PART 00800 - PERMANENT TRAFFIC SAFETY AND GUIDANCE DEVICES

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Section 00810 - Metal Guardrail

Description

00810.00 Scope - This work consists of constructing metal guardrail and metal median barrier to the lines and grades shown or established and includes the assembly and erection of all components, parts and materials complete at the locations shown or directed.

Metal guardrail and metal median barrier will be referred to in this Section as "guardrail". The types of guardrail will be shown.

Materials

00810.10 Materials - Furnish materials meeting the following requirements:

Guardrail Anchor Hardware	02820.40
Guardrail Hardware	02820.30
Metal Beam Rail	02820.10
Metal Posts	02820.20
Wood Guardrail Blocks	02110.20
Wood Guardrail Posts	02110.10

Use guardrail terminals from the QPL conforming to the National Cooperative Highway Research Program (NCHRP) Report 350.

00810.11 Posts - Posts, except as specified for use on bridges or otherwise shown or directed, may be of steel or wood, as the Contractor elects. Once a type has been selected, use it throughout the continuous run of guardrail except in the transitions and terminals.

00810.12 Median Barrier on Bridges - Metal median barrier on bridge decks shall be comprised of metal beam rail, metal posts, and hardware conforming to 00810.10.

At expansion joints on bridge decks, the slots in the rail member for post bolt and rail joint bolts shall be of special dimensions as shown.

00810.13 Guardrail Anchors - Guardrail anchors shall be steel.

00810.14 Condition of Materials - All materials will be subject to inspection of condition at the latest practical time available before or during incorporation of materials in the work.

00810.15 Salvaged Materials - Materials salvaged as part of removal work on the Project may be reused in new construction, if the Engineer determines the materials conform to current design, 00810.10, and the following:

(a) Wood Posts - Wood posts shall be structurally sound, treated and free from damage that would affect their strength and durability. Do not incorporate into the work any post damaged to the extent that untreated wood is exposed.

(b) Metal Beam Rail Members - Metal beam rail members shall be unpainted, straight and free of breaks, kinks, dents, damage to galvanized coating, or any other damage that would affect the integrity of the member. If paint is removed from metal beam rail members salvaged from the Project, remove the paint at a location outside of the highway right of way, and in a manner that will not damage the galvanizing. Repair minor damage to galvanizing according to 00810.43.

Construction

00810.40 Timing and Coordination of Work - Time and coordinate construction of guardrail to hold disturbance of bases, surfacings and pavements to a minimum.

Place all salvaged metal guardrail or metal median barrier materials in continuous runs.

Do not leave posts installed for guardrail and median barrier exposed to traffic for more than 24 hours before installing the rail members, rail end pieces and anchors and tightening all bolts, except replacement rail shall be installed according to 00310.40(a).

00810.41 Excavation and Backfill - Subject to 00810.42, excavate to the lines, grades and depths shown or established. Make cuts through pavement by mechanical means, such as knife-edge cutters or rotary drills. Make cuts below the pavement by auger or other means that will prevent undue disturbance of abutting areas. Avoid fouling existing bases and pavements. Repair or replace, as directed, all materials that become fouled, at no additional cost to the Agency. Remove water and unsuitable material that would impair stability of the backfill, from areas to be backfilled.

In areas occupied by aggregates, bituminous material and pavements, backfill with like materials to the same thickness and density as the adjacent materials. In other areas, backfill with granular backfill materials meeting the requirements of 00330.14. Place all backfill in layers not exceeding 6 inches and compact each layer to a firm, dense condition.

Remove, replace, repair, or restore, as directed, adjoining areas that become misshapen or disturbed during excavating and backfilling operations at no additional cost to the Agency. Dispose of excess materials according to 00330.41(a-4).

00810.42 Installation of Posts and Anchors - Place posts and anchors as shown. If directed, install 8 foot guardrail posts. Set posts in excavated holes or drive them in place. If posts are driven through the bases, surfacings, or pavement, repair all damage as directed. Remove and replace posts, anchors or other components damaged during installation with sound components. Firmly set all posts at proper line, grade and spacing within a tolerance of 1/2 inch. Rigidly attach anchors, terminals and connections to other structures as shown.

When metal posts are required over box culverts, cattle passes, equipment passes or other concrete structures, place steel posts, base plates, or base plate concrete anchors as shown or directed.

00810.43 Erection of Rails and Other Components - Normally, all fabrication of metal beam rail members and other components shall be done in the shop or by the manufacturer. Limit field cutting, drilling and other field fabrication to the minimum and perform in a manner that will not impair the appearance or structural quality of the material. Burning new holes in metal beam rail members will not be allowed.

Restore to specified condition, surface finishes and protections that are damaged before or during erection. Repair the cut ends of galvanized bolts, rail elements and back-up plates, and any holes drilled or punched after galvanizing according to ASTM A 780. Minimum zinc content for Method A2 is 94 percent on the dry film.

Toe nail blocks to post with two 16d, galvanized, flat head nails to prevent rotation.

Draw tight all bolts. Bolts shall be of sufficient length to extend slightly beyond the nuts.

00810.45 Painted Guardrail - Projects that include the removal and dismantling of painted metal guardrail require that environmental protection and worker safety precautions be established. If

painted guardrail is reused in any application, comply with DEQ/EPA and OSHA regulations pertaining to paint removal.

Measurement

00810.80 Measurement - The quantities of guardrail items constructed under this Section will be determined as follows:

- **Length** - Measurement will be on the length basis, measured by one of the following methods:

  - **Count Method** - The number of standard sections will be counted and multiplied by 12 1/2 feet. For purposes of this subsection, a "standard section" is defined as 12 1/2 feet of complete guardrail or median barrier, without regard to the number of posts or rail elements used. Non-standard sections will be measured from center of post to center of post, and added to the total calculated length of the standard sections for each run.

  - **Length Method** - Measurement will be from center to center of end posts, or as otherwise shown, along the line and grade of each run of each type.

- **Unit** - Measurement will be by actual count.

Payment

00810.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Guardrail, Type ____	Foot
(b)	Metal Median Barrier	Foot
(c)	Guardrail Anchors, Type ____	Each
(d)	Guardrail End Pieces, Type ____	Each
(e)	Guardrail Transition	Each
(f)	Guardrail Connections	Each
(g)	Guardrail Terminals, ____	Each
(h)	Extra for ____ Foot Posts	Each
(i)	Guardrail Posts	Each

In item (a), the type of guardrail will be inserted in the blank . Item (a) includes all posts including steel, base plates, and base plate concrete anchors.

Items (a) and (b) include constructing the respective items except for:

- end pieces
- anchors
- transitions
- extra costs involved in constructing guardrail connections to existing bridges
- terminals

In item (c), the type of anchor will be inserted in the blank.

In item (d), the type of guardrail end piece will be inserted in the blank.

Item (e) includes preparing the bridge rail or concrete barrier for the transition and includes posts, rail elements, terminal connectors, connection plates, anchor bolts, and all necessary appurtenances and hardware.

Item (f) includes preparing the bridge rail or concrete barrier for the connection and installing the terminal connectors when there is no guardrail transition item and includes connection plates, anchor bolts, and all necessary appurtenances and hardware.

In item (g) the type of terminal will be inserted in the blank. Item (g) includes guardrail terminals, posts, anchors, rails, guards, end pieces, struts, soil tubes, and all necessary appurtenances and hardware.

In item (h) the length of post will be inserted in the blank. Item (h) includes installing 8 foot long or longer posts instead of standard 6 foot long posts, The extra costs for the longer posts are costs that are not covered and included in the unit price for one or more of the other listed pay items.

Item (i) includes only installing posts when upgrading or repairing existing guardrail installations.

Payment will be payment in full for furnishing and placing all materials, and furnishing all equipment, labor and incidentals necessary to complete the work, as specified.

No separate or additional payment will be made for excavation and backfill.

Section 00811 - Cable Barrier

Description

00811.00 Scope - This work consists of furnishing and installing cable barrier to the lines, grades, and at the locations shown or directed.

Materials

00811.10 Cable Barrier - Furnish cable barrier from the QPL. Provide all cable barriers on the Project from the same manufacturer regardless of the number of runs of cable barrier required and regardless of the types of cable barrier required.

Use pre-cast or cast-in-place concrete socketed foundation line posts. Furnish and place concrete meeting the requirements of Section 00440.

00811.11 Cable Barrier Terminals - Use the following options as specified:

- **Option 1** - Use cable barrier terminals from the QPL that matches the system used.
- **Option 2A** - Tie the cable barrier to new guardrail as approved by the cable barrier manufacturer.
- **Option 2B** - Tie the cable barrier to existing guardrail as approved by the cable barrier manufacturer.

Equipment

00811.20 Tension Measuring Device - Measure the cable barrier tension with a manufacturer supplied measuring device. At the completion of the Project, the measuring device becomes the property of the Agency at no additional cost to the Agency.

Labor

00811.30 Manufacturer's Representative - If it is a requirement of the manufacturer to have a manufacturer's representative on-site during installation, provide the services of a manufacturer's representative at no additional cost to the Agency.

Construction

00811.40 Cable Barrier - Install cable barrier according to the manufacturer's directions at the locations shown. Cable anchors and cable overlap as shown are approximate. Locate and overlap the actual anchor according to manufacturer's instructions.

Keep a tension log and give it to the Engineer upon completion of installation. The tension log shall show the time, date, location, ambient temperature, and the final tension readings, and be signed by the person performing the tension readings. Provide a copy of the manufacturer's recommended tension chart along with the tension log.

Perform all tension checks or adjustments required by the manufacturer within a 30 day period of installation.

00811.41 Cable Barrier Terminals - Place terminals according to the manufacturer's directions, at locations shown, and as required by the cable barrier manufacturer to meet their minimum

requirements. Ensure that there is compatibility between terminals and the cable barrier system installed.

00811.42 Placement - Place the concrete anchors and footings, and backfill them at least 2 weeks prior to tensioning the cables. Set the concrete anchors into the excavation as shown. Set the bottom of the anchor so it has full and even bearing in the surface under it. Excavate and backfill according to 00810.41.

Maintenance

00811.60 Training - After installation, provide at least one 4 hour manufacturer presented training session to Agency maintenance personnel at no additional cost to the Agency.

Measurement

00811.80 Measurement - The quantities of cable barrier will be measured on the length basis, from center of end post to center of end post along the line and grade of each separate run. Measurement will be made through the ends of the terminals and guardrail connections.

The quantities of cable barrier terminals and cable barrier guardrail connections will be measured on the unit basis.

Payment

00811.90 Payment - The accepted quantities of cable barrier will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Cable Barrier, Test Level 3	Foot
(b)	Cable Barrier, Test Level 4	Foot
(c)	Cable Barrier Terminals	Each
(d)	Cable Barrier Guardrail Connections	Each

Items (c) and (d) include all special rail elements, brackets, posts, and all necessary appurtenances and hardware.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Section 00812 - Adjusting and Repairing Guardrail

Description

00812.00 Scope - This work consists of adjusting and repairing existing guardrail as shown or directed.

Materials

00812.10 Materials - Furnish replacement metal beam rails, posts, blocks, and hardware meeting the requirements of 00810.10.

Construction

00812.40 General - Install all guardrail components during the same day they are removed. Repair minor damage to galvanizing according to ASTM A 780. Minimum zinc content for Method A2 is 94 percent on the dry film.

00812.41 Adjusting Guardrail - Adjust existing guardrail by one or both of the following methods:

(a) Posts Remain in Place:

- Remove the existing metal beam rails and blocks in a manner that will not damage galvanizing.
- If required, drill new bolt holes in posts.
- Treat all existing and all new holes with a preservative from the QPL.
- Reinstall the metal beam rails and blocks.
- Perform all other required work as shown.

(b) Raise Posts - Remove and reinstall posts to the required height, or raise them to the required height and work grout or other materials under them in a manner satisfactory to the Engineer.

Adjust existing terminal ends by raising the soil tubes and ground struts to the required height and placing and compacting matching material under the ground struts.

00812.43 Repairing Guardrail - Repair existing guardrail by replacing metal beam rails, posts, blocks, and hardware. Install new metal beam rails, posts, blocks, and hardware according to 00810.42 and 00810.43.

Measurement

00812.80 Measurement - The quantities of work performed under this Section will be determined as follows:

- **Adjusting Guardrail** - Adjusted guardrail will be measured on the length basis, of existing guardrail adjusted. Measurement will be by one of the following methods:

  - **Count Method** - The number of standard sections will be counted and multiplied by 12 1/2 feet. For purposes of this subsection, a standard section is defined as 12 1/2 feet of complete guardrail, without regard to the number of existing posts or existing rail elements. Non-standard sections will be measured from center of post to center of post and added to the total calculated length of the standard sections for each run.

- **Length Method** - Measurement will be from center to center of terminal end posts, or as otherwise shown, along the line and grade of each run of each type.

- **Repairing Guardrail** - Repaired guardrail metal beam rails, posts, and blocks will be measured on the unit basis. For purposes of this subsection, a metal beam rail is defined as 12 1/2 feet long.

Payment

00812.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Adjusting Guardrail	Foot
(b) Metal Beam Rails	Each
(c) Guardrail Posts	Each
(d) Guardrail Blocks	Each

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for:

- hardware
- adjusting terminal ends
- replacement metal beam rails, posts, and blocks that are damaged by Contractor equipment or operation

Section 00815 - Bollards

Description

00815.00 Scope - This work consists of furnishing and installing bollards at locations shown or as directed.

Materials

00815.10 Materials - Furnish materials meeting the following requirements:

Commercial Grade Concrete.....00440
Granular Drain Backfill 00430.11
Reflective Sheeting (Type III and Type IV)..... From QPL

00815.11 Posts and Sleeves - Use Schedule 40 steel posts and sleeves conforming to ASTM A 53.

00815.12 Plates, Shapes, Fasteners, and Hardware - Use plates and shapes conforming to ASTM A 36. Use fasteners and hardware conforming to ASTM A 449.

00815.13 Galvanizing - Hot-dip galvanize all metal components after fabrication according to AASHTO M 111 (ASTM A 123) or AASHTO M 232 (ASTM A 153), as applicable.

00815.14 PVC Pipe - Use Schedule 40 PVC pipe.

Construction

00815.40 Bollards - Install bollards as shown or as directed.

Measurement

00815.80 Measurement - The quantities of bollards will be measured on a unit basis.

Payment

00815.90 Payment - The accepted quantities of bollards will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Bollards	Each
(b) Removable Bollards	Each

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for excavation work.

Section 00820 - Concrete Barrier

Description

00820.00 Scope - This work consists of constructing precast and fixed form cast-in-place portland cement concrete barrier, to the lines and grades shown or established.

Materials

00820.10 Materials - Furnish materials meeting the following requirements:

Commercial Grade Concrete.....00440, except as provided in this Section
Concrete Coating 02210
Deformed Bar Reinforcement.....02510.10
Portland Cement Grout 02080.40
Preformed Joint Filler 02440.10

00820.11 Other Materials:

(a) Concrete - Concrete shall meet the requirements of Section 00440, except that aggregates shall be modified as follows:

(1) Fine Aggregate - Fine aggregate shall meet the test requirements of 02690.30(d) and 02690.30(e). Test results shall be no more than 1 year old.

(2) Coarse Aggregate - Coarse aggregate shall meet the test requirements of 02690.20(c) and 02690.20(d). Test results shall be no more than 1 year old.

(b) Hardware - Pins, bolts, and dowels shall conform to ASTM A 449 and shall be hot-dip galvanized according to AASHTO M 232 (ASTM A 153).

(c) Loop Bars - Fabricate loop bars from ASTM A 36, hot-rolled round bar and hot-dip galvanize according to AASHTO M 232 (ASTM A 153) and ASTM A 143.

(d) C-shape Connectors - Furnish perforated C-shape connectors fabricated from ASTM A 36 channel, hot-dip galvanized after fabrication according to AASHTO M 232 (ASTM A 153) and ASTM A 143.

(e) Identification - Permanently cast into the top surface or into the side lower vertical face of each precast concrete barrier piece an identifying code consisting of the initials of the barrier manufacturer, the date of casting and the form number. Barrier pieces without identifying code will not be accepted.

00820.12 Re-use of Concrete Barriers - Used precast concrete barriers may be placed in permanent installations according to the following:

(a) New Barrier Used for Temporary Application - New precast concrete barriers used in temporary applications on the Project may be reused in permanent installations, provided they:

- Are in good condition, without visible cracks, chips or spalls.
- Present a surface of uniform texture and appearance.
- Are free of markings, except as required by 00820.11(e).
- Are given two coats of a water-based coating material meeting the requirements of 02210.30 after installation in final position.

(b) Barrier Used on Previous Projects - Precast concrete barriers used on previous projects may be reused in permanent installations, provided they meet all the requirements of this Section and, prior to delivery to the Project Site:

- The Contractor furnishes documentation required by 00165.10(b).
- Barriers are restored to like-new condition, without visible cracks, chips, spalls or corroded loops.
- Barriers present a surface of uniform texture and appearance.
- Barriers are free of markings, except as required by 00820.11(e).

Apply two coats of a water-based coating material meeting the requirements of 02210.30 after installation in final position.

(c) Repair of Damage - If any concrete barrier segment is damaged by the Contractor during or after installation, immediately repair it to the Engineer's satisfaction or replace it with an undamaged section, at no additional cost to the Agency.

00820.15 Quality Control - Provide quality control according to Section 00165.

Labor

00820.30 Quality Control Personnel - Provide a technician having a QCT technical certification.

Construction

00820.40 General - Construct cast-in-place barrier using fixed forms unless specifically directed otherwise. Use the same barrier design in any continuous run of barrier.

00820.41 Line and Grade - Place precast barrier sections on the pavement surface. New pavement surfaces placed as a part of this Project shall meet the appropriate smoothness requirement prior to placing the barrier. If corrective work is required for existing surfaces to receive concrete barrier, it will be paid according to 00195.20.

Place the barrier sections so that the joints offset no more than 1/4 inch transversely and no more than 1/2 inch vertically.

Construct the top and face of finished barriers true and straight. The top surface of the barriers shall be uniform width and free from humps, sags, or other irregularities. When a 12 foot straightedge is laid on the top or face of the barrier, the surface shall not vary more than 1/4 inch from the edge of the straightedge, except at grade breaks or curves. To compensate for variations in the roadway grade and cross slope, adjust the height of the barrier at no additional cost to the Agency.

00820.42 Concrete Construction - Construct concrete barrier according to Section 00440 except as provided in this Section.

00820.43 Curing - Cure barriers as follows:

(a) Cast-In-Place Barriers - Cure cast-in-place concrete surfaces by one of the following methods:

(1) Water Cure - Cover with burlap, canvas or other satisfactory material and keep moist for at least 7 calendar days.

(2) Latex Paint Cure - If approved, barrier may be cured with latex paint, using the following procedures:

- Allow free moisture to flash off, but only until the concrete surface does not glisten, and never for more than 1 hour.
- Apply latex paint from the QPL as follows:
  - Apply first coat at an application rate of 150 square feet per gallon.
  - Allow first coat to air dry for 1 hour.
  - Apply second coat at the same rate as above, with application direction transverse to the direction that the first coat was applied.

Barriers cured in this manner will be considered to have met the surface finishing requirements of 00820.45 except that additional coats may be necessary to provide uniform coverage and appearance to correct construction damage.

(b) Precast Barriers - Cure precast concrete surfaces by one of the following methods:

(1) Water Cure - Water cure concrete surfaces by covering with burlap, canvas or other satisfactory material and keep moist for at least 7 calendar days.

(2) Steam Cure - Steam curing can be substituted for water curing if done under a suitable enclosure constructed to contain live steam and to minimize moisture and heat loss. The steam shall be at 100 percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of cement. Do not apply the steam directly to the concrete.

Equip the steam supply line to the enclosure with a motor-operated, modulating steam control valve operated by a temperature-sensing element that measures the temperature within the enclosure. Distribute the steam within the enclosure through suitable ports located on each side of the enclosure at not more than 30 foot centers, or closer if necessary, to keep the units being cured completely and uniformly surrounded with live steam.

Equip the enclosure with a 24-hour recording thermometer, and record the temperature on a single chart for each 24-hour period.

Apply the steam after the initial set of the concrete as determined by ASTM C 403. Continue steam curing until the barrier concrete reaches a minimum compressive strength of 2,000 psi as determined by Contractor test cylinders or as approved.

00820.44 Joints for Cast-in-Place Concrete Barriers:

(a) Construction Joints - Make construction joints at an expansion or contraction joint location. If the placement of the barrier is stopped at a normal contraction joint location, construct an expansion joint at that location, before proceeding with the placement of the barrier, as shown.

(b) Contraction Joints - Score or saw contraction joints before initial set to the depth and width shown.

(c) Expansion Joints - Fill expansion joints with a preformed joint filler. Place the filler in correct position on one side of the joint before placing concrete on the other side.

00820.45 Surface Finishing - After stripping forms and while the concrete is still green, remove all fins and form marks, and repair all rock pockets and holes having a surface opening over 3/8 inch in diameter with portland cement grout conforming to 02080.40. Prevent grout from drying

prematurely. Additional finishing after precast concrete barrier is set in its permanent position may be required to present a surface of uniform texture and appearance.

Coat the top and sides of all permanent barriers with a minimum of two coats of a latex paint from the QPL. Use additional coats as necessary to provide uniform coverage and appearance. Clean and thoroughly saturate with water the surfaces to be coated. Coat while damp. The second coat may be applied when the previous coat does not adhere to the fingers when touched lightly.

00820.47 Replacement or Price Reduction - Remove and replace barrier represented by cylinders that fail to meet the minimum strength requirement, at no additional cost to the Agency. If the Engineer determines the low-strength barrier is suitable for the purpose intended, the barrier may be accepted according to 00150.25.

00820.48 Inspection - Fabrication of barrier outside of the State of Oregon creates additional inspection costs to the Agency. The Contractor's payment for barrier will be reduced according to 00165.91.

Measurement

00820.80 Measurement - The quantities of concrete barrier will be measured on the length basis, according to the following:

- **Cast-In-Place Barriers** - Cast-in-place barrier will be measured along the line and grade of each separate run, including terminal sections and transition sections.

- **Precast Barriers** - Precast barrier will be the laying length of a standard section, as shown on the applicable standard drawing, multiplied by the number of standard sections installed in each separate run. Non-standard sections, terminal sections and transition sections will be measured separately and added to the total length of standard sections.

Payment

00820.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Concrete Barrier	Foot
(b) Concrete Barrier, Tall	Foot

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for excavating and backfilling concrete barrier buried ends.

Section 00822 - Glare Shields

Description

00822.00 Scope - This work consists of furnishing and installing glare shields on concrete median barrier.

Materials

00822.10 Materials - The Contractor has the option of providing modular glare shields or individual glare shields as specified.

- Furnish glare shields from the QPL.
- Furnish steel base plate brackets fabricated from ASTM A 304 stainless steel or merchant quality mild carbon steel. Mild carbon steel brackets shall be hot-dip galvanized after fabrication according to AASHTO M 111 (ASTM A 123).
- Furnish bolts, nuts, inserts, washers and other necessary assembly hardware made from ASTM A 304 stainless steel or mild carbon steel. Equip exposed hardware with vandal-resistant lock nuts or similar. Furnish mechanical inserts, if used, suitable for dynamic application. Galvanize carbon steel assembly hardware according to AASHTO M 111 (ASTM A 123).

All base plate brackets and necessary assembly hardware installed in a continuous run shall be of the same material.

Construction

00822.40 Construction - Install the glare shields according to the following:

- Recess inserts at least 1/4 inch below the concrete barrier surface.
- Install all glare shield blades vertical and true to line.
- Place glare shields according to the manufacturer's recommendation.
- Install so that the angle of light coming through from the other side does not exceed 22°.
- Firmly attach the base plate anchor bolts to the concrete barrier to withstand a 1,000 pounds vertical pull and to prevent horizontal and rotational displacement. Space modular unit anchor bolts as recommended by the manufacturer.
- Modular or single element glare shields that are installed in a continuous run shall be of the same manufacture and of like appearance throughout the entire installation.

Measurement

00822.80 Measurement - The quantities of glare shields will be measured on the length basis, along the line and grade of each run.

Payment

00822.90 Payment - The accepted quantities of glare shields will be paid for at the Contract unit price, per foot, for the item "____ inch Glare Shields".

The length of the blades will be inserted in the blank.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Section 00830 - Impact Attenuators

Description

00830.00 Scope - This work consists of furnishing and installing impact attenuators for permanent installations.

00830.02 Required Submittals - If placement or method of installation of impact attenuators is different than the manufacturer's recommendations, submit stamped shop drawings, including concrete components, according to 00150.35.

Materials

00830.10 Materials - Furnish impact attenuators from the QPL and as specified.

The following types of impact attenuators are allowed:

Type A: Gating device, Test Level 3, for Shoulder use only, Narrow Width, Regular Maintenance

Type B: Gating device, Test Level 3, for Shoulder, Gore and Median use, Narrow Width, Regular Maintenance

Type C: Non-Gating device, Test Level 2, for Shoulder, Gore and Median uses, Narrow Width, Regular Maintenance

Type D: Non-Gating device, Test Level 2, for Shoulder, Gore and Median use, Wide Width, Regular Maintenance

Type E: Non-Gating device, Test Level 3, for Shoulder, Gore and Median use, Narrow Width, Regular Maintenance

Type F: Non-Gating device, Test Level 3, for Shoulder, Gore and Median use, Wide Width, Regular Maintenance

Type G: Non-Gating device, Test Level 2, for Shoulder, Gore and Median use, Narrow Width, Low Maintenance

Type H: Non-Gating device, Test Level 2, for Shoulder, Gore and Median use, Wide Width, Low Maintenance

Type J: Non-Gating device, Test Level 3, for Shoulder, Gore and Median use, Narrow Width, Low Maintenance

Type K: Non-Gating device, Test Level 3, for Shoulder, Gore and Median use, Wide Width, Low Maintenance

Type L: Non-Gating device, Test Level 3, High Speed, for Shoulder, Gore and Median use, Narrow Width, Low Maintenance

Type M: Non-Gating device, Test Level 3, High Speed, for Shoulder, Gore and Median use, Narrow Width, Regular Maintenance

Furnish concrete meeting the manufacturer's requirements, or if the manufacturer makes no recommendations, furnish concrete meeting the requirements of Section 00440. Furnish reinforcement meeting the requirements of Section 00530.

Furnish all hardware, epoxy resin, and miscellaneous items according to the manufacturer's recommendations.

Construction

00830.40 General - Construct and surface finish concrete according to Section 00440.

Prepare surfaces, mix, and place epoxy grout for epoxy grout pad construction according to the manufacturer's recommendations.

Assemble and install impact attenuator systems according to the manufacturer's recommendations and shop drawings.

Install fixed object markers on the head of the impact attenuator.

Measurement

00830.80 Measurement - The quantities of impact attenuators will be measured on the unit basis, by actual count at each location a system is installed.

Payment

00830.90 Payment - The accepted quantities of impact attenuators will be paid for at the Contract unit price, per each, for the item "Impact Attenuator, Type _____ ".

The type of impact attenuator will be inserted in the blank.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for transitions, concrete bases, and object markers.

Section 00840 - Delineators and Milepost Marker Posts

Description

00840.00 Scope - This work consists of furnishing and installing delineators and milepost marker posts at locations shown or established.

Materials

00840.10 Materials - Furnish materials meeting the following requirements:

Barrier Markers ..... From QPL
Delineator Reflective Sheeting (Type III and Type IV)..... From QPL
Flexible Delineators..... From QPL

00840.11 Galvanized Milepost Marker Posts - Furnish milepost marker posts meeting the following requirements:

(a) General - Fabricate milepost marker posts from steel sections meeting either of the following requirements:

Metal Properties

Grade	Minimum Yield Strength, ksi	Minimum Ultimate Strength, ksi
Hot-rolled carbon steel - min. carbon content 0.32%	40	70
Hot-rolled rail steel *	50	80

* As defined in U.S. Department of Commerce Commercial Standard 1CS 150-48, rail steel products shall be rolled from standard tee-section steel rails. No other materials, such as those known by the terms "rerolled", "rail steel equivalent", and "rail steel quality", shall be substituted.

Fabricate milepost marker posts using channel sections of the nominal dimensions as shown, subject to the manufacturer's tolerances in dimensions, and a tolerance in weight of 3.5 percent in any one shipment and 5 percent under for any one post, and a tolerance in length of 1 inch under and 2 inches over. Ensure the milepost marker posts are straight and free of sharp corners and rough or burred edges or surfaces.

(b) Multiple Punching - Milepost marker posts with holes in addition to those called for on the plans will be acceptable provided that the critical net width of the section measured on the frontal plane projection of the post is not less than 2 1/2 inches.

(c) Galvanizing - Galvanize milepost marker posts after fabrication according to AASHTO M 111 (ASTM A 123).

(d) Acceptance - Acceptance of milepost marker posts will be according to 00165.35. Accompany each shipment of support posts with a quality compliance certificate.

Construction

00840.40 Lines, Grades, and Preparation Work:

(a) Delineator Posts - Install delineator posts to the lines, grades and spacings shown and as established. To avoid difficult installation at any individual post site, the spacing may be varied 5 percent in either direction and may deviate from line by 6 inches in either direction. Remove vegetative growth, litter and debris from the post sites.

(b) Milepost Marker Posts - Locate and install milepost marker posts as shown.

00840.41 Installation of Posts - Set posts firmly into the ground and vertical. Remove and discard posts that become split, cracked, twisted, or bent, or whose tops become badly misshapen during installation.

(a) Embedment Depth - Field verify post length. Posts set in sandy, gravelly or other unconsolidated material may require an anchor system or need to be longer to provide adequate anchorage. Posts may be shortened to avoid unnecessary penetration in solid rock or in large rock fragments. If set in rock, drill a 9 inch deep hole, 1 inch greater in diameter than the large dimension of the post, and grout in place with a fine mortar grout.

(b) Guardrail Locations - At wood guardrail post installations, attach Type 4 delineators (alternate 1, plastic or alternate 2, steel) to the wood guardrail posts as shown on the standard drawings . At metal guardrail post installations, Install full length Type 1, 1U, or 2 ground mounted delineators behind the rail, adjacent to metal guardrail posts.

(c) Concrete Barrier Locations - At concrete barrier installations, attach Type 5 delineators to the concrete barrier according to the manufacturer's recommendations and as shown on the standard drawings.

00840.42 Target Members for Delineator Posts - Assemble, fasten, set and align target members and reflective material appropriate to the type and color of delineators as shown. Attach reflective sheeting to the targets as recommended by the manufacturer.

00840.43 Signs For Milepost Marker Posts - Assemble, fasten, set, and align milepost marker signs and object marker signs according to Section 00940 and as shown.

Finishing and Cleaning Up

00840.70 General - Remove and dispose of excess excavated materials, litter, and debris resulting from the operations according to 00290.20. Finish the surface around the support to match the surrounding surface or as shown.

Measurement

00840.80 Measurement - The quantities of delineators and milepost marker posts will be measured on the unit basis.

Payment

00840.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Delineators, Type ___	Each
(b)	Milepost Marker Posts	Each

In item (a) the type of delineator will be inserted in the blank regardless of the color or number of reflectors and targets.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for preparation work, earthwork, grouting, backfilling, and cleaning up.

Signs mounted on milepost marker posts will be paid for according to 00940.90.

Section 00842 - Facility Identification Markers

Description

00842.00 Scope - This work consists of furnishing and installing facility identification markers as shown.

Materials

00842.10 Materials:

(a) Stormwater Control Field Facility Markers:

(1) Type S1 Markers - Furnish green and red Type 2 flexible delineator meeting the requirements of 00840.10 except do not include the reflective sheeting. Provide green #24190 and red #11350 meeting Federal Standard 595C.

(2) Type S2 Markers - Furnish white markers made of aluminum alloy meeting the requirements of ASTM B 209 approximately half-hard temper, suitable for enameling by continuous roller or other acceptable method. Fabricate the aluminum sheet having a nominal thickness of 0.050 inch, subject to standard manufacturer's tolerances and free of burrs, irregularities, and turned edges. When resting on a plane surface, the markers shall not show warp, twist, or variation from the surface in excess of 1/4 inch. Finish the markers as follows:

- Top band of non-reflective blue tape.
- Bottom band of non-reflective black tape.
- Non-reflective black type "C" font text and numbers.

Furnish galvanized Type IU support posts meeting the requirements of 00840.11.

(3) Type S3 Markers - Furnish manhole covers meeting the requirements of 2450.30 and permanently stamped with Type S3 markers as shown.

(b) Culvert Drainage Facility Markers:

(1) Type 1 Drainage Markers - Furnish 6 to 12 inch long by 4 inch wide green color Type B preformed fused thermoplastic film meeting the requirements of 00850.10.

(2) Type 2 Drainage Markers - Furnish white markers made of aluminum alloy meeting the requirements of ASTM B 209 approximately half-hard temper, suitable for enameling by continuous roller or other acceptable method. Fabricate the aluminum sheet having a nominal thickness of 0.050 inch, subject to standard manufacturer's tolerances and free of burrs, irregularities, and turned edges. When resting on a plane surface, the markers shall not show warp, twist, or variation from the surface in excess of 1/4 inch. Finish the markers as follows:

- Top band of non-reflective green tape.
- Non-reflective black type "C" font text and numbers.

Furnish galvanized Type 1U support posts meeting the requirements of 00840.11.

(c) Bridge Facility Markers - Furnish markers meeting the requirements of Section 02910. Furnish galvanized Type 1 support posts meeting the requirements of 00840.11. Furnish 1/4 inch x 1 3/4 inch stainless steel mechanical anchors for concrete surfaces from the QPL.

Construction

00842.40 General:

(a) Stormwater Control Field Facility Markers - Install field markers for each facility according to the following:

- **Posts** - Locate and install the Type S1 and S2 marker posts as shown and according to 00840.40 and 00840.41.

- **Markers** - Attach the Type S2 markers to the Type 1U posts as shown. Install the Type S3 markers as shown.

(b) Culvert Drainage Facility Markers:

(1) Type 1 Drainage Markers - Install the Type B preformed fused thermoplastic film to clean dry pavement surfaces and as shown.

(2) Type 2 Drainage Markers - Install Type 1U posts as shown. Twisted, bent, or damaged posts will not be accepted. If posts are set in rock or large rock fragments, shorten posts, drill 9 inch deep holes 1 inch greater in diameter than the large dimension of the post then grout the post in place with fine mortar grout.

Attach the markers to the Type 1U posts, wood guardrail posts, concrete barrier, and culvert headwalls as shown.

(c) Bridge Facility Markers - At bridge rail transition areas where wood guardrail posts are installed, install the bridge identification marker on a Type 1 post and attach it to a wood guardrail post according to the "Type 4, Alternate 2" detail shown on the standard drawings. At bridge rail transition areas where metal guardrail posts are installed, install the bridge identification marker on a Type 1 post behind and adjacent to the metal guardrail post as shown and according to 00840.41. Install bridge identification markers on vertical or near vertical structure surfaces as shown.

Measurement

00842.80 Measurement - The quantities of work performed under this Section will be measured on the unit basis.

Payment

00842.90 Payment - The accepted quantities for work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Field Facility Markers, Type ___	Each
(b)	Culvert Drainage Markers, Type ___	Each
(c)	Bridge Identification Markers	Each

In item (a), the type of field facility marker will be inserted in the blank.

In item (b), the type of culvert drainage marker will be inserted in the blank.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Section 00850 - Common Provisions for Pavement Markings

Description

00850.00 Scope - This work consists of furnishing, preparing, and installing all forms of pavement markings.

Materials

00850.10 Materials - Furnish the following materials from the QPL:

- Adhesive for Pavement Markers
- High Performance Pavement Markings
- Methyl Methacrylate
- Pavement Markers
- Reflective Elements*
- Marking Paint
- Marking Tape
- Thermoplastic

* Reflective elements used with materials other than marking paint are not required to be from the QPL. Use reflective elements according to the manufacturer's recommendations.

00850.11 Flexible Bituminous Adhesive - At least 2 weeks before using, submit for Agency testing and approval a 15 pound brick sample of flexible bituminous adhesive for each manufacturer lot number, including previously tested and approved lot numbers that are over 1 year old, that will be used on the Project. All previously rejected lot number samples will not be retested. Agency testing and approval is only for acceptance of use of the adhesive.

Equipment

00850.20 Equipment - Use equipment acceptable by the marking material manufacturer for the method specified and the following:

(a) Equipment for Pavement Legends and Bars - Use manual or automatic application equipment.

(b) Equipment for Longitudinal Lines - Use applicators, sprayers or extruders made specifically for applying the specified pavement marking material at a uniform width and thickness on the roadway surface.

Except for tape applications, use automatic bead applicators that place a uniform layer of beads on the line.

Provide equipment that can:

- Place two parallel lines simultaneously with 4 inch minimum to 12 inch maximum spacings between the two lines.
- Place the entire width of a line in one pass.

Use a three-gun system for applying sprayed markings.

Hand units are allowed for tape applications only.

(c) Equipment for Inlaid/Grooved Markings - For thermoplastic and methyl methacrylate inlaid markings on dense graded asphalt concrete pavement, provide grinders with either diamond cutting heads that create smooth, flat-bottomed cuts of uniform depth or carbide cutting heads that create smooth uniform depths and uniform patterned striations as the Contractor elects.

For all other operations, provide grinders with diamond cutting heads that create smooth, flat-bottomed cuts of uniform depth or sloped cuts as shown.

Labor

00850.30 Manufacture's Representative - For Sections referencing 00850.30, provide the services of a manufacturer's representative on-site during the installation, authorized to sign a warranty on behalf of the manufacturer.

00850.31 Manufacturer-Certified Installers - For Sections referencing 00850.31, provide installers certified by the marking materials manufacturer for the specified marking material and method. Do not begin installation before receiving the Engineer's approval.

Construction

00850.40 Plans:

(a) Projects With Complete Striping Plans - When striping Supplemental Drawings are included in the Project, install striping as shown.

(b) Projects With Partial Striping Plans - When partial Supplemental Drawings are included in a Project, install striping according to the following:

- In areas where striping details are shown on the Supplemental Drawings, install striping as shown.
- In areas where striping details are not shown on the Supplemental Drawings, install striping to match the original striping configuration with the appropriate striping items listed in the Contract Schedule of Items.

(c) Projects Without Striping Plans - When striping Supplemental Drawings are not included in the Project, install striping to match the original striping configuration with the appropriate striping items listed in the Contract Schedule of Items.

For Projects with partial striping plans or Projects without striping plans, document all existing striping that is not shown in the Supplemental Drawings. Submit documentation to the Engineer 7 calendar days before the loss of existing pavement markings.

00850.42 Pre-Striping Conference - Meet with the Engineer and striping subcontractor, if striping is done by a subcontractor, 2 weeks prior to beginning striping work to discuss methods and practices of accomplishing all required striping work. Submit the following in writing 5 calendar days before the pre-striping conference for approval:

- A striping schedule showing areas and timing of work, and placing of material.
- A list of materials proposed for use and the application method.
- A copy of the manufacturer's installation instructions and Material Safety Data Sheets (MSDS).
- Proof of installer's certification for those Sections referencing 00850.31.
- Equipment specifications.

- A spill recovery plan including:
  - Name, address, and phone number of the Contractor's contact with the DEQ.
  - Name, address, and phone number of the persons certified and on-call to do clean-up.

00850.43 Prepare and Prime Pavement - Prepare pavement surfaces according to the following:

- **Existing Pavement Surfaces** - When required by the pavement marking manufacturer, remove pavement markings from existing pavement surfaces that will adversely affect the bond of new pavement marking material to the roadway surface according to Section 00851.

  Remove all other contaminants from existing pavement surfaces that may adversely affect the installation of new pavement markings by sandblasting, shot-blasting, or sweeping. Air blast the pavement with a high-pressure system to remove extraneous or loose material.

- **New Asphalt Concrete Surfaces** - Remove contaminants from new AC surfaces that may adversely affect the installation of the pavement markings by sandblasting, shot-blasting, or sweeping. Air blast the pavement with a high-pressure system to remove extraneous or loose material. Apply materials to new asphalt concrete that is sufficiently cured according to the manufacturer's recommendations.

- **New Portland Cement Concrete Surfaces** - Remove curing compounds and laitance by an approved mechanical means. Air blast the pavement with a high-pressure system to remove extraneous or loose material. Apply materials to concrete that has reached a minimum compressive strength of 3,000 psi and that is sufficiently cured according to the manufacturer's recommendations.

After the pavement surface is clean and dry, apply primer as recommended by the manufacturer to the area receiving the pavement markings. Apply the primer in a continuous, solid film according to the recommendations of the primer manufacturer and the pavement markings manufacturer.

00850.44 Alignment Layout - Place control points for lines every 50 feet on tangent and every 25 feet on a curve. Using these control points, layout a continuous narrow guideline for each line, along one edge of, or uniformly offset from the intended permanent line location. Do not proceed with installation until the guidelines are approved by the Engineer.

For inlaid/grooved markings, indicate the exact grind-out location with a 4 inch wide line as the guideline. For broken lines, lane drop lines, and dotted lines, use 10 feet, 3 feet, and 2 feet long sections respectively, at the cycle length shown. For solid lines, use a continuous line. Use marking paint from the QPL applied at a thickness of 6 mils. Reflective elements are not required.

00850.45 Installation - Apply pavement marking materials to clean dry pavement surfaces and according the following:

- Place material according to the manufacture's recommendations.
- Place parallel double lines in one pass.
- Place the specified width of lines in one pass.
- The pavement surface shall not be visible in the striped areas.
- The top of pavement marking shall be smooth and uniform.
- Skip line ends shall be square and clean.
- Place pavement marking lines parallel and true to line.
- Place skip lines so that they are in cycle with at least one end of any adjacent project.
- Place markings in proper alignment with existing markings.
- Immediately clean up marking material dribbled beyond the cutoff.

For inlaid/grooved markings, grind the slot as shown. For each grinder operator and piece of equipment, obtain the Engineer's and manufacturer representative's approval of the slot within the first 150 feet for solid lines and within the first 300 feet for skip lines. Do not proceed with grinding until the slot is approved. Repeat this process for each new grinder operator or new piece of equipment used.

After grinding, obtain the Engineer's and manufacturer representative's approval before placing marking material. Clean the area with high pressure air immediately before placing the marking material.

00850.46 Placement Tolerance - Allowable tolerances for installation are:

- **Lateral location on roadway:** 1/2 inch on tangents; 1 inch on curves
- **40 foot skip cycle length:** ± 2 inches for skip length, ± 2 inches for gap length
- **12 foot skip cycle length:** ± 3/4 inch for skip length, ± 1 inches for gap length
- **8 foot skip cycle length:** ± 1/2 inch for skip length, ± 3/4 inches for gap length
- **Skip Cycle:** A tolerance of 1/10 of the skip line length on the first skip line of a run, but it shall be on cycle within one skip
- **Double lines:** Parallel, with a gap tolerance of ± 1/2 inch
- **Width of lines:** + 3/8 inch, - 1/16 inch
- **Thickness of flat, surface applied lines:** + 1/3 of the specified thickness, – 1/10 of the specified thickness
- **Divergence of parallel double lines:** ± 3/8 inch

00850.47 Quality Control - Record the following readings for each type and color of marking material and the locations where they were taken. Submit the results to the Agency within 1 day of taking the readings.

(a) Placement Tolerances - Measure the following at the time of installation or application:

- For inlaid/grooved markings, measure the depth of the slot every 300 feet.
- For surface applied markings, except paint and tape applications, measure the thickness of the lines, at 300 foot intervals. Thickness is measured from the top of the pavement marking to the top of the wearing surface. Marking material placed in a depression left by pavement line removal will not be included in measuring the thickness of the line.

(b) Curing of Material -
At the time of installation, note and report to the Engineer all soft spots and darkened areas that may result in poor bonding and durability of the pavement markings.

(c) Retroreflectivity - Except for paint applications, evaluate longitudinal and transverse marking retroreflectivity according to ODOT TM 777. Acceptance will be according to the following:

- **Longitudinal Markings** - Each longitudinal marking sublot will be accepted if the average of the measurements and at least 90 percent of the individual measurements within the sublot meet or exceed the required minimum initial retroreflectivity.

If more than 10 percent but no more than 25 percent of the individual measurements in a sublot fail, take additional measurements within the sublot according to ODOT TM 777, Section 7.2.1 halfway between the measurements taken during initial evaluation. Combine these additional measurements with the initial measurements and re-evaluate the sublot. If the combined sublot measurements do not meet the 90 percent criteria, remove and replace the entire longitudinal marking sublot at no additional cost to the Agency.

If more than 25 percent of the individual measurements in a sublot fail remove and replace the entire longitudinal marking sublot at no additional cost to the Agency.

- **Transverse Markings** - Each transverse marking sublot will be accepted if the average of the measurements and at least 90 percent of the individual measurements within the sublot meet or exceed the required minimum initial retroreflectivity.

  If more than 10 percent but not more than 25 percent of the individual measurements in a sublot fail, take additional measurements within the sublot according to ODOT TM 777, Section 7.2.2. The Engineer will randomly select an equal number of untested transverse markings to test. Combine these additional measurements with the initial measurements and re-evaluate the sublot. If the combined sublot measurements do not meet the 90 percent criteria, remove and replace the entire transverse marking sublot at no additional cost to the Agency

  If more than 25 percent of the individual measurements in a sublot fail remove and replace the entire transverse marking sublot at no additional cost to the Agency.

Temporary

00850.50 General - Protect all applied markings from traffic until sufficiently cured so as not to be damaged or tracked by traffic movements.

Finishing and Cleaning Up

00850.70 Disposal of Waste - Dispose of all materials according to 00290.20.

00850.71 Removal and Repair of Unacceptable Work - Remove unacceptable materials according to Section 00851. If more than one repair is required in a single 300 foot section, grind and repair the entire 300 foot section.

00850.75 Manufacturer's Warranty - For Sections referencing 00850.75, furnish a manufacturer's warranty according to 00170.85(c-1) on Agency supplied warranty forms. The forms are available from the Engineer.

The warranty shall recite that the manufacturer will repair or replace, at the discretion of the Engineer and at no additional cost to the Agency, all pavement markings that drop below the minimum required retroreflectivity, show insufficient color stability, or fail to bond, within 6 months of the Agency's request to do so.

Perform warranty repair work when weather permits. At the discretion of the Agency, temporary pavement markings may be required, at the manufacturer's expense, to protect traffic until repairs can be made.

Section 00851 - Pavement Marking Removal

Description

00851.00 Scope - This work consists of removing markings from the pavement surface.

Construction

00851.40 General - Remove durable and non-durable pavement markings by hydroblasting, steel shot blasting, or grinding so that the pavement surface is not damaged below a depth or 1/8 inch. Remove durable marking by steel shot blasting or grinding the pavement surface to a depth no greater than 1/8 inch, creating a smooth, flat slot of uniform depth.

Remove pavement markings the same day permanent markings are applied. Use vacuum shrouded equipment or other equally effective containment procedures. Dispose of all waste materials according to 00290.20.

Measurement

00851.80 Measurement - The quantities of pavement line removed will be measured on the length basis. Pavement line removed will be based on a nominal width of 4 inches. If the width of the line is other than 4 inches, measurement will be adjusted by converting to an equivalent length of nominal 4 inch line on a proportionate area basis. Measurement will be the actual stripe removed. Gaps between broken and dotted stripes will not be measured.

The quantities of pavement bars removed will be measured in the area basis, for each stop bar and crosswalk bar removed.

The quantities of pavement legends removed will be measured on the unit basis, by actual count. One legend is considered to include all letters, characters, and all markings associated with the particular pavement legend.

Payment

00851.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Pavement Line Removal	Foot
(b) Pavement Bar Removal	Square Foot
(c) Pavement Legend Removal	Each

Payment will be payment in full for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for removing existing pavement markings when directed by the pavement marking manufacturer, for the preparation of applying new pavement markings.

Section 00855 - Pavement Markers

Description

00855.00 Scope - In addition to the requirements of Section 00850, install reflective and non-reflective pavement markers according to the following Specifications.

Construction

00855.40 Pavement Markers:

(a) General - Install reflective (Type I) and nonreflective (Type II) markers as shown.

(b) Surface Preparation - Remove contaminants from the wearing course surface which would adversely affect the bond of the adhesive.

Sandblast or steel shot blast the pavement surface to remove all surface contaminants. Use a blast of clean air to remove all loose particles from the surface.

(c) Installation - Apply pavement markers to a clean, dry surface.

Do not install markers spanning a pavement joint or crack. To avoid longitudinal cracks and joints, adjust pavement markers up to one half the width of the marker. To avoid transverse cracks and joints, adjust pavement markers ahead or back on line $\pm$ 5 inches.

Place the adhesive uniformly on the prepared pavement surface or on the bottom of the marker in a quantity sufficient to result in a complete coverage of the area of contact of the marker with no voids present and a slight excess of material after the marker has been pressed in place.

Place the marker in position and apply pressure until firm contact is made with the pavement. Visually inspect the installation to ensure that a small bead approximately 1/8 inch thick forms around all edges and corners and the marker is fully supported on a pad of adhesive. Immediately remove excessive adhesive on the pavement, and adhesive on the exposed surfaces of the markers.

Completely remove adhesive from the surfaces of pavement markers using an approved adhesive remover.

00855.41 Recessed Pavement Markers:

(a) Surface Preparation - Construct grooves in the pavement to neat lines conforming to width, length and depth shown, and prepare the surface according to 00855.40(b).

(b) Installation - Install the pavement markers in the grove as shown and according to 00855.40(c).

Measurement

00855.80 Measurement - The quantities of pavement markers and recessed pavement markers will be measured on the unit basis, for each type of marker.

Payment

00855.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Mono-Directional White Type I Markers	Each
(b)	Mono-Directional White Type IAR Markers	Each
(c)	Bi-Directional Yellow Type I Markers	Each
(d)	Bi-Directional Yellow Type IAR Markers	Each
(e)	White Type II Markers	Each
(f)	Yellow Type II Markers	Each
(g)	Mono-Directional White Type IAR Markers, Recessed	Each
(h)	Bi-Directional Yellow Type IAR Markers, Recessed	Each

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work.

No separate or additional payment will be made for constructing pavement grooves, pavement preparation, adhesive, and clean-up.

Section 00856 - Surface Mounted Tubular Markers

Description

00856.00 Scope - This work consists of furnishing and installing permanent surface mounted tubular markers as shown or directed.

Materials

00856.10 Materials - Furnish surface mounted tubular markers from the QPL.

Construction

00856.40 General - Install surface mounted tubular markers straight and true to line at the spacings shown. In addition to bolting the base of the surface mounted tubular marker to the surface, bond the surface mounted tubular marker to the surface using an adhesive recommended by the manufacturer according to the manufacturer's recommendations.

Measurement

00856.80 Measurement - The quantities of permanent surface mounted tubular markers will be measured on the unit basis.

Payment

00856.90 Payment - The accepted quantities of permanent surface mounted tubular markers will be paid for at the Contract unit price, per each, for the item "Permanent Surface Mounted Tubular Markers".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Section 00857 - Rumble Strips

Description

00857.00 Scope - This work consists of milling rumble strips by constructing indentations in asphalt concrete surfaces as shown or directed.

Equipment

00857.20 Equipment:

(a) Longitudinal Rumble Strips - Construct continuous or gap pattern longitudinal shoulder, edge line, and centerline rumble strips as shown using a rotary type cutting head with a maximum outside diameter of 24 inches. Provide a cutting head length that matches the rumble strip width as shown. Arrange the cutting head cutting tips in a pattern that provides a relatively smooth cut with approximately 1/16 inch between peaks and valleys. Attach the cutting heads to the power unit in a manner that allows the tool to self-align with the slopes of the pavement and shoulder and any irregularities in the pavement and shoulder surfaces. The cutting equipment shall be capable of cutting rumble strips of the required width in a single pass while moving in the same direction as the flow of traffic.

(b) Transverse Rumble Strips - Form transverse rumble strips using a rotary type cutting head 5 1/2 inches long. Arrange the cutting head cutting tips in a pattern that provides a relatively smooth cut (approximately 1/16 inch between peaks and valleys). Attach the cutting heads to the power unit in a manner that allows the tool to self-align with the slope of the travel lane and any irregularities in the travel lane surface. The cutting equipment shall be capable of cutting rumble strips perpendicular to the travel lane.

Construction

00857.40 Construction - Where rumble strips will be constructed at the same locations where permanent pavement markings will be installed, construct rumble strips within 3 weeks after temporary pavement markings have been placed for the final roadway configuration, but before installing permanent pavement markings.

After constructing the rumble strips, clean the pavement by sweeping to remove dust and other foreign matter. Dispose of all materials according to 00290.20.

Measurement

00857.80 Measurement - The quantities of longitudinal rumble strips will be measured on the length basis, at least to the nearest 0.01 mile. Measurement will be made along each rumble strip run, regardless of location or width of strip with no deductions made for gaps in gap pattern rumble strips. Breaks in the rumble strips at intersections, interchange ramps, or other locations shown will not be measured for payment.

The quantities of transverse rumble strips will be measured on the unit basis, by actual count of rumble strip clusters.

Payment

00857.90 Payment - The accepted quantities of rumble strips will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Continuous Rumble Strips	Mile
(b) Gap Pattern Rumble Strips	Mile
(c) Transverse Rumble Strips	Each

Payment will be payment in full for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

Section 00860 - Longitudinal Pavement Markings - Paint

Description

00860.00 Scope - In addition to the requirements of Section 00850, install painted longitudinal pavement markings according the following Specifications.

Construction

00860.45 Installation - Apply painted longitudinal pavement markings as follows:

- Apply two separate applications of painted longitudinal pavement markings. Retrace the second application directly over the first application, within 1/16 inch as follows:
  - Apply the second application after 2 hours but within 48 hours of the first application.
  - For yellow colored markings that delineate two-way traffic, apply the second application in the opposite direction of the first application. For yellow colored markings on one-way roadways, apply the second application in the same direction of the first application. For white colored markings, apply the second application in the same direction of the first application.
- Apply each painted marking application at a thickness of 15 mils wet, equivalent to 17 gallons per mile for a 4 inch wide solid stripe.
- Apply reflective elements for each application at a minimum rate of 5 pounds per gallon of paint. Embed, by means of paint wicking, a minimum of 80 percent of the reflective elements in the paint to a minimum depth of 50 percent of their diameter.

Minimum initial retroreflectivity shall be the following:

- White - 250 $mcd/m^2/lx$
- Yellow - 200 $mcd/m^2/lx$

Measurement

00860.80 Measurement - The quantities of painted longitudinal pavement markings will be measured on the length basis. Painted longitudinal pavement markings will be based on a nominal line width of 4 inches. If the width of the line is other than 4 inches, measurement will be adjusted by converting to an equivalent length of nominal 4 inch line on a proportionate area basis. Measurement will be the actual stripe. Gaps between skip stripes will not be measured.

Payment

00860.90 Payment - The accepted quantities of painted longitudinal pavement markings will be paid for at the Contract unit price, per foot, for the item "Longitudinal Pavement Markings - Paint".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Section 00865 - Longitudinal Pavement Markings - Durable

Description

00865.00 Scope - In addition to the requirements of Section 00850, install durable longitudinal pavement markings according to the following Specifications.

Labor

00865.30 Manufacture's Representative - Provide a manufacturer's representative according to 00850.30.

00865.31 Manufacturer-Certified Installers - Provide certified installer's according to 00850.31.

Construction

00865.40 General - Before installing, and in the presence if the Engineer, conduct a performance test by applying a 150 foot test section on roofing felt. Do not place permanent material without the Engineer's approval of the performance test. Additional performance tests may be required. Conduct performance tests at no additional cost to the Agency.

00865.45 Installation - Place durable markings only when the manufacturer's representative determines that the pavement is ready for the pavement marking material.

Apply reflective elements at a rate to obtain the following minimum initial retroreflectivity readings:

- White - 250 mcd/m^2/lx
- Yellow - 200 mcd/m^2/lx

Apply marking materials by one or more of the following methods:

- **Method A: Extruded Markings** - Apply markings with an extrusion or ribbon type process and according to the following:
  - For grooved markings, grind the slot depth as shown. Apply the specified marking material into the slot so the slot is filled from edge to edge as shown. The top of the marking shall be flat or slightly convex.
  - For profiled markings, place lines and bumps straight and square.
- **Method B: Spray Markings** - Apply two separate applications of spray markings with each application being one half the total specified thickness. Retrace the second application directly over the first application within 1/16 inch. For white colored markings, apply the second application in the same direction of the first application. For yellow colored markings that delineate two-way traffic, apply the second application in the opposite direction of the first application. For yellow colored markings on one-way roadways, apply the second application in the same direction of the first application.
- **Method C: Pavement Marking Tape** - Do not place tape continuously on longitudinal pavement joints. Apply pavement marking tape as follows:
  - **Rolled-In Installation** - Apply the tape to the fresh asphalt concrete surface prior to the final rolling of the mat. Roll the tape into the fresh surface during the finishing of the mat.

- **Grooved Installation** - Grind slot depth to 130 to 150 mils with a smooth, uniform, and flat bottom. Apply tape into slot.

- **Method AB: Non-Profiled Extruded or Sprayed Markings** - Install Method A surface, non-profiled markings or Method B markings.

00865.75 Manufacturer's Warranty - Furnish a warranty according to 00850.75 and the following:

- **Warranty Period** - The warranty period shall be 3 years for surface mounted thermoplastic, and 4 years all other methods and materials in this Section.

- **Retroreflectivity** - Markings shall maintain a minimum retroreflectivity of 150 mcd/m^2/lx for white and 125 mcd/m^2/lx for yellow.

- **Color Stability** - Use Federal Color Chart PR-1 to determine color stability. Yellow markings shall meet 33538 Federal yellow. White markings shall have a minimum daylight reflectance of 84.

- **Adhesion** - A cumulative 5 percent or greater loss of line due to non-adhesion on any 300 foot segment of marking will constitute failure of the material in that segment.

Measurement

00865.80 Measurement - The quantity of durable longitudinal pavement markings will be measured on the length basis. Durable longitudinal pavement markings will be based on a nominal line width of 4 inches. If the width of the line is other than 4 inches, measurement will be adjusted by converting to an equivalent length of nominal 4 inch line on a proportionate area basis. Measurement will be the actual stripe. Gaps between skip stripes will not be measured.

Payment

00865.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
Method A (Extruded)	
(a) Methyl Methacrylate, Extruded, _____, _____	Foot
(b) Thermoplastic, Extruded, _____, _____	Foot
Method B (Sprayed)	
(c) Methyl Methacrylate, Sprayed, Surface, Non-Profiled	Foot
(d) Thermoplastic, Sprayed, Surface, Non-Profiled	Foot
Method C (Pavement Marking Tape)	
(e) Pavement Marking Tape, _____	Foot
(f) Pavement Marking Tape, Wet Weather, _____	Foot
Method AB (Non-Profiled Extruded or Sprayed)	
(g) Methyl Methacrylate, Extruded or Sprayed, Surface, Non-Profiled	Foot
(h) Thermoplastic, Extruded or Sprayed, Surface, Non-Profiled	Foot

In items (a) and (b), the word "Surface" or "Grooved" will be inserted in the first blank and the word "Profiled" or "Non-Profiled" will be inserted in the second blank.

In items (e) and (f), the word "Rolled-In" or "Grooved" will be inserted in the blank.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Payment for work done under this Section will be limited to 75 percent of the amount due until the Agency has received the signed warranty.

Section 00866 - Longitudinal Pavement Markings - High Performance

Description

00866.00 Scope - In addition to the requirements of Section 00850, install high performance longitudinal pavement markings according to the following Specifications.

Labor

00866.30 Manufacturer's Representative - Provide a manufacturer's representative according to 00850.30.

00866.31 Manufacturer-Certified Installers - Provide certified installer's according to 00850.31.

Construction

00866.40 General - Before installing, and in the presence of the Engineer, conduct a performance test by applying a 150 foot test section on roofing felt. Do not place permanent material without the Engineer's approval of the performance test. Additional performance tests may be required. Conduct performance tests at no additional cost to the Agency.

00866.45 Installation - Place markings only when the manufacturer's representative determines that the pavement is ready for the pavement marking material.

Do not place the pavement markings on longitudinal pavement joints.

Apply reflective elements at a rate to obtain the following minimum initial reflectivity readings:

- White - 250 mcd/m^2/lx
- Yellow - 200 mcd/m^2/lx

Apply marking material by one or more of the following methods:

- **Method 1: Spray Markings** - If more than one application is required to obtain the thickness specified, place additional applications directly over previous applications, within 1/16 inch.

- **Method 2: Protected Inlaid Markings** - Grind the slot to the correct depth, and in proper alignment. Place the specified marking material such that the slot is filled from edge-to-edge with the thickness of the marking material as specified. Make the marking flat or slightly convex on top.

00866.75 Manufacturer's Warranty - Furnish a warranty according to 00850.75 and the following:

- **Warranty Period** - The warranty period shall be for 1 year.

- **Retroreflectivity** - Marking shall maintain a minimum retroreflectivity of 150 mcd/m^2/lx for white and 125 mcd/m^2/lx for yellow.

- **Color Stability** - Use Federal Color Chart PR-1 to determine color stability. Yellow marking shall meet 33538 Federal Yellow. White marking shall have a minimum daylight reflectance of 84.

- **Adhesion** - A cumulative 5 percent or greater loss of line due to non-adhesion on any 300 foot segment of marking will constitute failure of the material in that segment.

Measurement

00866.80 Measurement - The quantities of high performance pavement markings will be measured on the length basis. High performance pavement markings will be based on a nominal line width of 4 inches. If the width of the line is other than 4 inches, measurement will be adjusted by converting to an equivalent length of nominal 4 inch line on a proportionate area basis. Measurement will be the actual stripe. Gaps between skip stripes will not be measured.

Payment

00866.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Modified Urethane, 25 mil, Sprayed	Foot
(b) Modified Urethane, Protected Inlaid	Foot
(c) Hi-Build Paint, 25 mil, Sprayed	Foot
(d) Polyurea, 20 mil, Sprayed	Foot

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Payment for work under this Section will be limited to 75 percent of the amount due until the Agency has received the signed Warranty.

Section 00867 - Transverse Pavement Markings - Legends and Bars

Description

00867.00 Scope - In addition to the requirements of Section 00850, install pavement markings for legends and bars according to the following Specifications.

Labor

00867.30 Manufacturer's Representative - Provide a manufacturer's representative according to 00850.30.

00867.31 Manufacturer-Certified Installers - Provide certified installer's according to 00850.31.

Construction

00867.45 Installation - Place permanent markings only when the manufacturer's representative determines that the pavement is ready for the pavement marking material.

Transverse joints will be allowed with no overlap or gap allowed at the joint.

Minimum initial retroreflectivity shall be 250 mcd/m^2/lx.

Apply one or more of the following marking material types:

- **Type A: Liquid, Hot-Laid Thermoplastic Material** - For pavement bars, apply the thermoplastic material to the pavement by a spray or extrusion method, to the full width shown, in a single application. For pavement legends, apply the thermoplastic material to the pavement by a spray method, to the full width shown, in a single application. Pavement markings shall be 90 mils to 120 mils in thickness, exclusive of projecting surface-applied reflective elements, with a continuous and uniform cross sectional configuration, and with the upper surface slightly arched.

  Separately apply reflective elements to the material as it is placed at a sufficient rate to obtain an initial reflectivity reading of 250 mcd/m^2/lx. Locate the dispenser behind the pavement marking extrusion die and uniformly distribute the reflective elements over the entire width of the thermoplastic material

- **Type B: Preformed, Fused Thermoplastic Film** - Install preformed, fused thermoplastic film as shown.

- **Type B-HS: Preformed, Fused Thermoplastic Film High Skid** - Install preformed, fused thermoplastic film high skid, that has intermixed reflective elements with factory installed crushed glass or aggregate on the surface for all staggered continental crosswalks, bike lane stencils, bike path railroad crossings, and other transverse pavement markings as shown.

- **Type AB**: Install Type A, Type B or Type B-HS as the Contractor elects

- **Type C: Cold-Applied Plastic Film (Tape)** - On asphalt, apply the tape on the fresh asphalt concrete surface prior to final rolling of the mat. Roll the tape into the fresh surface during the finish rolling of the mat. On concrete, install tape with primer as recommended by the manufacturer.

  Apply Type C - HS, cold applied plastic film that has intermixed reflective elements with factory installed crushed glass or aggregate on the surface. On asphalt, apply the tape on the fresh

asphalt concrete surface prior to final rolling of the mat. Roll the tape into the fresh surface during the finish rolling of the mat. On concrete, install tape with primer as recommended by the manufacturer.

- **Type D: Methyl Methacrylate** - Apply the methyl methacrylate material to the pavement by a gravity and extrusion method, to the full width shown, in a single application. Pavement markings shall be 90 mils to 120 mils in thickness, exclusive of projecting surface-applied reflective elements, with a continuous and uniform cross-sectional configuration, and with the upper surface slightly arched. Provide intermixed reflective elements.

Separately apply reflective elements to the material as it is placed at a sufficient rate to obtain an initial reflectivity reading of 250 mcd/m^2/lx. Locate the dispenser behind the pavement marking extrusion die and uniformly distribute the reflective elements over the entire width of the methyl methacrylate material.

00867.75 Manufacturer's Warranty - Furnish a warranty according 00850.75 and the following:

- **Warranty Period** - The warranty shall be for 18 months.
- **Retroreflectivity** - Markings shall maintain a retroreflectivity of 100 mcd/m^2/lx.
- **Color Stability** - White markings shall have a minimum daylight reflectance of 84.
- **Adhesion** - 5 percent or greater loss of marking due to non-adhesion will constitute failure.

Measurement

00867.80 Measurement - The quantities of pavement legends will be measured on the unit basis, by actual count.

The quantities of pavement bars will be measured on the area basis, for each stop bar and crosswalk bar.

Payment

00867.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Pavement Legend, Type ____ : Arrows	Each
(b)	Pavement Legend, Type ____ : "ONLY"	Each
(c)	Pavement Legend, Type ____ : "SCHOOL"	Each
(d)	Pavement Legend, Type ____ : "SCHOOL" Large	Each
(e)	Pavement Legend, Type ____ : "CROSSING" Large	Each
(f)	Pavement Legend, Type ____ : "X-ING"	Each
(g)	Pavement Legend, Type ____ : "BUS"	Each
(h)	Pavement Legend, Type ____ : Railroad Crossing	Each
(i)	Pavement Legend, Type ____ : Railroad Crossing, Narrow	Each
(j)	Pavement Legend, Type ____ : Railroad Crossing, Bike	Each
(k)	Pavement Legend, Type ____ : HOV Diamond	Each
(l)	Pavement Legend, Type ____ : Cattle Guard	Each
(m)	Pavement Legend, Type ____ : Bicycle Lane Stencil	Each
(n)	Pavement Legend, Type ____ : Disabled Parking	Each
(o)	Pavement Legend, Type ____ : On-Street Parking	Each

(p) Pavement Legend, Type ____ : Yield Line Triangle .....Each
(q) Pavement Legend, Type ____ : _____ .....Each
(r) Pavement Bar, Type ____ .....Square Foot

In items (a) through (r), the type of pavement marking materials will be inserted in the first blank.

In item (q), the name of the legend will be inserted in the second blank.

Item (a) includes single or multiple headed arrows as required.

Items (h) and (i) include the R x R symbol, two 24 inch wide white pavement bars placed directly above and directly below the R x R symbol, and one 24 inch wide white stop bar placed prior to the tracks.

Item (j) includes a R x R Symbol and one 12 inch wide white pavement bar placed above the R x R symbol.

Item (m) includes the bike lane stencil and arrow.

Item (n) includes the wheelchair stencil only. The 4 inch wide white lines used to mark the disabled parking space and access aisle will be paid for according to 00860.90

Item (o) includes the cross style marking or the end marking.

Item (p) includes one 2 by 3 foot triangle used to form the yield line.

Item (r) includes all transverse pavement markings that are defined as a "BAR", including but not limited to, stop bars, crosswalk bars, chevron bars, transverse median bars, and transverse shoulder bars.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Payment for work under this Section will be limited to 75 percent of the amount due until the Agency has received the signed warranty.