under each class of tree trimming and the individual prices for each unit included in the lump sum price. The total of the individual units shall equal the lump sum price.

The size designation under which each class of selective tree trimming is performed will be determined in conformance with the following schedule of pay sizes. The caliper of a tree shall be the diameter at breast height measured 4-1/2 feet above the ground.

TREE SIZE DESIGNATIONS	
TREE CALIPER INCHES	**PAY SIZE INCHES**
under 10	6
10+ to 18	14
18+ to 26	22
26+ to 34	30
34+ to 42	38
42+ to 46	44
over 46+	50

The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 713 — SELECTIVE THINNING

713.01 DESCRIPTION. This work shall consist of the selective thinning and disposing of undesirable live and dead trees, shrubs and vegetation, selective pruning of trees to be saved, and removing and disposing of windfalls, logs, stumps and rubbish as specified in the Contract Documents or as directed by the Engineer and in conformance with the Maryland Department of Natural Resources Roadside Tree Law.

713.02 MATERIALS.

Furnished Topsoil	920.01.02
Herbicide	920.08.07
Marking Dye	920.08.08
Tree Wound Dressing	920.08.20

713.03 CONSTRUCTION.

713.03.01 Equipment. Refer to 712.03.01

713.03.02 Operation. A Roadside Tree Care Permit shall be obtained from the Maryland Department of Natural Resources for all tree thinning. All work shall be performed by personnel under the supervision of a Maryland Licensed Tree Expert. The Contractor shall notify the Engineer 10 days prior to the beginning of any selective thinning work.

All selective thinning shall be completed before any new planting is performed in selective thinning areas as directed by the Engineer.

Growth to be removed will be as marked by the Engineer. Dead wood in shrubs shall be removed as determined by the Engineer. Trees shall be pruned by removing all branches and stubs up to 15 ft high. All cuts over 3 in. in diameter, visible from the public right-of-way shall be painted with tree wound dressing. Trees and shrubs to be saved shall not be harmed by the Contractor. Injuries to bark, trunks, and limbs shall be repaired by properly cutting, smoothing, tracing the bark and painting as directed by the Engineer.

When undesirable growth is removed, it shall be cut as nearly flush with the ground surface as feasible. Trees which cannot be felled without danger to traffic or injury to other plants or property shall be cut in sections from the top down.

In open areas where mowing is to be performed, stumps shall be completely removed to a minimum of 8 in. below the ground surface.

The stump hole shall be backfilled with approved topsoil to the height of the adjacent ground surface and seeded as specified in Section 705.

713.03.03 Herbicide Application. Where regrowth from stumps is not desired, the exposed bark and cut surfaces shall be thoroughly saturated with an approved herbicide solution to which marking dye has been added. This mixture shall be applied the same day the plant is cut.

The herbicide shall be mixed and used as directed by the Engineer and in conformance with the manufacturer's recommendations.

All herbicide applications shall be performed as specified in the Maryland Pesticide Applicator's Law and in conformance with the manufacturer's recommendations. Herbicide applications shall be performed under the supervision of a Certified Applicator of Pesticides (Category III A or VI).

713.03.04 Removal and Disposal. All trimmings, dead wood, windfalls, logs, stumps, and rubbish shall be removed and disposed of by the Contractor, as directed by the Engineer

713.03.05 Site Restoration. When selective thinning in an area has been completed, the area shall be thoroughly cleaned. Existing turf areas that have been injured by the work shall be regraded and seeded or sodded, and the entire area shall be neat and clean as directed by the Engineer.

713.04 MEASUREMENT AND PAYMENT. Selective Thinning will be measured and paid for at the Contract unit price per acre. The payment will be full compensation for all herbicide, wound dressing, stump removal, backfill, site restoration, and for all material, labor, equipment, tools, and incidentals necessary to complete the work. Outer measurements will be taken from the drip line of the forest canopy.

SECTION 714 — SELECTIVE TREE FELLING

714.01 DESCRIPTION. This work shall consist of felling trees as specified in the Contract Documents or as directed by the Engineer and in conformance with the Maryland Department of Natural Resources Roadside Tree Law.

714.02 MATERIALS. Not applicable.

714.03 CONSTRUCTION.

714.03.01 Equipment. Refer to 712.03.01.

714.03.02 Operation. A Roadside Tree Care Permit shall be obtained from Maryland Department of Natural Resources prior to any tree felling operations. All work shall be performed by personnel under the supervision of a Maryland Licensed Tree Expert. Tree felling operations are:

(a) Operation 1. Operation 1 shall consist of felling and removal of trees in mowed areas. The stump shall be removed or ground to a minimum depth of 8 in. below the ground surface. The stump hole shall be backfilled level with the adjacent ground surface using approved topsoil and seeded and mulched as specified in Section 705. All wood debris shall be removed from the site and disposed of by the Contractor.

(b) Operation 2. Operation 2 shall consist of felling and removal of trees in areas that are not mowed. The trees shall be felled and the stumps shall be cut to a maximum height of 4 in. above the ground surface. All wood and debris shall be removed from the site and disposed of by the Contractor.

(c) Operation 3. Operation 3 shall consist of felling trees to prevent damage to adjacent trees and structures. The stumps shall be cut to a maximum height of 4 in. above the ground surface. All branches on felled trees extending 3 ft or more above the ground surface shall be cut off. Removal of the felled trees and the cut branches will not be required.

714.04 MEASUREMENT AND PAYMENT. Selective Tree Felling will not be measured but will be paid for at the Contract lump sum price. The Contractor shall submit a breakdown tabulation within 10 days after the Notice to Proceed. The Contractor's breakdown shall list each selective tree felling operation specified in the Contract Documents with a tabulation of the numbers and sizes of trees included in the lump sum price. The total of the individual units shall equal the lump sum price. In the event of a change in the number of trees included under this item, payment will be adjusted on the basis of the Contractor's breakdown of the lump sum price.

The size designation, under which each selective tree felling operation is performed will be determined in conformance with the Tree Size Designation Table specified in 712.04. The caliper of a tree shall be the diameter at breast height measured 4-1/2 feet above the ground.

The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

CATEGORY 800
TRAFFIC

SECTION 801 — CONCRETE FOUNDATIONS

801.01 DESCRIPTION. This work shall consist of constructing concrete foundations for installing traffic signals, highway lighting and signs at locations specified in the Contract Documents or as directed by the Engineer.

801.02 MATERIALS.

Curing Materials	902.07.03
Concrete Mix No. 2	902.10
Corrugated Metal Pipe	905
Reinforcement Steel	908.01
Anchor Bolts	909.07
Conduit	921.07
Galvanizing for Hardware	A 153

801.03 CONSTRUCTION.

801.03.01 Excavation. The Contractor shall perform all excavation to the dimensions specified in the Contract Documents. All excavation work will be inspected and approved by the Engineer before proceeding with construction.

801.03.02 Galvanized parts that have been cut or chipped to bare metal shall be repaired as specified in A 780.

801.03.03 Concrete Placement. It is intended that all concrete be placed against undisturbed earth. However, where the existing ground will not retain its shape during or after excavation or if the excavation should show any tendency to cave in before placing the foundation, the Contractor shall provide and install a corrugated metal pipe to retain the earth and receive the concrete. The pipe shall remain in place.

Concrete shall be mixed, placed and tested as specified in Section 420. Footings including reinforcement and bolt circle data shall be as specified in the Contract Documents and in conformance with the approved working drawings. Anchor bolts shall be plumb. Suitable templates for setting anchor bolts shall be accurately placed and left in place until the concrete has attained its initial set.

Tops of foundations shall be troweled to a dense smooth finish. Exposed surfaces shall be cured by use of a liquid membrane curing compound.

801.03.04 Unusual Soil Conditions. When unexpected subsurface conditions are encountered, the excavation depth shall be modified as directed by the Engineer. Rock or boulders which cannot be removed by ordinary means shall be removed to the levels and dimensions specified in the Contract Documents, or to a depth necessary to obtain the required stability as directed by the Engineer.

801.03.05 Backfill. Material used for backfill shall be free of topsoil, organic, frozen, or other undesirable material. Spaces to be backfilled shall be kept free of trash and shall be cleaned before backfill is placed. Backfill material shall be suitable material from the excavation or other sources conforming to Section 204. All backfill shall be compacted in layers not exceeding 8 in. loose thickness. Compaction shall be done with mechanical or vibratory compaction equipment to obtain at least 92 percent of maximum density at a moisture content within 2 percent of the optimum in conformance with T 180, Method C.

801.04 MEASUREMENT AND PAYMENT. Concrete foundations for installing traffic signals, highway lighting and signs will be measured and paid for at the Contract unit price per cubic yard for the pertinent Concrete Foundation item. The payment will be full compensation for all concrete, excavation, corrugated metal pipe or forms, reinforcement steel, anchor bolts, backfill and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

When concrete barrier transitions, conduit, and grounding are required, they will be measured and paid for as specified in Sections 604, 802, 803, 804, 805, 808, 816 and 818.

SECTION 802 — GALVANIZED STEEL BEAM SIGN POSTS

802.01 DESCRIPTION. This work shall consist of furnishing and installing galvanized steel beam sign posts as specified in the Contract Documents or as directed by the Engineer.

802.02 MATERIALS.

Bolts, Nuts and Washers	909.07
Galvanizing for Beams	A 123

Galvanizing for Hardware	A 153
Steel Beams	A 709

802.03 CONSTRUCTION. Galvanized parts that have been cut or chipped to bare metal shall be repaired as specified in A 780.

Galvanized steel beam sign posts shall be placed in the ground in a plumb position to the lateral orientation specified in the Contract Documents.

Each location where galvanized steel beam sign posts are to be installed shall be staked out by the Contractor and approved by the Engineer. After staking out the galvanized steel beam sign posts and obtaining approval for their location from the Engineer, the Contractor shall submit working drawings and upon approval be permitted to order materials. The Contractor shall indicate on the working drawings the highest elevation of the traveled roadway and the shoulder elevation where sign posts will be installed.

802.04 MEASUREMENT AND PAYMENT. Galvanized Steel Beam Sign Posts will be measured and paid for at the Contract unit price per linear foot for the various sizes of posts specified in the Contract Documents. The payment will be full compensation for stakeout, furnishing and installing the posts and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Breakaway Base Support Systems, when specified in the Contract Documents, will be measured and paid for as specified in Section 821.

SECTION 803 — OVERHEAD SIGN STRUCTURES

803.01 DESCRIPTION. This work shall consist of furnishing and fabricating overhead sign structures and other appurtenances as specified in the Contract Documents or as directed by the Engineer. Sign panels, electrical work, luminaires, and foundations are excluded.

803.02 MATERIALS.

Bolts, Nuts and Washers	909.07
Overhead Sign Structures	950.04

803.03 CONSTRUCTION. All fabrication shall be done in the shop as specified in Section 430, except that welding shall conform to ANSI/AWS D1.1, Tubular Structures.

All assemblies and tubular members shall be designed and manufactured as specified in A 385 to permit hot dip galvanizing. All holes required in the supports shall be made before galvanizing. The surfaces shall be protected during transportation and handling.

The structure shall be free from sharp edges, irregularities, misfits or structural deficiencies. After erection and before final acceptance, the Contractor shall repair or replace damaged surfaces in a manner acceptable to the Engineer.

Each location where overhead sign structures are to be installed shall be staked out by the Contractor and approved by the Engineer. After staking out the overhead sign structures and obtaining approval for their location from the Engineer, the Contractor shall submit working drawings and upon approval be permitted to order materials. The Contractor shall indicate on the working drawings the highest elevation of the traveled roadway and the shoulder elevation where sign structure supports will be installed.

803.04 MEASUREMENT AND PAYMENT. Overhead Sign Structures will be measured and paid for at the Contract unit price per each. The payment will be full compensation for all stakeouts, overhead sign structures, sign/luminaire supports, nuts and washers, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 804 — GROUNDING

804.01 DESCRIPTION. This work shall consist of furnishing and installing grounding systems as specified in the Contract Documents or as directed by the Engineer. The grounding system shall conform to the latest editions of the National Electrical Code (NEC) and the National Electric Safety Code (NESC).

804.02 MATERIALS.

Ground Wire and Rods	950.06.04

804.03 CONSTRUCTION.

804.03.01 Equipment Grounding System. Equipment grounding system shall consist of the ground wire, electrically continuous metallic conduit system, grounding conductors, ground rods and terminations.

Every item of equipment served by the electrical system shall be bonded to the equipment grounding system.

804.03.02 Grounding Conductors. Grounding conductors shall be the size and type specified in the Contract Documents.

804.03.03 Ground Rods. Ground rods shall be installed as specified in the Contract Documents. Maximum acceptable earth resistance value shall be 25 ohms. Ground resistance of each rod shall be measured before connecting the rod to the grounding conductor. If the measured resistance exceeds 25 ohms, a 10 ft extension rod shall be exothermically welded to the top of the first rod, then driven to its full depth. Earth resistance shall again be measured, and if it still exceeds 25 ohms, the Engineer shall be contacted for instructions.

Where rock is encountered and acceptable earth grounds cannot be accomplished by driving as described above, the Engineer may direct the use of a grounding grid utilizing direct buried rods exothermically welded end to end to bond lighting standards and structures in continuous series to some point where an acceptable earth ground can be obtained.

804.03.04 Continuity. Continuity of the equipment grounding system shall be maintained throughout the project.

804.03.05 Terminations. Connection to equipment grounding system shall be made with suitable lugs at all grounding bushings specified in Section 805, and at the ground lugs in lighting structure access holes or in a breakaway base. Connections to ground rods shall be as specified in the Contract Documents. Connections to neutral grounding systems shall be made with lugs, as specified in Section 805.

804.03.06 Testing. Refer to Section 820.

804.04 MEASUREMENT AND PAYMENT. Ground Rods will be measured and paid for at the Contract unit price per each 10 ft length. The payment will be full compensation for all rods, lugs, driving rods, weldings, excavation, backfill, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Ground Wire will be measured and paid for as specified in 810.04.01.

SECTION 805 — ELECTRICAL CONDUIT AND FITTINGS

805.01 DESCRIPTION. This work shall consist of furnishing and installing electrical conduit and fittings as specified in the Contract Documents or as directed by the Engineer. The requirements of Section 820 shall be a part of this Specification.

805.02 MATERIALS.

Concrete	902.10
Metallic Conduit and Fittings	921.07.01
Nonmetallic Conduit and Fittings	921.07.02
Flexible Conduit and Fittings	921.07.02
PVC Coated Metallic Conduit and Fittings	921.07.03

805.03 CONSTRUCTION.

805.03.01 Bends. Unless otherwise specified in the Contract Documents, changes in direction of conduit shall be accomplished by use of manufactured bends or by field bends. Changes in the direction of conduit shall have an 18 in. trade radius.

805.03.02 Connections. Conduit runs shall be made with as few couplings as standard length will permit. Rigid steel conduit connections shall be threaded. Field cut threads of galvanized conduit shall be painted with an approved galvanizing repair paint prior to assembly. Nonmetallic conduit shall be connected by a solvent welding process. Fittings for electrical metallic tubing (EMT) conduit shall be watertight cast ferrous compression type.

805.03.03 Conduit Terminations. Pull boxes or conduit bodies shall be used at conduit terminations. Conduits terminating in cast iron junction boxes shall be threaded into hubs with bonding screws furnished and installed on the interior of the box. Conduits terminating in junction boxes without hubs shall be secured with two lock nuts with an insulated grounding bushing furnished and installed. Conduits terminating at concrete foundations and manholes or hand holes shall be secured as specified in the Contract Documents. All ends of unused conduit shall be capped.

805.03.04 Cleaning and Capping. Prior to installation of conductors in any run, the conduit shall be checked for cleanliness and all obstructions removed. Each conduit run and all fittings shall be cleaned of all debris by a pull through mandrel type device inserted in the presence of the

Engineer. All ends of conduits shall be capped by use of a manufactured cap or plug. Prior to the installation of wiring, manufactured caps or plugs shall be removed and an insulated bonding bushing for galvanized rigid conduit, or bell end fittings for PVC conduit installed.

805.03.05 Pull Wire. After installation, all conduit which will be left empty shall have a pull wire or cord installed. Pull wire or cord shall be made of corrosion resistant material with a minimum breaking strength of 200 lb.

805.03.06 Exposed Conduit. Exposed conduit runs shall be parallel to, or at right angles to, walls, slabs, girders, etc. Conduit shall be located to minimize accumulation of dirt and to provide accessibility for painting. Conduit shall be attached to steel, concrete, masonry or timber by straps, clamps or hangers of an approved type made of stainless steel or galvanized malleable iron. Spacing of attachments shall be as specified or as directed by the Engineer. When specified, all exposed rigid steel conduit surfaces shall be painted to match the color of adjacent material. All galvanized surfaces shall be prepared as specified in Section 435 before the application of paint approved by the Engineer.

805.03.07 Expansion Joints. Where conduits cross expansion joints in the structure, or where otherwise specified, expansion fittings shall be of the type that assures electrical continuity across the joint.

805.03.08 Buried Conduit (Trenched). Conduit shall have a minimum cover of 24 in. and shall slope to drain.

805.03.09 Encased Conduit (Slotted or Trenched). Conduit to be encased in concrete shall be accurately placed and rigidly held in position so that line and grade are maintained when concrete is placed.

805.03.10 Conduit Installation Under Existing Paved Areas (Bored). All conduit placed under existing pavement shall be installed with no disturbance to the existing roadway.

805.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all excavation, backfill, conduit encasing concrete, hot mix asphalt, attachments, hangers, paint, bends, connections, fittings, mandrelling, pull wires and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

805.04.01 Electrical Conduit and Fittings and Electrical Conduit and Fittings Attached to Bridges will be measured and paid for at the Contract unit price per linear foot measured along the center line of the conduit from end to end.

805.04.02 Electrical hand holes, manholes, pull and junction boxes will be measured and paid for as specified in Section 811.

805.04.03 Electrical conduit and fittings and junction boxes to be constructed into concrete structures will not be measured but the cost will be incidental to the pertinent Concrete Traffic Barrier, Concrete Parapet, or other pertinent Concrete items specified in the Contract Documents.

805.04.04 Concrete Foundations will be measured and paid for as specified in Section 801.

SECTION 806 — LUMINAIRES AND LAMPS

806.01 DESCRIPTION. This work shall consist of furnishing and installing luminaires and lamps. The requirements of Section 820 shall be a part of this Specification.

806.02 MATERIALS.

Luminaires and Lamps	950.12
Photoelectric Controls	950.13.02

806.03 CONSTRUCTION.

806.03.01 Arm Mounted Luminaires. Luminaire mounting shall be installed on the respective structures and adjusted as specified in the Contract Documents. The socket positions shall be adjusted to provide the required photometric performance. The luminaire shall include an individual photocell when specified in the Contract Documents.

806.03.02 Bridge Underpass Luminaires. Bridge underpass luminaires shall be installed on structures as specified in the Contract Documents. Luminaires shall be connected and lamp sockets adjusted where necessary as specified in the manufacturer's recommendations.

806.03.03 Cleaning. After installation has been completed and prior to the 30 days performance test, refractors and reflectors shall be cleaned with a product approved by the manufacturer.

806.03.04 Installation. All luminaires and lamps shall be furnished and installed as specified in the Contract Documents or in conformance with the manufacturer’s recommendations.

806.04 MEASUREMENT AND PAYMENT. Luminaires will be measured and paid for at the Contract unit price per each. The payment will be full compensation for luminaires, lamps, ballast, photocell, mounting hardware, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 807 — ELECTRICAL SERVICE EQUIPMENT

807.01 DESCRIPTION. This work shall consist of furnishing and installing electrical service equipment necessary for the utility company to connect the electrical power supply as specified in the Contract Documents or as directed by the Engineer and coordinating the connection with the local utility company.

807.02 MATERIALS.

Control and Distribution Equipment	950.13

807.03 CONSTRUCTION. Electrical service equipment shall consist of the equipment necessary to connect a utility company service to a traffic signal controller cabinet, lighting control cabinet, traffic monitoring station cabinet, or other traffic control device cabinet. Electrical service equipment shall be provided at the phasing and amperage specified in the Contract Documents.

807.03.01 Metered Service Pedestal. Metered service pedestals shall consist of a galvanized steel post containing a 100 amp 2 pole main circuit breaker for service disconnect, branch circuit breakers, and integral meter socket.

The galvanized steel post shall be designed to be imbedded into the soil a minimum of 18 in. and have a stabilizer shoe. Where specified in the Contract Documents, the post shall be imbedded in concrete. The post and meter socket shall conform to NEMA 3R. Provisions shall be provided to padlock the post closed to protect the circuit breakers, and to install a utility company seal to secure the meter.

Branch circuit breakers shall consist of a combination of 4 single pole 20 amp circuit breakers, and 1 double pole 20 amp circuit breaker or as specified in the Contract Documents.

Metered service pedestals shall be UL listed "Suitable for Service Equipment," and shall be acceptable to the local utility companies for use as a service connection.

807.03.02 Electrical Service Distribution Cabinet. Where an electrical service distribution cabinet is specified, the Contractor shall furnish and install an equipment enclosure, meter socket, disconnect switch, panel boards, transformers, circuit breakers, thermostats, fans, lightning arresters, conduit, wiring and wiring devices, ground fault interrupters, and all other equipment necessary to provide a complete functioning electrical service distribution cabinet. All electrical outlets shall be protected by ground fault interrupters (GFI).

807.03.03 Meter Socket. Meter sockets shall be provided in either ringed or ringless types as required by the utility company. If a meter is not required, a ringless socket with suitable shunts and a metallic cover plate shall be provided. Hardware for attaching the meter socket to a cabinet, wood post, of other structure shall be provided by the Contractor.

807.03.04 Disconnect Switch. Disconnect switch shall include all hardware for attaching the disconnect switch to a cabinet, wood post, or other structure as specified in the Contract Documents.

807.03.05 Service Cable. Electric service cable for traffic signals, intersection control beacons, hazard identification beacons, and luminaires mounted on traffic signal structures shall have three individual type THWN wires. Each wire shall be a minimum of 19 strands. Electric service cable color identification by spray paint, tape, heat shrink tubing, or any other post-manufacturing method is prohibited.

807.03.06 Utility Connection. The Contractor shall arrange a meeting with the utility company representatives, Traffic Operations Division representatives, the Engineer, and the District Utility Engineer as specified in the Contract Documents to establish a schedule for utility connections before any control equipment or material is ordered.

The Contractor shall not disconnect, de-energize, reconnect, tamper with, or otherwise handle any of the utility company's facilities. The Contractor shall be responsible for the utility service connection to the utility company supplied point of service.

The Contractor shall make the necessary arrangements with the utility companies to ensure having needed utilities available at the time of turn on. Any utility energization, connection or disconnection delays will not be a valid reason for any time extension. Difficulties in securing utility

company services are to be reported to the Engineer at the earliest possible time.

807.04 MEASUREMENT AND PAYMENT.

807.04.01 Electrical Utility Service Equipment will be measured and paid for at the Contract unit price per each at the phasing and amperage specified. The payment will be full compensation for the disconnect switch, meter socket, meter, shunts, cover plate, lightning arresters, wiring, conduit risers, wiring trough, conduit nipples and adapters, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

807.04.02 Metered Service Pedestal will be measured and paid for at the Contract unit price per each. The payment will be full compensation for all enclosures, panel boards, circuit breakers, internal wiring, wiring devices, meter sockets, meter, shunts, cover plates, wiring and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

807.04.03 Electrical Service Distribution Cabinet will be measured and paid for at the Contract unit price per each. The payment will be full compensation for all enclosures, disconnect switches, lightning arresters, panel boards, circuit breakers, internal wiring, ground fault interrupter outlets, conduits, wiring devices, meter sockets, meter, shunts, cover plates, wiring and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

807.04.04 Meter Socket will be measured and paid for at the Contract unit price per each. The payment will be full compensation for attachment hardware, meter, shunts, cover plate, and for all material, labor, equipment, tools, and incidentals necessary to complete the work. When an item for meter socket is not included in the Contract documents, this work will not be measured, but the cost will be incidental to other pertinent items.

807.04.05 Disconnect Switch will be measured and paid for at the Contract unit price per each. The payment will be full compensation for attachment hardware, fuses, switch, and for all material, labor, equipment, tools and incidentals necessary to complete the work. When an item for this work is not included in the Contract Documents, this work will not be measured, but the cost will be incidental to other pertinent items.

807.04.06 Underground conduit will be measured and paid for as specified in 805.04.

807.04.07 Service lateral cable will be measured and paid for as specified in 810.04.

807.04.08 Concrete foundation will be measured and paid for as specified in 801.04.

807.04.09 Utility connection coordination with the utility company will not be measured, but the cost will be incidental to other pertinent items.

807.04.10 All utility company energization, connection or disconnection costs will be the responsibility of the Administration.

SECTION 808 — LIGHTING STRUCTURES

808.01 DESCRIPTION. This work shall consist of furnishing and installing low level steel and aluminum lighting poles, bracket arms and fittings, as specified in the Contract Documents or as directed by the Engineer. Concrete foundations are excluded.

808.02 MATERIALS.

Cast Iron	909.04
Hardware	909.10
Conduit	921.07
Lighting Structures	950.07
Galvanization	A 123
Stainless Steel Hardware	A 167, Type 302
Aluminum Castings	B 26 or B 108, alloy 356-T6
Anchor Base Plate for Aluminum Structures	B 209, 6000 series alloy

808.03 CONSTRUCTION. Refer to Section 801 for concrete foundations.

All fabrication and welding shall conform to Section 430. After forming and welding, the pole shall have a smooth finish with only one longitudinal and no transverse welds. When fully assembled, each lighting structure shall be installed so that the pole is vertical.

All welding for aluminum poles shall be metallic arc consumable electrode inert gas shielded process. After welding, the entire assembly shall be precipitation heat treated to the T-6 temper by an approved method and rotary sand finished.

All aluminum poles shall be furnished with internal vibration dampening devices.

Bracket Arms. The bracket arm shall be secured to the poles as specified in the manufacturer's recommendations. Each bracket arm shall be perpendicular to the travel lane of roadway, unless otherwise specified.

808.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

808.04.01 Lighting Structures will be measured and paid for at the Contract unit price per each pole height, bracket arm length and material type.

808.04.02 Concrete Foundation will be measured and paid for as specified in Section 801.

808.04.03 Breakaway Base Support Systems, when specified in the Contract Documents, will be measured and paid for as specified in Section 821.

808.04.04 Bracket arms for signal structures or wood poles will be measured and paid for at the Contract unit price per each for the pertinent Bracket Arm item.

SECTION 809 — TRENCHING AND BACKFILLING

809.01 DESCRIPTION. This work shall consist of excavating and backfilling trenches to the width required to receive underground conduit, wire, or duct cable for traffic control devices as specified in the Contract Documents or as directed by the Engineer.

809.02 MATERIALS.

Backfill	950.05
Conduit Detection Tape	950.11

809.03 CONSTRUCTION. Trenches shall be excavated to the dimensions and lines specified and shall conform to Section 402.

In areas where conduit is trenched, a detector tape shall be placed in the trench at a depth of 6 in. below the finished grade. The color of the

tape shall be red. The tape shall be imprinted with a continuous warning message that reads **"CAUTION: SHA ELECTRICAL LINE BURIED BELOW,"** repeated every 36 in. The tape shall be inductively and conductively traceable using a standard pipe and cable locating device.

Cable Treatment. The duct cable and direct buried wires shall be bedded into the special backfill material as specified in the Contract Documents.

Backfill. The trench shall be backfilled and compacted as specified in Section 801 and restored to its original condition, including replacing topsoil, reseeding, and resodding where directed by the Engineer.

All excess or unsuitable material shall be disposed of as specified in Section 402.

809.04 MEASUREMENT AND PAYMENT. Trenching and backfilling will not be measured but the cost will be incidental to the Contract unit price for the installation of the pertinent conduit, detector tape, wire, or duct cable.

SECTION 810 — ELECTRICAL CABLE, WIRE, AND CONNECTORS

810.01 DESCRIPTION. This work shall consist of furnishing and installing loop detector wires and leads, electrical cable, cable ducts, wire, micro-loop probe sets, communication cable, and associated connectors of the type and at the locations specified in the Contract Documents or as directed by the Engineer.

810.02 MATERIALS.

Micro-Loop Probe	As approved by the Office of Traffic & Safety (OOTS)
Sealer for Loop Detector	911.06
Conduit	921.07
Electrical Cable and Wire	950.06
Communication Cable	950.06.08
Cable and Wire Connectors	950.14

810.03 CONSTRUCTION. The Contractor shall furnish and install copper conductor wire and cable of the types and sizes and at the locations specified in the Contract Documents. No splicing will be permitted for cables unless specified in the Contract Documents. When

specified, lighting cable splices and loop detector lead in cable will be permitted only in junction and pull boxes and hand holes. Cable shall not be installed until the entire related raceway, including manhole, hand hole, and foundation system is in place. A 6 ft cable slack shall be provided neatly tied, coiled and positioned in the bottom of the hand holes, manholes, and cabinets. Drip loops measuring 8 in. shall be provided at all overhead entrance points into structures. Insulated spade type terminal ends shall be installed upon all wiring placed on terminal blocks.

810.03.01 Direct Burial Cable. Direct burial cable shall be installed to the depth of cover specified in the Contract Documents. Backfill shall conform to 801.03.05.

810.03.02 Cable in Conduits. Cable in conduits shall be installed in a manner and by methods to prevent harmful stretching of the conductor, injury to the insulation, or damage to the other protective covering. The ends of all cables shall be sealed until ready for connection. Where more than one wire or cable is to be installed in a single duct or conduit, they shall be pulled into the conduits by hand or power winch with the use of cable grips or pulling eyes. Pulling tension shall be governed by recommended standard procedures for straight pulls or bends. A lubricant compatible with the cable insulation shall be used.

810.03.03 Preassembled Cable Duct. Prior to installation, the cable duct shall be payed out from its reel as the reel is moved alongside and parallel to the trench. Cable duct shall not be pulled off a reel located in a stationary position. The cable shall be installed using cable grip in a manner that will not stress or damage conductors, insulation, or sheath wall.

After backfilling the Contractor shall demonstrate that the conductors move freely within the duct by pulling the conductors out a minimum length of 2 ft. Pulling tensions shall conform to 810.03.02. The cable shall then be pulled to its original position. Cable duct ends shall be completely sealed with a waterproof removable sealing compound, molded plastic or rubber device.

810.03.04 Cable in Lighting Structures. The cable shall be supported at each luminaire with a suitable clamp as an integral part of the luminaire or a device approved by the Engineer for the application.

810.03.05 Identification Tags. Identification tags for circuit wiring in all hand holes, junction boxes, and control cabinets shall be furnished and installed. Nonconductive identifying bands shall be nylon, self clinching type with adequate sized tab for labeling. Each band shall be marked

using 1/4 in. minimum lettering dies, engraving device or other permanent marking process approved by the Engineer. Bands shall indicate circuit number for lighting systems, terminal block position for loop detector cables, and traffic signal phase for all other signal cables.

810.03.06 Loop Detector Wire and Loop Detector Lead-in. Prior to the installation of loop wires, the saw cut area shall be dry and free of any saw cut debris. Loop detector wire cable shall be twisted five turns per foot from the loop itself to the terminal point. Loop detector wire shall be installed at the bottom of the saw cut. A blunt instrument shall be used to seat the loop detector wire at the bottom of the saw cut. Loop detector wire shall be spliced to loop detector lead-in as specified in the Contract Documents.

810.03.07 Grounding Wire. Refer to Section 804.

810.03.08 Connector Kits. Connector kits shall be furnished and installed as required for the types of cables specified in the Contract Documents and shall conform to the manufacturer's recommendations.

810.03.09 Micro-Loop Probes. Micro-loop probe sets shall be installed as specified in the Contract Documents or as directed by the Engineer. All leads shall be terminated in the controller cabinet.

810.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all cable, preassembled cable ducts, wire, lubricants, splices, overhead communication cable attachments, identification tags, trench excavation and backfill, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

810.04.01 Electrical Cable, Cable Ducts, Loop Detector Wire and Loop Detector Lead-in Cable, Grounding Wire and Communication Cable will be measured and paid for at the Contract unit price per linear foot for the type and sizes specified in the Contract Documents.

810.04.02 Connector Kits will be measured and paid for at the Contract unit price per each type.

810.04.03 Micro-Loop Probe Sets will be measured and paid for at the Contract unit price per each set. The payment will be full compensation for all sealant, PVC conduit, hole drilling, installation of lead-in cable, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Saw cuts for loop detector wire and micro-loop probe sets will be measured and paid for as specified in Section 815.

SECTION 811 — ELECTRICAL HAND HOLES, MANHOLES, PULL AND JUNCTION BOXES

811.01 DESCRIPTION. This work shall consist of furnishing and installing electrical hand holes, manholes, pull and junction boxes as specified in the Contract Documents or as directed by the Engineer.

811.02 MATERIALS.

811.02.01 Hand holes.

No. 57 Coarse Aggregate	901.01
Concrete Mix No. 2	902.10
Brick	903.02
Bolts	A 276, Type 304
Frames and Covers	AISC 1020 Steel
Precast Concrete	M 199

811.02.02 Manholes.

No. 57 Coarse Aggregate	901.01
Reinforced Concrete Pipe	905
Cast Iron Manhole Covers	909.04
Polyethylene (PE)	921.10
Precast Concrete	M 199

811.02.03 Pull and Junction Boxes.

Steel Plate	909.02
Cast Iron	909.04

811.03 CONSTRUCTION.

811.03.01 Hand Holes and Manholes. Hand holes and manholes shall be installed flush to drain with the finished grade. Concrete shall be mixed, placed and tested as specified in Section 420. Aggregate drain shall be installed as specified in the Contract Documents. Excavation and backfill shall conform to Section 809. When hand holes and manholes are installed in sidewalks, the sidewalk shall be removed and reinstalled to the nearest joint. Spaces between conduit and the hand hole and manhole wall shall be filled or patched with concrete or other sealer as directed by the Engineer.

Hand hole and manhole frames shall be set in a mortar or concrete bed as shown in the Contract Documents.

811.03.02 Pull and Junction Boxes. Conduit entrance shall be provided with conduit hubs or bosses of sufficient thickness that five full threads of the conduit shall engage the threaded holes in the box.

811.04 MEASUREMENT AND PAYMENT. Electrical Hand Holes, Manholes, and Pull and Junction Boxes will be measured and paid for at the Contract unit price per each unless otherwise specified in the Contract Documents. The payment will be full compensation for all excavation, aggregate drain, concrete, bolts, bricks, pipes, backfill, sealer, frames and covers, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 812 — WOOD SIGN SUPPORTS

812.01 DESCRIPTION. This work shall consist of furnishing and erecting wood sign supports as specified in the Contract Documents or as directed by the Engineer. Signs shall be as specified in Section 813.

812.02 MATERIALS. Wood supports shall be No. 1 dense grade.

Wood	921.05
Preservatives	921.06

812.03 CONSTRUCTION. Wood sign supports shall be placed in the ground in a plumb position to the depth and lateral orientation specified in the Contract Documents. Backfill shall consist of suitable excavation material compacted in place. Holes for embedding sign supports shall be augered or dug using methods approved by the Engineer. Driving or hammering wood sign supports into undisturbed earth is prohibited.

When specified in the Contract Documents, wood sign supports shall have drilled holes conforming to the breakaway requirements specified in AASHTO Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, or as indicated in the Contract Documents.

812.04 MEASUREMENT AND PAYMENT. Wood Sign Supports will be measured and paid for at the Contract unit price per linear foot for the length and size specified in the Contract Documents. The payment will be full compensation for all excavation and backfill, drilled holes, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 813 — SIGNS

813.01 DESCRIPTION. This work shall consist of furnishing and installing signs of sheet aluminum or extruded aluminum panels, all with a reflective or nonreflective sheeting background, and all direct applied or silk screened copy or demountable copy with bolts and fittings to erect the signs as specified in the Contract Documents or as directed by the Engineer. Sign supports shall be as specified in Sections 802, 803, and 812.

The sign installation shall include clearing work to provide for good sight distance.

813.02 MATERIALS.

Sign Panel Supports and Hardware	909.07, 921.05, 921.06, 950.04, A 123, A 153 and A 709
Reflective and Nonreflective Sheeting	950.03
Sign Materials	950.08

The Administration will supply traffic signal related signs and their mounting hardware for span wire, mast arm, and signal pole mounted signs. All other mounting hardware shall be supplied by the Contractor and shall be manufactured from stainless steel.

813.03 CONSTRUCTION. Extruded aluminum shall have demountable copy. Sheet aluminum shall have direct applied or silk screen copy. After installation of the signs is completed, they will be inspected. If specular reflection is apparent on any sign, its positioning shall be adjusted by the Contractor as directed by the Engineer.

Each new sign location shall be inspected to determine if clearing is required. All clearing and disposal shall be done as specified in Section 101. Any tree limbs protruding within the limits of clearing shall be removed as specified in Section 712. The limits of clearing for each location shall be as specified in the Contract Documents.

813.04 MEASUREMENT AND PAYMENT.

813.04.01 Signs will be measured and paid for at the Contract unit price per square foot of area of the vertical front face of the completed sign with no deduction for required shaping. The payment will be full

compensation for the mounting hardware and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

813.04.02 Administration furnished signs and mounting hardware will be measured and paid for at the Contract unit price per square foot for the completed sign installed. The payment will be full compensation for all transportation, drilling holes as specified, installation, and for all materials, labor, equipment, tools, and incidentals necessary to complete the work.

813.04.03 Clearing for signing will not be measured but the cost will be incidental to the Contract unit price for furnishing and installing the signs.

SECTION 814 — SIGNAL HEADS

814.01 DESCRIPTION. This work shall consist of furnishing and installing vehicle traffic control signal heads and pedestrian traffic control signal indications and mounting hardware as specified in the Contract Documents or as directed by the Engineer.

814.02 MATERIALS.

Traffic Signal Heads	950.15

814.03 CONSTRUCTION.

Aiming. Signal heads shall be aimed to be visible in conformance with the minimum requirements of the MUTCD.

814.04 MEASUREMENT AND PAYMENT. Aluminum, Polycarbonate, and Optically Programmed Signal Heads and Pedestrian Signal Indications furnished and installed will be measured and paid for at the Contract unit price per each section of signal head type and size as specified in the Contract Documents. The payment will be full compensation for all lens, mounting hardware, assembly, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 815 — SAW CUTS FOR TRAFFIC CONTROL DEVICES

815.01 DESCRIPTION. This work shall consist of saw cutting and sealing the saw cuts for traffic control devices, within and alongside the roadway, between the detector location and the nearest terminal point as specified in the Contract Documents or as directed by the Engineer.

815.02 MATERIALS.

Sealer	911.06

815.03 CONSTRUCTION.

815.03.01 Saw Cut. Prior to saw cutting, holes shall be drilled at all turns as specified in the Contract Documents. All saw cuts shall be made utilizing a water quenched process. Saw cutting curbs and gutters is prohibited. The saw cut width shall be as specified in the Contract Documents.

815.03.02 Saw Cut Sealing. Sealer used to seal saw cuts shall be applied as specified in the manufacturer's recommendations into washed, cleaned, and dried saw cuts. The saw cuts shall not be sealed until electrical testing is performed as specified in Section 820. Sealer shall not be poured when the roadway surface temperature is below 35 F or during any precipitation.

815.04 MEASUREMENT AND PAYMENT. Saw Cuts for Traffic Control Devices will be measured and paid for at the Contract unit price per linear foot. The payment will be full compensation for all drilled holes, washing, cleaning, drying, sealing, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 816 — TRAFFIC CONTROL DEVICE CABINETS AND EQUIPMENT

816.01 DESCRIPTION. This work shall consist of installing Administration furnished traffic signal controllers and cabinets, furnishing and installing traffic signal controllers and cabinets, and furnishing and installing lighting control cabinets for highway and sign lighting as specified in the Contract Documents or as directed by the Engineer.

816.02 MATERIALS.

Conduit	902.10, 921.07.01, 921.07.03, and 950.11
Control and Distribution Equipment	950.13
Anchor Bolts, Hardware, Cabinets and Controllers	Furnished by, or as approved by the Office of Traffic and Safety

816.03 CONSTRUCTION.

816.03.01 Base Mounted Traffic Signal Cabinets. Base mounted cabinets shall be mounted on concrete foundations conforming to Section 801 and as specified in the Contract Documents. Conduit shall be furnished and installed as specified in Section 805.

816.03.02 Pole Mounted Traffic Signal Cabinets. Pole mounted cabinets shall be installed as specified in the Contract Documents. Conduit shall be furnished and installed as specified in Section 805.

816.03.03 Base Mounted Lighting Cabinets. Where base mounted lighting cabinets are specified, the Contractor shall furnish and install an equipment enclosure, panel boards, transformers, circuit breakers, lighting contactor, relay, photoelectric controls, thermostats, selector switches, fans, lightning arresters, conduit, wiring and wiring devices, ground fault interrupters, and all other equipment necessary to provide a complete functioning lighting cabinet as specified in the Contract Documents. All electrical outlets shall be protected by ground fault interrupters (GFI).

816.03.04 Pole Mounted Lighting Cabinets. Where pole mounted lighting cabinets are specified, the Contractor shall furnish and install a NEMA 4x, stainless enclosure with attachment hardware for attaching the unit to a utility pole, wood post or traffic control device structure. Included electrical equipment shall be a 60 amp, 2 pole main circuit breaker; a 60 amp, 2 pole electrically held lighting contactor; four 2 pole circuit breakers at the amperage specified in the Contract Documents; photoelectric control; lightning arrester; and all incidentals necessary to provide a complete lighting control unit.

816.04 MEASUREMENT AND PAYMENT.

816.04.01 Installing Administration furnished Signal Controllers and Cabinets or Furnishing and Installing Contractor furnished Traffic Signal Controllers and Cabinets will be measured and paid for at the Contract

unit price per each for the pertinent item. The payment will be full compensation for furnishing the controller or cabinet when specified, installation, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

816.04.02 Concrete foundations will be measured and paid for as specified in 801.04.

816.04.03 Conduit will be measured and paid for as specified in 805.04.

816.04.04 Ground rods will be measured and paid for as specified in 804.04.

816.04.05 Lighting Cabinets will be measured and paid for at the Contract unit price per each of the type and size as specified in the Contract Documents. The payment will be full compensation for all enclosures, panel boards, transformers, circuit breakers, contactors, relays, photoelectric controls, thermostats, fans, selector switches, ground fault interrupters, lightning arresters, conduit, internal wiring, wiring devices, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 817 — PUSH BUTTONS AND PUSH BUTTON SIGNS

817.01 DESCRIPTION. This work shall consist of furnishing and installing round pedestrian push button assembly with 2 in. plunger and push button signs at locations specified in the Contract Documents, or as directed by the Engineer.

817.02 MATERIALS.

Retroreflective Sheeting (Type II)	950.03.01
Push Button Sign	950.08
Push Buttons	A 319

The push button assembly shall be weather-tight and tamper proof. The assembly shall be designed to prevent an electrical shock under any weather condition and shall have provisions for grounding in conformance with the NEC.

(a) The push button assembly shall be fabricated from aluminum ingot and have an anodized finish.

(b) The push button plunger shall be chrome plated, 2 in. diameter, and have a spring with operative force not to exceed 5 lb.

(c) The push button switch shall have single-pole momentary, normally-open, single-throw contacts and spade-type terminals.

(d) The switch assembly shall have an operating force of approximately 0.5 lb, but shall not exceed 1 lb.

(e) The switch assembly shall be UL approved and electrically rated to carry 25 amps at 120 volts AC.

817.03 CONSTRUCTION. Push buttons shall be located as specified in the Contract Documents in positions that clearly indicate to the pedestrian which crosswalks are actuated by each push button.

The Contractor shall furnish all mounting hardware and drill holes to provide cable and wire entrances as specified in the Contract Documents.

817.04 MEASUREMENT AND PAYMENT. Push Buttons and Push Button Signs will be measured and paid for at the Contract unit price per each. The payment will be full compensation for furnishing, installing, drilling of holes, mounting hardware, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 818 — SIGNAL STRUCTURES

818.01 DESCRIPTION. This work shall consist of the pickup and the installation of Administration furnished signal structures of the sizes specified in the Contract Documents or as directed by the Engineer. The anchor bolts, grommets and miscellaneous hardware will be furnished by the Administration.

818.02 MATERIALS.

Signal Structures Hardware Furnished by the Administration

818.03 CONSTRUCTION. The signal structure shall be installed on a concrete foundation conforming to Section 801 and as specified in the Contract Documents.

Breakaway base support systems, when specified, shall conform to Section 821.

Any finish on the signal structures and mounting hardware damaged during transportation and erection shall be repaired to match the original finish by the Contractor as approved by the Engineer at no additional cost to the Administration.

818.04 MEASUREMENT AND PAYMENT.

818.04.01 Installation of Administration furnished signal structures will be measured and paid for at the Contract unit price per each for the type of structure erected in place. The payment will be full compensation for the transportation and installation of all steel poles, mast arms, twin mast arms, triple mast arms, strain poles, pedestal poles, breakaway base support systems, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

818.04.02 Concrete foundations will be measured and paid for as specified in 801.04.

SECTION 819 — STEEL SPAN WIRE

819.01 DESCRIPTION. This work shall consist of furnishing and installing steel span wire for signal head or sign mountings, interconnect runs, or for tethering purposes when specified in the Contract Documents or as directed by the Engineer.

819.02 MATERIALS.

Steel Span Wire	950.09
Galvanizing	A153

Steel messenger rings shall be sized as specified in the Contract Documents and shall be mechanically or hot dip galvanized after fabrication.

819.03 CONSTRUCTION. The span wire shall be attached to poles by wrapping two full turns of the span wire around the pole at the specified height.

The free end of the wrapped span wire shall be 2 ft in length and shall be secured to the traversing span wire by a three bolt clamp and serving sleeve as specified in the Contract Documents.

All messenger rings shall be spaced 8 in. apart.

819.04 MEASUREMENT AND PAYMENT. Steel Span Wire of the size specified in the Contract Documents will be measured and paid for at the Contract unit price per linear foot for the wire installed. The payment will be full compensation for all hardware, material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 820 — GENERAL ELECTRICAL WORK AND TESTING

820.01 DESCRIPTION. This work shall consist of furnishing, installing, and testing of all applicable electrical items referred to in Category 800.

820.02 MATERIALS. All materials and equipment installed as part of the permanent installation shall be new, UL listed, or labeled, and shall conform to NEC, NESC, NEMA, IES, and local codes applicable to the area of installation.

820.03 CONSTRUCTION.

820.03.01 General. All installations shall conform to NEC, NESC, local utility company requirements, and State and local laws and ordinances governing the work. All electrical work shall be accomplished under the direct supervision of a master electrician licensed in the State of Maryland, or in the county where the work is being performed. All work performed under Sections 804, 805, 806, 807, 810 (except loop wire), 811, 814, 816, 817, and 820 shall be preformed by a journeyman electrician. The Contractor shall obtain and pay for all permits, licenses and inspection fees.

820.03.02 Testing. The Contractor shall supply all personnel and equipment required to successfully perform the following tests and shall furnish four certified copies of the complete test reports to the Engineer.

Not less than 30 days prior to the commencement of each required test, the Contractor shall submit to the Engineer the types, styles or catalog numbers of all testing equipment to be used for the tests. A written certification shall be included stating when the testing equipment was last calibrated by an Administration approved testing agency. The calibration date shall be within 180 days of the date when the tests are to be performed. All tests shall be performed in the presence of the Engineer.

Any defects found in the completed installation shall be repaired or replaced immediately to the satisfaction of the Engineer at no additional cost to the Administration.

(a) Ground Resistance Testing. Ground resistance testing shall be conducted using a megger ground tester, using the null balance fall of potential method. Corrected readings greater than 25 ohms will not be accepted.

(b) Circuit Testing. A circuit test to determine insulation resistance shall be performed on all cables of every circuit except those installed in lighting structures. Cable insulation resistance shall be a minimum of 10 megohms at 500 volts D.C. except loop detector wire and loop detector lead in shall have a minimum of 100 megohms at 500 volts D.C.

The Contractor shall demonstrate in a manner acceptable to the Engineer that all conductors are continuous, free from short circuits and unspecified grounds, and that all circuits are properly connected as specified in the Contract Documents.

(c) Performance Testing. A performance test using the design power source shall be conducted by the Contractor prior to acceptance. The electrical system, including automatic control equipment, shall be operated for 30 consecutive days without failure. If any component fails, it shall be immediately replaced and the test shall be continued. The Contractor shall record each fault, the method and date of correction of each, and the beginning and end of the 30 day test period. If more than 5 percent of any component fails during the test, the component shall be replaced and the 30 day test cycle for the entire system shall be restarted.

(d) Illumination Testing. An illumination test shall be conducted by the Contractor to determine the illumination characteristics of the roadway lighting installation. The test shall conform to procedures approved by the Administration.

820.03.03 Traffic Signal Testing. Testing shall be accomplished without hazard to the traveling public.

The Contractor shall maintain all new materials until satisfactorily tested and their operation accepted by the Engineer.

All signal heads and signs in place but not in use shall be entirely covered with opaque burlap.

After completion, testing, and acceptance, any new traffic signal shall be placed on flashing operation for a 72 hour period prior to placing the signal on full color operation. Existing full color and flashing signals shall not flash, but shall be kept in operation until the new signal is completed, satisfactorily tested, and approved by the Engineer.

The Contractor shall remove any STOP signs at new full color signals at the end of the 72 hour flashing period. The date and time of removal shall be logged and provided to the Engineer.

All signal heads, signs, spans and mast arms, that are not to be put in use, shall be removed upon acceptance by the Engineer and placement of the new traffic control device into operation.

New traffic signals, exclusive of signal system interconnect installation, may be placed into operation upon completion of the new traffic signal being satisfactorily tested and accepted by the Engineer. Upon the signal system interconnect installation completion, the signal system interconnect shall also be satisfactorily tested and approved by the Engineer.

820.04 MEASUREMENT AND PAYMENT. General electrical work and testing and the as-built drawings will not be measured but the cost will be incidental to the other pertinent items specified in the Contract Documents.

SECTION 821 — BREAKAWAY BASE SUPPORT SYSTEMS

821.01 DESCRIPTION. This work shall consist of furnishing and installing breakaway base support systems or installing Administration furnished breakaway base support systems as specified in the Contract Documents.

821.02 MATERIALS. Breakaway base support systems shall conform to the breakaway requirements specified in AASHTO Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals as approved by the Office of Traffic & Safety.

821.03 CONSTRUCTION. The Contractor shall furnish and install breakaway base support systems for signals, lighting and signing, including post hinge assembly units for sign structures, as specified in the Contract Documents and in conformance with the manufacturer's

recommendations. The ground adjacent to the breakaway base shall be graded as specified in the Contract Documents.

The concrete foundation shall conform to Section 801.

821.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all excavation, backfill, grading, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Breakaway Base Support Systems will be measured and paid for at the Contract unit price per each for breakaway support systems furnished and installed as specified in the Contract Documents.

Installation of Administration supplied breakaway support systems will be measured and paid for at the Contract unit price per each. Transportation to and pick up of Administration supplied components will not be measured but the cost will be incidental to this item.

Breakaway base support systems for signals. Refer to 818.04.01.

SECTION 822 — REMOVE AND RELOCATE EXISTING SIGNS AND SIGN STRUCTURES

822.01 DESCRIPTION. This work shall consist of removing and relocating existing signs and sign structures as specified in the Contract Documents or as directed by the Engineer.

822.02 MATERIALS. Not applicable.

822.03 CONSTRUCTION. All existing cable shall be made safe in conformance with the appropriate electrical codes and as directed by the Engineer.

822.03.01 Removing Existing Signs. Existing signs may be relocated during construction. All existing and relocated signs shall be removed when the new signing system is installed. All new signs in a particular sequence giving similar directions shall be installed before existing signs are removed.

Concrete foundations remaining after removing the sign structure shall be removed as specified in 207.03.01. All holes left after sign removal shall be backfilled, compacted, and restored to conditions similar to its surroundings as approved by the Engineer.

822.03.02 Relocating Existing Signs. Existing signs specified in the Contract Documents shall be relocated as part of the new signing system. Concrete foundations remaining after relocating the sign shall be removed as specified in 207.03.01.

The Contractor shall be responsible for the storage and handling of materials to be reused as specified in GP-6.02.

822.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for removing and relocating existing signs and sign structures, removing existing concrete foundations, backfilling and compacting existing holes left after foundation removal and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

822.04.01 Remove Existing Ground Mounted Signs and Supports will be measured and paid for at the Contract unit price per square foot area of the sign. Removal of sign supports and concrete foundations will not be measured but the cost will be incidental to the Contract unit price for removing the signs.

822.04.02 Remove Signs From Existing Overhead Structure will be measured and paid for at the Contract unit price per square foot area of the sign. Removal of sign and sign luminaire supports, luminaires, conduit and cable will not be measured but the cost will be incidental to the Contract unit price for removing the signs.

822.04.03 Relocate Existing Ground Mounted Signs will be measured and paid for at the Contract unit price per square foot area of the sign. Removal and disposal, or removal and relocation of the sign support will not be measured but the cost will be incidental to the Contract unit price for relocating the signs.

822.04.04 Relocate Signs From Existing Overhead Structure will be measured and paid for at the Contract unit price per square foot area of the sign. Removal and relocation of sign and sign luminaire supports and luminaires will not be measured but the cost will be incidental to the Contract unit price for relocating the signs.

822.04.05 Remove Existing Cantilever or Overhead Sign Structure and Signs and Supports will be measured and paid for at the Contract unit price per each structure. Disconnecting the electrical service and removal of concrete foundations will not be measured but the cost will be incidental to the Contract unit price for removing the structure.

822.04.06 Concrete for sign foundation, galvanized steel beam sign posts, breakaway base support system for steel beams and wood sign supports for new sign supports, if required, will be paid for as specified in the applicable portions of Sections 801, 802, 812 and 821.

SECTION 823 — REMOVE AND RELOCATE OR REMOVE AND DISPOSE OF ROADWAY LIGHTING STRUCTURES

823.01 DESCRIPTION. This work shall consist of removing and relocating or removing and disposal of roadway lighting structures as specified in the Contract Documents or as directed by the Engineer.

823.02 MATERIALS.

Hardware	909.10
Conduit	921.07

823.03 CONSTRUCTION. Concrete foundations shall be removed as specified in 207.03.01. All holes caused by this removal shall be backfilled and compacted as approved by the Engineer. Lighting structures removed and not reused shall become the property of the Contractor. Lighting structures scheduled to be reused on the same project shall be removed and stored by the Contractor in conformance with GP-6.02.

All existing cable shall be made safe in conformance with the appropriate electrical codes and as directed by the Engineer.

823.04 MEASUREMENT AND PAYMENT. Remove and Dispose of Roadway Lighting will be measured and paid for at the Contract unit price per each. The payment will be full compensation for the removal and disposal of the lighting structure, removal of existing concrete foundation and all material, labor, equipment, tools, and incidentals to complete the work.

Remove and Relocate Roadway Lighting Structure will be measured and paid for at the Contract unit price per each. The payment will be full compensation for the removal, storage, reinstallation, connection to existing lighting circuits, removal of existing concrete foundations, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 824 — MODIFY EXISTING SIGN MESSAGES

824.01 DESCRIPTION. This work shall consist of removing and adding new sign copy, shields and arrows for existing signs, or overlaying existing sign messages as specified in the Contract Documents or as directed by the Engineer.

824.02 MATERIALS.

Reflective and Nonreflective Sheeting and Copy	950.03
Sign Materials	950.08

824.03 CONSTRUCTION.

824.03.01 Modifying Signs With Demountable Copy. Existing copy or shields shall be carefully removed. The sign background material shall be thoroughly cleaned using mild detergent and water. New copy shall be installed as specified in the Contract Documents.

When specified in the Contract Documents, existing demountable copy shall be covered with sheet aluminum having a minimum thickness of 0.040 in. The overlay shall contain the sign background and copy.

824.03.02 Modifying Signs With Direct Applied Copy. When specified in the Contract Documents, existing copy shall be covered with sheet aluminum having a minimum thickness of 0.040 in. The overlay shall contain the sign background and copy.

The Contractor may use direct applied overlays for minor modifications to sign messages in conformance with the manufacturer's recommendation.

824.04 MEASUREMENT AND PAYMENT. The payment will be full compensation for all cleaning, material, labor, equipment, tools, and incidentals necessary to complete the work.

824.04.01 Modify Message On Existing Ground Mounted or Overhead Signs will be measured and paid for at the Contract unit price per each removed or each installed character for the type of sign installation specified. Characters include shields, arrows and sign copy.

824.04.02 Overlay Existing Ground Mounted or Overhead Signs will be measured and paid for at the Contract unit price per square foot, removed or installed for the type of sign specified.

SECTION 825 — CUTTING AND CAPPING MAST ARMS AND POLES

825.01 DESCRIPTION. This work shall consist of cutting, cleaning, galvanizing, and capping mast arms, mast arm poles, pedestal poles, and strain poles as specified in the Contract Documents.

825.02 MATERIALS.

Cold Galvanizing Compound	A 780

825.03 CONSTRUCTION. Galvanized parts that have been cut or chipped to bare metal shall be repaired as specified in A 780.

Saw cut the pole or mast arm to the required length. Clean the affected area inside and outside with a wire brush. Spray cold galvanizing compound on the affected area. Place an end cap of matching size.

825.04 MEASUREMENT AND PAYMENT. Cutting and Capping of Mast Arms and Poles will be measured and paid for at the Contract unit price per each. The payment will be full compensation for cutting, cleaning, galvanizing, capping, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

CATEGORY 900
MATERIALS

900.01 GENERAL. All materials included in this Category will be sampled, tested, and inspected as specified in the most recently published cited standards. The specification limits for each material are established and no deviation from these limits will be permitted except when, in the judgment of the Engineer, the deviation will not be detrimental to the work. In these cases, refer to the appropriate specification governing price adjustments for nonconformance.

Within 30 days after receipt of notification of award of the Contract, the Contractor shall submit in writing, to the Regional Engineer, the sources from which the Contractor proposes to obtain all materials to be incorporated into the project. All nursery stock sources shall be updated and submitted to the Regional Engineer 45 days prior to the planting season in which the planting is to begin. No material shall be introduced into the work until approval of sources has been obtained. The Administration reserves the right to completely or partially test any material for Specification compliance.

Sampling shall conform to the Administration's Sample Testing and Frequency Guide unless otherwise directed by the Engineer. All source approvals are made subject to continuing production of materials conforming to these Specifications. Material sources may be rejected where it is evident that the material tends to be of marginal quality when compared to the Specification limits in any of its specified properties.

900.02 TECHNICIAN QUALIFICATION REQUIREMENTS. Technicians performing Quality Assurance/Quality Control sampling and testing on Administration projects shall be qualified through the certification program provided by the Administration. All private laboratories performing testing on Administration projects shall be in the AASHTO Accreditation Program or approved by the Administration.

Technicians include those who work for inspection agencies, Contractors, consultants, producers, private laboratories, as well as State and local government employees.

SECTION 901 — AGGREGATES

901.01 This section covers the material details, quality requirements, and test methods applicable to aggregates. Grading requirements are outlined in Tables 901 A and 901 C; physical properties in 901 B and

901 D. Force drying may be used in the preparation of samples for grading tests conducted in the field.

901.01.01 Steel Slag. Steel slag may be used for chip seal surface treatment, but it shall not be used for any other aggregate.

TABLE

AGGREGATE GRADING REQUIREMENTS

MATERIAL		SIEVE SIZE					
		2-1/2"	2"	1-1/2"	1"	3/4"	1/2"
CRUSHER RUN AGGREGATE CR -6 (f)(g)		—	100	90–100	—	60–90	—
BANK RUN GRAVEL — SUBBASE		100	—	—	90–100	—	60–100
GRADED AGGREGATE — BASE DESIGN RANGE (a)		—	100	95–100	—	70–92	—
TOLERANCE (b)		—	–2	±5	—	±8	—
BANK RUN GRAVEL — BASE		100	—	—	85–100	—	60–100
COARSE AGGREGATE - PORTLAND CEMENT CONCRETE	57 and UNDERDRAIN (h)	—	—	100	95–100	—	25–60
	67	—	—	—	100	90–100	—
	7	—	—	—	—	100	90–100
FINE AGGREGATE — PORTLAND CEMENT CONCRETE, UNDERDRAIN, and PNEUMATIC MORTAR (d)		—	—	—	—	—	—
COARSE AGGREGATE — LIGHTWEIGHT PORTLAND CEMENT CONCRETE		—	—	—	100	90–100	—
FINE AGGREGATE — LIGHTWEIGHT PORTLAND CEMENT CONCRETE (d)		—	—	—	—	—	—
FINE AGGREGATE/SAND MORTAR and EPOXIES (d)		—	—	—	—	—	—
MINERAL FILLER		—	—	—	—	—	—
CRUSHED GLASS (e)		—	—	—	—	100	—

(a) To establish target values for design.
(b) Production tolerance.
(c) ±2 for field grading (omitting T 11).
(d) Fine aggregate includes natural or manufactured sand.
(e) Crushed glass shall not contain more than one percent contaminants by weight.
(f) Not to be used in the structural part of any Administration project.
(g) Recycled asphalt pavement may be used as a component not to exceed 15 percent and is not subject to aggregate physical property requirements in TABLE 901 B.
(h) When this material is used for drainage applications, recycled concrete shall not be used.

901 A

TEST METHOD T 27

SIEVE SIZE									
3/8”	**No. 4**	**No. 8**	**No. 10**	**No. 16**	**No. 30**	**No. 40**	**No. 50**	**No. 100**	**No. 200**
—	30–60	—	—	—	—	—	—	—	0–15
—	—	—	35–90	—	—	20–55	—	—	5–25
50–70	35–55	—	—	—	12–25	—	—	—	0–8
±8	±8	—	—	—	±5	—	—	—	±3(c)
—	—	—	35–75	—	—	20–50	—	—	3–20
—	0–10	0–5	—	—	—	—	—	—	—
20–55	0–10	0–5	—	—	—	—	—	—	—
40–70	0–15	0–5	—	—	—	—	—	—	—
100	95–100	—	—	45–85	—	—	10–30	0–10	—
10–50	0–15	—	—	—	—	—	—	—	—
100	85–100	—	—	40–80	—	—	10–35	5–25	—
—	100	95–100	—	—	—	—	—	0–25	0–10
—	—	—	—	—	100	—	95–100	—	70–100
—	0–55	—	—	45–85	—	—	—	0–10	—

TABLE

AGGREGATE PHYSICAL

MATERIAL TYPE I	SPECIFICATION	TEST METHOD			
		T 90	T 104	T 112	T 113
		PI max	SODIUM SULFATE SOUNDNESS % max	CLAY LUMPS & FRIABLE PARTICLES % max	CHERT; LESS THAN 2.40 Sp Gr % max
CRUSHER RUN AGGREGATE CR-6	D 2940 (h)	6	12	—	—
BANK RUN GRAVEL — SUBBASE	D 2940	9	12	—	—
GRADED AGGREGATE — BASE	D 2940	6	12	—	—
BANK RUN GRAVEL — BASE	D 2940	9	12	—	—
COARSE AGGREGATE — PCC (b)	M 80 CLASS A	—	12	2.0	3.0
FINE AGGREGATE — PCC (b)(d)	M 6 CLASS B	—	10	3.0	—
COARSE AGGREGATE — LIGHTWEIGHT PCC	M 195	—	—	2.0	—
FINE AGGREGATE — LIGHTWEIGHT PCC (f)	M 195	—	—	2.0	—
FINE AGGREGATE/SAND MORTAR & EPOXIES	M 45	—	10	1.0	—
MINERAL FILLER (g)	M 17	NP	—	—	—
CRUSHED GLASS	M 80	—	12	—	—

(a) Dimensional ratio of calipers shall be 5:1.
(b) Coarse and fine aggregate for PCC shall be tested for alkali silica reactivity (ASR) as specified in MSMT 212.
(c) 1.5 if material passing No. 200 sieve is dust of fracture, free of clay or shale.
(d) In areas exposed to traffic manufactured sand shall have a minimum ultimate polish value of 8, based on the parent rock.
(e) 5.0 for concrete not subject to surface abrasion.
(f) Fine aggregate conforming to M 6 may be used if the lightweight concrete does not exceed the maximum unit weight specified in the Contract Documents.
(g) Fly ash shall have a maximum of 12 percent loss on ignition.
(h) Other approved inert materials of similar characteristics may be used provided they conform to these provisions. When crushed reclaimed concrete is used, the soundness loss by five cycles of the magnesium sulfate test shall not exceed 18 percent when tested as specified in T 104.

901 B

PROPERTY REQUIREMENTS

TEST METHOD					
T 112 & T 113	**T 11**	**T 113**	**D 4791 (a)**	**T 96**	**T 21**
SUM OF CLAY LUMPS, FRIABLE PARTICLES & CHERT	**MATERIAL FINER THAN No. 200 SIEVE**	**COAL & LIGNITE**	**FLAT & ELONGATED**	**LOS ANGELES ABRASION**	**ORGANIC IMPURITIES**
% max	**% max**	**% max**	**% max**	**% max**	**max**
—	—	—	15	50	—
—	—	—	—	50	—
—	—	—	15	50	—
—	—	—	—	50	—
3.0	1.0(c)	0.5	12	50	—
—	4.0(e)	1.0	—	—	3.0
—	—	—	12	—	—
—	—	—	—	—	3.0
—	—	0.5	—	—	3.0
—	—	—	—	—	—
—	—	—	—	45	—

TABLE

ASPHALT

AGGREGATE GRADING REQUIREMENTS, % PASSING

MATERIAL		SIEVE SIZE		
		19.0 mm	12.5 mm	9.5 mm
HOT MIX ASPHALT SUPERPAVE- 4.75mm		—	—	100
GAP GRADED HOT MIX ASPHALT- 9.5mm		100	100	75–90
GAP GRADED HOT MIX ASPHALT-12.5mm		100	90–99	70–85
GAP GRADED HOT MIX ASPHALT-19.0mm		100	82–88	60 max
MATERIAL		**SIEVE SIZE**		
		3/4”	**1/2”**	**3/8”**
SLURRY SEAL (SS) AND LATEX MODIFIED SLURRY SEAL (LMSS)	MIX II	—	—	100
	MIX III	—	—	100
CHIP SEAL SURFACE TREATMENT	7	100	90–100	40–70
	8	—	100	85–100

Note: HMA Superpave 4.75 mm shall be designed with ESAL ranges of 0.3 to less than 3.0 million.

901 C

MIXES

FOR MIX DESIGN, TEST METHOD T 27

SIEVE SIZE						
4.75 mm	**2.36 mm**	**1.18 mm**	**600 µm**	**300 µm**	**150 µm**	**75 µm**
80–100	36–76	—	—	—	—	2–12
30–50	20–30	—	—	—	—	8–13
28–40	18–30	—	—	—	—	8–11
22–30	14–20	—	—	—	—	9–11
SIEVE SIZE						
No. 4	**No. 8**	**No. 16**	**No. 30**	**No. 50**	**No. 100**	**No. 200**
90–100	65–90	45–70	30–50	18–30	10–21	5–15
70–95	45–70	28–50	19–34	12–25	7–18	5–15
0–15	0–5	—	—	—	—	—
10–30	0–10	0–5	—	—	—	—

TABLE

AGGREGATE PHYSICAL PROPERTY

MATERIAL	SPECIFICATION	TEST METHOD			
		T 90	T 104	T 112	T 113
		PI	SODIUM SULFATE SOUNDNESS	CLAY LUMPS and FRIABLE PARTICLES	CHERT LESS THAN 2.40 Sp Gr
		max	% max	% max	% max
HOT MIX ASPHALT SUPERPAVE— 4.75mm	MP2	NP	12	2.0	3.0
HOT MIX ASPHALT SUPERPAVE— 9.5, 12.5, & 19.0mm HIGH ESAL	MP2	NP	12	2.0	3.0
HOT MIX ASPHALT SUPERPAVE— 9.5, 12.5, & 19.0mm LOW ESAL	MP2	NP	12	2.0	3.0
HOT MIX ASPHALT SUPERPAVE—9.5, 12.5, & 19.0mm 8PV	MP2	NP	12	2.0	3.0
HOT MIX ASPHALT SUPERPAVE— 25.0 & 37.5mm	MP2	NP	12	2.0	3.0
GAP GRADED HOT MIX ASPHALT SUPERPAVE— 9.5, 12.5, & 19.0mm	MP2	NP	12	2.0	3.0
SLURRY SEAL (SS) & LATEX MODIFIED SLURRY SEAL (LMSS)	—	NP	12	—	—
CHIP SEAL SURFACE TREATMENT	M 80, CLASS A	—	—	2.0	3.0
CRUSHED GLASS	M 80	—	12	—	—

(a) Dimensional ratio of calipers shall be 5:1.
(b) 5.5 when aggregate from no more than two sources are blended. Proportions of blended aggregate shall be determined as specified in MSMT 416. Not applicable for Gap Graded surface mixes or any other surface mix requiring high polish aggregate.
(c) Polish Value (PV) and British Pendulum Number (BPN) determined on parent rock. When recycled asphalt pavement (RAP) is used the PV shall be 4.
(d) 1.0 for samples taken at the point of production. Samples taken at any point after shipment shall not have more than 1.5 percent finer than No. 200 sieve.
(e) PV shall be 9 when the aggregate is blended. When carbonate rock is used it shall have a minimum of 25 percent insoluble residue retained on the No. 200 sieve.
(f) No blending allowed.
(g) Dimensional ratio of calipers shall be 3:1/5:1.
(h) The test for flat and elongated particles (max/min) shall be conducted on the blend.
(i) Test conducted on particles retained on the No. 4 sieve.

901 D

REQUIREMENTS FOR ASPHALT MIXES

TEST METHOD						
T 112 & T 113	**T 11**	**T 113**	**D 4791 (a)**	**T 96**	**MSMT 411**	**T 279**
SUM OF CLAY LUMPS, FRIABLE PARTICLES and CHERT	**MATERIAL FINER THAN No. 200 SIEVE**	**COAL and LIGNITE**	**FLAT and ELONGATED (h)**	**LOS ANGELES ABRASION (LA)**	**PV (c)**	**BPN (c)**
% max	**% max**	**% max**	**% max**	**% max**	**min**	**min**
3.0	—	0.5	10	45	5 (b)	—
3.0	—	0.5	10	45	5 (b)	—
3.0	—	0.5	10	45	5 (b)	—
3.0	—	0.5	10	45	8 (e)	—
3.0	—	0.5	10	45	—	—
3.0	—	0.5	20/5 (g)(i)	30	8 (e)	—
—	—	—	—	—	4 (f)	16
3.0	1.0(d)	0.5	—	45	—	—
—	—	—	—	45	—	—

901.02 STONE FOR RIPRAP, CHANNELS, DITCHES, SLOPES, AND GABIONS. The stone shall be field or quarry stone of approved quality and may be certified from a source previously approved. Maximum dimension shall not exceed four times the minimum dimension.

901.02.01 Stone for Riprap. Stone for riprap shall be uniformly graded from the smallest to the largest pieces as specified in the Contract Documents. The stone will be accepted upon visual inspection at the point of usage, and shall conform to the following:

CLASS OF RIPRAP	SIZE	PERCENT OF TOTAL by weight
0	Heavier than 33 lb Heavier than 10 lb Less than 1 lb	0 50 10 max
I	Heavier than 150 lb Heavier than 40 lb Less than 2 lb	0 50 10 max
II	Heavier than 700 lb Heavier than 200 lb Less than 20 lb	0 50 10 max
III	Heavier than 2000 lb Heavier than 600 lb Less than 40 lb	0 50 10 max

Note: Optimum gradation is 50 percent of the stone being above and 50 percent below the midsize. Reasonable visual tolerances will apply.

901.03 STONE FOR CHANNELS AND DITCHES. Stone for channels and ditches shall conform to the size requirements of Class I Riprap and the following:

QUALITY REQUIREMENTS	
TEST AND METHOD	**SPECIFICATION LIMITS**
Apparent Specific Gravity T 85, min	2.50
Absorption T 85, % max	3.0
Sodium Sulphate Soundness - 5 cycles, 2-1/2 to 1-1/2 in. Aggregate T 104, % loss max	20

901.04 STONE FOR SLOPES. Stone for slopes shall conform to M 43, size number 1 omitting T 11. The stone shall also conform to the quality requirements specified in 901.03.

901.05 STONE FOR GABIONS. Stone for gabions shall conform to the quality requirements specified in 901.03 and the following, except that the loss by sodium sulfate shall not be greater than 12 percent:

DEPTH OF BASKET in.	SIZE OF INDIVIDUAL PIECES * in.
6	3 – 6
9	4 – 7
12	4 – 7
18	4 – 7
36	4 –12

*Size of pieces will be determined visually.

SECTION 902 — PORTLAND CEMENT CONCRETE AND RELATED PRODUCTS

902.01 STORAGE. Storage of materials shall conform to the Contract Documents and as directed by the Engineer.

902.02 CERTIFICATION OF PORTLAND CEMENT AND BLENDED HYDRAULIC CEMENT. The manufacturer shall furnish certification as specified in TC-1.02. The certification shall also include:

(a) The mill shall report its quality control procedures, and submit a new report whenever there is a procedural change.

(b) The mill's control laboratory shall be inspected by the Cement and Concrete Reference Laboratory of the National Institute of Standards and Technology on their regularly scheduled visits. The Engineer shall be provided with copies of the reports of these inspections along with an account of the action taken to correct cited deficiencies.

(c) Records of data accumulated by the quality control procedures shall be produced upon request.

(d) A certified document shall accompany each shipment stating that the contents conform to all applicable requirements. Additionally, the document shall show the producer's name, mill location, carrier number, date loaded, weight contained in carrier, silo number, consignee, destination, Contract number, and type of cement. The signature and title of the signer shall be shown on the document.

(e) The mill shall, upon request, supply certified chemical and physical test values that can be associated with any sample representing cement drawn from a particular silo on a given date.

(f) Acceptance of cement by certification will be terminated if test results differ from mill results by more than the precision limits given in the test method. The acceptance procedure shall then revert to storage testing and approval prior to shipment.

902.03 PORTLAND CEMENT. Portland cement shall conform to M 85, with the fineness and the time of setting determined in conformance with T 131 and T 153, respectively.

902.04 BLENDED HYDRAULIC CEMENT. Blended hydraulic cement shall conform to M 240, Type I (PM) or a Type IP containing 15 to 25 percent pozzolan by weight of cement. Maximum loss on ignition shall be 3.0 percent and ground iron blast furnace slag shall not be used for blending. The requirement for a manufacturer's written statement of the chemical composition is waived.

902.05 MASONRY CEMENT. Masonry cement shall conform to C 91, except the water retention and staining tests are waived.

902.06 CONCRETE ADMIXTURES. Concrete admixtures shall not contribute more than 200 ppm of chlorides based on the cement content when tested as specified in MSMT 610. Only prequalified admixtures shall be used.

A pozzolan and Type I (PM) or Type IP cement shall not be used in the same mix. Since the strength gains are delayed with these materials, a longer period of time may be required for curing and form removal.

902.06.01 Air Entraining Admixtures. Air entraining admixtures shall conform to M 154.

902.06.02 Chemical Admixtures. Chemical admixtures shall conform to M 194, Type A, D, or nonchloride C.

902.06.03 High Range Water Reducing Admixtures. High range water reducing admixtures shall be liquid and shall conform to M 194, except that the water content shall be a maximum of 85 percent of that of the control, and the durability factor shall be a minimum of 90. Type F shall be used for early strength and shall produce a minimum compressive strength in 12 hours of 180 percent of that of the control. Type G shall be used when early strength is not specified. The manufacturer shall furnish certification as specified in TC-1.02. The certification shall include curves indicating the fluid ounces of admixture per 100 lb of cement as related to water reduction and strength gain for 12 hours when used with a minimum cement factor of 700 lb.

902.06.04 Pozzolans. The Contractor may request the use of pozzolans to control alkali silica reactivity or for other reasons. When a pozzolan is used, the minimum cement factor and water/cement ratio shall be determined on the basis of the combined weight of cement and pozzolan. See Table 902 B for percentage of fly ash, ground iron blast furnace slag, and microsilica.

(a) **Fly Ash.** Fly ash shall conform to M 295, pozzolan Class C or F, except that the maximum permissible moisture content shall be 1.0 percent, and when used in concrete Mix Nos. 3 and 6 the loss on ignition shall not exceed 3.0 percent.

(b) **Ground Iron Blast Furnace Slag.** Ground iron blast furnace slag shall conform to M 302, Grade 100 or 120.

(c) **Microsilica.** Microsilica shall conform to C 1240, except that the oversize requirement is waived.

902.06.05 Ground Iron Blast Furnace Slag. The Contractor may request to substitute a maximum of 50 percent of the weight of cement with ground iron blast furnace slag. When ground iron blast furnace slag is used, the minimum cement factor and water/cement ratio will be determined on the basis of the combined weight of the cement and ground iron blast furnace slag. Ground iron blast furnace slag shall conform to M 302, Grade 100 or 120.

902.06.06 Synthetic Fibers. When synthetic fibers are specified in the Contract Documents, the fibers shall be 1/2 to 1-1/2 in. long and conform to C 1116, Type III. The manufacturer shall furnish certification as specified in TC-1.02. The quantity of fibers used and their point of introduction into the mix shall conform to the fiber manufacturer's recommendations.

902.07 PORTLAND CEMENT CONCRETE CURING MATERIALS. Curing materials shall be burlap cloth, sheet materials, liquid membrane forming compounds, or cotton mats.

902.07.01 Burlap. Burlap cloth shall be made from jute or kenaf and conform to M 182, Class 1, 2, or 3.

902.07.02 Sheet Materials. Sheet material shall conform to M 171 with the following exceptions:

(a) **White Opaque Burlap Polyethylene Sheeting.** Tensile strength and elongation requirements are waived. The sheeting shall have a finished product weight of not less than 10 oz/yd^2.

(b) **White Opaque Polyethylene Backed Nonwoven Fabric.** The material shall conform to 902.07.02(a), with the thickness requirement waived. The finished product weight shall be a minimum of 5 oz/yd^2.

(c) **White Opaque Polyethylene Film.** Tensile strength and elongation requirements are waived.

902.07.03 Liquid Membrane. Liquid membrane forming compounds shall conform to M 148.

Field control testing of the white pigmented curing compounds shall be on the basis of weight per gallon. The samples shall not deviate more than ± 0.3 lb/gal from the original source sample.

902.07.04 Cotton Mats. Cotton mats shall consist of a filling material of cotton bats or bats covered with unsized cloth and tufted or stitched to maintain the shape and stability of the unit under job conditions of handling.

The covering shall be either cotton cloth, burlap or jute having the following properties:

(a) Cotton cloth covering shall weigh not less than 6.0 oz/yd^2 and shall have an average of not less than 32 threads/in. of warp and not less than 28 threads/in. of filling. The raw material used in the manufacture of the cotton cloth shall be raw cotton, cotton comber waste, cotton card strip waste, or combinations thereof.

(b) Burlap or jute covering for cotton mats shall weigh not less than 6.4 oz/yd^2 and shall have not less than of 8 threads/in. of warp and not less than 8 threads/in. of filling. It shall be the grade known commercially as "firsts" and shall be free from avoidable

imperfections in manufacture and from defects or blemishes affecting the serviceability.

The filling material for the mats shall be a cotton bat, or bats made of raw cotton, cotton waste, cotton linters, or combinations thereof, and shall weigh not less than 12 oz/yd^2.

902.08 FORM RELEASE COMPOUNDS. Form release compounds shall effectively prevent the bond of the concrete to the forms. The form release compounds shall not cause discoloration of the concrete or adversely affect the quality or rate of hardening at the interface of the forms.

The flash point of the form release compound shall be a minimum of 100 F when tested as specified in T 73.

902.09 PARAFFIN WAX. Paraffin wax for use as a bond breaker for concrete shall be clear. The flash point shall not be less than 380 F when tested as specified in D 92.

902.10 PORTLAND CEMENT CONCRETE. Portland cement concrete shall conform to the applicable portions of Section 915 and the following:

902.10.01 Proportioning. Prior to the start of construction, the Contractor shall submit to the Regional Engineer the source and proportions of materials to be used for each concrete mix. The mixture shall conform to 902.10.03.

The concrete, with the exception of water and chemical admixtures, shall be proportioned by weight. Water and chemical admixtures may be proportioned by volume or weight. The mix shall be uniform and workable.

902.10.02 Materials.

Coarse Aggregate	901.01
Fine Aggregate	901.01
Cement	902.03 and 902.04
Concrete Admixtures	902.06
Water	921.01

902.10.03 Portland Cement Concrete Mixtures.

The concrete mixes shall conform to the following:

TABLE

				PORTLAND CEMENT
MIX NO.	**28 DAY SPECIFIED COMPRESSIVE STRENGTH** **psi**	**STANDARD DEVIATION** **psi**	**CRITICAL VALUE** **psi**	**MIN CEMENT FACTOR** **lb/yd^3**
1	2500	375	2430	455
2	3000	450	3010	530
3	3500	525	3600	580
4	3500	525	3600	615
5	3500	525	3600	580
6	4500	675	4770	615
7	4200	630	4420	580
8	4000	600	4180	750

Note 1: When concrete is exposed to water exceeding 15 000 ppm sodium chloride content, Type II cement shall be used. In lieu of a Type II cement, a Type I cement may be used in combined form with an amount of up to 50 percent replacement with ground iron blast furnace slag, or an amount of up to 25 percent replacement with Class F fly ash. The Contractor shall submit to the Engineer the proposed mix proportions and satisfactory test results in conformance with C 1012 showing a sulfate resistance expansion not exceeding 0.10 percent at 180 days.

Note 2: The temperature of Mix No. 6 when used for other than superstructure work as defined in TC-1.02 shall be 70 ± 20 F

Note 3: When synthetic fibers are used, the slump shall not exceed 5 in.

Note 4: Nonchloride Type C admixtures may be used when approved by the Engineer.

Note 5: If a high range water reducing admixture Type F or Type G is used, the slump requirement shall be 4 to 8 in.

Note 6: Type A or D admixture shall be added to bridge, box culvert, and retaining wall concrete.

902 A

CONCRETE MIXTURES				
COARSE AGGREGATE SIZE **M 43**	**MAX WATER/ CEMENT RATIO** **by wt**	**SLUMP RANGE** **in.**	**TOTAL AIR CONTENT** **%**	**CONCRETE TEMPERATURE** **F**
57, 67	0.55	2 – 5	5 – 8	70 ± 20
57, 67	0.50	2 – 5	5 – 8	70 ± 20
57, 67	0.50	2 – 5	5 – 8	70 ± 20
57, 67	0.55	4 – 8	N/A	70 ± 20
7	0.50	2 – 5	5 – 8	70 ± 20
57, 67	0.45	2 – 5	5 – 8	65 ± 15
57	0.50	1-1/2 – 3 2-1/2 max if slip-formed	5 – 8	70 ± 20
7	0.42	1 – 3	5 – 8	65 ± 15

Coarse and fine aggregate tested for alkali silica reactivity (ASR) as specified in MSMT 212 having an expansion up to 0.10 percent may be used without restriction. Those having an expansion greater than or equal to 0.35 percent shall not be used. Aggregates having an expansion greater than 0.10 but less than 0.35 percent shall be considered reactive and shall only be used when one of the following options is employed:

TABLE 902 B

OPTION	ALKALI CONTENT OF CEMENT % max	REPLACE CEMENT WITH		SPECIFICATION
		MATERIAL	% BY WEIGHT	
1	1.50	Class F Fly Ash	15 – 25	M 295
2	1.50	Ground Iron Blast Furnace Slag	25 – 50	M 302 Grade 100 or 120
3	1.50	Microsilica	5 – 7	C 1240
4	—	Blended Cement (a)	100	M 240
5	0.60 (b)	Low Alkali Cement	100	M 85

(a) Pozzolan content of 15 – 25 percent by weight of cement
(b) For mixes (Mix 6 Modified, 12 Hour Patch Mix) used for portland cement concrete pavement repairs; the maximum allowable percentage of alkalies in portland cement shall be 0.70.

When reactive aggregate is used, the Contractor shall designate which option will be used to control the formation of the ASR gel. If an option other than option 5 in Table 902 B above is chosen, the Contractor shall conduct tests as specified in MSMT 212 using the reactive aggregate and the proposed cementitious material. For approval, the expansion test results shall not be greater than 0.10 percent. When more than one reactive aggregate is used in a concrete mix, each shall be tested individually and the maximum amount of pozzolan required to reduce the expansion of all the aggregates to less than or equal to 0.10 percent shall be used. The Contractor shall submit to the Engineer the aggregate source, test results, and the percent and type of replacement cement. The Engineer may withhold source approval pending verification testing.

902.10.04 Trial Batch. A trial batch will be prepared to certify that each mix conforms to 902.10.05 and 902.10.06. Approval will be given when the test results conform to the minimum required average strength.

The Contractor shall make arrangements with the Regional Engineer, at least two weeks in advance, to have an authorized representative present during the batching and testing. Each trial batch shall consist of at least 3 yd^3 of concrete. All materials, equipment, and labor required to

produce the trial batches and conduct the required tests shall be supplied at no additional cost to the Administration.

The requirement for a trial batch may be waived by the Regional Engineer when past performance records show that the required average strength requirement has been met.

902.10.05 Design Required Average Strength. The required average strength (fcr') shall be the larger of:

$$fcr' = fc' + (1.34 \times S)$$

or

$$fcr' = fc' + (2.33 \times S) - 500$$

where:

fc' = the 28 day specified compressive strength.
S = the standard deviation as specified in 902.10.06.

A test is defined as the average strength of two companion cylinders.

902.10.06 Standard Deviation.

(a) When past performance records are available, a standard deviation shall be established from documented performance records of the producer consisting of a minimum of 15 consecutive 28 day compressive strength tests obtained within the last 12 months.

The standard deviation shall be established as the product of the calculated standard deviation and multiplier.

NUMBER OF TESTS	MULTIPLIER FOR STANDARD DEVIATION
15	1.16
20	1.08
25	1.03
30 or more	1.00

Interpolate for intermediate number of tests.

(b) When past performance records are not available, the required average strength shall conform to the following:

SPECIFIED COMPRESSIVE STRENGTH fc', psi	REQUIRED AVERAGE COMPRESSIVE STRENGTH fcr', psi
Less than 3000	fc' + 750
3000 – 4000	fc' + 1000
4001– 5000	fc' + 1200
over 5000	fc' + 1400

902.10.07 Standard of Control. The average of all sets of three consecutive strength tests shall equal or exceed the critical value as specified in 902.10.03 which shall be computed using the following formula:

$$\text{Critical Value} = fc' + (1.14 \times S) - 500$$

Failure to conform to this criteria shall be cause for immediate investigation and remedial action up to and including suspension of production. A design standard deviation equal to 15 percent of the specified strength shall be used for calculation until a minimum of 15 test results are obtained.

The actual average strength and standard deviation shall be computed upon the availability of 28 day strength data comprising a minimum of 15 tests. Should this determination indicate an excessive margin of safety, the concrete mix may be modified to produce lower average strength as approved by the Engineer. If these calculations indicate a

coefficient of variation greater than 15, the quality of the concrete and testing will be evaluated.

902.10.08 Testing. Sampling shall conform to T 141. Testing shall be performed as follows:

TEST	METHOD	MINIMUM TEST FREQUENCY
Slump	T 119	1 per 50 yd^3 (or fraction thereof)
Air Content	T 152 T 196	1 per 50 yd^3 (or fraction thereof)
Compression	T 23	1 per 50 yd^3 (or fraction thereof)
Compression Mix No. 7 Only	T 23	3 per Day

Note 1: Compressive strength tests are defined as the average of two companion cylinders.

Note 2: A second test will be made if the first slump or air content test fails. Acceptance or rejection will be based on the results of the second test.

Note 3: When constructing plain and reinforced concrete pavements, the testing frequency for slump and air content shall be 1 per 100 yd^3 or fraction thereof.

902.10.09 Acceptance. Concrete will be acceptable if both of the following requirements are met:

(a) The average of all sets of three consecutive strength tests equal or exceed the specified design strength.

(b) No individual strength test (average of two companion cylinders) falls below the specified design strength by more than 500 psi.

902.10.10 Price Adjustment. A price adjustment will be based on the Contract unit price per cubic yard of concrete. If the unit is a lump sum item, the price per cubic yard for the concrete will be determined by dividing the cubic yards into the Contract lump sum price.

(a) Test Results More Than 500 psi Below The Specified Design Strength. Failing strength tests will be considered individually with a price adjustment being applied on the percentage basis as shown below.

(Price per yd^3) x (quantity of yd^3 represented by the failing concrete strength) x (percent of failure).

Example:

$400.00 per yd^3 x 50 yd^3 x [1-(3600/ 4500 psi)] = $4,000.00

No payment will be allowed when the test results fall below 50 percent of the specified design strength for structural concrete or 40 percent for incidental concrete.

The Engineer will determine when the strength of the concrete represented by the failing tests is sufficient to remain in place or whether it must be removed and replaced with Specification concrete.

(b) Test Results 500 psi or less Below The Specified Design Strength. Strength failures 500 psi or less than the specified design strength will be averaged with the next two consecutive tests. If those two tests include a failure greater than 500 psi, those tests will be evaluated as in 902.10.10(a) and replaced with the next consecutive test. If the resulting average falls below the specified design strength, a price adjustment will be applied in conformance with the table below. Any failure will only be included in one grouping.

STRENGTH BELOW THE SPECIFIED (avg of 3 tests) DESIGN LEVEL, psi	**ADJUSTMENT FACTOR**
MIX NO. 1 THRU MIX NO. 7	
1 – 100	0.005
101 – 200	0.01
201 – 300	0.02
301 – 400	0.04
401 – 500	0.08

Adjustment price equals (price per yd^3) x (quantity of yd^3 represented by the failing cylinders) x (the adjustment factor).

Example:

$400.00 per yd^3 x 50 yd^3 x 0.01 = $200.00

902.11 MORTAR FOR GROUT. Mortar used for grouting anchor bolts, pipe, handrail posts, and miscellaneous items shall be composed in conformance with one of the following:

(a) One part portland cement or blended hydraulic cement and one part mortar sand by dry loose volume.

(b) Prepared bag mixes consisting of portland cement or blended hydraulic cement and mortar sand. The prepared mixes shall produce a mortar conforming to the strength requirements specified in the Contract Documents.

(c) Nonshrink grout shall be used when specified. The grout shall have a minimum compressive strength of 5000 psi in seven days when tested as specified in T 106, except that the cube molds shall remain intact with a top firmly attached throughout the curing period. The nonshrink grout shall have a minimum expansion of 0.0 percent after seven days when tested as specified in T 160.

(d) Epoxy grout shall consist of sand and epoxy mixed by volume in conformance with the manufacturer's recommendations. The grout shall be capable of developing a minimum compressive strength of 6500 psi in 72 hours when tested as specified in MSMT 501. Sand for epoxy grout shall conform to 901.01.

(e) An epoxy or polyester anchoring system may be used when approved by the Engineer in conformance with the manufacturer's recommendations. Strength values shall be as specified in the Contract Documents.

902.12 LINSEED OIL. Linseed oil shall consist of a 50-50 mixture (by volume) of boiled linseed oil conforming to Federal Specification TT-L-190 and kerosene conforming to D 3699.

902.13 LATEX MODIFIED CONCRETE. Portland cement concrete containing prequalified Laboratory approved styrene butadiene latex emulsion is defined as Latex Modified Concrete (LMC).

Latex emulsion shall have a minimum of 90 percent of the nonvolatiles as styrene butadiene polymers. The latex emulsion shall conform to Table 902.13 A. The material shall be stored in suitable containers and be protected from freezing and exposure to temperatures in excess of 85 F.

Latex modified concrete shall be proportioned using volumetric mixing and designed as follows:

LATEX MODIFIED CONCRETE	
MATERIAL	**SPECIFICATION LIMITS**
Portland Cement, CWT/yd^3, min	6.6
Latex Emulsion/Cement Ratio	0.31 – 0.34
Water/Cement Ratio, max	0.22
Entrained Air, %	6.0 ± 3
Slump, in.	5 ± 1

The physical properties of LMC shall conform to Table 902.13 B. The Contractor shall also furnish the necessary 3 × 6 in. molds conforming to M 205 to be used for the fabrication of compressive strength cylinders.

Control and Acceptance Sampling.

(a) One sample, 2 qt minimum, of the styrene butadiene latex emulsion shall be submitted to the Regional Engineer daily for each lot of material used in a day's production.

(b) A batch for LMC is defined as the capacity of the equipment being used on the project. Slump and air samples will be taken and tested before the placement of a batch is permitted. The slump shall be measured four to five minutes after discharge from the mixer. The test material shall be deposited off the deck and not be disturbed during this waiting period. One additional sample for slump and air will be taken randomly during the placement of each batch. For seven day compressive strength, two tests each per batch are required. A test is defined as consisting of two companion cylinders. The samples for these tests will be taken at random while the placement is in progress.

TABLE 902.13 A

REQUIREMENTS FOR CHEMICAL PROPERTIES OF LATEX EMULSION MATERIALS				
PROPERTY	**SPECIFICATIONS**		**QUALITY ASSURANCE TESTS**	
	LIMITS	**TOLERANCE**	**PREQUALIFICATION TESTS**	**CONTROL AND ACCEPTANCE**
Color	White	—	X	X
pH	9.0 – 11.0	—	X	X
Weight, lb/gal	8.40 – 8.47	—	X	X
Solids Content, %	46 – 53	—	X	X
*Butadiene Content, % of polymer	30 – 40	—	—	—
Viscosity @ 10 rpm-cps	Match Original	± 20	X	X
*Surface Tension, dynes/cm max	50	—	—	—
*Mean Particle Size, polymer – Å	1400 – 2500	—	—	—
Coagulum, % max	0.10	—	X	X
*Freeze-Thaw Stability, coagulum, % max	0.10	—	X	X
Infrared Spectra of Latex Film	Match Original	—	X	X
Infrared of Alcohol, Soluble Portion of Latex	Match Original	—	X	X
Shelf Life, min	1 yr	—	X	—

Note 1: Quality assurance tests shall be conducted as specified in MSMT 612 except those denoted by an * shall be conducted as specified in FHWA RD – 78-35.

Note 2: The original or prequalification sample shall be accompanied by the producer's certification on all of the tests and properties noted above and as specified in TC-1.02. The certification shall contain actual test values of the product and the infrared spectrograph.

Note 3: A separate certification is required for each lot of material. The document shall note the date of manufacture, lot size, and whether or not the material is identical to the formulation of the original sample.

TABLE 902.13 B

LATEX MODIFIED CONCRETE PHYSICAL PROPERTIES			
TEST PROPERTY	TEST VALUES	QUALITY ASSURANCE TESTS	
		PREQUALIFIED TESTS	CONTROL AND ACCEPTANCE
7 Day Compressive Strength, psi min	3000	X	X
28 Day Compressive Strength, psi min	3500	X	—
42 Day Compressive Strength, psi min	3500	X	—
7 Day Flexural Strength, psi min	550	X	—
28 Day Flexural Strength, psi min	650	X	—
42 Day Shear Bond Strength, psi min	2000	X	—
Durability Factor, 300 cycles, % min	85	X	—
Chloride Permeability, ppm max	510	X	—
Scaling Resistance, 50 cycles, max	3	X	—

Note 1: Quality assurance tests shall be conducted as specified in MSMT 721.

Note 2: Seven Day Compressive Strength Test will be used for Control & Acceptance of the material. The strength level of 3000 psi at seven days shall be the minimum specified design strength. The mix design approval and acceptance will be based on a coefficient of variation of 10 percent with a probability of 1 in 10 tests falling below the specified strength. No test value shall fall below 80 percent of the specified strength.

902.14 RAPID HARDENING CEMENTITIOUS MATERIALS FOR CONCRETE PAVEMENT REPAIRS. Materials shall be a dry, packaged cementitious mortar having less than 5 percent by weight of aggregate retained on the 3/8 in. sieve and shall conform to the following requirements:

Classification.

Class I — For use at ambient temperatures below 50 F.
Class II — For use at ambient temperatures of 50 – 90 F.
Class III — For use at ambient temperatures above 90 F.

Chemical Requirements. The material shall conform to the chemical requirements of C 928 and contain no organic compounds such as epoxy resins or polyesters as the principal binder.

Physical Requirements. The material shall conform to the following when tested as specified in MSMT 725:

COMPRESSIVE STRENGTH, psi min				
	< 2 hr	**2-6 hr**	**6 hr**	**28 days**
Type I — Slow	—	—	2000	4500
Type II — Rapid	—	2000	—	4500
Type III — Very Rapid	2500	—	—	4500

TEST RESULTS	
Bond Strength, 7 days, psi min	2000
Length Change, increase after 28 days in water, based on length at 3 hr, % max	+ 0.15
Length Change, decrease after 28 days, % max	- 0.15
Freeze Thaw, loss after 25 cycles in 10% $CaCl_2$ solution, % max	8
Initial Setting Time, minutes min	10

Marking. All packages delivered to the project shall be marked with the following information:

(a) Date material was packaged.

(b) Approximate setting time.

(c) Recommended dosage of water or liquid component.

(d) Mixing instructions.

(e) Class or temperature range.

Certification. The manufacturer shall furnish certification as specified in TC-1.02 showing the actual test results for each class and type of material submitted to the Laboratory.

SECTION 903 — MASONRY PRODUCTS

903.01 SEWER BRICK. Sewer brick shall have a standard size of 2-1/4 x 3-3/4 x 8 in. and conform to M 91, Grade SM.

903.02 MANHOLE BRICK. Manhole brick shall conform to M 91, Grade MS.

903.03 BUILDING BRICK. Building brick shall conform to M 114, Grade SW.

903.04 HOLLOW CONCRETE MASONRY BLOCK. Hollow load bearing concrete masonry block shall conform to C 90, Grade N, Type I, normal weight.

903.05 SOLID CONCRETE MASONRY BLOCK. Solid concrete masonry block shall conform to C 139.

903.06 MORTAR FOR MASONRY. Mortar used for masonry shall be composed in conformance with one of the following:

(a) One part portland or blended cement and three parts mortar sand by dry loose volume and hydrated lime not to exceed 20 percent of the cement by weight.

(b) One part masonry cement and three parts mortar sand by dry loose volume.

(c) Prepared bag mixes consisting of masonry cement and mortar sand. The prepared mixes shall produce a minimum compressive strength of 500 psi in seven days when tested using the applicable procedures specified in C 91.

Materials for mortar shall conform to the following:

Mortar Sand	901.01
Portland Cement	902.03
Blended Cement	902.04
Masonry Cement	902.05
Water	921.01
Lime	921.03

SECTION 904 — PERFORMANCE GRADED ASPHALT BINDERS AND HOT MIX ASPHALT

904.01 CERTIFICATION. The manufacturer and hauler shall furnish certifications as specified in TC-1.02 and the following:

The manufacturer shall also certify:

(a) Date and time of loading.

(b) Tank or blending system.

(c) Identification of hauling unit.

(d) Binder grade, temperature, and quantity of materials.

(e) Complete certified analysis.

(f) Lot number, if applicable.

(g) Mixing and compaction temperatures when the binder is polymer modified.

The hauler shall also certify:

(a) Identification of hauling unit.

(b) Binder grade and source of last delivery.

(c) The date of the last delivery using this hauling tank and volume of material remaining in the tank at the time of current loading.

904.02 PERFORMANCE GRADED ASPHALT BINDERS. Performance graded asphalt binders for mixes containing all virgin materials, recycled asphalt pavement materials, or roofing shingles from manufacturing waste shall conform to AASHTO MP1, Table 1, for the specified performance grade. The asphalt binder recovered from the final plant mixed material will be considered Rolling Thin Film Oven (RTFO) material and shall conform to AASHTO MP1, Table 1 for the specified performance grade.

The performance graded binder shall be preapproved by the Administration. The Contractor shall submit a certificate of analysis showing conformance with the Performance Graded Binder Specification AASHTO MP1 and the critical cracking temperature as described in the Binder ETG Draft, Standard Practice for Determination of Low-

Temperature Performance Grade (PG) of Asphalt Binder, for the binders specified in the Contract Documents.

The PG binder for HMA mixes shall be achieved by the use of Neat Asphalt with elastomer polymer modifications when needed.

904.03 EMULSIFIED ASPHALTS. Emulsified asphalts shall conform to M 140 or M 208 with the following exceptions:

(a) Cement mixing tests are waived.

(b) Grade SS-1 viscosity shall be 50 to 400 seconds at 77 F.

(c) Maximum of 3.0 percent by volume of oil distillate.

(d) The sieve test requirement for field samples shall be a maximum of 0.4 percent.

904.04 HOT MIX ASPHALT (HMA). Mixes shall be produced in a plant as specified in Section 915.

904.04.01 Aggregates. Aggregates shall conform to Section 901, and AASHTO MP2 with the exception that the aggregate retained on the 4.75 mm sieve shall be tested for flat and elongated particles in conformance with D 4791. When recycled asphalt pavement is used in an HMA mix as defined in MSMT 412, it shall be considered an aggregate source.

904.04.02 Mix Design. The Contractor shall develop a Superpave mix design in conformance with AASHTO PP 28. HMA Superpave mixes shall conform to the specification for Superpave Volumetric Mix Design, AASHTO MP 2, and shall be designed for the Equivalent Single Axle Loading (ESAL) range specified in the Contract Documents.

The Contractor may elect to use crushed, recycled asphalt pavement (RAP) material or a maximum of 5 percent roofing shingles from manufacturing waste. The allowable percentage and its suitability for use shall be determined in conformance with MSMT 412. When using 15 percent or less of RAP, binder viscosity adjustments are not required.

The use of RAP may be considered for applications where higher polish value aggregates are required. Approval for use will be on an individual project basis. Documentation of RAP stockpile quality and traceability shall be submitted to the Engineer for approval prior to use.

Crushed glass shall not be used in surface mixes. RAP and roofing shingles from manufacturing waste shall not be used in gap-graded mixes,

surface mixes requiring high polish aggregate, or mixes requiring elastomer type polymer binder.

904.04.03 Mix Design Approval. Documents containing the data from the Contractor's laboratory study shall be submitted to the Engineer for tentative approval at least two weeks prior to paving operations using Administration approved AASHTO software, and shall include the following:

(a) Mix designation.

(b) Source and percentage of aggregate.

(c) Source, percentage, and grade of performance graded asphalt binder.

(d) Anticipated gradation and proportion of each component aggregate.

(e) Combined cold feed grading, extracted grading, or ignited grading.

(f) Plant where the HMA mix will be produced.

(g) Plant target mixing temperature based on viscosity of 0.22 Pa·s.

(h) Percent passing No. 200 sieve removed by dust collecting system.

(i) Ratio of dust to binder material on effective asphalt.

(j) Maximum specific gravity at the target binder content.

(k) Mix design grading plotted on 0.45 power gradation chart.

(l) Tensile strength ratio and worksheets.

(m) The gyratory compaction curve for N_{max}.

(n) The bulk specific gravity at N_{design} gyrations.

(o) The air void content (percent Va) at $N_{initial}$, N_{design}, and N_{max} gyrations.

(p) The voids in the mineral aggregate (percent VMA) and the voids filled with asphalt (percent VFA) at N_{design} gyrations (TP4).

(q) The slope of the gyratory compaction curve.

(r) All consensus and source properties.

(1) Coarse aggregate angularity.

(2) Flat and elongated.

(3) Sand equivalent.

(4) Uncompacted void content of fine aggregate.

(5) Bulk and apparent specific gravity of coarse and fine aggregate.

(6) Absorption of coarse and fine aggregate.

Mix designs submitted to the Regional Engineer for approval shall be accompanied by a quantity of job mix formula aggregate and appropriate amount of required PG binder for ignition oven calibration.

If previous construction or performance experience has shown the proposed mix design to be unsatisfactory, the Regional Engineer may require the Contractor to submit a more suitable design.

If the Contractor proposes to change the source of aggregate used in the mix, a revised mix design shall be submitted with the information required above and in 904.04.02. The conditions set forth above relative to initial submission shall apply. If a change in the Performance Grade binder source becomes necessary, a stripping test shall be conducted in conformance with MSMT 410, prior to approval. The Administration may require an antistripping additive test in conformance with D 4867 before giving the final approval.

Field Verification of Mix Design. After receiving the tentative approval for the mix design from the Regional Engineer, the Contractor shall conduct a field verification of the mix at the beginning of production in each plant. Field verification shall be performed by the certified personnel as specified in 504.03. The verification samples shall be prepared as specified in PP28. The Contractor shall notify the Engineer at least two working days in advance of the scheduled verification.

Verification Evaluation.

(a) Initial verification shall consist of four samples tested for the parameters listed in MSMT 730, Table 3. These samples shall be randomly drawn from the first day's production. If the first day of production is less than 1000 tons, the Contractor may choose to spread verification testing over the number of days needed to

accumulate 1000 tons. The verification testing shall be completed on the day when production has reached the 1000 tons. The Contractor shall evaluate the verification tests results as specified in MSMT 730. All tonnage up to and including the final day of verification will not be subject to a price adjustment if individual test data is within the allowable control limits specified in Table 904 A.

(b) If the mix produced by the plant conforms to the parameters listed in MSMT 730, Table 3 with the Percent Within Specification Limit (PWSL) a minimum of 85, production may proceed without any changes. If the Contractor has submitted mixes with identical aggregate combinations and differing asphalt contents associated with changes in ESAL loads, verification will be limited to volumetric analysis at the Engineer's discretion.

(c) If the mix produced by the plant does not conform to the parameters listed in MSMT 730, Table 3 with PWSL a minimum of 85, then an adjustment to the asphalt content or gradation may be made to bring the mix design requirements within acceptable levels.

Permissible adjustment limitations between the approved Mix Design and Adjusted Mix Design are as follows:

TEST PROPERTY	PERMISSIBLE ADJUSTMENT % (*)
Larger than 1/2 in. (12.5 mm) sieve	± 5
1/2 in. (12.5 mm) thru No. 4 (4.75 mm) sieves	± 4
No. 8 (2.36 mm) thru No. 100 (1.50 μm) sieves	± 3
No. 200 (75 μm) sieve	± 1.0
Binder Content	± 0.20

* The permissible adjustment for all mixes shall establish a job mix formula having targets outside the restricted zone. Additionally, Superpave mixes shall be within control points.

When an adjustment is made to the mix design, a second verification shall be performed to ensure that the modified mix conforms to all design requirements. The time and tonnage limitations shall be as specified in (a) above. Material produced during this verification will be subject to a price adjustment if it does not conform to Specifications.

If the adjusted mix conforms to the PWSL, production may proceed. If the mix does not conform to these requirements, production for the mix shall be suspended and a new mix design shall be submitted to the Engineer for approval. The new mix shall be designed as specified in MSMT 412 or AASHTO PP28.

(d) Subsequent designs submitted due to nonconformance will be subjected to the price adjustment during the required field verifications. If the mix does not conform to (b) above during the initial verification, production for the mix shall be suspended until corrective action is taken as approved by the Engineer.

904.04.04 Antistripping Additives. HMA shall have a minimum Tensile Strength Ratio (TSR) of 0.85 when tested in conformance with D 4867. The freeze-thaw conditioning cycle is required. HMA mixes not conforming to the minimum TSR requirement shall include an antistripping additive.

When an antistripping additive is needed, the exact quantity shall be determined by the producer in conformance with D 4867 based on a minimum TSR of 0.85.

When a heat stable antistripping additive is used, the minimum dosage rate shall be 0.20 percent of the total weight of asphalt. The additive shall be introduced at the plant by line blending, metering, or otherwise measuring to ensure accurate proportioning and thorough mixing.

When hydrated lime is used, it shall be added in slurry form at the rate of 1.0 to 1.5 percent by weight of total aggregate. The hydrated lime shall conform to C 1097. Lime slurry shall be sprayed uniformly on the damp, cold aggregate on the feed belt prior to entry into the HMA plant dryer.

Plant control and acceptance of the mix shall be based on MSMT 410 with respect to its stripping potential.

904.04.05 Plant Control. The following tolerances shall apply:

TABLE 904 A – MIX TOLERANCES

PHYSICAL PROPERTY	TOLERANCE (b)
Passing No. 4 (4.75 mm) sieve and larger, %	± 7
Passing No. 8 (2.36 mm) thru No. 100 (150 µm) sieve, %	± 4
Passing No. 200 (75 µm) sieve, %	± 2
Asphalt content, %	± 0.4
Ratio of dust to binder material	0.6 to 1.6 (a)
Mix temperature leaving plant versus mix design temperature, F	± 25
Deviation of maximum specific gravity per lot versus design maximum specific gravity	± 0.030
Voids, total mix, (VTM), %	4 ± 1.2
Voids, total mix, 4.75mm mix (VTM), %	3 ± 2
Voids in mineral aggregate, (VMA), %	± 1.2 from design target
Voids filled asphalt (VFA), %	Within spec
Bulk specific gravity, G_{mb}, %	± 0.022
G_{mb} at N_{max}, %	+ 0.5

(a) Not applicable to 4.75 mm.
(b) For mixes other than Gap Graded HMA.

PWSL computations shall be performed for maximum specific gravity, voids in the total mix, voids in the mineral aggregate, and voids filled with asphalt. This computation shall be performed as specified in 504.04.02 using the moving average of the last three consecutive test values for each parameter. If the PWSL for the three test values fall below 85, corrective action shall be taken to bring the PWSL to at least 85. If the PWSL drops below 68, production shall be suspended until corrective action is taken as approved by the Engineer.

904.05 GAP GRADED HOT MIX ASPHALT (GGHMA).

904.05.01 Aggregates. Refer to 904.04.01.

904.05.02 Mix Design. Refer to 904.04.02 and the following table:

MIX TOLERANCES

PHYSICAL PROPERTIES	MIX DESIGN	PLANT CONTROL
VCA* Mix, %	Less than VCA_{drc}	Less than VCA_{drc}
VMA, %	18.0 min.	17.0 min.
VTM, %	4.0	± 1.2
N_{design} Gyrations	100	—
AC% by volume	6.5 min.	± 0.4
Draindown, % max	0.3	—
Stabilizer, by weight of total mix, %	0.2 – 0.4	± 0.1

*VCA – voids in coarse aggregate.

904.05.03 Mix Design Approval. Refer to 904.04.03.

904.05.04 Performance Graded Binder. As specified in the Contract Documents, 904.02, and the following table:

TABLE BASED ON MINIMUM ASPHALT BINDER CONTENT OF 6.5 BY VOLUME		
Combined Aggregate Bulk Specific Gravity	**Minimum Asphalt Content, %**	**Rounded Minimum Asphalt Content, %**
2.40	7.38	7.4
2.45	7.24	7.2
2.50	7.11	7.1
2.55	6.98	7.0
2.60	6.85	6.8
2.65	6.73	6.7
2.70	6.61	6.6
2.75	6.50	6.5
2.80	6.39	6.4
2.85	6.29	6.3
2.90	6.19	6.2
2.95	6.09	6.1
3.00	5.99	6.0

Note: The above table shall be used to establish minimum asphalt binder content requirements based on the combined aggregate bulk specific gravity.

Minimum Asphalt Content = $16.13 / (0.1613 + 0.8434\ G_{sb})$

G_{sb} = bulk specific gravity of combined aggregate

904.05.05 Stabilizer. GGHMA shall incorporate a stabilizer selected from a source previously approved by the Administration.

904.05.06 Stabilizer Supply System. A separate system for feeding shall be used to proportion the required amount into the mixture so that uniform distribution is obtained.

When a batch plant is used, the stabilizer shall be added to the aggregate in the weigh hopper and both dry and wet mixing times shall be increased. The stabilizer shall be uniformly distributed prior to the addition of asphalt cement into the mixture. The plant shall be interlocked so that asphalt can not be added until the stabilizer has been introduced into the mix.

When a drum plant is used, the stabilizer shall be added to the mixture in a manner that prevents the stabilizer from becoming entangled in the exhaust system.

The stabilizer supply system shall include low level and no-flow indicators, and a printout of the status of feed rate in lb/minute and shall have a 60 second plant shut down function for no-flow occurrences.

The stabilizer supply line shall include a section of transparent pipe for observing consistency of flow or feed.

All stabilizer addition systems shall be as approved by the Engineer.

904.05.07 Antistripping Additives. Refer to 904.04.04.

SECTION 905 — PIPE

905.01 Certification. The manufacturer shall furnish certification for all pipe as specified in TC-1.02.

MATERIAL	SPECIFICATION	REMARKS
Nonreinforced Concrete Pipe	M 86, Class 3	—
Reinforced Concrete Pipe	M 170, Class 4 & 5	54 in. and smaller diameter M 170, load bearing option. 60 in. and larger diameter M 170, material option.
Concrete End Sections	M 170	—
Polyethylene (PE) Plastic Drain Tube or Pipe	M 252 or M 294	—
	M 252	underdrain outlet pipes Type S minimum pipe stiffness 50 psi.
Polyvinyl Chloride (PVC) Plastic Pipe & Drain Pipe	AASHTO Bridge Section 18PVC Ribbed Pipe	—
	M 278	underdrain outlet pipes.
	F 758, Type PS 28, D 3034, SDR 35 (a), M 278 (a)	perforated underdrain.
Reinforced Concrete Arch Culvert	M 206	—
Reinforced Concrete Elliptical Pipe	M 207	horizontal elliptical pipe only.
Preformed Rubber Joint for Circular Pipe	M 198, Type A	—
Corrugated Steel Pipe, Pipe Arches & Underdrain	M 36 (b)	end finish shall be annular corrugations
Corrugated Aluminum Alloy Pipe	M 196 (b)	end finish shall be annular corrugations
Structural Plate for Pipe, Pipe Arches & Arches	M 167	—
Copper Pipe	Federal Spec WW – T – 799 Type K	—
Polyethylene (PE) Precoated Corrugated Steel Pipe	M 245 & M 246	minimum thickness 10 mil on each of the surfaces.
Concrete Drain Tile	M 178	—

(a) Perforations shall conform to the requirements of F 758.
(b) Bands with dimples are prohibited.

905.02 Certified Reinforced Concrete Pipe Plants. Reinforced concrete pipe conforming to the Specifications will be accepted on the

manufacturer's certification based on the requirements outlined below. This includes the sampling, testing, documentation, and certification of the product by the manufacturer in combination with an Administration monitoring program.

905.02.01 Responsibilities of the Concrete Pipe Producer. The concrete pipe producer shall submit a quality control plan to the Engineer for approval prior to the start of production. The plan shall indicate the following:

(a) Reinforced concrete pipe shall conform to the applicable portion of the pipe table under Section 905.

(b) The manner in which the materials will be handled.

(c) Quality control procedures shall include the following:

(1) The names, qualifications, and responsibilities of the quality control personnel and the designation of a quality control manager.

(2) Sampling and testing in conformance with MSMT Sample Frequency Guide Table 1.

(3) Method used for inspecting reinforcement cages prior to and during production.

(4) Method of curing.

(5) Method of maintaining accurate quality control records.

(6) Samples of forms approved by the Administration.

(7) Patching procedure.

(8) Method of preparation of units for shipping.

(9) Method of identification of each unit as tested and approved.

A lot is defined as a production run of concrete pipe, all being of like size, material, strength designation, and manufactured by the same process. The lot size may include up to 500 units produced in not more than 14 days. The 14 days need not be consecutive, as long as they occur within a one month period and the process is not altered in any way between production days.

If a manufacturing process is used which produces two or more pipe sizes, styles, or classes simultaneously, one set of material tests (compression and absorption) may be used to represent all sizes, styles or classes, provided there is no change in the mix design. Individual load bearing tests, if used as a basis of acceptance, will be required for each size, style, or class in conformance with the MSMT Frequency Guide.

905.02.02 Test Facilities. The producer's facilities, equipment, and testing personnel shall be capable of conducting the tests specified in T 280 and shall be as approved by the Engineer.

If compression cylinders or cores are used in lieu of three edge bearing tests, they shall be as specified in T 22.

The producer shall maintain yearly calibration certificates on all equipment used for testing.

The producer may elect to use the services of an independent commercial testing laboratory that is acceptable to the Engineer, in lieu of conducting their own tests.

905.02.03 Shipment. Units may be shipped to the Administration's projects under either of the following conditions:

(a) The required testing for all units in the lot has been completed with acceptable results and all of the units to be shipped are at least the age of the test specimens at testing.

(b) Units otherwise conforming to all test criteria may be shipped prior to completion of absorption testing if the concrete mix and manufacturing process used have historically produced the required absorption results, with final acceptance pending acceptable test results.

The quality control stamp shall be affixed to each unit shipped.

905.02.04 Certification. A manufacturer's certification shall accompany each shipment of pipe. A copy of the certification shall be delivered to the Engineer, the Administration's laboratory, and the Contractor for each shipment. One copy shall remain at the plant. The certification shall include the following:

(a) The plant name, address, and location.

(b) Size and class of the pipe.

(c) Date of manufacture and shipment.

(d) Number of units or linear feet.

(e) Administration Contract number,

(f) Statement of Specification compliance.

(g) Signature of the quality control manager.

905.02.05 Records. All testing and inspection documents shall be maintained at the production plant for a minimum of three years from the manufactured date and shall be made available to the Administration upon request.

The producer shall collect and maintain conformance certificates and mill test reports for aggregates, cement, joint material, and reinforcing steel intended for use in products used on Administration projects.

905.02.06 Quality Control Forms. The producer shall maintain an Administration approved quality control form for all pipe produced for use on Administration projects. Each form, for each lot shall contain the following:

PIPE DIMENSIONS	REINFORCEMENT	TESTS	GENERAL INFORMATION
Diameter Length Wall Thickness Joint Style	Size Spacing Area-Spec & Test Results Adequacy & Quality of Welds & Splices	Cylinder Compressive Strength Spec & Test Results Core Compressive Strength Spec & Test Results Absorption Spec & Test Results Visual Inspection	Plant Name Technician Signature Lot Identification Production Dates Pipe Class Units Per Lot Material Sources Cement Fine Aggregate Coarse Aggregate Reinforcement
THREE EDGE BEARING			
0.01 in. Crack Strength Spec & Test Results	Ultimate Strength Spec & Test Results		

905.02.07 Responsibilities of the Administration. Verification of certification will be performed at the discretion of the Administration a minimum of once per year.

905.03 Certified Corrugated Polyethylene Pipe Plants. Polyethylene pipe conforming to the Specifications will be accepted on the manufacturer's certification based on the requirements outlined

below. This includes the sampling, testing documentation, and certification of the product by the manufacturer in combination with an Administration Monitoring Program.

905.03.01 Responsibilities of the Corrugated Polyethylene Pipe Producer. The polyethylene pipe producer shall submit a quality control plan to the Engineer for approval. The plan shall indicate the following:

(a) The plan may be general, but shall be site specific.

(b) The plan shall indicate in detail how the producer proposes to control the equipment, materials, and the production methods to ensure that products produced are in conformance with the Specifications.

(c) The plan shall list the personnel responsible for production and quality control at the site and include information on how to contact each person. Additionally, the following specific information shall be included:

(1) Identification of the physical location of the plant.

(2) The method of identification of each lot of material during manufacture, testing, storage, and shipment, including identifying it as intended for Administration projects.

(3) The method of sampling and testing of raw materials and of the finished product, including lot sizes, type of material tests performed, and a description of equipment modifications or equipment developed in-house to perform the tests.

(4) A plan for dealing with quality control sample failures. This plan shall include how the producer plans to initiate an immediate investigation and what corrective action will be implemented to remedy the cause of the problem.

(5) A loading and shipping control plan that includes a description of the methods by which products are to be loaded and shipped for Administration projects.

(6) A lot is defined as a production run of polyethylene pipe, all being of like size, material, and manufactured by the same process. It shall represent a single days production, not to exceed 15 000 linear feet for culvert pipe and 85 000 linear feet for underdrain pipe.

905.03.02 Test Facilities. The Certification Program requires all tests to be conducted at laboratories that are accredited by AASHTO or approved by the Administration. Each source may establish and maintain its own laboratory for the performance of quality control testing or may request to utilize an approved independent laboratory. The producer shall make a written request and have written approval from the Administration prior to having material tested off site. The equipment required for all approved laboratories shall be sufficient to perform the required test procedures as required by the applicable specification and standards such as M 252, M 294 and D 2412.

905.03.03 Certification. A manufacturer's certification shall accompany each shipment of pipe. A copy of the certification shall be delivered to the Engineer, Administration's laboratory, and the Contractor for each shipment. One copy shall remain at the plant. The certification shall include the following:

(a) Plant name, address, and location.

(b) Lot or production identification.

(c) Date of manufacture and shipment.

(d) Number of units of each size pipe or total linear feet of each size pipe.

(e) Administration Contract number.

(f) Statement of Specification compliance.

(g) Signature of the quality control manager, or authorized representative (name shall be designated in the Quality Control Plan).

905.03.04 Records. All testing and inspection documents shall be maintained at the manufacturing facility for a minimum of three years from the manufactured date, and shall be made available to Administration personnel upon request.

905.03.05 Quality Control Forms. The manufacturer shall maintain an Administration approved quality control form for all pipe produced on Administration projects that contain the following:

GENERAL INFORMATION	TESTS
Plant Identification QC Technician's Signature Lot Identification Production Dates Tubing/Pipe Dimension Perforation Dimensions Workmanship Identification Markings	Pipe Stiffness Pipe Flattening Elongation* Environmental Stress Cracking Brittleness Low Temperature Flexibility*

*Type C or CP only.

905.03.06 Responsibilities of the Administration. The Administration will randomly conduct a minimum of two plant inspections per year with the cooperation and assistance of the producer to ensure that specifications and quality control requirements are being met. Visual inspection will be made by the Engineer when pipe is received on the project. The Administration will verify the manufacturer's certification test results by sampling in conformance with Table 4 of the Administration Frequency Guide.

SECTION 906 — GABIONS

906.01 WIRE FOR GABIONS. The wire shall have a minimum tensile strength of 60 000 psi when tested as specified in A 370. All wire sizes and mesh spacing shall be as recommended by the manufacturer. Tie and connecting wire shall also conform to this Specification.

Stainless steel interlocking fasteners may be substituted for wire ties. The fasteners shall conform to A 313. When subjected to directional tension along its axis, the fastener shall remain in a closed and locked condition for a minimum force of 900 lb.

906.01.01 Galvanized Coating for Gabions. Galvanized coating for fabric, ties, and connecting wire shall not be less 0.8 oz/ft^2 when tested as specified in A 90.

906.01.02 Polyvinyl Chloride (PVC) Coating for Gabions. PVC coating for fabric, ties, and connecting wires for gabions shall exhibit no weight loss when tested as specified in MSMT 508. Color shall conform to Federal Standard 595, gray color No. 26440 or green color No. 24533 and shall match throughout the project.

SECTION 907 — PILES AND PILING

907.01 TIMBER PILING. Timber piling shall conform to M 168.

907.01.01 Resin and Fiberglass Caps for Timber Pile Heads. Resin and fiberglass for use in protecting timber pile heads shall conform to the following:

PROPERTY	SPECIFICATION LIMITS	TEST METHOD
MOISTURE INSENSITIVE RESIN		
Tensile Strength, psi, min	5000	D 638
Tensile Elongation, % min	0.05	D 638
Compressive Strength, psi, min	9000	C 109
Abrasive Resistance, *l/mil, min	60	D 968
WOVEN GLASS CLOTH		
Weight, oz/yd^2, min	9	—
Type	Volan A	—

*liters (l) of fine aggregate per mil thickness of resin

907.02 STEEL PIPE PILES. Steel pipe piles shall conform to A 252, Grade 2.

907.03 STEEL BEARING PILES. Steel bearing piles and steel bearing pile splice material shall conform to A 36.

907.04 STEEL SHEET PILES. Steel sheet piles shall conform to A 328. Sheet pile accessories shall conform to A 36. High strength bolts shall conform to 909.07.

907.05 WELDING MATERIALS. Welding materials shall conform to AASHTO/AWS D1.5.

SECTION 908 — REINFORCEMENT STEEL

908.00 CERTIFICATION. The steel manufacturer shall furnish certification for each heat of steel as specified in TC-1.02.

908.01 DEFORMED REINFORCEMENT. Unless otherwise specified, reinforcement bars and reinforcement bars used as anchoring devices shall be deformed bars conforming to A 615, Grade 60.

Deformed bars shall be epoxy coated when specified in the Contract Documents. Epoxy powder shall conform to 917.02.

908.02 PLAIN REINFORCEMENT. Unless otherwise specified, dowel bars and dowel bars used as ties in portland cement concrete pavement expansion and contraction joints shall be plain round steel bars conforming to A 615, Grade 60 or A 36. Bars shall be epoxy coated. Epoxy powder shall conform to 917.02.

908.03 STAINLESS STEEL BARS. In lieu of epoxy coated plain bars, the Contractor may use stainless steel bars. Deformed bars shall be stainless steel when specified in the Contract Documents. Stainless steel shall conform to A 276, Type SM-29. Deformed stainless steel bars shall conform to A 615 for cross sectional area and deformations.

908.04 SLEEVES FOR DOWEL BARS IN PAVEMENT EXPANSION JOINTS. Sleeves for dowel bars shall be of sheet metal capable of sliding over 2 ± 1/4 in. of the dowel and shall have a closed end with a stop to hold the end of the sleeve at a minimum distance of 1 in. from the end of the dowel bar.

908.05 WELDED STEEL WIRE FABRIC. Welded steel wire fabric shall conform to M 55. Fabric used in pavement construction shall be furnished in flat sheets.

908.06 WELDED DEFORMED STEEL WIRE FABRIC. Welded deformed steel wire fabric shall conform to M 221.

908.07 FABRICATED STEEL BAR MATS. Fabricated steel bar mats shall consist of steel conforming to A 184.

908.08 WIRE FABRIC FOR PNEUMATICALLY APPLIED MORTAR. Wire fabric for pneumatically applied mortar and concrete encasement shall conform to A 185. It shall be fabricated either from size W1.5 wire on 3 in. centers in each direction or from W1 wire on 2 in. centers in each direction. It shall be galvanized as specified in 906.01.01.

908.09 COLD DRAWN STEEL WIRE. Cold drawn steel wire for concrete reinforcement shall conform to M 32.

908.10 TIE DEVICES FOR CONCRETE PAVEMENT. Tie device sizes shall be as specified in the Contract Documents and produce a frictional force of at least 160 lb/ft per foot of spacing when tested as specified in MSMT 512.

908.11 STEEL STRAND. Steel strand shall conform to M 203, Grade 270, Low Relaxation Strand.

SECTION 909 — METALS

909.00 CERTIFICATION. The metal producer shall furnish certification as specified in TC-1.02. The certification shall include actual mill test results. The chemical and physical properties of the finished metal products shall also be furnished by the processing manufacturer.

909.01 STRUCTURAL STEEL. Structural steel shall conform to the requirements specified in the Contract Documents. All primary load carrying members shall conform to the supplementary toughness requirements of M 270, Zone 2.

Primary load carrying members are as follows or as designated in the Contract Documents: Finger joint steel from which saw tooth configurations have been cut, all stringers, cover plates, bearing stiffeners, splice plates, pins and pin links for straight rolled steel beam bridges; all flanges, webs, bearing stiffeners, splice plates, pins and pin links for straight steel girder bridges. Additionally, on curved rolled steel beam and steel girder bridges; all diaphragms, cross frames, lateral bracing, including connection plates to main stringers.

909.02 STEEL FOR MISCELLANEOUS USE. Steel for miscellaneous use shall conform to A 36 or A 709, Grade 36.

909.03 WELDING MATERIALS. Welding materials shall conform to AASHTO AWS D1.5.

909.04 GRAY IRON CASTINGS. Iron castings shall conform to A 48, Class 30B.

909.05 STEEL STUD SHEAR DEVELOPERS. Shear developers shall conform to AASHTO AWS D1.5.

909.06 BOLTS, NUTS AND WASHERS FOR GENERAL USE. Bolts, nuts and washers for general use shall conform to A 307, and shall be galvanized as specified in A 153. Anchor bolts shall be galvanized and shall conform to A 709, Grade 36.

909.07 HIGH STRENGTH BOLTS, NUTS AND WASHERS. High strength bolts, nuts and washers shall conform to A 325.

909.08 Anchor Bolts for Traffic Signals, Highway Lighting, and Signs. Anchor bolts for traffic signals, highway lighting, and signs shall conform to F 1554, Grade 55 S1. Anchor bolts shall be galvanized for the full length of the threads and 3 in. below the threads in conformance with A 153. Nuts shall be hex nuts conforming to A 194, Grade 2H or A 563 Gr DH. Flat washers shall be heavy washers conforming to F 436. All hardware shall be galvanized in conformance with A 153.

909.09 CAST WASHERS. Cast washers, ogee washers, and special cast washers shall conform to A 47. Cast washers shall be hot dip galvanized. The coating shall conform to the thickness, adherence, and quality requirements of A 153.

909.10 HARDWARE. Spikes, wood screws, staples, brads, lag screws, carriage bolts, and other parts under the general heading of HARDWARE shall be composed of carbon steel and shall conform to Federal Specification FF-N-105.

909.11 STEEL FORMS. Steel bridge deck forms and deck form supports which remain in place shall be fabricated from steel conforming to A 653, Designation SS, Grades 33 through 80, Coating Designation G 165. The minimum thickness of uncoated steel shall be 0.0359 in.

SECTION 910 — BEARINGS

910.00 CERTIFICATION. The bearing producer shall furnish certification as specified in TC-1.02. The certification shall include actual mill test results. The chemical and physical properties of the finished bearings shall also be furnished by the processing manufacturer.

910.01 BRONZE OR COPPER ALLOY BEARING AND EXPANSION PLATES. Bronze or copper alloy plates shall be either of cast bronze or rolled copper alloy.

910.01.01 Cast Bronze. Cast bronze bearing and expansion plates shall conform to B 22, Alloy No. 91100 or No. 91300.

Self-lubricating bronze bearing plates shall be an article of standard production by an approved manufacturer of such equipment. They shall be provided with trepanned recesses (not grooves) that shall be filled with a lubricating compound consisting of graphite and metallic substances with a lubricating binder capable of withstanding the atmospheric elements. The lubrication compound shall be compressed into the recesses by pressure to form dense, nonplastic lubricating inserts. The

lubricating area shall comprise not less than 25 percent of the total area. The static coefficient of friction shall not exceed 0.10.

The certification shall be as specified above and shall include the actual test results showing that bearing plates of the same design as those supplied conform to the static coefficient of friction requirements.

Test specimens shall measure not less than 4 in. long by 4 in. wide. The static coefficient of friction shall be determined by testing a specimen plate subjected to a vertical pressure of 1000 psi and 1000 cycles consisting of 1/2 in. horizontal strokes at a speed not to exceed 9 cycles per minute. Testing shall be conducted at an ambient temperature of 77 ± 9 F. The static coefficient of friction on the specimen bearing plate shall be calculated by dividing the total applied vertical load on the plate into the total horizontal load required to start motion between the bearing plate and its mating surface while subject to the vertical load. Upon completion of the test, the bronze plate shall show no signs of galling.

910.01.02 Rolled Copper. Rolled copper alloy bearing and expansion plates shall conform to B 100, Alloy No. 51000.

910.02 STRUCTURAL BEARING PADS. The manufacturer shall furnish certification as specified in TC-1.02.

910.02.01 Elastomeric Pads. Elastomeric bearing pads shall conform to the material requirements described in the AASHTO Standard Specifications for Highway Bridges. The elastomeric bearing shall be 60 durometer hardness, Shore Type A. Accompanying the certificate for elastomeric bearing pads shall be two standard ASTM tensile slabs molded from the same compound batch as the furnished elastomeric bearings.

The static load deflection of any layer of elastomeric bearing pads shall not exceed seven percent at 800 psi average unit pressure when tested under laboratory conditions.

The design load for the elastomeric bearing pads will be specified in the Contract Documents. The manufacturer shall proof load each steel reinforced bearing design with a compressive load of 1.5 times the maximum design load and shall specify that the material conforms to the material certification.

When test specimens are cut from an actual bearing pad, a reduction of 10 percent in the minimum requirements for original tensile strength and ultimate elongation will be required.

910.02.02 Self-Lubricating Bearing Assembly. Self lubricating bearing assembly shall consist of a fabric reinforced elastomeric pad, Tetrafluoroethylene (TFE) bonded to the pad, and a stainless steel sheet. All the elements shall conform to AASHTO Standard Specifications for Highway Bridges as modified herein.

Fabric reinforced elastomeric pad shall be Type A, durometer hardness of 70 to 90. Stainless steel sheet shall be Type 304, minimum thickness of 16 gauge. The surface of the stainless steel sheet in contact with TFE shall have 2B finish, and shall be welded to the sole plate using a welding procedure approved by the Engineer.

910.02.03 Preformed Fabric Pads for General Application. Preformed fabric pads shall be composed of multiple layers of 8 oz cotton duck impregnated and bound with high quality natural rubber or of equally suitable materials, approved by the Engineer and compressed into resilient pads of uniform thickness, after compression and vulcanizing. The finished pads shall withstand compression loads perpendicular to the plane of the laminations of not less than 10 000 psi without detrimental reduction in thickness or extrusion.

SECTION 911 — JOINTS

911.01 JOINT SEALER AND CRACK FILLER. Joint sealer and crack filler shall conform to D 3405 as modified by MSMT 404. The manufacturer shall furnish certification as specified in TC-1.02. Manufacturer's recommendations regarding heating and pouring temperatures will be used when testing these materials. If a range of temperatures is recommended, the midpoint will be used as the pour point.

911.01.01 Silicone Joint Sealer And Crack Filler. Silicone joint sealer and crack filler shall be low modulus, one component compound which may or may not require a primer for bonding to concrete. If a primer is required, it shall be as recommended by the sealant manufacturer and shall be placed on the joint faces following the insertion of the backup material.

Silicone material, when tested at 73 ± 3 F and 45 to 55 relative humidity, shall conform to the following:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Shore A Hardness, at 7 days	D 2240	10-25
Tensile Strength at 150 % Elongation, psi max	D 412 Die C	45
Elongation, % min	D 412 Die C	700
Adhesion in Peel, lb/in. min	Federal Spec TT-S-00230	20
Flow, 0.01 in. max	T 187	0.3
Tack-Free Time, minutes	D 2377	20-75

Each container of silicone sealer and crack filler shall have a minimum shelf life of six months. Material more than six months old shall be retested.

911.02 PREFORMED JOINT FILLERS. Preformed joint fillers shall conform to M 153. The bituminous fiber type shall conform to M 213, with the bitumen content determined using T 164. The weathering test shall be deleted for either type of material.

911.03 PREFORMED JOINT INSERTS. Preformed inserts shall conform to M 220.

911.04 PREFORMED POLYCHLOROPRENE ELASTOMERIC COMPRESSION JOINT SEALS. The manufacturer shall furnish certification as specified in TC-1.02.

911.04.01 Roadway Seals. Roadway seals for concrete pavement shall conform to M 220.

911.04.02 Bridge Seals. Bridge seals shall conform to M 297.

The minimum depth of all seals measured at the contact surface shall be at least 90 percent of the minimum uncompressed width of the seal.

911.04.03 Lubricant Adhesive. The lubricant adhesive shall be compatible with the preformed joint seals and concrete. The Engineer will determine if consistency is suitable at the time of installation.

The manufacturer shall furnish certification as specified in TC-1.02 showing that lubricant adhesive conforms to the following:

TEST AND METHOD	SPECIFICATION LIMITS
Viscosity, D 1084, Method B, CP min	25 000
Film Strength, D 412, psi min	2000
Elongation, D 412, % min	250

No lubricant adhesive shall be used after nine months from the date of manufacture. Each container shall be plainly marked with the manufacturer's name or trademark, lot number, and date of manufacture.

911.05 NEOPRENE STRIP SEALS. The manufacturer shall furnish certification as specified in TC-1.02 showing that the neoprene strip seals conform to the following:

PHYSICAL PROPERTIES FOR PREFORMED ELASTOMERIC STRIP SEALS		
PROPERTY	**REQUIREMENT**	**TEST METHOD**
Tensile Strength, psi min	2000	D 412
Elongation at Break, %, min	250	D 412
Hardness, Type A Durometer, points	60 ± 5	D 2240 (modified)(a)(c)
Oven Aging,70 hr at 212 F Tensile Strength, % loss, max Elongation, % loss, max Hardness, Type A Durometer, points change	 20 20 0 to + 10	D 573 D 2240 (modified)(a)(c)
Oil Swell, ASTM oil 3 70 hr at 212 F weight change, % max	45	D 471
Ozone Resistance 20% strain, 300 pphm in air, 70 hr at 104 F	No Cracks	D 1149 (modified)(b)
Low Temperature Stiffening 7 days at 14 F Hardness, Type A Durometer, points change	 0 to + 15	D 2240 D 2240 (modified) (a)(c)
Compression Set, 70 hr at 212 F, % max	40	D 395 Method (modified) (b)(a)

(a) The term "modified" in the table relates to the specimen preparation. The use of the strip seal as the specimen source requires that more applications than specified in either of the modified test procedures be used. The specimen modification shall be agreed upon by the purchaser and producer or supplier prior to testing.
(b) Test in conformance with procedure A of D 518 and ozone concentration is expressed in pphm.
(c) The hardness test shall be performed with the durometer in a durometer stand as recommended in D 2240.

911.05.01 Special Molded Intersection Pieces. Where joint elements intersect, a special strip seal element manufactured by molding in one piece from neoprene material similar to that specified above shall be 10 in. from point of intersection to nearest end along center line of joint in any direction. Ends shall be plane and square to facilitate bonding to adjacent extruded areas, and corners of sharp angles shall be rounded sufficiently to relieve damaging stress concentrations. Angles to which

moldings are fabricated shall be within 5 degrees of the actual angle as specified in the Contract Documents to avoid excessive deformation when installed in steel joint components.

Lubricant adhesive for use in installing and bonding neoprene seal elements to steel joint components shall be one part moisture curing polyurethane and hydrocarbon solvent mixture having the following physical properties:

TEST AND METHOD	SPECIFICATION LIMITS
Average Weight, lb/gal	8 ± 0.8
Solids Content, % min	65
Adhesives shall remain liquid from, F	5 to 120
Film Strength, D 412, psi min	2000
Elongation, D 412, % min	250

Steel extrusions and neoprene seals shall be matching components by the same manufacturer. The steel extrusions shall have a minimum thickness of 3/8 in. All steel portions of the joint assembly shall be painted with an inorganic zinc rich primer conforming to 912.03. The primer shall be applied in conformance with Section 435.

911.06 SEALER FOR LOOP DETECTOR. Sealing material to seal saw cuts for loop detector wires shall be either Type A, two part epoxy or Type B, one part polyurethane. The manufacturer shall furnish certification as specified in TC-1.02. No aggregate shall be mixed with the sealer material. The sealer shall be applied in conformance with the manufacturer's recommendations.

911.06.01 Tests. Tests shall conform to the following:

TYPE A – TWO PART EPOXY	
TEST AND METHOD	**SPECIFICATION LIMITS**
Viscosity, cone and plate Viscometer@ 25 C, cps max	12 000
Pot life @ 25 C, minutes min	10
Cure time @ 25 C, no tackiness, hr max	1
Hardness, Type A durometer, D 2240	50 – 60
Tensile elongation, D 638, % min	100
Water absorption, D 570, %/24 hr max	0.5
Oil absorption, D 471, % max	0.02
Volume resistivity @ 25 C, D 257, ohm-cm min	2.4×10^{10}
TYPE B - ONE PART POLYURETHANE	
TEST AND METHOD	**SPECIFICATION LIMITS**
Viscosity, Brookfield RVF #6 spindle @ 20 rpm 25 C, cps max	30 000
Cure time @ 25 C, no tackiness, hr max	24
Hardness, Rex Type A, min	70
Tensile strength, D 412, psi min	500
Tensile elongation, D 412, % min	300
ARC resistance, D 495, sec min	70
Dielectric constant, D 150, min	6 @ 50 hz 4.25 @ 500 khz
Nonvolatile content, %	85

911.07 ROOFING PAPER. Roofing paper to be used in expansion joints shall be composed of roofing felt saturated and coated on both sides with an asphaltic material. It shall not weigh less than 39.8 lb/100 ft^2 and shall not crack when bent 90 degrees over a 1/2 in. radius at room temperature.

911.08 WATER STOPS. Water stops shall be made of rubber or polyvinyl chloride (PVC).

The water stop shall be of the shape and dimensions specified in the Contract Documents. The cross section shall be uniform along its length

and transversely symmetrical so that the thickness at any given distance from either edge of the water stop shall be uniform.

The water stop shall conform to the following:

TEST AND METHOD	SPECIFICATION LIMITS
Tensile Strength, D 412, psi min	2000
Elongation @ Break, D 412, % min	300
Hardness, Rubber, Type A durometer, D 2240	55 ± 5
Hardness, PVC, Type A durometer, D 2240	75 ± 5

The Contractor shall furnish a test sample for each lot or shipment of water stop. The manufacturer shall furnish certification as specified in TC-1.02.

911.09 ASPHALT SEALER FOR CONCRETE PIPE. The sealer shall be a mixture of asphalt, mineral filler, and petroleum solvents, and shall have adhesive and cohesive properties. Each container shall be clearly marked with a lot number, manufacturer, and location of manufacturer.

The supplier shall furnish a certified copy of the test results showing that the sealer conforms to the following:

TEST AND METHOD	SPECIFICATION LIMITS
Residues by evaporation, nonvolatile matter, D 2939, % min	70
Inorganic filler on ignition, ash content, D 2939, %	15 – 45

911.10 CLOSED CELL NEOPRENE SPONGE ELASTOMER. Closed cell neoprene sponge elastomer shall conform to D 1056, Type S. Skin coating is optional. The material shall conform to the following:

TEST AND METHOD	SPECIFICATION LIMITS
Compression Deflection, D 1056	Pressure necessary for 25 % deflection, 5 – 10 psi, one layer 1/2 in. thick pad @ 70 ± 5 F
Accelerated Aging Test	Change in compression deflection after aging 7 days @ 158 F, 20 % max
Permanent Set*, D 1056	50 % deflection @ 158 F for 22 hr, 40 % max residual permanent set after 10 days recovery, 10 % max
Water Absorption by weight	2 in. immersion of 1.129 in. diameter sample for 24 hr @ room temperature, 10 % max
Water Resistance, D 1171	Quality retention, 6 weeks exposure, 100 %

*Method to calculate permanent set:

$$\text{Permanent set} = \frac{(t_0 - t_1) \times 100}{t_0}$$

where:
t_0 = original thickness of sample, and
t_1 = thickness of specimen 30 minutes after removal of clamps or after 10 days recovery.

911.11 NEOPRENE DRAINAGE TROUGHS. Neoprene for drainage troughs shall conform to M 220, and the following:

PHYSICAL PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Tensile Strength, psi min	D 412	2000
Elongation at Break, % min	D 412	250
Hardness, Type A Durometer	D 2240 (modified)	60 ± 5
Compression Set, 22 hr @ 212 F, % max	D 395	35
Oven Aging, 70 hr @ 212 F		
Tensile Strength, % loss max	D 573	20
Elongation, % loss max		20
Hardness, Type A Durometer (points change)		0 to + 10

911.12 PREFORMED FABRIC DRAINAGE TROUGHS. Optional performed fabric drainage trough shall be a sheet composed of multiple plies of 15 ± 5 oz/yd^2 polyester fabric laminated with butadiene

acrylonitrile, vulcanized to form an integral laminate. Physical properties of the laminate shall conform to the following:

PHYSICAL PROPERTY	SPECIFICATION LIMITS
No. of Piles	3
Laminate Weight, psf	0.85
Thickness, in. min	5/32
Tensile Strength, lb/in. of width, min	1200
Elongation at Tensile, % max	30
Elongation at 1/10 Tensile Strength, % max	3

911.13 SHIMS FOR NOISE BARRIER INSTALLATION. Shims for noise barrier installation shall be either neoprene or composite elastomer with a durometer of 60 ± 5 (Shore A) value.

SECTION 912 — COATING SYSTEMS FOR STRUCTURAL STEEL

912.01 GENERAL. The Office of Materials and Technology will maintain a list of Approved Paint Manufacturers. Only manufacturers on this list will be acceptable as sources for paint on Administration projects. Unless otherwise specified, paint shall be tested in conformance with Federal Test Method Standard 141. Only one formulation per color will be permitted per project. Tests shall be performed at 75 F and 50 percent relative humidity unless otherwise specified. All paint shall be satisfactory for brushing, rolling, or spraying. All paints within a system shall be from the same manufacturer and shall be tinted at the point of manufacture to differentiate between coats, existing coats, and bare metal. Paint shall be shipped in the original containers and all containers shall bear the identification of the paint, consisting of the manufacturer's name, the name or title of material, volume of contents, manufacturer's paint identification number, the date of manufacture, color name and number, handling instructions, precautions, and the batch number.

912.01.01 Approved Paint Manufacturers. Admission onto the list of Approved Paint Manufacturers will be based upon the acceptance of the manufacturer’s submitted Quality Control Plan.

912.01.02 Quality Control Plan. The Quality Control Plan shall define the manufacturer’s process to ensure that the quality of the products

during and upon completion of the manufacturing process. As a minimum, the Quality Control Plan shall list the following information:

(a) Name of quality control tests and test procedures used.

(b) Detailed description of the test procedures if not a standard test.

(c) Frequency of quality control tests.

(d) Maintenance of quality control records and length of time that they will be maintained.

912.01.03 Acceptance. The paint manufacturer shall furnish certified test results for each lot and color of paint as specified in TC-1.02. Certified test results for each lot shall list the actual test results for the specified properties. The certification shall be approved by the Office of Materials and Technology prior to shipment, and a copy shall accompany each shipment.

912.01.04 Original Infrared Spectrogram. The manufacturer shall submit an original analysis of vehicle solids by infrared spectroscopy performed as specified in D 2621 as follows:

(a) For zinc primer coatings, infrared spectrum (2.5 to 15 μm) of each vehicle component.

(b) For two component coatings, infrared spectrum (2.5 to 15 μm) of each single component and each mixed component, when applicable, in appropriate mixing ratios.

912.01.05 Certification Verification Tolerances. The manufacturer's facilities will be visited at random intervals, and samples will be taken. A comparison will be made between the manufacturer's certified test results and the Administration's tests results on the same batch. The tolerances between these results shall conform to the following:

TEST	TOLERANCE	TEST METHOD
Total Solids by mass, %	± 2	D 2369
Pigment Content by mass, %	± 2	D 2698 or D 4451
Vehicle Solids by mass, %	± 2	D 2369
Viscosity, KU	± 10	D 562
Unit Weight, lb/gal	± 0.5	D 1475

Volatile Organic Compound (VOC) maximum limits shall conform to the current regulations governing the point of application.

912.02 PRIMER COATS AND SEALERS.

912.02.01 Inorganic Zinc Rich. Inorganic zinc rich primer shall conform to M 300, Type I or IA. Zinc dust shall conform to D 520, Type II.

912.02.02 Aluminum Epoxy Mastic. Aluminum epoxy mastic primer shall have one component that is the condensation product of the reaction of epichlorohydrin with bisphenol A. Drying times shall be 8 hours maximum to touch, 24 hours minimum to 30 days maximum for recoat, and 48 hours maximum for hard. Minimum pot life shall be three hours. Solids by weight shall be 90 percent minimum and 80 to 90 percent by volume. Viscosity shall be 95 to 140 KU and flexibility shall pass a 180 degree bend around a 3/4 in. mandrel when tested in conformance with D 522. The material shall resist sagging when tested in conformance with D 4400 with no sagging at the manufacturer's recommended wet film thickness. The material shall weigh 13.0 ± 0.5 lb/gal.

912.02.03 Organic Zinc Rich. Organic zinc rich primer shall conform to SSPC-Paint 20, Type II.

912.02.04 Zinc Rich Moisture Cured Urethane. Zinc rich moisture cured urethane primer shall be one-component having a minimum zinc pigment content in the dry film of 80 percent. Minimum solids shall be of 80 percent by weight and 62 percent by volume. The viscosity shall be 95 to 105 KU, and shall be capable of being applied at 50 percent greater film build than required without runs or sags in conformance with D 4400. The interval for application of next coat shall be 8 hours minimum and 30 days maximum. The coating shall also conform to the Moisture Cured Urethanes Additional Performance Criteria Table except that the maximum loss for Abrasion Resistance shall be 82.0 mg, and Salt Spray after 1000 hours shall be 1/32 in. maximum.

912.02.05 Micaceous Iron Oxide And Aluminum Filled Moisture Cured Urethane. Micaceous iron oxide and aluminum filled moisture cured urethane shall have a minimum solids of 75 percent by weight and 60 percent by volume. The viscosity shall be 95 to 100 KU. The coating shall also conform to the Moisture Cured Urethanes Additional Performance Criteria Table.

912.02.06 Penetrating Sealer. Penetrating sealer shall have a viscosity of 75 to 101 KU and be able to penetrate and seal existing coatings and substrate. It shall be suitable for application over marginally prepared steel and most generic types of aged coatings. The sealer shall conform to one of the following:

(a) Epoxy penetrating sealer shall be cross-linked amido-amine epoxy primer/sealer having two components mixed in conformance with the manufacturer's recommendations. It shall be a minimum 95 percent solids by weight.

(b) Moisture cured urethane micaceous iron oxide filled penetrating primer/sealer shall be one component having a minimum 75 percent solids by weight. It shall also conform to the Moisture Cured Urethanes Additional Performance Criteria Table.

912.03 INTERMEDIATE COATS.

912.03.01 Acrylic. Acrylic intermediate coat shall be a single component 100 percent acrylic and have minimum solids of 48 percent by weight and 36 percent by volume. Maximum dry time to touch and recoat shall be 2 and 8 hours, respectively.

912.03.02 Epoxy Polyamide. Epoxy polyamide intermediate coat shall have one component that is the condensation product of the reaction of epichlorohydrin with bisphenol A. The epoxy polyamide shall have a 3.0 minimum fineness of grind (Hegman Units), and minimum solids of 75 percent by weight and 62 percent by volume. Maximum dry time to touch and recoat shall be 6 and 15 hours, respectively.

912.03.03 Micaceous Iron Oxide Moisture Cured Urethane. Micaceous iron oxide moisture cured urethane intermediate coat shall be one-component having minimum solids of 80 percent by weight and 60 percent by volume. The viscosity shall be 90 to 100 KU. The interval for application of next coat shall be 8 hours minimum and 30 days maximum. The coating shall also conform to the Moisture Cured Urethanes Additional Performance Criteria Table. The micaceous iron oxide content shall be a minimum of 3.0 lb/gal.

912.04 FINISH COATS. The color number will be specified in the Contract Documents and shall conform to Federal Standard 595. All finish coats shall resist sagging when tested in conformance with D 4400 with no sagging at the manufacturer's recommended wet film thickness.

912.04.01 Acrylic. Acrylic finish coat shall conform to 912.03.01.

912.04.02 Aliphatic Urethane. Aliphatic urethane finish coat shall have minimum solids of 70 percent by weight and 47 percent by volume. Drying time to touch and hard shall be the minimum recommended by the paint manufacturer.

912.04.03 Moisture Cured Aliphatic Urethane. Moisture cured aliphatic urethane finish coat shall be one-component having a maximum

free monomer content of 0.7 percent. Minimum solids shall be 75 percent by weight and 60 percent by volume, and the viscosity shall be 70 to 80 KU. The interval for application of next coat shall be 8 hours minimum and 30 days maximum. The coating shall also conform to the Moisture Cured Urethanes Additional Performance Criteria Table.

912.05 PAINT SYSTEMS. Paint systems shall be as specified in the Paint Systems Table.

PAINT SYSTEMS TABLE

PAINT	COAT	SECTION	DRY FILM THICKNESS, mils, min - max	USAGE
SYSTEM A				
Inorganic Zinc	I	912.02.01	3.0 - 5.0	Shop Primer
Acrylic	II	912.03.01	2.0 - 4.0	First Field Coat
Acrylic	III	912.04.01	2.0 - 4.0	Finish Coat
SYSTEM B				
Inorganic Zinc	I	912.02.01	3.0 - 5.0	Shop Primer
Epoxy Polyamide	II	912.03.02	5.0 - 8.0	First Field Cover-All Coat
Aliphatic Urethane	III	912.04.02	2.0 - 3.0	Finish Coat
SYSTEM C				
Organic Zinc	I	912.02.03	3.0 - 5.0	Primer/First Cover-All Coat
Epoxy Polyamide	II	912.03.02	5.0 - 8.0	Second Cover-All Coat
Aliphatic Urethane	III	912.04.02	2.0 - 3.0	Finish Coat
SYSTEM D				
Organic Zinc	I	912.02.03	3.0 - 5.0	Primer/First Cover-All Coat
Acrylic	II	912.03.01	2.0 - 4.0	Second Cover-All Coat
Acrylic	III	912.04.01	2.0 - 4.0	Finish Coat
SYSTEM E				
Aluminum Epoxy Mastic	I	912.02.02	5.0 - 8.0	Primer/First Cover-All Coat
Epoxy Polyamide	II	912.03.02	5.0 - 8.0	Second Cover-All Coat
Aliphatic Urethane	III	912.04.02	2.0 - 3.0	Finish Coat

PAINT	COAT	SECTION	DRY FILM THICKNESS, mils, min - max	USAGE
SYSTEM F				
Micaceous Iron Oxide, Aluminum Filled Moisture Cured Urethane	I	912.02.05	2.0 - 3.0	Primer/First Cover-All Coat
Micaceous Iron Oxide Moisture Cured Urethane	II	912.03.03	3.0 - 5.0	Second Cover-All Coat
Moisture Cured Aliphatic Urethane	III	912.04.03	1.5 - 2.0	Finish Coat
SYSTEM G				
Zinc Rich Moisture Cured Urethane	I	912.02.04	2.0 - 3.0	Primer/First Cover-All Coat
Micaceous Iron Oxide Moisture Cured Urethane	II	912.03.03	3.0 - 5.0	Second Cover-All Coat
Moisture Cured Aliphatic Urethane	III	912.04.03	1.5 - 2.0	Finish Coat
SYSTEM H				
Penetrating Sealer	I	912.02.06	1.0 - 2.0	Sealer
Aluminum Filled Epoxy Mastic	II	912.02.02	3.0 - 5.0	Spot Coat
Aliphatic Urethane	III	912.04.02	3.0 - 5.0	Finish Coat

MOISTURE CURED URETHANES
ADDITIONAL PERFORMANCE CRITERIA TABLE

TEST PROPERTY	TEST METHOD	TEST CRITERIA	COAT I & II	ENTIRE SYSTEM
Cyclic Salt Fog/UV Exposure of Painted Metal	D 5894	Final Ratings: Rusting: 6 min Blistering:10 min Rust Creep: 6 max Cracking: Degree & Type Flaking: Degree & Type	1000 hr	3000 hr
Salt Spray	B 117	1/32 in Scribe, 1/16 in. max undercut	1000 hr	3000 hr
Abrasion Resistance	D 4060	Taber Abraser, CS-17 Wheel, 1000 g load, 1000 cycles, max loss	100 mg	56 mg
Adhesion	D 3359	Cross-Cut Tape Test	No peeling or removal	No peeling or removal
Flexibility	D 522	Conical Mandrel Bend Test, min elongation	10 %	40 %
Pencil Hardness	D 3363	min	F	F
Accelerated Weathering	G 53	QUV using UV - B Lamp, time after no more than 10 % loss of gloss	—	400 hr
Impact Resistance	D 2794	min	—	40 in.·lb
Chemical Resistance, Solutions	Fed. Spec. T-C-550 4.4.6	5 % Sodium Hydroxide 5 % Hydrochloric Acid 5% Sulfuric Acid 5 % Acetic Acid	—	Unaffected - Slight discoloration permitted
Reversed Impact	D 2794	Rapid Deformation	—	No cracking or delamination

SECTION 913 — WATERPROOFING

913.00 CERTIFICATION. The producer shall furnish certification as specified in TC-1.02.

913.01 ASPHALTIC MATERIALS FOR DAMPPROOFING AND WATERPROOFING.

913.01.01 Hot Applied Asphalt. Hot applied asphalt shall conform to D 449.

913.01.02 Cold Applied Asphalt. Cold applied asphalt shall conform to the following when tested as specified in MSMT 423, Procedure A. The material shall not contain isocyanide or any derivative of cyanide.

TEST AND METHOD		SPECIFICATION LIMITS		
		GRADE I	GRADE II	GRADE III
R & B Softening Point T 53		104 – 143 F	145 – 170 F	172 – 200 F
Penetration, 0.10 mm, T 49	32 F, 200 g, 60 sec	10 min	5 min	5 min
	77 F, 100 g, 5 sec	30 – 100	25 – 50	20 – 40
	115 F, 50 g, 5 sec	100 min	130 max	100 max
Permeability, g/cm^3, max, MSMT 423		0.09	0.09	0.09
Flow test, mm, max, MSMT 423		–	20	15
Flexibility,60 F, MSMT 423		No peeling or loss of adhesion		
Imperviousness Test, MSMT 423		No pitting or discoloration		
Sag test, MSMT 423		No movement		

Grade I — Suitable for below ground and horizontal applications.
Grade II — Suitable for below ground and above ground where surface temperatures do not exceed 120 F.
Grade III — Suitable for below ground and above ground where surface temperatures exceed 120 F.

913.01.03 Cold Applied Asphalt Emulsion. Cold applied asphalt emulsion shall conform to D 1227, Type II, when tested as specified in D 2939, modified by MSMT 423, Procedure B.

913.02 PRIMER FOR USE WITH ASPHALT FOR DAMPPROOFING AND WATERPROOFING. The primer shall conform to D 41.

913.03 FABRIC SATURATED WITH ASPHALT FOR USE IN WATERPROOFING. The fabric shall conform to D 173.

913.04 DAMPPROOFING AND WATERPROOFING MEMBRANE. The adhesive side of the membrane shall be protected with a special release paper that can be easily removed for installation. The membrane shall conform to the following requirements:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Grab Tensile Strength, lb/in. @ 12 in./minute rate of loading, min	D 5034	70
Pliability, 180° bend, 1 in. mandrel @ 20 F	D 146	unaffected
Resistance to Puncture, lb min	E 154 (square mounting frame method)	40
Permeance, perm (kg/Pa · s · m^2), max	E 96, Method B	0.1
Weight, oz/yd^2 min	D 3776	40
Primer	—	as specified by the manufacturer

Roll and sheet waterproofing membrane may be accepted on certification. The manufacturer shall furnish certification as specified in TC-1.02 with actual test results showing that the material conforms to these Specifications.

913.05 SHEET METAL FOR FLASHING. Sheet metal for flashing shall be of a material and gauge as specified in the Contract Documents.

913.05.01 Copper. Copper shall conform to the weight per square foot and gauge requirements of B 152.

913.05.02 Galvanized Sheets. Galvanized sheets shall conform to A 653, Coating Designation G 90.

SECTION 914 — CHAIN LINK FENCE

914.00 CERTIFICATION. The manufacturer shall furnish certification as specified in TC-1.02. In addition, a sample of the fence fabric shall be submitted with the fabric certification.

914.01 CHAIN LINK FENCING FABRIC. Chain link fencing fabric shall be 2 in. mesh woven from coated No. 6 gauge wire for 6 ft and 8 ft fence and No. 9 gauge wire for 5 ft fence unless otherwise specified in the Contract Documents. The ends shall have a knuckled selvage at the bottom and a barbed selvage at the top. The fabric shall

conform to M 181. Type I fabric shall conform to Class D coating. Vinyl coated steel shall conform to F 668, Class 2B thermally fused. Vinyl color shall be warm gray or black as specified in the Contract Documents.

914.01.01 Fence Fabric for Super Silt Fence. Galvanized fabric for super silt fence shall conform to 914.01, except that it shall be woven from No. 9 gauge wire having a Class C coating. The mesh shall be 42 in. in height.

914.02 TIE WIRES, LINE POST CLIPS, TENSION WIRES, AND TENSION WIRE CLIPS. These items shall conform to M 181. The galvanized coating shall have a minimum weight of 1.2 oz/ft^2. These items, when used with aluminum coated steel fabric, shall be coated with aluminum at a minimum weight of 0.40 oz/ft^2. The tension wire used with polyvinyl chloride (PVC) coated steel fabric shall have the same coating thickness and color requirements as the fence fabric.

914.03 POSTS, BRACES, FITTINGS, AND HARDWARE. All posts, braces, fittings, and hardware shall conform to M 181. When these items are specified to be PVC coated, they shall be thermally fused and bonded. The PVC thickness shall be 10 to 15 mil except that bolts, nuts, and washers shall be metallic coated steel.

When opting to use round posts, the posts shall conform to industry standards for Class 1 or 2.

914.04 GATES. The fabric used for gates shall be identical to the fencing fabric. The gate frame and other hardware shall conform to 914.02 and 914.03. When the gate frame is PVC coated, movable fittings, such as hinges and latches, shall be field coated with a PVC coating specifically prepared for this purpose.

914.05 BARBED WIRE. Barbed wire shall conform to A 121. The barbed wire shall be 12-1/2 gauge with four point, round barbs at 5 in. spacings and Class 3 coating requirements.

SECTION 915 — PRODUCTION PLANTS

915.01 GENERAL. These specifications are applicable to all batching and proportioning plants.

915.01.01 Approval. The plant from which the Contractor proposes to obtain material shall be approved by the Regional Engineer before starting deliveries.

915.01.02 Lead Time. The Contractor shall notify the Regional Engineer at least two working days prior to the start of operations. The Regional Engineer or his representative shall be kept informed of plant operational procedures and notified when a change is planned. Inspectors shall have safe access to all areas of the plant for the performance of their duties. All equipment, tools, machinery, and parts of the plant shall be maintained in a satisfactory working condition at all times.

915.01.03 Storage. The storage and handling of aggregates in stockpiles and bins shall be done in a manner that will prevent segregation, intermingling, and contamination by foreign material or equipment. Bins discharging to feeder systems shall be equipped with accessible calibrated devices to vary the quantity of material being fed.

915.01.04 Measuring Devices. Measuring devices shall conform to the current edition of the National Institute of Standards and Technology Handbook 44, except as modified by Table 915. The producer shall be responsible for providing all personnel and equipment for calibrating measuring devices.

Before any proportioning plant starts operation, and at least once each year thereafter, all measuring devices, meters, dispensers, test weights, and other measuring devices shall be inspected, tested, and certified to be in proper operating condition by competent testing agencies approved by the Engineer. During the period of operation, all measuring devices, meters, dispensers, and other measuring devices shall be tested monthly and certified for accuracy and operating condition by the producer or an approved testing agency. Any weighing device by which materials are sold by weight as a basis of payment shall be tested monthly and certified by an approved testing agency. The Engineer shall be notified at least two working days in advance of monthly scale inspections. The certifications shall state capacities, minimum graduations, loads applied, degree of accuracy, and magnitude.

Balance and zero conditions of scales shall be checked daily, and at any other time requested by the Regional Engineer or his representative. The Engineer may, at any time, direct that any measuring device be tested by the producer or an outside agency if there is any doubt about the accuracy of the measuring device. Certificates of inspection shall be posted in a prominent place in the plant, and a copy shall be promptly submitted to the Engineer.

Production plant tolerances shall conform to the following table:

TABLE 915

MATERIAL	*MAINTENANCE TOLERANCE	UNIT OF MEASURE
Aggregate	0.2%	Weight
Portland Cement or Blended Hydraulic Cement of Ground Iron Blast Furnace Slag or Fly Ash	0.2%	Weight
Asphalt	0.2%	Weight or Volume
Water	1.5%	Weight or Volume
Additives	0.5%	Weight or Volume

* Maintenance tolerance shall be the specified percent of the total capacity of the scale or the smallest scale graduation, whichever is greater.

If during the monthly check, the measuring devices are found to deviate from the allowable tolerance, they shall be suspended from use until recalibrated to the Specification requirements. A price adjustment will apply to materials sold and accepted by weight that are supplied during the measuring device malfunction period when the malfunction resulted in an overpayment. The measuring device malfunction period is defined as the elapsed time between the two successive monthly checks.

915.01.05 Sampling Equipment. The producer shall provide all personnel and equipment for obtaining samples from the last practical point prior to combination with other ingredients or introduction into the mixer. Sampling of liquid binder from HMA plants shall be from a tap located at the last practical, safe point, between the binder control unit and the plant (refer to M 156 and D 140). Sampling shall conform to Tables 1 and 2 of the MSMT Manual. The sampling equipment shall have a minimum capacity of 30 lb and shall be positioned in a manner that will provide an accurate representation of the material being furnished. When the size of the sample is too large to be transported, approved sample splitting devices shall be available at the point of sampling that will split the sample to no more than twice the proper testing size.

915.01.06 Quality Control Laboratory. The producer shall provide at proportioning or batching plants an on-site Administration approved laboratory suitable for conducting the various tests required. An off site laboratory shall require approval of the Engineer. Continued approval of the laboratory and the testing personnel will be subject to periodic

inspection by the Administration. Any deficiencies shall be corrected to the satisfaction of the Engineer or the approval will be withdrawn.

915.02 HOT MIX ASPHALT (HMA) PLANTS. All plants shall conform to M 156, and be equipped with Automatic Batching and Recording of Batching, except as modified in 915.01 and the following:

(a) **Dryer.** The fuel used for drying aggregates shall be compatible with the plant manufacturer's recommendations.

(b) **Hot Aggregate Bins.** Existing plants shall be equipped with alarms. New plants shall conform to M 156.

(c) **Mixer Unit for Batch Method.** Minimum dry and wet mixing times shall be 5 seconds and 15 seconds, respectively.

(d) Truck scale weighing shall conform to the National Institute for Standards and Technology (NIST), except as follows:

(1) A written plant summary shall be kept by the producer showing the Contract number, truck identification (I.D.) number, type material being produced, the number of truck loads, and the total tons of mix.

(2) The producer shall supply a delivery ticket with the I.D. number, Contract number, date, truck I.D. number, time loaded, gross and tare weights, and net weight of the mix for each load. When requested by the Engineer, the temperature of the mix shall also be shown on the delivery ticket.

(e) **Automatic Weighing and Printout.** The producer shall use an approved plant automatic weighing and printing system. A printed delivery ticket for each load shall be provided with the cumulative total weighed into the truck, Contract number, time loaded, I.D. of the type of mix, and net weight of mix. When requested by the Engineer, the temperature of the mix shall also be shown on the delivery ticket. The temperature may be handwritten on the delivery ticket.

(f) **Hauling Units.** The mixture shall be transported to the work site in units previously cleaned of all foreign material and the contents of each load completely covered with suitable material of sufficient size to protect it from the weather. Each unit shall have convenient access from ground level to insert thermometers to determine mix temperature.

The inside surface of all hauling units shall be treated with an approved release agent that will not contaminate or alter the characteristics of the mixture. Petroleum derivatives shall not be used. Approval will be based on results from tests performed in conformance with MSMT 414.

(g) Drum mixer plants shall be calibrated in conformance with MSMT 453 and approved by the Engineer. A monitoring station for the purpose of controlling the entire operation shall be provided. If any part of this control system fails, an alternative control system approved by the Engineer may be used for a maximum of two working days.

The producer shall determine the moisture content of all aggregates in conformance with MSMT 251.

915.02.01 Certified Hot Mix Asphalt (HMA) Plant. The producer shall be responsible for quality control of plant operations to ensure that the material conforms to Specifications. The quality control process will be subject to unannounced periodic inspection by representatives of the Engineer when Administration projects are in progress. The plant's certified technician shall fully participate in the inspections.

Initial Inspection. Any plant initially setting up and starting production will be subject to a comprehensive inspection to determine whether the plant equipment and personnel conform to all applicable Specifications. The Administration will accept certification by a professional engineer registered in the State of Maryland that the plant facilities conform to all applicable Specifications; however, final acceptance will be determined by the Administration.

Responsibilities of the HMA Producer.

(a) Notification. The producer shall notify the Engineer one working day prior to producing materials for Administration projects.

(b) Quality Control. The minimum sampling and testing frequencies and criteria necessary for quality control of the HMA is the responsibility of the producer. The producer shall develop and use a quality control plan acceptable to the Engineer which addresses all elements necessary for quality control in the plant.

The producer shall conduct the minimum sampling and testing as specified in MSMT 730, Table 3. The producer shall perform any additional sampling and testing when directed by the

Engineer. The producer shall offer to the Engineer the opportunity to witness all sampling and testing.

(c) Reports. The producer's test results shall be furnished to the Engineer on documents approved by the Administration.

Responsibilities of the Administration.

(a) Verification Testing. The Administration will provide acceptance by conducting verification sampling and testing and Independent Assurance Sampling and Testing on quality control sampling and testing as follows:

The Engineer will conduct Acceptance Verification by directing the producer to obtain independent verification samples at any time and location during production or placement, by monitoring the required production control charts and the required quality control plan. Verification sampling and testing of asphalt mixtures will be in conformance with MSMT 730, Table 3. The Engineer's verification testing will be separate from the producer's testing.

The Engineer may take or request the producer to obtain test samples at any time to confirm the effectiveness of the activities of the plant and field quality control technicians. The Engineer may direct that production be suspended if proper sampling and testing procedures are not followed or if the producer is not following the approved quality control plan.

Acceptance will be given when the Engineer's verification test results conform to Specifications and are within two standard deviation (2S) of the quality control test results from the last verification visit. Also, all mixes produced since the last verification visit will be evaluated as specified in 504.04.02 to determine the pay factor based on the deviation from target values.

No acceptance will be given when the Engineer's verification test results do not conform to the Specifications or are outside the 2S limits of the quality control test results from the last verification visit. However, the Engineer may give acceptance outside these results depending on the outcome of any additional investigation. If the producer disagrees with the Engineer's decision, the dispute may be resolved as specified in (e) below. An investigation will be conducted to determine the cause of the differences. The plant will be closely monitored until the quality control process is satisfactory to the Engineer. If the Engineer determines that the

plant has a recurring problem with the quality control process, plant approval will be rescinded and the plant shall be recertified before Administration production is permitted.

(b) Recertification of HMA Plant. Documentation of corrective action shall be submitted to the Engineer by a professional engineer registered in the State of Maryland. When this documentation is approved by the Engineer, a comprehensive inspection will be conducted to recertify the HMA plant.

(c) Independent Assurance Audits (IAA). The Administration will evaluate the proficiency and equipment of QC/QA Technicians through audits performed on a random basis as outlined in the Quality Assurance Manual. The technician being audited shall cooperate with the IAA Technician in the evaluation of their proficiency and equipment.

(d) Technician Certification. Technician certification will be in conformance with MSMT 731.

(e) Dispute Resolution System. This is a general procedure to resolve conflicts resulting from discrepancies between test results from the Engineer and producer, and nontest related disputes of sufficient magnitude to impact payment.

When a dispute arises, the producer or Engineer will file a written complaint to the Chief Engineer describing the nature of the dispute along with the pertinent information. The Chief Engineer will appoint a panel of three members to resolve the conflict. The panel will include a member selected by the asphalt industry. The panel will make recommendations to the Chief Engineer. The Chief Engineer will decide the disposition of the dispute based on the panel's recommendations.

A written report from the panel describing all subsequent actions and final disposition of the dispute shall be included in the project records.

If subsequent disputes arises on the same issue, the written report will be included as a resource during the resolution process.

915.03 PORTLAND CEMENT CONCRETE PLANTS. Portland cement concrete plants shall conform to M 157 except as modified herein, including the applicable requirements of 915.01.

915.03.01 Storage of Aggregate. Coarse and fine aggregate for use in portland cement concrete shall be maintained at a uniform moisture

content in excess of its saturated surface dry condition. Water added for this purpose shall conform to 921.01.

915.03.02 Temperature of Water and Cement. The plant shall be equipped with methods of heating or cooling the mix as approved by the Engineer. The temperature of the plastic concrete shall conform to 902.10.03. The temperature of the cementitious materials and the mixing water at the time they are to be used in the mix shall not exceed 170 F.

915.03.03 Load Tickets. The producer shall issue a completed Administration Form 116 in duplicate for each load. Distribution shall be made as specified in 915.03.05(c)(2). The producer's copy shall be readily available for inspection upon request by the Regional Engineer or his representative. Computer generated printouts may be used in lieu of the Administration's Load Ticket when approved by the Regional Engineer.

915.03.04 Mixers and Agitators. The requirements for mixers and agitators and for mixing and delivery of ready mixed concrete shall conform to M 157 with the following exceptions:

(a) During transit, drums shall be operated at agitating speed only. Mixing during transit is prohibited.

(1) At least 85 percent of design water requirement shall be added at the plant through the certified plant water meter.

(2) Water for slump adjustment may be added at the plant through the Administration approved truck water system under the supervision of the certified concrete technician, provided the maximum specified water/cement ratio is not exceeded.

(3) A maximum of 3 gal of water per cubic yard of concrete may be added at the job site provided the maximum specified water/cement ratio is not exceeded.

(4) No water shall be added after partial discharge of the load.

(b) No mixer or agitator containing wash water in the drum shall be loaded.

(c) When the concrete is specified or permitted to be made by volumetric batching and continuous mixing, the batching and mixing unit shall conform to C 685. Calibration shall conform to MSMT 558.

Where no mixer performance tests are made for stationary mixers, the minimum mixing time shall be 75 seconds.

915.03.05 Certified Concrete Plant. The producer shall be responsible for quality control of plant operations to ensure that the material conforms to Specification requirements. The quality control process will be subject to unannounced periodic inspection by representatives of the Regional Engineer. Full participation in the inspection by the plant's certified technician will be required.

Initial Inspection. Any plant initially setting up and starting production will be subject to a comprehensive inspection to determine whether the plant equipment and personnel conform to all applicable Specification requirements. The Administration will accept certification by a professional engineer registered in the State of Maryland that the plant facilities conform to all applicable Specification requirements. However, final acceptance will be determined by the Administration.

Responsibilities of the Concrete Producer.

(a) The producer shall notify the Regional Engineer one working day prior to producing materials for Administration projects.

(b) Quality Control. All producers supplying concrete shall have the certified concrete plant technician present while concrete is being batched and delivered to the project. This technician shall supervise concrete production.

(1) The producer shall develop and use a Quality Control Plan acceptable to the Engineer that addresses all elements necessary for quality control in the plants.

(2) Control tests shall be performed by the certified concrete plant technician. This technician shall perform moisture tests, adjust proportions of aggregate for free moisture, complete and sign batch or approved delivery tickets, and ensure quality control of the batching operations.

(3) Technician certification will be awarded upon satisfactory completion of examinations administered by the Administration in conformance with MSMT 560.

(4) The producer shall supply all necessary test equipment.

(5) Sample frequency shall conform to the MSMT Frequency Guide, Table 1.

(c) Reports. The following reports will be processed by the producer:

(1) Administration Form 113, daily, stating that the material was sampled and tested in conformance with the Administration's sampling and testing guidelines and complies with the applicable Specifications. Distribution to producer's file and Regional Laboratory.

(2) Administration Form 116, for each load. Distribution to project and producer's file.

(3) Administration Forms for all concrete materials sampled at the plant in conformance with MSMT Frequency Guide Table 1.

(4) Test Worksheet, daily - for all tests performed at the plant.

Responsibilities of the Administration.

(a) Comprehensive Inspection.

(b) Acceptance Inspection and Testing.

(1) If deficiencies are found during an Administration inspection, the producer will be notified immediately to correct the deficiencies to the satisfaction of the Engineer. Production will be suspended for critical deficiencies.

(2) If consecutive inspections reveal identical deficiencies, or if additional deficiencies are found, the producer will be notified that a reinspection will be held in two production days. All deficiencies shall be corrected by the reinspection date.

(3) If reinspection fails, the Regional Engineer will assign an Inspector to monitor plant operations for a maximum of five Administration production days. If at the end of this period the quality control process is not satisfactory, plant approval will be rescinded and the plant shall be recertified before Administration production will be continued.

(4) Recertification of Concrete Plant. Documentation of corrective action shall be submitted to the Regional Engineer by a professional engineer registered in the State of Maryland. When this documentation is approved by the

Engineer, a comprehensive inspection will be conducted to recertify the concrete plant.

(c) Independent Assurance Audits (IAA). The Administration will evaluate the proficiency and equipment of QC/QA Technicians through audits performed on a random basis as outlined in the Quality Assurance Manual. The Technician being audited shall cooperate with the IAA Technician in the evaluation of their proficiency and equipment.

(d) Technician Certification in conformance with MSMT 560.

915.04 BASE COURSE PLANTS.

915.04.01 Nonstabilized. Base course plants producing graded aggregate base material without a stabilizing agent shall conform to 915.01, 915.04.03, and the following:

(a) The material is produced in a processing plant using an approved aggregate source.

(b) The Quality Control Plan shall be submitted to and approved by the Regional Engineer prior to production.

(c) The production shall conform to the gradation requirements of the approved job mix formula.

(d) The required moisture content shall be maintained prior to shipment.

(e) Stockpiles shall be maintained to prevent segregation.

(f) Frozen aggregates shall not be used.

(g) Mixed material shall be handled and transported in a manner that will minimize segregation and the loss of moisture. All loads shall be covered in conformance with State laws unless hauling is off road and approved by the Engineer.

915.04.02 Stabilized. Stabilized base course plants shall conform to 915.01, 915.04.03, and the following:

Mechanical mixers shall be used, as approved by the Engineer. All plants shall be equipped with automatic cutoff devices interlocked so the plant will stop operating if delivery of any component of the mix fails.

The amount of stabilization shall be determined in conformance with MSMT 254.

The charge in a batch mixer, or rate of feed to a continuous mixer, shall not exceed that which will permit complete mixing of all materials.

Mixed materials shall be handled and transported in a manner that will minimize segregation and loss of moisture or volatiles. All loads shall be covered in conformance with State laws unless hauling is off road and approved by the Engineer.

When cement is used as a stabilizing agent, the amount of water added at the plant shall be controlled to obtain a uniform mixture that conforms to the required density.

When emulsified asphalt is used as a stabilizing agent, all aggregate shall contain moisture in excess of the saturated surface dry condition at time of mixing.

915.04.03 Certification of Base Course Plants. The quality control and condition of all materials used in base courses, as well as all necessary adjustments required in using the materials, shall be the responsibility of the base course producer. The quality assurance process will be subject to unannounced periodic inspection by representatives of the Regional Engineer when Administration projects are in progress. The plant's certified technician shall participate in the inspection.

Inspection. Any plant initially setting up and starting production will be subject to a comprehensive inspection to determine whether the plant equipment and personnel conform to all applicable Specification requirements. After the initial inspection the plant shall conform to 915.01.04. The Administration will accept certification by a professional engineer registered in the State of Maryland that the plant facilities conform to all applicable Specification requirements. However, final acceptance will be determined by the Administration.

Responsibilities of the Base Course Producer.

(a) The producer shall notify the Regional Engineer one working day prior to producing materials for Administration projects.

(b) Quality Control. The producer shall be responsible for quality control of plant operations to ensure that the material conforms to Specification requirements. All producers supplying base courses shall have a certified base course plant technician present while base course material is being plant mixed and delivered to the project. This technician shall supervise base course production.

(1) Control tests shall be performed by a certified base course plant technician. This technician shall obtain samples and test in conformance with MSMT Frequency Guide Table 1 and 2.

(2) Technician certification will be awarded upon satisfactory completion of an examination given by the Administration in conformance with MSMT 562. The certification shall be as follows:

Applications for certification shall be obtained from the Regional Engineer a minimum of 30 days prior to producing material for the Administration.

The Regional Engineer will contact the producer and schedule an examination based on AASHTO and MSMT procedures and knowledge of the Administration's base course plant reports and documentation.

Upon satisfactory completion of the examination, a certificate will be issued.

(3) The producer shall supply all necessary test equipment. In addition, the producer shall provide on-site facilities suitable for conducting the required tests. Off-site test facilities shall require approval of the Regional Engineer.

(c) Reports. The following reports shall be processed by the producer:

(1) MD SHA Form 43, daily, stating that the material was sampled and tested in conformance with the Administration's sampling and testing guidelines and conforms to the applicable Specifications. Distribution to Regional Laboratory and producer's file.

(2) MD SHA Form 88, for all additives introduced at the plant, frequency in conformance with Table 2. Distribution to Regional Laboratory and producer's file.

(3) Daily Plant Certification Form showing that a technician was on duty at the plant. Distribution to project and producer's file.

(4) Test Worksheet, daily - for all tests performed at the plant.

(5) Base course plant checklist daily. Distribution to producer's file.

Responsibilities of the Administration.

(a) Comprehensive Inspection.

(b) Acceptance Inspection and Testing.

(1) If deficiencies are found, as defined in the base course plant checklist during an acceptance inspection, the producer will be notified immediately and operations shall be suspended if corrections are not made to the satisfaction of the Engineer.

(2) If on consecutive inspections identical deficiencies are found, the producer will be notified that a re-inspection will be held in two Administration production days. All deficiencies shall be corrected by the re-inspection date. The Regional Engineer will determine whether plant certification will be revoked.

(c) Independent Assurance Audits (IAA). The Administration will evaluate the proficiency and equipment of QC/QA Technicians through audits performed on a random basis as outlined in the Quality Assurance Manual. The technician being audited shall cooperate with the IAA Technician in the evaluation of their proficiency and equipment.

(d) Recertification of Aggregate Base Course Plant. Documentation of corrective action shall be submitted by a professional engineer registered in the State of Maryland. When this documentation is approved, a comprehensive inspection will be conducted to recertify the base course plant.

(e) Technician Certification in conformance with MSMT 562.

915.05 CERTIFIED PRECAST CONCRETE PLANTS. The producer shall be responsible for quality control plant operations to ensure that the material conforms to Specifications. The quality control process will be subject to unannounced periodic inspection by representatives of the Regional Engineer. The plant's certified technician shall fully participate in the inspections.

Initial Inspection. Any plant initially setting up and starting production will be subject to a comprehensive inspection to determine whether plant equipment and personnel conform to all applicable Specifications and that suitable testing facilities will be available. The Administration will

accept certification by a professional engineer registered in the State of Maryland that the plant facilities conform to all applicable Specifications; however, final acceptance will be determined by the Administration.

915.05.01 Responsibilities of the Precast Concrete Producer.

(a) Notification. The producer shall notify the Engineer at least two working days prior to producing materials for Administration projects.

(b) Quality Control Procedures. Quality control procedures shall include the following:

(1) Sampling and testing in conformance with Tables 1, 2, and 3 of the MSMT Sample Frequency Guide.

(2) The method of inspecting reinforcement steel placement and forms prior to pouring concrete.

(3) The method of curing the concrete.

(4) The method of maintaining accurate quality control records.

(5) Samples of documents approved by the Engineer.

(6) Patching procedures.

(7) Methods of preparing the concrete units for shipment.

(8) A method of identifying each piece as tested and approved by quality control.

(c) Quality Control Plan. The producer shall submit a Quality Control Plan prior to the start of production. The plan shall indicate the following:

(1) All precast concrete products shall conform to the Standards or approved working drawings. All materials shall be from an Administration approved source and shall conform to all applicable Specifications.

(2) The plan shall indicate how the producer intends to handle all of its materials. Certification of materials shall be as specified in the MSMT Sample Frequency Guide.

(3) The names, qualifications, and responsibilities of a Quality Control Manager and a Quality Control Technician.

(d) Quality Control Technician. The Quality Control Technician may be approved if certified from at least one of the following:

(1) The National Precast Concrete Association.

(2) The Precast/Prestressed Concrete Institute Plant Certification Program.

(3) American Concrete Institute.

(4) Taking the Maryland Certified Concrete Technician course given by the Administration and passing the test.

(e) Test Equipment and Facilities. The producer shall supply all necessary test equipment. In addition, the producer shall provide Administration approved facilities suitable for conducting the various tests required. Off site test facilities shall require approval of the Engineer.

915.05.02 Responsibilities of the Administration.

(a) Comprehensive Inspection.

(b) Verification Testing.

(1) Verification of certification will be performed at the discretion of the Administration a minimum of once per year.

(2) The Administration reserves the right to discontinue acceptance of precast units if its verification indicates that materials or test procedures do not conform to the Contract Documents.

SECTION 916 — SOIL AND SOIL-AGGREGATE BORROW

916.01 BORROW EXCAVATION. All borrow excavation shall be a soil or soil aggregate mixture and shall conform to the following:

Maximum dry density and optimum moisture content of the material shall be determined as specified in T 180, Method C unless the material has more than 35 percent retained on the No. 4 sieve, in which case Method D shall be used. Material with a maximum dry density of less than 100 lb/ft^3 is unsatisfactory and shall not be used in embankments

unless otherwise specified in the Contract Documents. Potentially expansive materials, such as steel slag, shall not be used.

Recycled portland cement concrete or recycled HMA pavement may be used as select borrow, capping borrow, and modified borrow with the written approval of the Engineer. Recycled portland cement concrete, recycled HMA pavement, and processed contaminated soil shall not be used within 1 ft of the surface in any area to be vegetated. All recycled or rehandled materials shall conform to Section TC-6.10.

916.01.01 Select Borrow. Select borrow shall conform to A-2, A-3, or A-2-4 material as specified in the Contract Documents. The maximum dry density shall be a minimum of 105 lb/ft^3.

916.01.02 Capping Borrow. Capping borrow shall conform to the select borrow requirements except when A-3 material has less than 10 percent retained on the No. 10 sieve, at least 15 percent shall pass the No. 200 sieve. Sieve analysis shall be determined in conformance with MSMT 302.

916.01.03 Modified Borrow. Modified borrow shall have a minimum of 50 percent retained on the No. 4 sieve, a maximum liquid limit of 30 when tested as specified in T 89, and a maximum plasticity index of 9 when tested as specified in T 90. The maximum dry density shall not be less than 125 lb/ft^3. A-5 material, as defined in the Contract Documents shall not be used.

916.01.04 Common Borrow. Common borrow shall have a maximum dry density of not less than 100 lb/ft^3.

SECTION 917 — EPOXY PROTECTIVE COATINGS

917.01 EPOXY PROTECTIVE COATINGS FOR CONCRETE. The protective coatings shall be two component epoxy systems for use in conjunction with concrete. One component shall be a clear or pigmented condensation product of the reaction of epichlorohydrin with bisphenol A, the resin of which shall be composed of 100 percent reactive constituents. The other component shall be a clear polyamide hardener.

The producer shall submit a sample of each component for laboratory analysis. The sample shall be coded as the original sample. The original and all subsequent samples shall conform to the following:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Pot Life, hr min	Fed. Spec TT-C-535	8
Color	Fed. Standard 595	Gray No. 26440
Dry Film Thickness 1st coat, mil min 2nd coat, mil min	D 1005	 2 3
Sagging	D 4400	Must pass test for Recommended film Thickness
Flexibility	Federal Spec TT-P-115	Must not crack, check or delaminate
Infrared Spectrogram	Equipment Manufacturer's Procedure	Each component shall match original sample
Tensile Strength, psi min	MSMT 609	400

917.02 FUSION BONDED EPOXY POWDER COATINGS FOR STEEL. The epoxy protective coatings shall be a one coat, heat curable, thermosetting powdered coating that is electrostatically applied on metal surfaces as specified in the Contract Documents. Unless otherwise specified in the Contract Documents, the color for structural steel shall match Federal Standard No. 595, No. 20040. For reinforcement steel the color shall be a bright color to contrast with the normal color of reinforcement steel and rust (e.g., orange, red, green, yellow, etc., and not brown or any color in the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss. The epoxy coating material shall be selected from the prequalified materials list maintained by the Office of Materials and Technology.

Epoxy coatings shall conform to D 3963.

917.02.01 Touch Up System. Material used for the touch up system shall be a two part epoxy system designated and color matched for patching the epoxy coating used.

Patching material shall be available through the manufacturer of the epoxy powder. The patching material shall be fully cured one hour after application at 35 F ambient.

917.02.02 Certification. The manufacturer shall furnish certification as specified in TC-1.02.

917.03 FUSION BONDED POLYESTER COATING FOR METAL TRAFFIC BARRIERS.

917.03.01 Cleaning and Coating. Cleaning and coating shall be performed in an environmentally controlled plant that is fully enclosed and preapproved by the Administration.

All components shall be free of any oil or grease and shall be grit blasted to Near White SSPC-SP 10. Cleaned surfaces shall be protected from high humidity, rainfall or surface moisture and shall not be allowed to flash rust. Blast profile shall be approximately 1 to 1.5 mil, but not greater than 2 mil, as checked with a surface profile gauge approved by the Engineer.

The polyester coating shall be checked for continuity using a 67-1/2 volt wet sponge detector to check for holidays, pinholes, and discontinuities. Coating thickness shall be checked with a properly calibrated magnetic gauge. Minor defects shall be repaired with a liquid touch up recommended by the manufacturer.

The polyester coating shall conform to the following additional requirements:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Abrasion	Taber Abraser CS-10, 1000 gm load, 1000 cycles, D 1044	100 mg max weight loss
Adhesion	D 3359, Initial & 1000 hr, Method A	Rating 5A
Gloss	D 523, Initial 500 hr 1000 hr	82% @ 60° 90% @ 60°
Hardness	D 3363	2H - No Gouge
Impact	D 2794	Pass 80 in.·lb
Salt Spray Resistance	B 117, D 1654 1000 hr unscribed 400 hr scribed	Table 2, Rating 10 Table 2, Rating 10
Weather Resistance	G 23, 102 minutes of light followed by 18 minutes of light & Water Spray as in Method I.	No film failure
Thickness	G 12	7 ± 2 mil
Color	Federal Standard 595	Color No. 20040 or as specified in Contract Documents
Infrared Spectrogram	Equipment Manufacturer's Procedure	Match original
Flexibility	1/4 in. Mandrel 180° bend in 1 second, cured per manufacturer's recommendations or specimen prepared by manufacturer.	No breaks, flaking, or cracks. Tested with a Q-panel with no cracking.
Humidity	D 2247, 1000 hr	No blistering.

917.03.02 Certification. The manufacturer shall furnish certification as specified in TC-1.02.

SECTION 918 — TRAFFIC BARRIERS

918.00 CERTIFICATION. The manufacturer shall furnish certification as specified in TC-1.02.

918.01 TRAFFIC BARRIER W BEAM. Rail elements and end treatments shall conform to M 180, Type II or IV. In lieu of galvanizing, rail elements may be coated with a minimum of 5 mil dry film thickness of inorganic zinc rich primer conforming to 912.02.01. The primer shall be applied in conformance with Section 435 after the rail elements are fabricated.

918.02 TRAFFIC BARRIER POSTS. Posts shall conform to M 183 for steel and M 111 for galvanized coating. In lieu of galvanizing, posts may be coated with a minimum of 5 mil dry film thickness of inorganic zinc rich primer conforming to 912.02.01. The primer shall be applied as specified by the manufacturer after the posts are fabricated.

918.03 HARDWARE FOR TRAFFIC BARRIERS. Hardware for traffic barriers shall conform to M 183 for quality of steel and M 232 for galvanized coating.

918.04 TIMBER RAIL AND POSTS. Timber rail and posts shall conform to M 168.

918.05 WIRE ROPE. Wire rope shall conform to Federal Specification RR-W-410, Type I, General Purpose, Class 2, 6 by 19, improved plow steel, fiber core. The individual wire strands shall have a zinc coating of 0.8 oz/ft^2 when tested as specified in T 65.

SECTION 919 — RESERVED

SECTION 920 — LANDSCAPING

920.01 TOPSOIL AND SUBSOIL.

920.01.01 Salvaged Topsoil. Salvaged topsoil shall be that surface material to be salvaged from the project which has been classified as topsoil as specified in the Contract Documents.

920.01.02 Furnished Topsoil. Furnished topsoil shall be natural, friable surface soil uniform in color and texture and not supplied from the project. Topsoil shall be free from any parts of Johnsongrass, Canada Thistle, or Phragmites.

Topsoil shall have an organic content between 1.5 to 10.0 percent by weight when tested as specified in T 194. Furnished topsoil shall have a corrected pH value of not less than 6.0 nor more than 7.5.

Grading analysis shall be as follows:

SIEVE SIZE	MINIMUM PERCENT PASSING BY WEIGHT
2 in.	100
No. 4	90
No. 10	80

Topsoil shall be analyzed for sand, silt, and clay as specified in T 88.

Textural analysis shall be as follows:

SOIL PARTICLE SIZES mm	PERCENT PASSING BY WEIGHT
Sand (2.0 – 0.050)	20 – 75
Silt (0.050 – 0.002)	10 – 60
Clay (less than 0.002)	5 – 30

920.01.03 Salvaged Subsoil. Salvaged subsoil shall be material salvaged from the project that has been classified as subsoil as specified in the Contract Documents.

920.01.04 Furnished Subsoil. Furnished subsoil shall be natural, friable subsurface soil uniform in texture and not salvaged from the project. Subsoil shall be free from any parts of Johnsongrass, Canada Thistle, or Phragmites. The Contractor shall submit a source of supply for the material to the Administration for approval, prior to use. Material shall conform to Section 916 with the following exceptions:

(a) The use of recycled portland cement concrete or recycled HMA pavement is prohibited.

(b) The corrected pH value shall be 5.0 to 7.5.

(c) The organic matter content shall be 0.1 to 5.0 percent.

Grading analysis shall be as follows:

SIEVE SIZE	MINIMUM PERCENT PASSING BY WEIGHT
2 in.	100
No. 4	85
No. 10	60

Material shall be analyzed for sand, silt and clay as specified in T 88.

The textural analysis shall be as follows:

SOIL PARTICLE SIZES mm	PERCENT PASSING BY WEIGHT
Sand (2.0 – 0.050)	20 – 85
Silt (0.050 – 0.002)	10 – 60
Clay (less than 0.002)	5 – 40

920.02 AGRICULTURAL LIMESTONE. Limestone shall contain not less than 85 percent calcium and magnesium carbonates. Dolomitic (magnesium) limestone shall contain at least 10 percent magnesium as magnesium oxide and 85 percent calcium and magnesium carbonates. Limestone shall conform to the following gradation:

SIEVE SIZE	MINIMUM PERCENT PASSING BY WEIGHT
No. 10	100
No. 20	98
No. 100	50

920.03 FERTILIZER.

920.03.01 Granular and Liquid Fertilizer. Fertilizer shall be commercial grade conforming to all State and Federal regulations and the Standards of the Association of Official Analytical Chemists.

Standard analyses shall be: 0–20–20, 5–20–20, 10–10–10, 10–20–10, 10–22–22 (50% nitrogen from 38–0–0 ureaform), 20–20–20 and 38–0–0

(ureaform). All analyses are subject to approval by the Engineer prior to application.

920.03.02 Fertilizer Packets. Fertilizer shall be contained in a slow release polyethylene perforated bag with micropore holes for controlled feeding. The bag shall contain 4 oz of water soluble fertilizer, analysis 16–8–16 to be effective for approximately eight years.

Minimum guaranteed analysis of the packets shall be as follows:

MINIMUM ANALYSIS	
Total Nitrogen (N) 16%	9% Ammoniacal Nitrogen (NH_3N) 7% Nitrate Nitrogen (NO_3N)
Available Phosphoric Acid (P_2O_5)	8% from Ammonium Phosphate (NH_4PO_4)
Soluble Potash (K_2O)	16% from Potassium Chloride (KCl)
Potential Acidity equivalent to 850 lb Calcium Carbonate ($CaCO_3$) per ton.	

920.03.03 Fertilizer Tablets. Fertilizer tablets shall consist of a minimum 21 gram tablet containing a slow release (two year) fertilizer, analysis 20–10–5.

Minimum guaranteed analysis of the tablets shall be as follows:

MINIMUM TABLET ANALYSIS	
Total Nitrogen (N) 20%	7% Water Soluble Organic Nitrogen 13% Water Insoluble Organic Nitrogen
Available Phosphoric Acid (P_2O_5)	10%
Soluble Potash (K_2O)	5%

920.03.04 Iron Sulfate. Iron sulfate shall be an approved horticultural product produced as a fertilizer for supplying iron and as a soil acidifier.

920.04 SEED, SEED MIXES, AND SOD.

All seed, seed mixes, and sod shall be free from Maryland prohibited noxious weed seeds and the following:

Annual Bluegrass
Bermudagrass
Bindweed
Cocklebur
Corn Cockle
Dodder
Giant Foxtail
Horse Nettle
Spurred Anoda
Wild Garlic
Wild Onion

920.04.01 Seed. Seed will be sampled and tested by an inspector from the Turf and Seed Section, Maryland Department of Agriculture (MDA), Annapolis, Maryland. All seed containers shall be tagged with a MDA supervised mix program seed tag. Seed shall comply with the Maryland Seed Law, Agricultural Article of the Annotated Code of Maryland. The authority for seed names shall be the current printing of USDA, Agriculture 505 Handbook.

Grass and legume seeds shall conform to the latest construction directives regarding cultivars and varieties and the following:

SEED	PURITY NOT LESS THAN %	WEED SEED NOT MORE THAN %	MINIMUM GERMINATION (including hard seed) %	HARD SEED NOT TO EXCEED %
Kentucky Bluegrass (Poa pratensis)	90	0.4	80	—
Canada Bluegrass (Poa compressa)	90	0.5	80	—
Redtop (Agrostis gigantea)	92	0.7	80	—
Lehmann's Lovegrass (Eragrostis lehmanniana)	98	0.5	80	—
Foxtail Millet (Setaria italica)	99	0.1	80	—
Hard and Fine Fescue (Festuca longifolia)	98	0.5	85	—
Sheep Fescue (Festuca ovina)	98	0.5	85	—
Tall Fescue (Festuca arundinacea)	98	0.5	90	—
Chewings Fescue (Festuca rubra commutata)	98	0.5	85	—
Oats (Avena sativa)	99	0.5	90	—
Crownvetch (Coronilla varia)	98	0.5	80	30
Serecia Lespedeza (Lespedeza cuneata)	98	0.5	85	20
Birdsfoot Trefoil (Lotus corniculatus)	97	0.7	85	20
Weeping Lovegrass (Eragrostis curvula)	98	0.5	80	—
Barley (Hordeum vulgare)	98	0.3	90	—
Rye Grain (Secale cereale)	98	0.1	85	—
Perennial Ryegrass (Lolium perennial)	98	0.5	85	—

920.04.02 Seed Mixes. The Contractor or seed supplier shall notify the Turf and Seed Section, Maryland Department of Agriculture, Annapolis, Maryland, at least 10 days prior to the mixing date as to the hour, date, and location of the mixing operation. The Contractor or seed supplier shall assume charges for seed inspections and seed testing service. Seed mixes shall conform to the following:

(a) Seed Mix No. 1

85% Tall Fescue (Certified Seed Only)
10% Kentucky Bluegrass (Certified Seed Only)
5% Perennial Rye grass (Certified Seed Only)

(b) Seed Mix No. 2

60% Kentucky Bluegrass (Certified Seed Only)
40% Fine (Chewings, Creeping Red, Hard, Sheep) Fescue (Certified Seed Only)

(c) Temporary Seed Mix

95% Barley or Rye
5% Foxtail Millet

(d) Cover Companion Seed Mix. Cover Companion Seed Mix for use with Woody Shrub Seed Mix shall conform to 705.01.01 Regional Areas.

REGION 1

35% Tall Fescue
35% Canada Bluegrass
15% Redtop
15% Birdsfoot trefoil (inoculant required)

REGIONS 2 & 3

30% Chewings Fescue
30% Canada Bluegrass
10% Redtop
30% Serecia Lespedeza (inoculant required)

(e) Woody Shrub Seed Mix

REGIONS 1, 2, & 3

25% Amur Honeysuckle (Lonicera maackii) or Tatarian Honeysuckle (Lonicera tatarica)
20% Bristly Locust (Robina fertilis)(inoculant required)
25% Shrub Lespedeza(Lespedeza bicolor)(inoculant required)
30% Arrowwood Viburnum (Viburnum dentatum)

The woody shrub seed mix shall have a minimum purity of 98 percent.

(f) Wildflower Seed Mix

REGIONS 1, 2, & 3

3 % Spurred Snapdragon (Linaria maroccana)
6 % Plains Coreopsis (Coreopsis tinctoria)
6 % Corn Poppy (Papaver rhoeas)
6 % Black Eyed Susan (Rudbeckia hirta)
3 % Scarlet Sage (Salvia coccinea)
3 % Lemon Mint (Monarda citriodora)
1.2 % Shasta Daisy (Chrysanthemum maximum)
1.2 % New England Aster (Aster novae angliae)
3 % Siberian Wallflower (Cheiranthus allioni)
0.6 % Evening Primrose (Oenothera hookerii)
1.2 % White Yarrow (Achillea millefolium)
6 % California Poppy (Eschschoizia california)
7 % Dames Rocket (Hesperis matronalis)
3 % Rocket Larkspur (Delphinium ajacis)
7.6 % Tall Cornflower (Centaurea cyanus)
12.2 % Purple Cornflower (Echinacea purpurea)
6 % Lance-leaf Coreopsis (Coreopsis lanceolata)
1.5 % Yellow cosmos (Cosmos sulphureus)
1.5 % Purple Cosmos (Cosmos bipinnatus)
3 % Sweet William (Dianthus barbatus)
6.6 % Crimson Clover (Trifolium incarnatum)
1.2 % Firewheel (Gaillardia aristata)
6 % Blanket Flower (Gaillardia pulchella)
3 % Calendula (Calendula officianialis)
1.2 % Sunflower Autumn Beauty (Helianthus Autumn Beauty)

The wildflower seed mix shall conform to the following:

75% Minimum Germination
98% Minimum Purity

(g) Cover Companion Seed for use with Wildflower Seed Mix.

100% Hard Fescue (Festuca longifolia) or Sheep Fescue (Festuca ovina)

920.04.03 Sod. Sod shall either be Maryland Certified or Maryland Approved Sod and shall comply with the Maryland Turfgrass Law and Certification Regulations of the Annotated Code of Maryland. Each load of sod shall bear a Maryland State Approved or Certified label at the time of delivery on the job.

The sod shall be well rooted and shall be grown in the State of Maryland. It shall be field grown for a minimum of 12 months. Once cut and rolled, sod shall be placed within 48 hours. It shall be cut in strips not less than 14 in. or more than 20 in. wide. Sod shall be machine cut to a uniform thickness of 3/4 in., plus or minus 1/4 in., at the time of cutting. Thickness shall exclude top growth and thatch. Sod shall be relatively free of thatch, 3/8 in. or less at time of cutting. Prior to cutting, sod shall be mowed to a height of 1-1/2 to 2-1/2 in. for Bluegrass, 3/4 to 1 in. for Bermudagrass, and 2 to 2-1/2 in. for Tall Fescue.

920.05 MULCH.

920.05.01 Shredded Hardwood Bark. Shredded hardwood bark shall consist of the bark from hardwood trees which has been milled and screened to a maximum 4 in. particle size and provide a uniform texture free from sawdust, toxic substances, and foreign materials.

920.05.02 Wood Chips. Wood chips shall be produced by a wood chipping machine and be composted. Wood chips shall be a maximum size of 2 X 2 X 0.5 in. Composted wood chips shall be free of toxic substances and any foreign materials.

Grading analysis shall be as follows:

SIEVE SIZE (in.)	MAXIMUM PERCENT PASSING BY VOLUME
2	100
1	30
0.5	10

920.05.03 Straw and Hay. Straw shall consist of thoroughly threshed cereal grains. Hay shall consist of forage grasses and legumes. Straw and

hay shall be free of noxious weeds and weed seeds as specified in 920.04. Straw and hay shall be visually inspected to ensure that it is free from mold, foreign substances, plant parts of Canada Thistle, Johnsongrass, or Phragmites, and is in an air-dry condition suitable for placing with mulch blower equipment.

920.05.04 Wood Cellulose Fiber. Wood cellulose fiber shall be a processed wood product having uniform fiber characteristics which will remain in uniform suspension in water under agitation and will blend with seed, fertilizer, and other additives to form a homogeneous slurry. The fiber shall perform satisfactorily in hydraulic seeding equipment without clogging or damaging the system. The slurry shall contain a green dye that provides easy visual inspection for uniformity of application.

The manufacturer shall furnish certification as specified in TC-1.02 showing conformance to the following:

WOOD CELLULOSE FIBER REQUIREMENTS	
Particle Length, in.	Approximately 1/2
Particle Thickness, in.	Approximately 1/16
Net Dry Weight Content	Minimum as stated on bag
TAPPI* T 509, pH	4.0 – 8.5
Ash Content, TAPPI* Standard T 413, % max	7.0
Water Holding Capacity, % min	90

* Technical Association of Pulp and Paper Industry

The material shall be delivered in packages of uniform weight, which shall not exceed 75 lb net weight and shall bear the name of the manufacturer, the net weight, and a supplemental statement of the net weight content.

920.06 SOIL STABILIZATION MATTING. Soil stabilization matting shall be supplied in 40 to 96 in. width rolls. The material shall be selected from the Administration's Office of Materials and Technology Prequalified Materials List for the use specified.

Type A. Type A soil stabilization matting shall consist of a machine produced mat of degradable natural or man made fibers. Matting shall be smolder resistant. When a chemical is used, it shall be nonleaching, nontoxic to vegetation and the germination of seed, and noninjurious to the skin.

Type A matting shall have a uniform thickness and distribution of fibers throughout. The top and bottom of the matting shall be covered with a degradable extruded plastic netting having a maximum mesh opening of 2 X 2 in. or covered on the top side with netting machine sewn or bonded on 2 in. centers along the longitudinal axis of the material. The average breaking strength of any two strands of netting shall be 5 lb minimum. The netting shall be entwined with the matting fibers in a manner which shall provide sufficient reinforcement against damage during handling and placement and shall resist degradation for a minimum of six months and a maximum of one year.

Type B. Type B soil stabilization matting shall consist of a machine produced mat of nondegradable fibers or elements and have a uniform thickness and distribution of weave throughout.

920.06.01 Staples for Type A Soil Stabilization Matting and Sod. Staples shall be U or T shaped steel wire having minimum gauges of No. 11 and No. 8, respectively. The U shaped staples shall average 1 to 1-1/2 in. wide. The T shaped staples shall have a main and a secondary leg and a 4 in. head. For the length of the staples to be used with the Type A matting, refer to 709.03.03. For sod the U shaped staples shall be a minimum length of 6 in. and the T staples shall have a main leg length of 8 in. and a secondary leg length of 1 in.

920.06.02 Fasteners for Type B Soil Stabilization Matting. Fasteners shall be staples or wood stakes. Staples shall be U or T shaped steel wire having minimum gauges of No. 11 and No. 8, respectively. The U shaped staples shall average 1 to 1-1/2 in. wide. The T shaped staples shall have a main and secondary leg and a 4 in. head. Wood stakes shall be sound, rough sawn, hardwood measuring 1 X 3 in. at the top. For the length of the fasteners to be used with the Type B matting, refer to 709.03.03.

920.07 PLANT MATERIALS.

920.07.01 Plants. All plants, unless otherwise specifically permitted, shall conform to the standards of the current edition of "American Standard for Nursery Stock" as approved by the American Standards Institute, Inc.

All plant grades shall be those established in the current edition of American Standards for Nursery Stock manual. Only one size per grade will be listed rather than a size range. The one size shall mean the minimum size for that grade and shall include plants from that size up to but not including the next larger grade size.

All plants, unless otherwise specifically permitted, shall be nursery grown and shall have been grown within plant hardiness zones 5, 6, 7 or

the Virginia portion of zone 8A as recorded in the current edition of "Plant Hardiness Zone Map," prepared by the U.S. National Arboretum, Agricultural Research Service, U.S. Department of Agriculture.

All plant materials shall have normal, well developed branches and a vigorous root system. They shall be healthy plants free from physical defects, plant diseases, and insect pests. Plant materials grown in fields or blocks which show evidence of containing any parts of Johnsongrass or Canada Thistle will be rejected.

Shade and flowering trees shall be symmetrically balanced. Major branches shall not have V shaped crotches capable of causing structural weakness. Trunks shall be free of unhealed branch removal wounds greater than a 1 in. diameter.

Shade trees shall have a single main trunk. Trunks shall be free of branches below the following heights:

CALIPER in.	**HEIGHT ft**
1-1/2 to 2-1/2	5
3	6

920.07.02 Plant Names. The authority for all plant names shall be the current printing of "Hortus Third", except for Ilex opaca (American Holly) which shall be the current edition of the International Checklist of Cultivated Ilex. Representative samples of every shipment of plant materials shall be labeled as to genus, species, and specified size.

Approved Varieties of Ilex Opaca. When approved varieties of Ilex opaca are specified, the Contractor shall select from the following list of cultivated varieties.

ILEX OPACA	
Female	**Male**
Miss Helen Patterson Wyetta Jersey Princess Satyr Hill Old Heavy Berry Dan Fenton	Jersey Knight David Leather Leaf

The Contractor shall supply 90 percent female varieties and 10 percent male varieties unless otherwise specified by the Engineer.

920.07.03 Plant Inspection. The initial inspection for conformance with these Specifications will be made at the nursery, holding area, or job site. The condition of all plant material will be subject to reinspection for the life of the Contract. Inspection and tagging of plant material with an Administration seal prior to digging will be at the option of the Engineer. Material arriving with broken seals (if tagging is required), broken or loose root balls, mechanical damage, insufficient protection, and shriveled or undeveloped roots will be rejected. All container grown plants shall be well rooted, vigorous and established in the size pot specified, shall have well balanced tops for their pot size, and shall not be root bound.

All plant materials shall be declared and certified free from disease and insects of any kind as required by law for the necessary interstate or interdistrict transportation.

920.07.04 Plant Digging and Handling. All plants shall be dug in conformance with the digging Specifications in the current edition of "American Standard for Nursery Stock," unless otherwise specified.

All bare root deciduous plants shall be shipped in a dormant condition. Roots shall be adequately protected and kept moist.

920.07.05 Substitute Plants. No substitutions shall be made without the permission of the Engineer.

In cases where plant materials are not available at the time of planting, the Contractor shall submit, in writing, evidence that the plants are unavailable. The Engineer will determine a suitable substitution.

920.07.06 Maryland Plant Dealer's License.

All Contractors performing planting work and suppliers of trees, shrubs, vines, seedling stock, perennials, and bulbs shall possess a Maryland Plant Dealer's License as required by the Maryland Plant Disease Control Law of the Annotated Code of Maryland.

Out-of-state Contractors may substitute a dealers license from their home state in lieu of the Maryland license. Contractors not possessing a similar Plant Dealer's License from their home state shall obtain a License from the Maryland Department of Agriculture.

920.08 MISCELLANEOUS LANDSCAPING ITEMS.

920.08.01 Water. Water used in the planting, establishing, or caring for vegetation shall be free from any substance that is injurious to plant life.

920.08.02 Peat Moss. Peat moss shall be milled sphagnum peat moss and shall be free from woody substances.

920.08.03 Peat Humus. Peat humus shall originate from fresh water sites of sedge and reed peat deposits in which the organic matter consists of incompletely decomposed plant residues containing a minimum of 70 percent organic material by weight and a negligible amount of woody matter by visual inspection. Inorganic material shall consist only of sand, silt and clay without inclusion of gravel, debris or toxic compounds. Peat humus with a pH value of less than 4.5 shall be corrected to a value of 6.5 by the addition of limestone as directed by the Engineer. Samples of peat humus will be taken by the Engineer and will be tested for conformance to Federal Specification Q-P-166.

920.08.04 Manure. Manure shall be dehydrated cow manure as approved by the Engineer.

920.08.05 Compost. Compost shall be screened, approved by the State Agencies listed below, and subject to approval by the Engineer. Compost shall have a pH between 6.0 and 7.5 except when specified in Section 710 where it shall have a pH between 6.0 and 7.0. It shall be stable and not reheat upon restacking. Compost shall have a moisture content between 30 and 55 percent, a particle size of 0.5 in. or less.

Grading analysis shall be as follows:

SIEVE SIZE	MAXIMUM PERCENT PASSING BY VOLUME
No. 4	90
No. 40	25
No. 200	2.2

Compost shall be one of the following types:

(a) Biosolids Compost (Type A). Biosolids compost will be approved for distribution by the Maryland Department of the Environment. Compost shall a soluble salt concentration not to exceed 10 dS (mmhos/cm).

(b) Source-Separated Compost (Type B). Source-separated compost will be approved by the Maryland Department of Agriculture (MDA). Compost shall be produced by a MDA certified compost operator. Compost shall have a soluble salt concentration not to exceed 5 dS (mmhos/cm).

Source-separated compost shall be one of the following types:

(1) Tree leaf compost.

(2) Non-tree leaf compost. When compost is from lawn clippings, it shall be tested for contaminants in conformance with COMAR 15.18.04.05.

920.08.06 Insecticide. Insecticide shall be an EPA approved chemical that provides protection against insect pests. The insecticide will be subject to approval by the Engineer.

920.08.07 Herbicide. Herbicide shall be an EPA approved chemical to control and prevent regrowth of undesirable vegetation. The herbicide will be subject to approval by the Engineer.

920.08.08 Marking Dye. Marking dye shall be herbicide compatible and oil or water soluble, as required. Marking dye shall be from a commercial source as approved by the Engineer.

920.08.09 Stakes. Stakes for supporting trees shall be rough sawn, straight grain hardwood reasonably free from knot holes, bark, wane, warp, and splits, as determined by the Engineer. Stakes shall be full cut 2 X 2 in. thickness. The length shall be as specified in the Contract Documents.

920.08.10 Outline Stakes. Outline stakes shall be full cut 1-3/4 X 1-3/4 in. sound hardwood, 48 in. long, as approved by the Engineer. They shall have the words "MOW LIMIT" stenciled in orange paint vertically on one side in 1-1/2 in. letters beginning within 2 in. from the top of the stake.

920.08.11 Wire. Wire shall be No. 12 gauge and 14 gauge new annealed galvanized wire, as approved by the Engineer.

920.08.12 Wire Rope. Wire rope shall be 1/4 in. zinc coated steel wire seven strand as commonly used for guying large trees and as approved by the Engineer.

920.08.13 Cable Clamps. Cable clamps shall be galvanized or cadmium plated as approved by the Engineer.

920.08.14 Hose. Hose shall be 5/8 in. inside diameter corded synthetic rubber hose or as approved by the Engineer.

920.08.15 Turnbuckles. Turnbuckles shall be galvanized or cadmium plated with 4-1/2 in. openings and 5/16 in. threaded ends with screw eyes.

920.08.16 Anchors. Tree anchors shall be earth anchors of a type commonly used for anchoring large trees and as approved by the Engineer.

920.08.17 Wrapping Material. Wrapping material for trees shall be clean new burlap 6 to 7 oz/yd^2 in strips 4 to 6 in. wide.

920.08.18 Twine. Twine used for tying wrapping on trees shall be three ply untreated jute twine as approved by the Engineer.

920.08.19 Antidesiccant. Antidesiccant shall be an approved emulsion which will provide a film over plant surfaces permeable enough to permit transpiration.

920.08.20 Tree Wound Dressing. Tree wound dressing shall be an asphalt based emulsion prepared especially for tree pruning operations.

920.08.21 Pegs. Pegs shall be wooden wedges 1/2 X 1 X 6 in. to 1/2 X 1 X 12 in. as approved by the Engineer.

920.08.22 Water Absorbent Gel. Water absorbent gel shall be a cross linked polyacrylamide horticultural product used to maintain moisture around bare root plants and as a soil conditioner. Formulas used shall conform to the manufacturer's recommendations.

SECTION 921 — MISCELLANEOUS

921.01 WATER FOR CONCRETE MIXES. Water shall conform to the pH requirements of T 26, Method B and shall be clear. If questionable quality is suspected, the water shall conform to the limits of the comparison tests with distilled water as specified in T 26. The chloride concentration of water used in mixing and curing of portland cement concrete shall be determined in conformance with D 512 and shall not exceed the following limits:

Bridge Superstructure and Prestressed Concrete	500 ppm
Latex Modified Concrete	50 ppm
Other Concrete and Water Used in Curing	1000 ppm

921.02 MOISTURE AND DUST CONTROL AGENTS.

921.02.01 Calcium Chloride. Solid calcium chloride shall conform to M 144, Type S, Grade I, Class A. Calcium chloride in solution shall contain a minimum of 30 percent salts. The solution shall be made using potable water in a quantity designated by the Engineer. When analyzed in conformance with MSMT 601, the residue shall conform to M 144.

921.02.02 Magnesium Chloride. Magnesium chloride flakes shall conform to the following:

TEST PROPERTY	SPECIFICATION LIMITS
Magnesium Chloride $MgCl_2$, %	46.0 – 47.0
Calcium Chloride $CaCl_2$, %	2.0 – 3.0
Potassium Chloride KCl, %	0.5 – 1.0
Sodium Chloride NaCl, %	0.5 – 1.0
Sulfates, % max	0.05

Magnesium chloride, when used as a solution, shall contain 30 to 32 percent solids.

921.03 LIME.

921.03.01 Hydrated lime shall conform to the chemical requirements of C 206, Type N when used in finishing or C 207, Type N when used for masonry.

921.03.02 Hydrated lime for soil stabilization shall have a minimum combined calcium oxide and magnesium oxide content of 65 percent when tested as specified in C 25 and shall conform to the following gradation:

SIEVE SIZE	PERCENT RETAINED max
3/8 in.	0
No. 30	3
No. 200	25

921.03.03 Quicklime shall have a combined calcium oxide and magnesium oxide content of 75 percent minimum and a gradation of 100 percent passing the 3/8 in. sieve when tested as specified in C 25.

921.04 EPOXY ADHESIVES. Epoxy resin bonding material shall consist of a thermosetting epoxy resin and a hardener. The individual components of mixed epoxy shall not settle or skin and contain no volatile solvents, lumps, or foreign materials. The epoxy shall conform to C 881. Unless otherwise specified, epoxy adhesive used for bearing and expansion pads shall be nonsagging.

The manufacturer shall furnish certification as specified in TC-1.02. The certification or data sheet shall show actual test results for each required property of the type, grade, and class of epoxy submitted, and shall accompany each sample.

The manufacturer shall supply actual bond test results for each batch submitted for use.

921.05 STRUCTURAL TIMBER AND LUMBER. The manufacturer shall furnish certification as specified in TC-1.02. Structural timber and lumber shall conform to M 168.

921.06 TIMBER PRESERVATIVES. Preservatives and pressure treatment for timber shall conform to M 133.

921.07 CONDUITS. Conduit shall conform to the following:

921.07.01 Metallic Conduit.

MATERIAL	SPECIFICATION
Electrical Metallic Tubing	UL 797
Intermediate Metal Conduit	UL 1242
Rigid Metal Conduit	UL 6
Rigid Steel Conduit, Zinc Coated	ANSI C80.1
Metallic Outlet Boxes	UL 514A
Fittings for Conduit and Outlet Boxes	UL 514B

921.07.02 Nonmetallic Conduit. The manufacturer shall furnish certification as specified in TC-1.02. Each length shall be stamped or embossed with the grade or type and applicable UL or NEMA designation.

MATERIAL	SPECIFICATION
Schedule 40 and 80 Rigid Polyvinyl Chloride (PVC) Conduit	UL 651
Electrical Plastic Tubing (EPT) and Electrical Plastic Conduit (EPC-40 and EPC-80)	NEMA TC 2
Nonmetallic Outlet Boxes, Flush Device Boxes and Covers	UL 514C
Electrical Nonmetallic Conduit (ENC)	NEMA TC 13
PVC Fittings for use with Rigid PVC Conduit and Tubing	NEMA TC 3
Flexible PVC Coated Conduit	UL 360
Liquid Tight Flexible Nonmetallic Conduit for Detector Sleeves	UL 1660

921.07.03 PVC Coated Metallic Conduit.

MATERIAL	SPECIFICATION
PVC Externally Coated, Galvanized, Rigid Steel Conduit and Electrical Metallic Tubing	NEMA RN 1

921.08 STRAW BALES. Straw bales for erosion and sediment control shall conform to the Contract Documents and shall be approximately 14 X 18 X 36 in.

921.09 GEOTEXTILES.

921.09.01 Geotextile Requirements. All geotextiles shall be listed in the National Transportation Product Evaluation Program (NTPEP) for geotextiles. The geotextile shall be manufactured from fibers consisting of long chain synthetic polymers, composed of a minimum 95 percent by weight of polyolefins or polyesters. The fibers shall be formed into a stable network so that the filaments or yarns retain their dimensional stability relative to each other, including selvages. The geotextile shall conform to the following:

MARYLAND APPLICATION CLASS	TYPE OF GEOTEXTILE	GRAB STRENGTH lb D 4632	PUNCTURE STRENGTH lb D 4833	PERMITTIVITY sec^{-1} D 4491	APPARENT OPENING SIZE, max mm D 4751	TRAPEZOID TEAR STRENGTH lb D 4533
SD TYPE I	NONWOVEN	160	56	0.50	0.43	55
	WOVEN, MONOFILAMENT	250	90	0.50	0.43	90
TYPE II	NONWOVEN	160	56	0.20	0.25	55
	WOVEN, MONOFILAMENT	250	90	0.20	0.25	90
PE TYPE I	NONWOVEN	200	80	0.70	0.43	80
	WOVEN, MONOFILAMENT	250	90	0.70	0.43	90
TYPE II	NONWOVEN	200	80	0.20	0.25	80
	WOVEN, MONOFILAMENT	250	90	0.20	0.25	90
TYPE III	NONWOVEN	200	80	0.10	0.22	80
	WOVEN, MONOFILAMENT	250	90	0.10	0.22	90
SE	NONWOVEN	200	80	0.20	0.30	80
	WOVEN	250	90	0.20	0.30	90
ST	WOVEN	300*	110	0.05	0.15**	110
F	WOVEN	100	–	0.05	0.60	–
E	NONWOVEN	90	30	0.50	0.30	30

Note 1: All property values are based on minimum average roll values in the weakest principle direction, except for apparent opening size.
Note 2: The ultraviolet stability shall be 50 percent after 500 hours of exposure for all classes, except Class F, which shall be 70 percent (D 4355).

* Minimum 15 percent elongation.
**This is a MINIMUM apparent opening size, not a maximum.

Only those geotextiles that have been tested by NTPEP will be considered candidates for use. In addition, the geotextiles shall conform to the Contract Documents and to the Geotextile Acceptance and Quality Assurance Procedure, MSMT 732.

Geotextiles used for reinforcement applications shall have a separate approval process.

921.09.02 Seam and Overlap D 4884. When geotextiles are joined by sewing, the geotextile seam shall conform to the following:

(a) Seams shall be either "J" or "Butterfly" type and shall utilize a lock stitch.

(b) Seams shall conform to the tensile strength requirements for the geotextile when tested across the seam.

(c) The durability of the thread for seaming shall be at least equal to the geotextile itself.

921.09.03 Securing Pins or Staples. Securing pins or staples shall have a minimum 10 in. length and shall be designed to securely hold the geosynthetic in place during construction.

921.10 POLYETHYLENE (PE) MANHOLES. PE manholes shall conform to D 1248, Type III, Class C, Category 3, Grade P34. Working drawings shall be submitted to the Engineer prior to fabrication.

Compressive strength shall be determined in conformance with D 2412, modified pipe stiffness test. Pipe stiffness shall be a minimum of 12 psi at 5 percent deflection, including joints. Axial compressive strength shall be a minimum of 10 000 lb at less than 3 percent deflection.

PE manholes for storm drains shall be manufactured with an invert bowl which will not interrupt flow. Manholes for sanitary sewers shall have a factory molded invert for channeled flow.

The manufacturer shall furnish certification as specified in TC-1.02. The certification shall accompany each shipment of PE manholes and shall show actual test results, the quantity of manhole sections, and date of manufacture. Manholes shall be marked with the manufacturer's name and trademark.

921.11 PREFORMED FIBERGLASS. Preformed fiberglass shall conform to the following:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Density, g/cm, min	D 792	1.25
Absorption, % max	D 570	1.0
Tensile Strength, average of five specimens each direction*, psi min	D 638	10 000
Thickness (unless otherwise specified), in.	—	3/16
Thickness Tolerance, in.	—	+1/16, -0
Color No.	Fed. Std. 595	26622

* Longitudinal and transverse directions.

SECTION 922 — PREFABRICATED EDGE DRAINS

922.01 CERTIFICATION. The manufacturer shall furnish certification as specified in TC-1.02.

922.02 PREFABRICATED EDGE DRAINS. Prefabricated edge drains shall be flexible, rectangular conduit consisting of supporting drainage core encased in a geotextile.

Drainage Core. Drainage core material shall be manufactured from polymers having a high resistance to deterioration by pavement deicing salts, petroleum based materials, and naturally occurring soil chemicals. The core shall have sufficient flexibility to withstand bending and handling without damage or significant weakening.

The core geotextile contact point spacing for post and cuspated sheet type cores shall not exceed 1.125 in. Elongated pipe core sections shall have a 7.5 in./ft minimum open area to allow lateral flow into the core. Cores with support on only one side shall have a minimum of 5 percent of the area of that support side in unobstructed flow. The drain core shall conform to the following requirements:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Thickness, in. min	—	0.75
Compressive Strength, psi, @ 20% maximum deformation, min	(a)	40
In-plane Flow Rate, gal/min/ft of width, min	D 4716 (b)	15

(a) D 5034 for crushed sheet and post type cores.
D 2412 for elongated pipe type cores.
(b) 10 psi load after 100 hr at a hydraulic gradient of 0.1.

Geotextile Wrap. The geotextile wrap for prefabricated edge drain shall conform to 921.09, Class SD, Type II.

The fabric shall be bonded to contact points of supporting core for post and cuspated sheet type cores to ensure that the geotextile does not sag into the core flow area. The geotextile shall be tightly stretched over the core for elongated pipe type cores.

922.03 FITTINGS. Fittings for the pavement edge drain systems, including, but not limited to end seals, splices, outlets, and shunts shall conform to the manufacturer's recommendations and shall be of sufficient strength to withstand construction handling and permanent loading. All fittings shall be as approved by the Engineer.

922.04 OUTLET PIPE. Pipe for outlets shall be 6 in. minimum diameter and shall conform to Section 905.

SECTION 923 — SLURRY SEAL

923.01 AGGREGATES. Aggregates shall be crushed stone, compatible with the emulsion and shall conform to Section 901.

923.02 MINERAL FILLER. Refer to Section 901.

923.03 EMULSIFIED ASPHALT. Emulsified asphalt shall conform to M 208, Grade CSS-1h, except that the cement mixing test is waived.

Emulsified asphalt shall not separate before placement of SS or LMSS.

923.04 LATEX MODIFIED EMULSION. The latex modifier and other emulsifiers shall be milled into the asphalt cement. The emulsified asphalt shall be modified by the addition of 3.0 ± 0.4 percent latex solids by weight of the asphalt. The latex modifier shall be an unvulcanized styrene butadiene rubber (SBR) or 100 percent natural latex in liquid form. The manufacturer shall furnish certification as specified in TC-1.02 showing actual test results in conformance with these Specifications.

923.05 MIX DESIGN APPROVAL. Mix design data shall be submitted to the Engineer for approval at least three weeks in advance of the paving operation. The mix design shall list the ingredients and their proportions as well as the gradation of the proposed aggregate.

The SBR latex modifier shall conform to the following:

TEST PROPERTY	SPECIFICATION LIMITS
Styrene butadiene Ratio	24:76 ± 1.5
Solids Content, % min	60
pH, max	6.2
Weight Per Gallon, Wet Basis @ 25 C, lb min Dry Basis @ 25 C, lb min	 7.9 4.5

Latex modified emulsion CSS-1h shall conform to M 208 modified as follows:

The 100 percent natural latex shall be a high ammonia natural latex conforming to D 1076, Type I.

The mix design report shall show test results conforming to the following:

TEST PROPERTY	SPECIFICATION LIMITS
MSMT 403, Mixing Test, minutes min	2
MSMT 403, Setting Time, minutes max	30
MSMT 403, Water Resistance	Slight Discoloration
MSMT 403, Wet Track Abrasion, g/ft^2 max	75
International Slurry Seal Association (ISSA) TB 139, Set Time Test, 30 minutes, kg/cm min	12

The percent of residual asphalt, based on the dry aggregate weight, shall be between 8.0 and 12.5 for Type II Mix and 7.0 and 11.0 for Type III Mix, each having a control tolerance of ± 1.0 percent.

The Contractor shall submit sufficient material for testing the mix design whenever corroborating information is required by the Engineer.

RESIDUE REQUIREMENTS	
TEST PROPERTY	SPECIFICATION LIMITS
Penetration @ 25 C, min	30
Ductility @ 25 C, min @ 4 C, min	150 100
R and B Softening Point, F, min	140
Cement Mixing Test	Waived

The latex modified emulsion, after standing undisturbed for 24 hours, shall be a uniform color throughout.

923.06 MIX DESIGN. The mix design shall conform to the following:

The stability shall be a minimum of 1800 lb and the flow shall be 0.06 to 0.16 in. when tested as specified in T 245, Modified (modification permits air drying of the mixture at 70 to 75 F for a minimum of 24 hours, followed by placement in a 140 F oven and drying to a constant weight prior to reheating and placing in molds).

SECTION 924 THRU 949 — RESERVED

SECTION 950 — TRAFFIC MATERIALS

950.01 PRECAST CONCRETE TRAFFIC BARRIER. Precast concrete traffic barrier shall conform to the Contract Documents. Welded wire fabric shall conform to 908.05.

950.02 RESERVED.

950.03 REFLECTORIZATION OF SIGNS AND CHANNELIZING DEVICES. Unless otherwise specified in the Contract Documents, retroreflective sheeting for signs shall conform to 950.03.02. Retroreflective sheeting for channelizing devices shall conform to 950.03.02 or 950.03.06.

950.03.01 Type II Retroreflective Sheeting. When specified in the Contract Documents, engineering grade retroreflective sheeting shall conform to D 4956, Type II.

950.03.02 Type III Retroreflective Sheeting. Type III retroreflective sheeting shall conform to D 4956, Type III and the following:

MINIMUM REFLECTIVE INTENSITY VALUES FOR TYPE III SHEETING Minimum Coefficient of Retroreflection (R_A) cd/(lx · m^2)								
Observation Angle°	**Entrance Angle°**	**Silver-White**	**Yellow**	**Red**	**Orange**	**Green**	**Blue**	**Brown**
0.2	+50	75	40	8.4	25	10.3	2.9	1.6
0.5	+50	35	20	6.8	10	6.4	2.0	1.1

The Contractor shall furnish certification as specified in TC-1.02 that the reflective sheeting conforms to these requirements for each batch.

950.03.03 High Performance Wide Angle Retroreflective Sheeting. High performance wide angle retroreflective sheeting shall conform to D 4956, and the following:

MINIMUM REFLECTIVE INTENSITY VALUES FOR HIGH PERFORMANCE WIDTH ANGLE PRISMATIC LENS SHEETING Minimum Coefficient of Retroreflection· (R_A) cd/(lx · m^2)								
Observation Angle°	**Entrance Angle°**	**White**	**Yellow**	**Red**	**Orange**	**Green**	**Blue**	**Fluorescent Orange**
0.2	- 4	800	660	215	450	75	43	200
0.2	+30	400	340	100	250	30	20	120
0.2	+50	35	23	6.6	16	1.8	1.0	50
0.5	- 4	200	160	45	120	18	9.8	80
0.5	+30	100	85	26	70	10	5.0	50
0.5	+50	30	20	6.4	16	2.5	2.0	20

950.03.04 Temporary Roll Up Warning Signs. Temporary roll up warning signs shall conform to D 4956, Type VI.

950.03.05 Black Sheeting. Black sheeting shall be nonreflective.

950.03.06 Type VI Retroreflective Sheeting. Type VI retroreflective sheeting shall conform to D 4956, Type VI.

950.04 OVERHEAD SIGN STRUCTURES. Structural steel shall conform to A 709, Grade 36; steel tubes or pipes shall conform to A 595, Grade A or API 5-LX52. Design and minimum thickness of material

shall conform to AASHTO Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. All steel shall be galvanized as specified in A 123. Hardware shall be galvanized as specified in A 153.

950.05 BACKFILL MATERIAL FOR TRENCHES FOR BURIED CABLE. The lower 1 ft depth of trench shall be fine aggregate conforming to Section 901. Material above the 1 ft depth shall be select material conforming to Section 916.

950.06 ELECTRICAL CABLE AND WIRE. Electrical cable and wire shall be the standard commercial product of the manufacturer and shall have been manufactured not more than one year prior to the date of the Contract. All cable and wire shall be made of copper.

950.06.01 Direct Burial Cable. Direct burial cable shall be single conductor, stranded, with an unshielded, chemically crosslinked thermosetting polyethylene insulation rated for 600 volts. The cable shall be suitable for direct earth burial or installation in ducts or conduit and shall conform to Underwriters' Laboratories Type USE, XHHW or THW and shall bear the applicable UL labels denoting type, size, stranding, manufacturer's name and surface marking or molded ridges for phase and neutral identification. Sizes shall be as specified in the Contract Documents.

950.06.02 Building Cable and Wire. Building cable and wire shall be 600 volt, plastic insulated, nylon jacketed and shall conform to Underwriters' Laboratories Type THWN/THHN and shall bear the applicable UL labels denoting type, size, stranding, manufacturer's name and surface marking or molded ridges for phase and neutral identification. Sizes shall be as specified in the Contract Documents.

950.06.03 Cable Duct. Cable duct shall consist of cables preinstalled in either a polyvinyl chloride (PVC) or polyethylene (PE) plastic duct conforming to NEMA TC 7 and the NEC. PVC shall conform to D 3485. PE duct shall be manufactured from black, virgin, high density PE resin conforming to D 1248, Type III, Grade P34, Class C, Category 5. Minimum inside diameter of duct shall be 1-1/2 in. Cable shall be rated for 600 volts.

950.06.04 Ground Wire and Rods. Ground wire shall be bare medium drawn copper. Ground wire installed underground shall be of the size (solid or stranded) configuration shown in the Contract Documents. Ground rods shall be 0.75 in. diameter, a minimum of 10 ft in length, with a steel core and copper jacket.

950.06.05 Traffic Signal Cable. Traffic signal cable shall conform to IMSA Specification 19-1, and shall be stranded. Conductors shall be No. 14 AWG.

950.06.06 Loop Detector Lead-In Cable. Loop detector lead-in cable shall be two conductor, No. 14 AWG, PE jacketed, conforming to IMSA Specification 50-2.

950.06.07 Loop Detector Wire. Loop detector wire shall be single conductor, 600 volt, No. 14 AWG, 19 strand wire in a flexible PE tubing.

950.06.08 Voice Grade Communication Cable. Self-supporting cable shall be solid No. 19 AWG and conform to IMSA 40-4. Underground cable shall conform to IMSA 60-2.

950.06.09 Electric Service Wire. Electric service wire for traffic signals, intersection control beacons, hazard identification beacons and luminaires mounted on traffic signal structures shall have three individual wires. Each wire shall be seven stranded. Electric service wire color identification by spray paint, tape, heat shrink tubing, or any other after manufacturing method is prohibited.

950.07 LIGHTING STRUCTURES. Lighting structures shall conform to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, based on 90 mph wind loads, luminaire weight of 70 lb and luminaire projected area of 3 ft^2.

Ground mounted lighting structures shall consist of a one piece, round tapered shaft, a cast steel anchor base for steel structures and a cast aluminum base for aluminum structures, bracket arms, complete with all necessary accessories including anchor bolts, pole top, shims, grounding lug, and handhole.

Steel shafts shall conform to A 595, Grade A. After forming and welding, the shaft shall have a smooth finish with only one longitudinal weld and no transverse welds. Steel bracket arms and mounting brackets shall conform to A 53, Schedule 40. Structures shall be either mechanically or hot-dipped galvanized. The coating shall conform to the thickness, adherence, and quality requirements of A 123.

Aluminum shafts and bracket arms shall be spun from one piece of extruded tubing conforming to B 241, 6000 T6 series alloy. The shaft and bracket shall be cold worked to form the required taper.

Each lighting structure shall be provided with a permanent tag which shall be 2 X 4 in. fabricated from clear anodized 1/16 in. thick aluminum. The edge shall be smooth and corners rounded and the tag shall fit the

lighting structure shaft. Tags shall be secured to shafts by means of four 1/8 in. diameter 18-8 stainless steel round head drive screws or self-tapping screws. The identifying letters or numerals shall be a minimum of 3/4 in. high with a minimum stroke of 3/16 in. Identifying letters or numerals shall be as specified in the Contract Documents or as directed by the Engineer.

950.08 SIGNS. The manufacturer or supplier shall furnish certification as specified in TC-1.02.

950.08.01 Sheet Aluminum Sign Panels. Sign panels shall conform to B 209, with an anodized mill finish. Alloys shall be either 6061 T6 or 5052-H38.

950.08.02 Extruded Aluminum Sign Panels and Edge Strip. Extruded aluminum sign panels and edge strip shall conform to B 221, alloy 6063 T6.

950.08.03 Hardware. Hardware shall be clear anodized, conforming to one of the following: B 209, alloy 2024 T4; B 211, alloy 2024 T4, 6262 T9, 6061 T6, 7075 T6 or 2017 T4.

950.09 STEEL SPAN WIRE. Steel span wire shall be 1/4 or 3/8 in. diameter, seven wire strand, galvanized as specified in A 475, Class C.

950.10 CONDUIT. Conduit shall conform to Section 805 and 921.07.

950.11 ELECTRICAL CONDUIT DETECTOR TAPE. Electrical conduit detector tape shall consist of one layer of aluminum foil laminated between two layers of inert plastic film. The foil shall be 3 in. wide with a tensile strength of 60 lb. The plastic film shall have a minimum thickness of 4.5 mil.

950.12 LUMINAIRES AND LAMPS. The luminaire shall be a complete lighting device consisting of a housing, support clamp, reflector, refractor or flat lens, socket, lamp, integral ballast, terminal block, associated hardware, and necessary wiring. All parts of the luminaire shall incorporate the latest ratings and design improvements. Luminaires shall incorporate individual photoelectric cells when specified. Exposed hardware shall be stainless steel.

950.12.01 Luminaire Construction.

(a) The bracket arm mounted luminaire housing shall be cast aluminum with natural finish. The housing shall contain and support the reflector, refractor or flat lens, socket, ballast,

terminal block and support clamp. Provisions shall be made for leveling and adjusting the luminaire to the specified transverse and longitudinal position to the roadway.

The refractor or flat lens retaining ring shall be securely latched with an operable hinge made from noncorrodible material.

The reflector shall be of specular polished alzak aluminum or equivalent aluminum reflective surface. It shall be held firmly in the housing but easily removed without the use of special tools. Silicone rubber, ethylene propylene terpolymer, dacron felt gaskets, or other gasketing materials as approved by the Engineer, shall seal the optical assembly at the socket entry and between the refractor and reflector to make a dust tight optical system. The reflector shall be clean and free from scratches.

Glass for the refractor or flat lens shall be heat resistant, borosilicate glass and shall be free of imperfections. The optical system of the luminaire shall clearly indicate the street side and curb side.

The socket shall be a mogul screw shell with large center contact spring providing a firm contact with the lamp base. The socket shall have lamp grips to prevent the lamp from loosening. The shell shall be of the skeleton type or shrouded in porcelain. The contacts shall be identifiable. Socket extension adapters will be permitted for special applications when directed by the Engineer. Luminaires providing various ANSI/IES type of distribution by socket adjustment shall also include a means of identification to associate each lamp position with each distribution type. The socket adjustment shall provide positive positionings by means of index holes, lugs or notches. Slots with infinite settings are prohibited.

The ballast shall be a high power factor, auto regulator type, capable of operating from a multiple circuit and shall operate a high intensity discharge lamp of the type, wattage, and voltage specified. Multi tap ballasts shall be provided where supply voltage is 277 volts or less. The ballast shall start the lamp at temperatures as low as -20 F, and shall deliver rated lamp current at circuit voltage variation of plus or minus 10 percent. The primary power factor shall not be less than 90 percent with normal secondary load. The ballast assembly shall be provided with plug in connectors and installed on a hinged door to permit ready interchange of ballast.

Glare shields shall be provided on luminaires where specified in the Contract Documents or as directed by the Engineer. The glare shield shall cut off the upward component of light but shall not reduce the total output of the luminaire more than 3 percent.

(b) Bridge underpass luminaires shall be a complete lighting device, consisting of a cast aluminum housing, a door with cast aluminum frame, and thermal shock resistant glass refractor attached to the frame with a stainless steel latch, hinges and retaining chain, a specular polished alzak aluminum reflector, a shrouded adjustable porcelain socket and an integral ballast as specified above.

The refractor and reflector shall direct all useful light well below all normal driver viewing angles to assure that glare will be at a minimum.

(c) Sign lighting luminaires shall be mercury vapor. A mercury vapor luminaire shall consist of a luminaire housing and a refractor/door assembly constructed of die cast aluminum. The refractor shall be a single piece molded thermal shock resistant borosilicate glass convex lens with discrete prism patterns. The refractor shall be permanently sealed to the door assembly with silicone adhesive around its perimeter. The reflector shall be a single piece dieform of sheet aluminum alloy 3002 or as approved by the Engineer, processed to Alcoa Class SI alzak finish. A heavy duty mogul lampholder shall be securely mounted to the reflector with a galvanized steel bracket. The refractor/door assembly shall be nonpermanently sealed to the luminaire housing and reflector assembly with a single piece neoprene gasket to effectively seal the luminaire and locked in place by stainless steel spring-loaded latches. The refractor/door assembly shall open and be held captive by double pivot internally mounted stainless steel hinges, and it shall be removable.

Weepholes shall be provided in the bottom of the housing in the lowest area of the luminaire as normally mounted.

The sign lighting luminaire shall be designed to properly illuminate the sign with the lamp source type and size as specified in the Contract Documents. The Contractor shall submit for the approval of the Engineer, working drawings showing locations and aiming angles of luminaires with relation to each of the signs of the various sizes.

950.12.02 Lamps shall be provided for luminaires of the type and wattage specified in the Contract Documents. Lamps shall be first line,

high quality and will be as approved by the Engineer. Lamp wattage, horizontal or vertical initial lumens, rated lamp life, and percent of initial lamp lumens at end of rated lamp life shall be as follows:

TYPE	WATTS	INITIAL LUMENS	RATED LIFE (10 hr/start)	PERCENT INITIAL LUMENS
Deluxe Mercury	175	8 600	24 000	74
Deluxe Mercury	250	12 100	24 000	74
Deluxe Mercury	400	22 500	24 000	60
H.P. Sodium	100	9 500	20 000	74
H.P. Sodium	150	16 000	24 000	74
H.P. Sodium	200	22 000	24 000	72
H.P. Sodium	250	30 000	24 000	73
H.P. Sodium	310	37 000	24 000	72
H.P. Sodium	400	50 000	24 000	73
Metal Halide	250	20 000	10 000	80
Metal Halide	400	40 000	15 000	80

950.13 CONTROL AND DISTRIBUTION EQUIPMENT. Control and distribution equipment enclosures shall be dead front type weatherproof metal enclosed self-supporting structures, as specified in the Contract Documents. Free standing enclosures shall be fabricated from sheet aluminum and shall be as specified herein. Panel and control equipment cabinets shall be the manufacturer's standard enclosure for the type and application specified.

950.13.01 Circuit Breakers. Circuit breakers shall be molded case type having a minimum rating of 10 000 amp interrupting capacity (AIC) and be quick make, quick break, thermal magnetic, trip indicating, and have common trip on all multiple breakers with internal tie mechanism. They shall have the current and voltage ratings and number of poles as specified in the Contract Documents, and shall be treated to resist fungus and be ambiently compensated for the enclosure and proximity to adjacent breakers. All circuit breakers shall be the bolt in type.

950.13.02 Photoelectric Controls. Photoelectric controls shall be solid state, cadmium sulfide type with hermetically sealed silicone rectifier rated 120 volts, 60 cycle AC and 1000 watts maximum load. Built in surge protection shall be provided, and a fail safe operating feature shall be included so that the lighting circuits will remain energized in the event the photo control components become inoperative. Nominal operating

levels of this control shall turn on at a minimum vertical illumination value of 3 FC and turn off at a maximum vertical illumination value of 6 FC. These limitations shall be set by the manufacturer, and tolerances of plus or minus 20 percent for the specified value will be acceptable.

Photoelectric controls for luminaires and lighting controls shall be twist lock type. A suitable mounting bracket with locking type receptacle and all other necessary mounting hardware shall be furnished.

950.13.03 Contactors and Relays. Contactors of the current ratings and number of poles specified in the Contract Documents shall be held by permanent magnets. They shall be fully rated for all classes of load to 600 volts AC and shall have an interrupting rating of 600 percent of rated current. A HAND-OFF-AUTOMATIC selector switch shall be provided in the photoelectric cell circuit. Relays shall be the type, size and contact ratings as specified in the Contract Documents.

950.13.04 Panel Boards. Panel boards shall conform to Federal Specification W-P-115 and shall be suitable for operation on the voltage and type service specified in the Contract Documents. They shall be listed and labeled by the Underwriters' Laboratories, Inc. Panel boards shall be equipped with the number and size circuit breakers specified. Circuit breakers in panel boards shall conform to Federal Specification W-C-375 and shall be bolted to copper busses. Buss ratings shall be as specified.

950.13.05 Lightning Arresters. Lightning arresters shall be secondary type, having the specified number of poles and 0-650 volts RMS. Arresters shall be provided with suitable mounting brackets and all other necessary mounting hardware.

950.13.06 Control Power Transformers. Control power transformers shall be the dry type, two windings, of the size and voltage ratings specified in the Contract Documents.

950.13.07 Enclosures. Enclosures shall conform to the NEMA type specified. They shall have door clamps, solid neoprene gaskets, welded seams, stainless steel external hardware and continuous hinges with stainless steel pins. Enclosures shall have two weepholes in the bottom and shall be equipped for padlocking.

950.13.08 Pad Mounted Enclosures. For ventilation, all cabinets shall be provided with louvered vents in the front door with a removable air filter.

(a) Louvers shall satisfy the NEMA Rod Entry Test for 3R rated ventilated enclosure.

(b) Filters for all cabinets shall be 16 in. long, 12 in. wide, and 1 in. thick. The filter shall cover the vents and be held firmly in place with top and bottom brackets and a spring loaded upper clamp.

(c) Exhaust air shall be vented out of the cabinet between the top of the cabinet and the main access door. The exhaust area shall be screened with a screen type material having a maximum hole diameter of 1/8 in.

950.13.09 Thermostats and Fans. A thermostatically controlled cooling fan shall be provided for all cabinets. The fan and thermostat shall be rated for 125 percent of capacity and they shall be mounted at the top of the cabinet.

(a) Thermostats shall be the inline type, single pole, 120 volts, 10 amps with a minimum range of 40 to 80 F.

(b) The fan shall have a minimum rated capacity of 100 CFM air flow and a minimum rated design life of 100 000 hours.

(c) The thermostat shall be manually adjustable, within a 10 degree range, from 70 to 160 F.

950.13.10 Disconnect Switches and Utility Connections. Disconnect switches shall conform to NEMA standard KS 1-1990. Disconnect switch enclosure shall be Type 4 stainless steel, with external operating handle, enclosure cover interlock, and external switch mechanism handle with provisions for securing in both the **ON** and **OFF** positions by padlock. The switch mechanism shall be of heavy duty design with quick make, quick break type operations and visible blades.

The disconnect switch shall be fusible with integral fuse puller. Single phase disconnect switches shall have 2 poles with a solid neutral and shall be rated at 240 Vac. Three phase disconnect switches shall have 3 poles with a solid neutral and shall be rated at 600 Vac. The design of the neutral bar may be factory or field installable.

Disconnect switch fuseholders for traffic signals, intersection control beacons, and intersection lighting operating at 120 Vac shall be single phase 60 amps (fused 35 amps).

Disconnect switch fuseholders for hazard identification beacons and luminaires mounted on traffic signal structures operating at 120 VAC shall be rated single phase 30 amps (fused 20 amps).

Disconnect switches for lighting control cabinets shall have the same number of poles and amperage rating specified in the electrical service equipment item.

Disconnect switches for electrical service distribution cabinets shall be 200 amp, 2 pole, single phase.

950.14 ELECTRICAL CABLE AND WIRE CONNECTORS.

950.14.01 Cable Connectors and Connector Kits. Cable connectors and connector kits for use in lighting structures, hand holes, junction or pullboxes and for terminating underground cables in lighting structures shall be rated for a minimum of 600 volt service. Cable connectors shall be compression type, applied by means of a compression tool. Connectors shall be fabricated from high strength copper alloy. Plated connectors fabricated from metals other than copper are prohibited. Bolted type connectors shall be utilized for splicing bare ground conductors.

950.14.02 Connector Kit Components. Each cable connector kit shall be furnished with all component parts described under the various listed types. Each kit shall contain sufficient silicone compound to lubricate metal parts and the housing for each assembly along with complete installation instructions.

(a) All housings shall be made of water resistant synthetic rubber suitable for burial in the ground or exposure to sunlight. Each housing shall form a watertight seal around the cable at the point of disconnection and between the insert body and enveloping Y housing.

(b) All copper pins, sockets, and fuse contacts shall have a minimum conductivity of 90 percent. The crimpable portion shall be fully annealed while the rest of the device is maintained in its original state.

(c) Plastic sleeves shall be rigid, molded insulating plastic material of sufficient outside diameter to form a watertight fit with its related housing. Wall thickness shall be 0.10 in. maximum, and sleeve lengths of 4 and 7 in. shall be available.

(d) All fuses shall be rated 600 volts, 100 000 amps AIC.

950.14.03 Connector Types. Each cable connector kit furnished shall be one of the following types:

(a) Type I is an unfused, quick disconnect inline connector kit containing:

(1) A copper pin crimpable to a conductor.

(2) A receptacle having a centrally located, recessed locking socket constructed so that it is filled and retained by its housing and a disposable assembly pin.

(3) A plug housing for retention of the copper pin.

(4) A receptacle housing with disposable protective sleeve.

(b) Type II is a fused, quick disconnect inline connector kit containing:

(1) A pair of spring loaded copper fuse contacts suitable for gripping the specified cartridge fuse. One contact shall be crimpable on a conductor and after insertion into its proper position within the load side plug housing, be capable of being securely retained therein. The other contact shall be preassembled for retention within the line side of the connector body.

(2) A load side housing permanently marked "Load Side".

(3) A disposable assembly pin.

(4) A fuse of the specified amp rating.

(c) Type III is a fused, quick disconnect Y connector kit containing:

(1) A pair of spring loaded copper fuse contacts suitable for gripping the specified cartridge fuse. One contact shall be crimpable on a conductor and after insertion into its proper position within the load side plug housing, be capable of being securely retained therein. The other contact shall be preassembled for retention within a Y insert body.

(2) A line side Y housing with two water seal cable ports.

(3) Two terminal lugs, each having a mounting hole.

(4) A bolt and a self-locking nut.

(5) A Y insert body with preassembled line side fuse contact and a ring tongue terminal.

(6) A load side plug housing permanently marked "Load Side".

(7) A disposable assembly pin.

(8) A fuse of specified amp rating.

(d) Type IV is an unfused, quick disconnect Y connector kit containing:

(1) A copper pin crimpable to a conductor and suitable for retention in the load side receptacle housing.

(2) A Y insert body with preassembled load side copper socket and ring tongue terminal.

(3) A line side Y housing with two water seal cable ports.

(4) Two terminal lugs, each having a mounting hole.

(5) A bolt and self-locking nut.

(6) A load side receptacle housing.

950.15 TRAFFIC SIGNAL HEADS. Pedestrian signal indications and vehicular signal heads shall conform to the latest revision of the Institute of Transportation Engineers (ITE) Specifications.

(a) All materials shall be clean, smooth, and free from flaws, cracks, blowholes, and other imperfections.

(b) Signal heads shall be furnished with the section assembled together including all hardware as specified in the Contract Documents.

(c) All metallic signal head hardware shall be stainless steel material.

(d) Vehicular, optically-programmed and pedestrian signal heads shall be capable of mating to the same type of the signal heads from either the top or bottom of each housing.

(e) All hardware furnished shall be installed on the corresponding fitting and threaded component.

Mounting hardware shall conform to the following:

ITEM	DESCRIPTION	A	B	C	D
1	Aluminum Alloy - Casting	A 319	A 380	A 713	6063 T6
2	Yield Strength, ksi	18	23	25	25
3	Tensile Strength, ksi	27	47	35	30
4	Brinell Hardness	70	80	75	73
5	Elongation (% in 2 in.)	1.5	4	3	12
6	Stainless Steel	A 316	-	-	-
7	Galvanized Steel	A 157	A 153	G 60	-
8	Steel-Flat Sheet	16 gauge	-	-	-
9	Coating	*	Anodized Finish	-	-

* The signal head housing shall be yellow in conformance with Federal Standards 595, Color Chip No. 13538. The signal head door and visor shall be optical flat (dull) black Federal Standards 595, Color Chip No. 37038. Aluminum signal heads shall be painted using fusion bonded polyester coating method.

Hardware.

Hub plate shall conform to A, 1 thru 5 and 9B.

(a) Span wire hanger clamp shall conform to C, 1 thru 5.

(b) Balance adjuster shall conform to 6A, 7A, and 7B.

(c) 2-way lower arm shall conform to 7C and 8A.

(d) 2-way tri-stud arm shall conform to A, 1 thru 5.

(e) Span wire entrance fitting shall conform to C, 1 thru 5.

(f) Mast arm mount signal bracket (1-way, 2-way, and 5-section) shall conform to 1A and 1D.

(g) Side pole upper and lower arm assembly shall conform to 1B thru 5B or 1D thru 5D.

Vehicular Signal Heads and Pedestrian Signal Indications Housings and Doors.

(a) Aluminum signal head housings and doors shall be die-cast aluminum as specified in the Institute of Transportation Engineers Vehicle Traffic Control Signal Head Specification.

(b) Dual hinge-latch mechanisms shall be mounted on the signal head housing and not the signal head door.

Captive door latch mechanisms (one for 8 in. and two for 12 in. vehicular signal heads, and one for 9 in. and two for 12 in. pedestrian signal indications) shall secure the door to the housing by use of stainless steel eyebolts and wing nut assemblies.

(c) All openings to the housing interior shall be provided with a gasket conforming to the physical properties listing in UL 508 and that forms a weather tight seal.

Visors.

(a) Visors shall be as specified in the Institute of Transportation Engineers Vehicle Traffic Control Signal Head Specification and shall be tunnel type. Visors shall be 10 in. deep for 12 in. vehicular signal heads, 8 in. deep for 8 in. vehicular signal heads, 9 in. deep for 12 in. pedestrian signal indications, and 9.5 in. deep for optically programmed signal heads.

(b) Visors shall be secured to the signal head door by a minimum of four screws mounted perpendicular to the face of the signal head door.

(c) Visors for aluminum vehicular signal and pedestrian signal sections shall be made from aluminum alloy sheet. Visors for polycarbonate signal sections shall be either formed from sheet plastic or assembled from one or more injection, rotational, or blow-molded polycarbonate sections.

Optical System. Optical system for vehicular and pedestrian traffic control signal indications shall conform to the following.

(a) **Signal Head Lamps.** Signal head lamps shall be approved by the Office of Traffic & Safety (OOTS).

(b) **Reflector.** Reflector shall be made of aluminum.

Reflector support assembly shall be die cast aluminum, separate from the reflector and fully encompass the periphery of the reflector.

Reflector support assembly shall be spring hinged to allow access to the rear of the signal head main body without the use of tools.

(c) **Lens.** Lens shall be standard (ball) red, yellow, or green, or specified arrow red, yellow, or green traffic signal lens.

The lens shall be glass.

Directional arrow lenses shall have the same brilliance, regardless which direction they are positioned in the signal face.

The lens shall fit into a one-piece slotted neoprene lens gasket designed to provide a weather resistant fit to the housing door. Lenses shall be secured by a flat clip/screw design fastened from the inside of the signal head door perpendicular to the face of the door. The flat clip/screw design shall not pass through the lens itself.

All pedestrian signal heads shall provide the messages of "walk" and "don't walk" in the international walking person and the raised hand symbols.

Optical System for Optically Programmed Signal Heads.

(a) The indication from the lens shall conform to the requirements of ITE transmittance and chromaticity standards.

(b) Optically programmed signal heads shall have an optical system containing a color filter, lamp fixture, lamp collar, optical limiter/diffuser, and objective lens.

(c) Lamp fixtures shall be comprised of a separately accessible housing and integral lamp support, indexed ceramic socket, and self-aligning and quick release lamp retainer. Electrical connection between case and lamp housing shall be accomplished with an interlock assembly that disconnects the lamp holder when opened.

(d) The optical limiter shall provide an accessible imaging surface at focus on the optical axis for objects 900 to 1200 ft distance and permit an effective veiling mask to be variously applied as determined by the desired visibility zone. The optical limiter shall be composed of heat-resistant glass.

(e) Optically programmed signal heads shall utilize incandescent PAR type lamps. The lamp shall be coupled to the diffusing element. The diffusing element may be discrete or integral with the convex surface of the optical limiter.

(f) The objective lens shall be a high resolution annular incremental lens hermetically sealed within a flat laminate of weather resistant acrylic or as approved by OOTS. The lens shall be symmetrical in outline and may be rotated to any 90 degree orientation about its axis without displacing the primary image.

Electrical.

(a) The entire signal head assembly shall be either listed or labeled by a Maryland State Fire Marshall or a recognized electrical inspection agency.

(b) Wiring connections at the lamp socket shall lock and not be of the male/female demountable type.

(c) A unitized bail wire with integral spring shall secure the socket to the rear of the reflector. The lamp socket shall have a serrated base to permit locking.

(d) Each single section and the middle section of three section signal heads shall have a minimum of a six section, twelve position terminal block capable of accepting three number 14 AWG spade terminal ends. The top section of two section pedestrian signal indications shall be furnished with a minimum of five section, ten position terminal blocks capable of accepting three number 14 AWG spade terminal ends.

(e) Optically programmed signal heads shall not contain a resistance device for use as an intensity controller with integral means for regulating its intensity between limits as a function of individual background illumination.