

**2501**  
**Pipe Culverts**

**2501.1 DESCRIPTION**

This work shall consist of the construction of pipe culverts, using plant-fabricated pipe and appurtenant materials, or using preformed structural plates fabricated for field assembly, installed primarily for passage of surface water through embankments.

**2501.2 MATERIALS****A Pipe**

Culvert pipe shall be one of the following kinds as specified or permitted as an option. Unless higher strength pipe is specified, pipe conforming to the lowest strength class covered in the referenced Specification will be acceptable. Special fabrication or jointing details shall be as required by the Plans.

A1	Corrugated Aluminum (CA).....	3225
A2	Corrugated Steel (CS).....	3226
A3	Corrugated Polyethylene (CP).....	3247
A4	Bituminous Coated-Corrugated Steel (BC-CS).....	3227
A5	Aramid Bonded-Corrugated Steel (AB-CS).....	3228
A6	Reinforced Concrete (RC).....	3236
A7	Polymeric Coated-Corrugated Steel (PC-CS).....	3229
A8	Corrugated Aluminized Steel (CAS).....	3222

Coating Type shall be as specified in the Plans or Special Provisions.

**B Structural Plate**

B1	Corrugated Aluminum (CA).....	3233
B2	Corrugated Steel (CS).....	3231

**C Aprons**

Aprons shall be the type designated in the Contract. Galvanized steel aprons may be furnished for attachment to corrugated steel, corrugated polyethylene, bituminous coated-corrugated steel, aramid bonded-corrugated steel, and polymeric coated-corrugated steel pipe. Galvanized steel aprons may be furnished for attachment to corrugated aluminum and corrugated aluminized steel pipe provided that geotextile Type II or other insulation material approved by the Engineer is applied between the contact surfaces of the different materials.

C1	Reinforced Concrete (RC).....	3236
C2	Galvanized Steel (GS).....	3226
C3	Aluminum Alloy (AA).....	3225C4
	Bituminous Coated-Galvanized Steel (BC-GS).....	3227
C5	Aluminized Steel.....	3222
C6	Corrugated Polyethylene (CP).....	3247
C7	Polymeric Coated-Corrugated Steel (PC-CS).....	3229
C8	Corrugated Aluminized Steel (CAS).....	3222

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<b>D</b>	<b>Flap Gates .....</b>	<b>3399</b>
<b>E</b>	<b>Anti-seepage Diaphragms .....</b>	<b>3351</b>
<b>F</b>	<b>Pipe Joint Sealer Materials</b>	
F1	Preformed Rubber, Type A.....	3726
F2	Preformed Plastic, Type B.....	3726
F3	Bituminous Mastic.....	3728
<b>G</b>	<b>Granular Materials.....</b>	<b>3149</b>
<b>H</b>	<b>Geotextile, Type II .....</b>	<b>3733</b>
<b>I</b>	<b>Blank</b>	
<b>J</b>	<b>Reinforced Concrete Dissipator Ring .....</b>	<b>3236</b>

2501.3 CONSTRUCTION REQUIREMENTS

The following construction requirements shall apply to the installation of all types of pipe culvert, whether new or old materials are used.

**A General**

The provisions of 2451 relating to prefabricated structures shall apply to the excavation, foundation construction, and backfilling of the culvert, together with the additional requirements or modifications contained herein.

**B Foundations**

Entrance culverts may be installed to the required grade without special foundation shaping, except that the foundation shall be shaped as required in 2451.3C2 when the culvert is installed in a trench or when special bedding is specifically designated in the Plans.

**C Laying Pipe**

**C1 General**

Pipes that connect with inlet structures shall terminate flush with the inside of the structure wall.

Jacking of culverts through the existing earth structure into position may be required by the Plans or permitted by the Engineer. The flow line elevation at the starting point for jacking shall be within 30 mm (**0.1 foot**) of the staked grade; the flow line shall not be reversed at any point; and the line and grade at any point within the pipe shall not vary by more than 150 mm (**½ foot**) from the line and grade designated. Metal pipe installed by this method shall have bolted or riveted field connections.

**C2 Metal Culvert**

Corrugated metal pipes having circumferential joints shall be laid with the outside laps pointing upgrade and with the longitudinal joints on the sides.

Metal pipe sections shall be joined by the use of metal connecting bands, centered over the joint, and with the pipe sections as close together as possible. The band shall be tightened sufficiently to ensure a tight joint.

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Structural plate culverts shall be assembled according to the instructions of the manufacturer, using approved fasteners. Where bolts are used, the bolts shall be tightened, after assembly, to a torque of 135 to 400 N•m (**100 to 300 foot pounds**). The Contractor shall furnish a calibrated torque wrench to prove, to the Engineer's satisfaction, the adequacy of the bolt tightening.

Bituminous coated pipe shall be handled with special care to preserve the coating. All exposed metal shall be recoated with a grade of asphalt similar to that originally applied. Fuel oil or similar solvent may be used to facilitate the installation of coupling bands.

The paved portion of bituminous coated and paved corrugated metal pipe shall be centered on the flow line.

Where beveled ends are required on metal pipe, the bevels shall be cut at right angles to a vertical plane through the longitudinal axis of the pipe.

#### C3 Concrete Culvert

Concrete pipe shall be laid with the groove end of each section up and the sections shall be tightly joined. Each joint shall be effectively protected against infiltration of backfill soil by filling the joint space with an approved sealer material or by providing a full circumferential wrap of geotextile material extending 300 mm (**12 inches**) or more on each side of the joint and being secured in place. A combination of sealer and geotextile materials will be permitted.

Where so required by the Contract, the joints in concrete pipe shall be effectively sealed to provide a flexible water-tight joint, using an approved elastic joint sealer material (preformed rubber, preformed plastic, bituminous mastic). Where the pipe specified is specifically designed to accommodate preformed gasket type seals, the joints shall be sealed with the gasket type designed especially for that type of joint as shown in the Plans and the joints shall meet the performance requirements of AASHTO M 198.

Mastic joint sealer materials shall be applied in accordance with the recommendations of the manufacturer. All joints shall be wiped clean on the inside after sealing. Lifting holes shall be plugged with a precast concrete plug, sealed, and covered with mastic or mortar.

Concrete culvert sections shall be tied together with approved fasteners, unless otherwise specified in the Plans or Special Provisions.

#### C4 Blank

#### C5 Extending In-Place Culverts

To the extent feasible, in-place culverts shall be cleared of any obstructions to water flow, before placing the extension pipe. Removal of sediment will only be required to the extent that improved flow is likely to be maintained. This work shall be incidental to the pipe extension, with no direct compensation being made therefor.

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Where the pipe ends differ because of changed design, the connection to the in-place culvert shall be made as indicated in the Plans or to the satisfaction of the Engineer.

When cast-in-place concrete box culverts are to be extended with plant-fabricated pipe, details of the connection shall be as shown in the Plans.

When a box-type concrete cattle pass is to be extended using precast concrete sections, a transition section as shown in the detailed Plans shall be used. The ends of the in-place structure shall be exposed and concrete removed to the extent indicated in the Plans. The cast-in-place portion of the transition shall be constructed according to the applicable material and construction requirements of 2411.

#### **D Culvert Appurtenances**

Appurtenant items such as aprons, safety aprons, and grates, diaphragms, dissipator rings, flap gates, and safety grates (this includes special grates for concrete pipe and large size pipe, trash racks and other devices of this nature requiring a special design) shall be furnished and installed as required by the Plans or Special Provisions.

#### **E Induced Trench Installation**

When required by the Plans, the backfill over the culvert shall be constructed as follows:

The embankment shall be constructed according to 2105 for a width on each side of the installed culvert at least equal to 3 pipe widths and to an elevation over the top of the culvert equal to the pipe height plus 300 mm (**1 foot**). Where specified density is called for, the density in each layer shall be not less than 100 percent of maximum density.

A trench shall then be excavated to a level 300 mm (**1 foot**) above the top of the culvert, for the width and length of the pipe, and with vertical sides. The trench shall be loosely filled with highly compressible soil, after which the remainder of the embankment shall be constructed in accordance with 2105.

#### **F Culvert Cleaning**

Before final acceptance of the Project, all culverts installed under the Contract shall be inspected and cleared of any sedimentation or other debris existing inside the pipe.

### **2501.4 METHOD OF MEASUREMENT**

#### **A Culvert Excavation**

When the proposal contains separate items for Culvert excavation under the payment provisions of this Specification, the excavations for culverts will be classified and measured in accordance with the applicable provisions of 2451.

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### **B Culvert Pipe**

Culvert pipe will be measured by length, as determined by summation of the nominal laying lengths of the individual pipe sections incorporated in each structure. Measurements will be separated as to size, type, kind, and strength class, to the extent indicated in the item name.

Elbow, tee, and wye sections will be measured for payment as pipe, with the measurements being made along the centerline of the culvert barrel. No length allowance will be made for branch legs, except as included in the measurements for a connecting structure. Transition sections will be measured for payment as pipe of the larger (or more costly) size, except for such special sections as may be designated for measurement as a unit.

On metal pipe installations requiring special fabrication such as skewed or sloped ends, length measurements will be to the extreme ends such as to include waste material, unless other limits are shown in the Plans.

### **C Culvert Appurtenances**

Appurtenant items such as aprons, safety aprons, and grates, diaphragms, dissipator rings, flap gates, and other specially designed and identified units designated for payment on a per each basis, will be measured separately by the number of units of each type and size incorporated in the culvert structures. A safety apron and grate is to be considered as a unit.

No direct compensation will be made for cast-in-place concrete work required in connection with the construction of pipe culverts.

### **D Granular Materials**

Granular materials for special backfill or bedding will be measured in accordance with 2451.4B.

### **2501.5 BASIS OF PAYMENT**

Payment for culvert pipe of each size, type, kind, and strength class, at the appropriate Contract prices per unit of measure, will be compensation in full for all costs of furnishing and installing the pipe complete in place as specified, except as otherwise provided herein.

Aprons, safety aprons and grates, flap gates, dissipator rings, diaphragms, and other specially designed and identified appurtenant items, as required by the Plans, will be paid for separately by type, size, and number of units incorporated in the structures, which payment will be compensation in full for all costs of furnishing and installing those items complete in place.

Granular materials for special backfill or bedding will be paid for separately in accordance with the payment provisions of 2451.5.

Culvert Excavation will be paid for separately, to the extent that the Proposal contains specific items and unit prices therefor, in which case

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payment will be subject to 2451.5. Otherwise, all excavating costs shall be included in bid prices for culvert pipe and appurtenant items.

For any culvert elbows, tee or wye sections and necessary additional connectors that are ordered by the Engineer but that are not indicated in the Plans, additional compensation will be made in the amount of the actual invoice cost of the materials involved.

Payment for installing culvert materials provided by the Department will be made under the applicable installation items indicated in the Proposal, and, except for Extra Work or work designated under other items, will be considered as full compensation for all the work and additional materials required for the installation complete in place.

Where installation by the jacking method is required or permitted in the absence of a separate bid item, payment will be made on the same basis as if the culvert were installed by the trenching method.

Payment will be made on the basis of the following schedule:

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2501.501	Culvert Excavation, Class (1) .....	cubic meter ( <b>cubic yard</b> )
2501.511	___ mm ( <b>inch</b> ) (2) Pipe Culvert (3) .....	meter ( <b>linear foot</b> )
2501.515	___ mm ( <b>inch</b> ) (2) Pipe Apron .....	each
2501.517	Anti-seepage Diaphragm for (4) Pipe .....	each
2501.519	Flap Gate for (4) Pipe .....	each
2501.521	___ mm ( <b>inch</b> ) Span (2) Pipe-Arch Culvert (3) .....	meter ( <b>linear foot</b> )
2501.525	___ mm ( <b>inch</b> ) Span (2) Pipe-Arch Apron .....	each
2501.527	Anti-seepage Diaphragm for (4) Pipe-Arch .....	each
2501.531	___ mm ( <b>inch</b> ) (2) Elliptical Pipe Culvert (5) .....	meter ( <b>linear foot</b> )
2501.535	___ mm ( <b>inch</b> ) (2) Elliptical Apron .....	each
2501.541	___ mm ( <b>inch</b> ) High (2) Cattle Pass Culvert (3) .....	meter ( <b>linear foot</b> )
2501.543	___ mm ( <b>inch</b> ) High (2) Cattle Pass Transition Section (3) .....	each
2501.545	___ mm ( <b>inch</b> ) High (2) Cattle Pass Apron Culvert (3) .....	each
2501.551	___ mm ( <b>inch</b> ) (2) Structural Plate Pipe Culvert (3) .....	meter ( <b>linear foot</b> )
2501.555	___ mm ( <b>inch</b> ) Span (2) Structural Plate Pipe-Arch Culvert (3) .....	meter ( <b>linear foot</b> )
2501.561	___ mm ( <b>inch</b> ) (2) Pipe Culvert, Design (6) (3) .....	meter ( <b>linear foot</b> )
2501.565	___ mm ( <b>inch</b> ) Span (2) Pipe-Arch Culvert, Design (6) (3) .....	meter ( <b>linear foot</b> )
2501.567	___ mm ( <b>inch</b> ) (2) Safety Apron & Grate Design (6) .....	each
2501.569	___ mm ( <b>inch</b> ) (2) (7) .....	each

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- 2501.571 Install (7) ..... meter (**linear foot**)
- 2501.573 Install (7) ..... each
- 2501.575 \_\_\_mm (**inch**) RC Dissipator Ring.....each

- NOTE: (1) Specify Class U, E, or R only---See 2451.3B2  
(2) Specify Kind---See 2501.2  
(3) Specify Strength Class, if other than minimum requirement.  
(4) Specify Size and Kind.  
(5) Specify HE or VE, and Strength Class, if other than minimum requirement.  
(6) Give Standard Plate Number for special pipe or joint designs.  
(7) Specify item name.

**2502**

**Subsurface Drains**

**2502.1 DESCRIPTION**

This work shall consist of the construction of subsurface drains, using plant-fabricated pipe and appurtenant materials, installed to:

- (a) collect and discharge water infiltrating into the pavement system (pavement edge drain).
- (b) collect and discharge water accumulated in the bottom of a granular-backfilled subcut (subcut drain).
- (c) cut off or intercept ground water flowing toward the roadway (cut-off drain).

Subsurface drains include all materials used to collect ground water and conduct it to a discharge point either at a structure or on a side slope. The typical system will include a drain pipe, radial connecting pipe, discharge pipe, and drain outlet.

Subsurface drains for high bridge abutments, installed to intercept and carry off underground water, shall include all appurtenances, including geotextiles, metal oversleeves with rodent screens, and precast concrete headwalls. The work shall be performed in accordance with applicable provisions of 2502, 3245, 3733, and as detailed in the Plans.

**2502.2 MATERIALS**

Drain pipe shall be one of the following kinds as specified or permitted as an option. Fittings connecting multiple length of drain pipe shall be of the same material as the pipe. Nonperforated pipe shall be furnished except where the perforated type is specified. Unless higher strength pipe is specified, pipe conforming to the lowest strength class covered in the referenced specification will be acceptable. All discharge pipe, radial connecting pipe, and associated fittings shall be

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nonperforated TP pipe. Special fabrication or jointing details shall be as required by the Plans or as approved by the Engineer.

<b>A</b>	<b>Drain and Discharge Pipe</b>	
A1	Thermoplastic (TP).....	3245
A2	Corrugated Polyethylene Drainage Tubing (PE) .....	3278
<b>B</b>	<b>Precast Concrete Headwall (Drain Outlet).....</b>	<b>Standard Plate 3131</b>
<b>C</b>	<b>Granular Materials.....</b>	<b>3149</b>
<b>D</b>	<b>Geotextile, Type I.....</b>	<b>3733</b>
<b>E</b>	<b>Erosion Blanket, Category 1 .....</b>	<b>3885</b>
<b>F</b>	<b>Seed.....</b>	<b>3876</b>
<b>G</b>	<b>Marking Tape .....</b>	<b>3354</b>

## 2502.3 CONSTRUCTION REQUIREMENTS

The following shall apply unless otherwise provided in the Plans or Special Provisions:

### **A Excavation**

The trench shall be excavated to the designated lines and grades, as shown in the Plans and as necessary to permit placement of the drains in accordance with the provisions hereof. Minimum trench width at the bottom of the excavation shall be the nominal pipe width plus two times the pipe diameter (for example, a 100 mm (**4 inch**) diameter pipe would be placed in a 300 mm (**12 inch**) wide trench). Corrugated polyethylene drainage tubing (PE) may be used only when placed in a narrow, controlled-width trench as typically constructed by a chain- or wheel-type trenching machine designed and used for this application. Other types of rigid pipe shall be used for all other uses where compaction is not controlled in a narrow trench. Installation of PE tubing by plowing is not permitted.

Rock encountered within the excavation shall be removed to a minimum width as specified above, and to a minimum depth of one pipe diameter below the pipe. Except where granular material is required, the backfill up to the bottom of the pipe may be made with suitable material removed from elsewhere in the excavation, which shall be compacted uniformly to provide a proper foundation.

### **B Laying Drains**

All perforated pipe drains shall be bedded on fine filter aggregate meeting 3149.2J, placed to a minimum thickness of one pipe diameter below the bottom of the pipe, and extending upwards under the haunches, for the full width and length of the trench, to such elevation as will permit the specified foundation preparations. Granular bedding will not be required on nonperforated pipe installations unless specifically required by the Plans. Stones in excess of 25 mm (**1 inch**) will not be permitted in the trench. The foundation for all drains, whether bedded on granular material or not, shall be carefully shaped

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to fit at least the lower 30 percent of the outside circumference of the pipe. Drains shall be laid carefully to line and grade, with uniform bearing throughout and with the perforations down unless otherwise directed.

All perforated pipe shall be wrapped with geotextile that is factory seamed or produced as a continuous knit weave. The fabric seam shall be placed at the top of the pipe (opposite the perforations). Where seams are necessary at fittings or connectors, the adjoining geotextiles shall be mechanically fastened, or overlapped a minimum of 150 mm (**6 inches**).

Pipe sections shall be joined securely with the appropriate coupling bands or fittings. Solvent type joints shall be cemented unless otherwise specified. Upgrade ends of all subdrain pipe shall be closed with suitable caps. All junctions and turns shall be made with wyes or bends and be suitable for cleaning and inspection.

Where a drain connects with a structure or catch basin, the Contractor shall make a suitable and secure connection through the wall of the structure. Unless otherwise specified, drainage outlets to the surface shall terminate at a standard precast concrete headwall.

#### **C Backfill**

Backfilling of drains shall proceed without delay as the installations are made. On all perforated pipe installations, fine filter aggregate shall be placed adjacent to and to a minimum height of 150 mm (**6 inches**) above the top of the pipe, and to the extent indicated in the Plans. Above that elevation, and on all nonperforated pipe installations, the backfill may be made with suitable material removed from the excavations. In all applications, stones greater than 25 mm (**1 inch**) shall not be used adjacent to, and for 150 mm (**6 inches**) above the pipe.

Fine filter aggregate need not be compacted, unless otherwise indicated in the Plans, but all other backfill material shall be compacted to a density equivalent to that of the adjacent soils, or to specified density where applicable.

#### **D Drain Outlets**

##### **D1 Precast Concrete Headwall**

Headwall outlets shall be kept 300 mm (**12 inches**) above ditch grades whenever possible, with the absolute minimum being 150 mm (**6 inches**). The uppermost point of the headwall shall be placed flush with the in-slope at a minimum downward grade of 2 percent to provide easy water exit. The earthen side slopes adjacent to the headwall shall then be shaped to conform to the sides and toe of the headwall. All soils around and under the concrete headwall outlet shall be compacted to the satisfaction of the Engineer to minimize future movement.

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#### D2 Discharge Pipe

The discharge pipe to the drain outlet shall be constructed concurrently with the drains and be laid at roughly right angles to the roadway centerline. The discharge pipe shall be fully inserted/coupled to the headwall. Connections shall be made with 3A Grout, rubber gasket on the pipe, rubber or plastic gasket cast into the headwall, or by solvent or gasket joint into a TP coupling securely cast into the headwall. The coupling method shall secure the pipe well enough so that small movements of the headwall will not cause separation. The Engineer shall approve the method of coupling. The radial connection between the drain pipe and the discharge pipe shall have a minimum radius of 300 mm (**12 inches**) and will provide easy access for probes, cleaners, and video cameras. All connections and solvent joints shall be secure to the extent that they will not decouple during backfilling and will prevent soil intrusion. The Engineer shall approve connection and coupling methods.

The discharge trench shall be constructed similar to the drains, but shall be backfilled with compacted mineral soil to the satisfaction of the Engineer. Discharge pipe grades shall be no less than the drain pipe and a minimum of 2 percent. Crushed or deformed discharge pipe or connection shall be replaced by the Contractor at no cost to the Department. All discharge pipes shall have concrete headwalls attached before termination of the construction season.

#### D3 Turf Establishment

The Contractor shall use seed and an erosion control blankets at the drain outlets except when outlets are placed at a location that will normally be sodded under terms of the Contract.

An erosion control blanket, Category 1, meeting 3885, shall be placed to a minimum width of 2 m (**6.5 feet**) with the headwall centered along the width of the blanket. The blanket shall also extend 1 m (**3 feet**) above the headwall, and 2 m (**6.5 feet**) or to the bottom of the ditch which ever is less below the headwall. Anchor staples shall be placed at ½ m (**1.5 feet**) maximum intervals. When a headwall is placed at a location that will normally be sodded under terms of the Contract, the seed and mulch shall be deleted in favor of sod. Installations shall be watered and maintained in accordance with 2575.3L. Seed installed under the erosion control blanket shall be the same mixture and rate as that designated in the Plan for the immediate surrounding area. In the absence of a seed mixture specified in the Plan, seed mixture 250 shall be placed at the rate of 1 kg/m<sup>2</sup> (**2 pounds per square yard**) before anchoring the blanket.

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### D4 Marking Outlet Locations

The Contractor shall permanently mark the location of all outlets with a 150 by 450 mm (**6 by 18 inch**) strip of white marking tape according to 3354. The Contractor shall place the tape at the outside edge of the bituminous shoulder, at right angles to the roadway, and roll the tape into the shoulder while the bituminous is still hot. When two runs of drain pipe come together at a low point and discharge via a "Y" to a single outlet, the Contractor shall place two markings side-by-side with a 150 mm (**6 inch**) spacing. If there is no bituminous shoulder, the Contractor shall place the tape on the bituminous pavement or spray a white paint strip on concrete pavements. If paint or tape marking is not appropriate, the Engineer may approve alternate methods. The furnishing of, and placement of the tape or paint, is incidental work.

### D5 Inspection and Cleanout

It shall be the responsibility of the Contractor to ensure that once installed, the discharge pipe and headwalls remain clean and operative so that water is not trapped in the pipe, and also to make a final inspection, with the Engineer, of all discharge pipes and headwalls to ensure that they have the proper grade, are clean, properly landscaped, erosion control has been properly installed and maintained, and are generally in satisfactory operating condition.

The inspection shall be conducted with a probe mounted on the end of a flexible fiberglass rod that has the dimensions of 100 mm (**4 inches**) long and a diameter of one nominal pipe size smaller than the drain pipe that is being inspected. The inspection will be conducted through the discharge pipe, radius connection, and at least 1 m (**3 feet**) into the main drainage line to verify that it is open and operative. Discharge pipe and connections that are judged to be inoperative, shall be cleaned or repaired to the satisfaction of the Engineer. Inspections and any required remedial work shall be at no cost to the Department.

## 2502.4 METHOD OF MEASUREMENT

### A Subsurface Drains

Drains will be measured by installed length along the centerline of the pipe. Terminal points of measurement will be the pipe end at free outlets; the point of junction with in-place pipe; or the center of structures, catch basins, or multiple junction points as they apply.

Where subsurface drains are furnished as a part of the Contract, the lengths of each size and type of pipe will be measured separately.

### B Granular Materials

Granular materials for special backfill or bedding will be measured in accordance with 2451.4B.

Measurement on the basis of compacted volume will be limited to the minimum dimensions shown in the Plans.

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**C Precast Concrete Headwalls**

Measurement will be by the number of precast concrete headwalls furnished.

**2502.5 BASIS OF PAYMENT**

Payment of subsurface drains and outlets of each size, type, kind and strength class, at the appropriate Contract prices per unit of measure will be compensation in full for all costs of furnishing and installing the item as specified, except as otherwise provided herein.

For any subdrain elbow or wye sections and necessary additional connectors that are ordered by the Engineer but that are not indicated in the Plan, additional compensation will be made in the amount of the actual invoice cost of the materials involved.

Unless otherwise provided, granular materials for special bedding or backfill will be paid for separately in accordance with 2451.5.

Payment for the drain outlet (precast concrete headwall and discharge pipe) is full compensation for furnishing and placing the unit, erosion control blanket and seed, marking, inspecting, and all other associated work. Where sodding is required, the Engineer will include the sod with other sod quantities on the Project.

No direct compensation will be made for geotextiles or other joint wrapping or sealing materials.

Any trench excavation required below an elevation more than 300 mm below the bottom of the pipe or tile as shown in the Plans will be paid for as Extra Work.

Unless its existence is shown in the Plans, the removal of ledge rock or rocks larger than 0.4 m<sup>3</sup> (½ cubic yard) volume from the excavation will be paid for as Extra Work.

Payment for subsurface drains will be on the basis of the following schedule:

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2502.501	___mm (inch) Precast Concrete Headwall .....	each
2502.502	Drainage System Type _____ .....	lump sum
2502.521	___mm (inch) (1) Pipe Drain (2).....	meter (linear foot)
2502.541	___mm (inch) Perforated (1) Pipe Drain (2) .....	meter (linear foot)
2502.571	___mm (inch) Install (3) .....	meter (linear foot)
2502.573	___mm (inch) Install (3) .....	each

- NOTE: (1) Specify Kind---See 2502.2B  
(2) Specify Strength Class, if other than minimum requirement.  
(3) Specify item name.

**2503**  
**Pipe Sewers**

**2503.1 DESCRIPTION**

This work shall consist of the construction of pipe sewers, using plant-fabricated pipe and other appurtenant materials, installed for conveyance of sewage, industrial wastes, or storm water.

Manhole and catch basin construction shall be in accordance with 2506. Where aprons are required, they shall be furnished and installed under the provisions of 2501.

**2503.2 MATERIALS****A Pipe**

Sewer pipe shall be one of the following kinds as specified or permitted as an option. Unless higher strength pipe is specified, pipe conforming to the lowest strength class covered in the referenced Specification will be acceptable. Special fabrication or jointing details shall be as required by the Plans.

A1	Nonreinforced Concrete (NC) .....	3253
A2	Reinforced Concrete (RC) .....	3236
A3	Corrugated Aluminum (CA).....	3225
A4	Corrugated Steel (CS) .....	3226
A5	Corrugated Aluminized Steel (CAS) .....	3222
A6	Bituminous Coated-Corrugated Steel (BC-CS) .....	3227
A7	Aramid Bonded-Corrugated Steel (AB-CS) .....	3228
A8	Blank	
A9	Corrugated Polyethylene (CP) .....	3247
A10	Plastic Truss (PT) .....	3241
A11	Vitrified Clay (VC).....	3251
A12	Polymeric Coated-Corrugated Steel (PC-CS) .....	3229
	Coating Type shall be as specified in the Contract.	
A13	Thermoplastic .....	3245

**B Flap Gates ..... 3399****C Pipe Joint Sealer Materials**

C1	Hot-Poured Sealing Compound .....	3724
C2	Preformed Rubber, Type A.....	3726
C3	Preformed Plastic, Type B .....	3726
C4	Bituminous Mastic .....	3728

**D Granular Materials..... 3149****2503.3 CONSTRUCTION REQUIREMENTS****A General**

All sewer installations shall be made according to the following requirements.

The requirements of 2451, as they related to the excavation, foundation construction, and backfilling of prefabricated structures,

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shall apply together with the additional requirements or modifications contained herein.

**B Excavation**

Where the cover over the top of the pipe will be 4.5 m (15 feet) or more, that portion of the required excavation that is below an elevation 300 mm (1 foot) above the top of the pipe shall have side slopes as nearly vertical as practicable and, at a point 300 mm (1 foot) above the top of the pipe, the width of the trench shall be no wider than the widths given in the following tabulation:

<u>Pipe Diameter</u>	<u>Maximum Trench Width (300 mm (1 foot) above pipe)</u>
Less than 1050 mm (42 inches)	..... Outside Diameter plus 600 mm (24 inches)
1050 mm to 1350 mm (42 to 54 inches)	..... 1.5 times Outside Diameter
Over 1350 mm (54 inches)	..... Outside Diameter plus 900 mm (36 inches)

If the trench is excavated to a greater width than that authorized according to the above tabulation, the Engineer may direct the Contractor to provide a higher class of bedding, a higher strength pipe, or both, than that required by the Contract; without additional compensation therefor; as the Engineer deems necessary to satisfy the design requirements.

**C Laying Pipe**

The pipe shall be laid to the required line and grade, each section having a firm and uniform bearing throughout its entire length.

Corrugated metal pipes having circumferential joints shall be laid with the outside laps pointing upgrade and with the longitudinal joints on the sides.

Metal pipe sections shall be joined by use of approved metal connecting bands, centered over the joint, and with the pipe sections as close together as possible. The band shall be tightened sufficiently to ensure a tight joint.

Bituminous coated pipe shall be handled with special care to preserve the coating. All exposed metal shall be recoated with a grade of asphalt similar to that originally applied. Fuel oil or similar solvent may be used to facilitate the installation of coupling bands. The paved portion of bituminous coated and paved pipe shall be centered on the flow line.

Clay and concrete pipe shall be laid with the bell or grooved ends upgrade.

All joints in concrete pipe shall be effectively sealed to provide a flexible water tight joint, using an approved elastic joint sealer material (rubber gasket, preformed plastic, bituminous mastic). Where the pipe

## 2503.4

specified is specifically designed to accommodate preformed gasket type seals, the joints shall be sealed with the gasket type designed especially for that type of joint as shown in the Plans and the joints shall meet the performance requirements of AASHTO M 198.

All joints in bell-and-spigot type clay pipe, which are not provided with factory fabricated compression seals, shall be effectively sealed with an approved mastic joint sealer, or by being caulked with asphalt impregnated oakum and filling the remainder of the annular space within the bell with hot-poured joint sealing compound. A pouring collar or other device shall be used to hold the hot sealer until set. When the air temperature is below 0°C (32°F), the pipe shall be heated before pouring the sealer.

Mastic joint sealer materials shall be applied in accordance with the recommendations of the manufacturer. All joints shall be wiped clean on the inside after sealing. Lifting holes shall be plugged with a precast concrete plug, sealed, and covered with mastic or mortar.

Pipe junctions and turns shall be made using standard or specially fabricated fittings.

When a sewer connects with an existing manhole or catch basin, the Contractor shall make a suitable connection through the wall of the manhole or catch basin.

All branch openings or service connections provided for future use shall be plugged with vitrified clay or concrete stoppers sealed in place.

Where specifically required by the Contract, concrete pipe sections shall be tied together with approved fasteners.

### **D Backfill**

The sewer installations shall be backfilled as required by the Plans and in accordance with 2451.

Excavated materials not required for backfill shall be disposed of as directed by Engineer.

### **E Installation by Jacking**

The applicable requirements of 2501.3C1 shall apply to installation of pipe by jacking.

### **F Cleanout**

The sewers shall be free of any debris before final acceptance.

## **2503.4 METHOD OF MEASUREMENT**

### **A Excavation**

Trench excavation shall be incidental to the sewer installation. Measurement of any Extra Work excavation will be as described in 2451.4 for prefabricated structures.

### **B Sewer Pipe**

Each pipe, as classified by Proposal item, will be measured separately by length along the line of the sewer. Terminal points of measurement will be the pipe end at free outlets; the point of junction

#### **2503.4**

with in-place pipe; or the center of manholes, catch basins or multiple junction points as they apply.

Pipe transition sections will be measured as the larger size pipe.

Sections of metal pipe at the outlets of clay or concrete sewers will be considered as metal sewers.

Sewer materials that are furnished by the Department for installation under the Contract will be measured as length of installed sewer, separated as to type but without regard to size.

#### **C Sewer Appurtenances**

Flap gates and other specially identified appurtenant items designated for payment on a per Each basis will be measured separately by the number of units of each type and size incorporated in the sewer structures.

#### **D Granular Materials**

Granular materials for special backfill and bedding will be measured in accordance with 2451.4B.

Measurement on the basis of compacted volume will be limited in width to the maximum trench widths allowed under 2503.3, Excavation.

#### **2503.5 BASIS OF PAYMENT**

Payment for sewer pipe of each size, type, kind, and strength class, at the appropriate Contract prices per unit of measure, will be compensation in full for all costs of furnishing and installing the pipe complete in place as specified, except as otherwise provided herein.

For elbow, tee or wye sections and the necessary additional connectors that are ordered by the Engineer but that are not indicated in the Plans, additional compensation will be made in the amount of the actual invoice cost of the materials involved.

Payment for installing sewer materials provided by the Department will be made under the applicable installation item indicated in the Proposal and, except for Extra Work or work designated under other items, will be considered as full compensation for all the work and additional materials used in installing the sewer complete in place.

Granular materials for special bedding or backfill will be paid for separately in accordance with 2451.5.

Where installation by jacking is permitted, in the absence of a specific pay item therefor, payment will be made on the same basis as if the sewer were installed by the trenching method.

Payment for flap gates at the Contract price per unit will be compensation in full for furnishing and installing the gates complete in place as specified.

Any aprons required in connection with the sewer construction will be paid for separately in accordance with 2501.5.

**2506.1**

Any required excavation more than 300 mm (**1 foot**) below the bottom of the pipe, as shown in the Plans, will be paid for as Extra Work.

Unless its existence is shown in the Plans, the removal of ledge rock or rocks larger than 0.4 m<sup>3</sup> (**½ cubic yard**) in volume from the excavation will be paid for as Extra Work.

Payment for sewers will be made on the basis of the following schedule:

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2503.511	___mm ( <b>inch</b> ) (1) Pipe Sewer (2).....	meter ( <b>linear foot</b> )
2503.519	Flap Gate for (3) Pipe .....	each
2503.521	___mm ( <b>inch</b> ) Span (1) Pipe-Arch Sewer (2).....	meter ( <b>linear foot</b> )
2503.531	___mm ( <b>inch</b> ) (1) Elliptical Pipe Sewer (4) .....	meter ( <b>linear foot</b> )
2503.541	___mm ( <b>inch</b> ) (1) Pipe Sewer, Design (5) (2) .....	meter ( <b>linear foot</b> )
2503.571	Install (6) .....	meter ( <b>linear foot</b> )
2503.573	Install (6) .....	each

- NOTE: (1) Specify Kind---See 2503.2A.  
(2) Specify Strength Class, if other than minimum requirement.  
(3) Specify Size and Kind.  
(4) Specify HE or VE, and Strength Class, if other than minimum requirement.  
(5) Special Pipe or Joint Designs---Give Standard Plate Number.  
(6) Special item name.

**2506**

**Manholes and Catch Basins**

**2506.1 DESCRIPTION**

This work shall consist of constructing or reconstructing brick or concrete block masonry, cast-in-place concrete, precast sectional concrete, or pipe structures, built for the purpose of providing access to underground drainage or other systems for the ingress of surface water into underground drainage systems.

For the purposes of this Specification, precast concrete median drains will be considered to be casting assemblies.

**2506.2**

**2506.2 MATERIALS**

**A Concrete ..... 2461**

3B42 concrete shall be used for cast-in-place structures of Designs A, C, F, or G; and for drop inlet surface block.

3Y43 concrete shall be used in all other cast-in-place structures.

**B Mortar**

Mortar shall conform to ASTM C 270. The cement shall be either Type S masonry cement or 2 to 4 parts of Portland cement to 1 part of Type S hydrated lime. Mortar sand shall have a volume equal to 2.25 to 3 times the total of the volume of cement and lime. Sufficient water shall be added for proper consistency.

The cement and lime shall be air-entrained unless approved otherwise by the Concrete Engineer. The entrained air content of the mortar shall be within the range of 7-10 percent.

B1	Portland Cement .....	3101
B2	Hydrated Lime (Type S) .....	3106
B3	Masonry Cement (Type S) .....	3107
B4	Mortar Sand .....	3128
<b>C</b>	<b>Clay Brick .....</b>	<b>3612</b>
<b>D</b>	<b>Concrete Brick .....</b>	<b>3616</b>
<b>E</b>	<b>Concrete Masonry Units .....</b>	<b>3621</b>
<b>F</b>	<b>Sectional Concrete Manhole/Catch Basin Units .....</b>	<b>3622</b>
<b>G</b>	<b>Clay Pipe, Standard Strength .....</b>	<b>3251</b>
<b>H</b>	<b>Nonreinforced Concrete Pipe .....</b>	<b>3253</b>
<b>I</b>	<b>Blank</b>	
<b>J</b>	<b>Reinforced Concrete Pipe .....</b>	<b>3236</b>
<b>K</b>	<b>Corrugated Steel Pipe .....</b>	<b>3226</b>
<b>L</b>	<b>Metal Drainage Castings .....</b>	<b>3321</b>
<b>M</b>	<b>Concrete Drainage Castings .....</b>	<b>3622</b>
<b>N</b>	<b>Granular Materials .....</b>	<b>3149</b>
<b>O</b>	<b>Blank</b>	
<b>P</b>	<b>Corrugated Aluminum Pipe .....</b>	<b>3225</b>
<b>Q</b>	<b>Corrugated Aluminized Steel (CAS) .....</b>	<b>3222</b>

**2506.3 CONSTRUCTION REQUIREMENTS**

**A General**

**A1 Combination Construction**

The Engineer may permit a combination of cast-in-place and prefabricated concrete construction for those structures where a type of construction is not specified and where structural strength and continuity is maintained.

**A2 Intercepting Existing Facilities**

Where the new structure will intercept an existing underground facility, the existing facility shall be incorporated into the structure to the extent required, including any necessary removal, replacement, or

**2506.3**

special connections, without detriment to the planned function of the facility.

**A3 Abandoned Pipes**

Any abandoned pipes that enter a structure that will not be abandoned shall be detached from the structure and the wall opening shall be permanently plugged with concrete or masonry. The upgrade end of the abandoned pipes shall also be plugged with concrete or masonry.

**A4 Excavation, Bedding, and Backfill**

Excavation, bedding, and backfill construction requirements shall be as indicated in 2451.

**A5 Inspection Before Construction**

Mortar shall not be placed in any unit or section of work, until the Engineer has inspected and approved the required foundation preparations, materials, and provisions for cold weather protection.

**A6 Temperature Restrictions**

**A6a** Mortar shall not be placed on a frozen foundation or against any surface with a temperature below freezing.

**A6b** Concrete or mortar production shall not commence or continue when the air temperature at the construction site in the shade or away from artificial heat is below 2°C (**36°F**):

- (1) Unless authorized by the Engineer when the air temperature is rising and has reached 1°C (**34°F**).
- (2) Unless provisions satisfactory to the Engineer have been made in advance for cold weather protection.

**A6c** Masonry units or aggregate whose temperature is 0°C (**32°F**), or less, shall not be used except under direct supervision of the Engineer.

**A6d** All concrete or mortar mixes shall have a temperature of not less than 10°C (**50°F**) nor more than 32°C (**90°F**). The mix shall be maintained within this temperature range until it is deposited in the work.

**A6e** The Engineer may approve heating of masonry units, mix materials, or mortar by an approved heating system operated in an acceptable manner. Spot heating of such materials by means of steam jets or direct application of combustion heating devices, as the work progresses, will not be permitted.

**B Cast-In-Place Concrete ..... 2411**

**C Masonry**

The following requirements shall apply when part or all of the structure is constructed using clay brick or concrete masonry units. The term, "unit", as applied herein, shall refer to either the brick or concrete block unless otherwise qualified.

### 2506.3

Concrete masonry units shall not be moistened prior to placement in the work, but all other types of masonry units shall be moistened before being laid.

Units shall be laid in a full mortar bed, in horizontal courses, using the "shove joint" method. All joints shall be filled with mortar. Joints on the inside of the structure shall be no more than 13 mm ( $\frac{1}{2}$  inch) wide and shall be struck. The outside of the structure shall be plastered with mortar to a smooth surface.

Steps, pipes, or other required fixtures shall be installed as the work progresses. The units shall be fitted carefully around any pipes that penetrate the structure, using only part of a unit as necessary to form a neat juncture at the pipe. All attachments to the structure shall be bonded using mortar to fill all voids.

Where the manhole/catch basin is constructed of brick, the following additional requirements shall apply:

- (1) In circular type structures, the bricks shall be laid flat and radially, with the ends exposed on the inside of the structure. Where the thickness of the wall is greater than the length of one brick, the outside bricks may be laid circumferentially, using full header construction in at least each sixth course.
- (2) In rectangular type manholes, the bricks shall be laid in regular courses of stretchers, using full header construction in at least each sixth course. No bats or spalls shall be used except for shaping around openings or for finishing out a course, in which case full bricks shall be placed in the corners and the bats in the interior of the course. The least dimension of the exposed faces of bats shall be not less than 50 percent of the width of a brick.

Where the Contractor elects to use the alternate method of constructing the tapered portion of a manhole with concrete block, as shown in the Plans, specially shaped concrete units shall be used to transition between the vertical and the sloped walls.

#### **D Sectional Concrete**

The bottom pre-cast section shall be set in a full mortar bed and the joints between sections and around pipes shall be filled with mortar or an approved plastic cementing compound.

#### **E Pipe**

Metal or concrete pipe manholes shall be constructed in accordance with the details shown in the Plans.

#### **F Castings**

The frame or ring castings shall be set to the designated elevation on a full mortar bed except when metal pipe construction is used.

Where the Plans indicate that the casting shall not be bonded to the manhole/catch basin, the mortar bed shall be finished to the required

#### 2506.4

grade and allowed to set, after which an approved lubricant shall be applied thereto and the casting installed.

##### **G Adjusting Frame or Ring Castings**

Vertical adjustment of access castings shall be made to the planned elevation on the existing structure, based on the criteria that full support for the casting is obtained above the cone section and that the structure construction above the cone does not exceed 600 mm (2 feet). Where these criteria cannot be maintained in the adjustment work, the structure shall be reconstructed.

For upward adjustment of castings, any of the structure materials or applicable construction methods indicated herein which are compatible with the in-place construction may be used. Auxiliary ring castings and adjusting rings, as indicated in the Plans, may be used as they apply.

##### **H Reconstructing In-Place Structures**

When the Plans call for a portion of the manhole/catch basin to be reconstructed, or when the frame or ring casting is to be raised or lowered beyond the limits defined in 2506.3G above, the structure shall be reconstructed to the extent shown in the Plans or directed by the Engineer.

Reconstruction shall be consistent, so far as possible with the type of construction used for the in-place structure. The work shall conform to the requirements specified above for new construction except that the salvaged material may be used if of acceptable quality. New work shall be thoroughly bonded to the old.

##### **I Blank**

##### **J Construction in Conjunction with Pavement Construction**

When manholes/catch basins are constructed, reconstructed or adjusted, in connection with the construction of a concrete pavement or base, the telescoping type of ring shall be used unless otherwise specified in the Plans.

When the telescoping type of ring is required, the frame or ring casting shall be set to the proper elevation before the pavement is placed.

##### **K Backfilling**

When the structure is made of cast-in-place concrete or of bricks or blocks laid in mortar, the backfilling shall not be made until at least 3 days have elapsed after the completion of the manhole or catch basin.

Excavated materials not required for backfill shall be disposed of as directed by the Engineer, within a haul distance of 1 km (½ mile).

#### **2506.4 METHOD OF MEASUREMENT**

Manholes and catch basins will be measured as drainage structures.

#### 2506.4

##### **A Constructing Drainage Structures**

When measurement by length is specified, for vertical structures constructed on a concrete base, the length measurement will be the difference in elevation between the bottom of the casting and the invert elevation of the outlet pipe, plus an allowance of 0.20 m (**0.70 foot**) for the depth of the concrete base, regardless of its actual thickness.

When measurement by length is specified, for pipe structures where the design provides for the use of a "tee" section in the sewer or culvert line, the length measurement will be the difference in elevation between the bottom of the casting and the flow line elevation of the sewer or culvert pipe in the case of vertical construction, or as shown in the Plans in the case of other special designs not constructed vertically. The "run" of the "tee" section will also be measured and paid for as culvert or sewer pipe, as the case may be.

When measurement by the structure is specified, drainage structures of each design will be measured separately as individual units complete in place, including any castings furnished and installed.

##### **B Reconstruction**

Measurement will be made, to the nearest 30 mm (**1/10 foot**), of the height from the bottom of the reconstructed portion to the bottom of the newly set casting, with no regard as to type.

##### **C Castings**

Measurements for casting assembly will be by the number of casting assemblies furnished and installed.

Measurements for install casting will be by the number of castings installed by the Contractor.

No measurement will be made of castings for structures that are measured as a unit. All castings required for an individual structure will be considered as one assembly.

##### **D Adjusting Castings**

Measurement will be by the number of casting assemblies adjusted, all castings in any one structure being considered as one assembly.

#### **2506.5 BASIS OF PAYMENT**

Manholes and catch basins will be paid for as drainage structures.

Payment for constructing or reconstructing drainage structures at the appropriate Contract prices will be compensation in full for all costs of the work (including all necessary excavation) except those costs for which the Proposal contains specific items, subject to the following additional provisions:

- (a) Any excavation that is in ledge rock and the removal of boulders or detached rocks each having a volume of more than 0.4 m<sup>3</sup> (**½ cubic yard**) will, unless the existence of such rock is shown in the Plans, be paid for as Extra Work.

**2506.5**

- (b) Payment for reconstructing drainage structures includes removal of the existing casting but does not include placement of a casting on the reconstructed structure.
- (c) Payment will be made for the removal and replacement of concrete base or concrete pavement when, except for the structure construction, the surface would not otherwise have been disturbed. Payment will be at the appropriate unit prices on the basis of the area, to the nearest 0.1 m<sup>2</sup> (**1/10 square yard**), within a rectangle having sides that lie ½ m (**1 ½ feet**) outside of the structure limits. No direct compensation will be made for removing and replacing any pavement outside of these limits or for replacing any other type of surfacing.
- (d) Payment for drainage structure construction by the structure as individual units complete in place will be compensation for furnishing and installing any castings required.
- (e) No direct payment will be made for removal and replacement of concrete surfacing in connection with the item of adjust frame and ring castings.
- (f) Granular materials for special bedding or backfill will be paid for in accordance with 2451.5.

Payment for drainage structures will be made on the basis of the following schedule:

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2506.501	Construct Drainage Structure,.....	
	Design ____ .....	meter ( <b>linear foot</b> )
2506.502	Construct Drainage Structure, Design ____ .....	each
2506.503	Reconstruct Drainage Structure .....	meter ( <b>linear foot</b> )
2506.516	Casting Assembly .....	each
2506.521	Install Casting .....	each
2506.522	Adjust Frame and Ring Casting.....	each

2511

**2511  
Riprap**

**2511.1 DESCRIPTION**

This work shall consist of furnishing and placing stone riprap, with or without grouting as specified, at the locations shown in the Plans or ordered by the Engineer, as a protective covering on earth slopes, piers, abutments, walls, or other structures, where the soil is susceptible to erosion.

Riprap will be classified by type as random riprap, handplaced riprap, or quarry-run riprap, depending on the method of placement and the stone size specified. Riprap shall be grouted when specified in the Contract or ordered by the Engineer. The riprap shall be placed on a filter layer consisting of granular material or geotextile unless otherwise specified.

**2511.2 MATERIALS**

<b>A</b>	<b>Riprap Materials</b> .....	<b>3601</b>
<b>B</b>	<b>Filter Materials</b>	
B1	Granular Filter .....	3601
B2	Geotextile Filter .....	3733
<b>C</b>	<b>3A-Grout</b> .....	<b>2461</b>

**2511.3 CONSTRUCTION REQUIREMENTS**

**A General**

The foundation for the riprap, with or without filter material, shall be excavated and shaped to the cross-sections indicated in the Plans, unless otherwise directed by the Engineer. All loose foundation material shall be thoroughly compacted before placement of the riprap or filter material.

When riprap is required, the Contractor shall place a thickness of 300 mm (**1 foot**) of riprap on a filter material unless otherwise indicated in the Contract or ordered by the Engineer.

**B Filter Material**

The Contractor shall place filter material under the riprap unless otherwise specified in the Contract. Filter material shall cover the entire area on which the riprap is to be placed. The Contractor may choose the type of filter material, except as restricted for geotextile filters, unless the type is specified in the Contract.

**B1 Granular Filter**

When granular filter is used, the thickness shall be 150 mm (**6 inches**) unless other dimensions are specified.

Granular filter materials shall be spread to uniform thickness over the prepared foundation. Granular material placed under water shall be deposited directly on the foundation by means of a bucket or similar container. Discharging the granular material above the water surface will not be permitted.

## 2511.3

### B2 Geotextile Filter

Wherever geotextile filter material is placed, the Contractor shall ensure that:

- (a) The foundation surface is relatively smooth and free of stones, sticks, and other debris or irregularities that might puncture the fabric.
- (b) Placing material or conducting construction operations do not tear, puncture, or shift the fabric.

Where multiple fabric widths or lengths are required, they shall be placed with the longest dimension parallel to the direction of water flow. If not seamed, splices and joints shall be overlapped a minimum of 0.5 m (**18 inches**), except that under water the overlap shall be 1 m (**36 inches**). The joint laps shall be shingled (both in the flow direction and from top of slope to bottom) so as to direct water flow over the joint without undermining. In lieu of joint overlapping, multiple fabric pieces may be sewn to meet appropriate sections of 3733. Upgrade edges of the fabric area shall be buried sufficiently to direct water flow over the fabric without undermining. If not seamed, washered steel pins, edge stakes, stones, etc. shall be placed at locations and in quantities as approved by the Engineer, to prevent movement of the geotextile filter during placement of the riprap.

Dumping of stone at the top of the slope and rolling of stone down the slope will not be permitted. When stones are placed directly on the geotextile filter without a granular cushion, equipment will not be permitted to operate on top of the stones once they are placed. Construction equipment shall not operate directly on top of the geotextile.

Geotextile filter material shall not be used under handplaced or grouted riprap unless so specified.

Geotextile filter may be used only on 1 vertical to 3 horizontal or flatter slopes, unless slopes up to 1 vertical to 2 horizontal are stepped (terraced) before fabric placement.

### C Riprap Stone

Stones shall not be dropped on the fabric from a height greater than 0.3 m (**1 foot**) unless the fabric is covered with a 150 mm (**6 inch**) thick granular cushion course, in which case the riprap stone may be dropped from a height not greater than 1 m (**3 feet**).

Riprap shall generally be placed by starting at the lowest elevations and working upwards.

Before placement of riprap stone on geotextile, the Engineer may require the Contractor to demonstrate that the placement methods will not damage the fabric. The Engineer may order the removal of at least 3 m<sup>2</sup> (**4 square yards**) of riprap to inspect for fabric damage, subject to 1511.

### 2511.3

#### C1 Random Riprap

Random riprap shall be positioned in a manner that will provide uniform distribution of the various sizes of stone and produce a dense, well-keyed layer of stones with the least practical quantity of void space. The surface shall be leveled as necessary, to produce a reasonably uniform appearance and the required thickness.

#### C2 Hand-Placed Riprap

The stones for hand-placed riprap shall be firmly embedded in the foundation material, with the axis of the stone that most nearly approximates the specified thickness of riprap laid perpendicular to the foundation slope. Stones shall be laid with minimum practicable quantity of space between them and positioned to stagger the joints up the slope. Each stone shall be so placed that its mass is carried by the foundation material as well as adjacent stones.

The ends and edges of each riprap area shall be well defined using selected stones set to line and grade.

After the larger stones have been laid, the spaces between the stones shall be filled with firmly seated, smaller stones to produce a uniform surface.

#### C3 Quarry-run Riprap

Quarry-run riprap shall be placed as specified for random riprap.

### D Grouting

For grouted riprap, the Contractor shall eliminate some of the smaller stones so that the spaces between stones, throughout the entire thickness of the riprap, are filled with grout.

Immediately before placing the grout for grouted riprap, the stones shall be thoroughly wetted with water. Grout shall not be poured over stones that have become surface dry. The surface of the grouted riprap shall be finished by sweeping with a stiff broom.

### E Thickness Requirements

The riprap on each separate area shall have, upon completion, a minimum thickness of not less than 80 percent of the specified thickness and an average thickness of not less than 95 percent of the specified thickness, as measured at right angles to the face.

## 2511.4 METHOD OF MEASUREMENT

### A Riprap

Riprap of each type and class measured by volume will be computed on the basis of actual surface dimensions as staked and the specified thickness.

Riprap of each type and class measured by mass will be based upon scale tickets of materials delivered and placed within the staked areas.

2512.2

**B Filter Materials**

Filter materials measured by mass will be based upon scale tickets of material delivered and placed within the staked areas.

Filter materials measured by volume will be computed on the basis of actual surface dimensions as staked and the specified thickness.

Geotextile filter material measured by area will be computed on the basis of actual surface dimensions as staked, with no allowance for overlaps or seams.

**2511.5 BASIS OF PAYMENT**

The Contractor will accept payment for riprap of each type and class at the Contract price per unit of measure as compensation in full for all costs of furnishing the required materials; excavating and preparing the foundations; and placing the riprap stone, grouting, and filter materials as specified. The Contractor will receive separate compensation for filter materials only when the Contract contains the appropriate pay items.

Payment will be as follows:

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2511.501	Random Riprap, Class ____ .....	cubic meter <b>(cubic yard)</b>
2511.502	Random Riprap, Class ____ .....	metric ton <b>(ton)</b>
2511.503	Quarry-run Riprap .....	cubic meter <b>(cubic yard)</b>
2511.504	Quarry-run Riprap .....	metric ton <b>(ton)</b>
2511.505	Hand-placed Riprap.....	cubic meter <b>(cubic yard)</b>
2511.507	Grouted Riprap .....	cubic meter <b>(cubic yard)</b>
2511.511	Granular Filter ____ .....	cubic meter <b>(cubic yard)</b>
2511.513	Granular Filter Material .....	metric ton <b>(ton)</b>
2511.515	Geotextile Filter, Type ____ .....	square meter <b>(square yard)</b>

**2512**

**Gabions and Revet Mattresses**

**2512.1 DESCRIPTION**

Furnish and construct gabions and revet mattresses (placing stone in wire baskets) at the locations shown in the Plans or ordered by the Engineer.

**2512.2 MATERIALS**

<b>A</b>	<b>Riprap Materials</b> .....	<b>3601</b>
<b>B</b>	<b>Filter Materials</b>	
B1	Granular Filter .....	3601
B2	Geotextile Filter .....	3733
<b>C</b>	<b>Gabions</b> .....	<b>3602</b>
<b>D</b>	<b>Revet Mattresses</b> .....	<b>3602</b>

**2512.3**

**2512.3 CONSTRUCTION REQUIREMENTS**

**A General..... 2511.3**

The Contractor shall:

- (1) Excavate, shape, and compact the foundation to the elevation and alignment indicated in the Contract.
- (2) Furnish and place filter material, unless otherwise stated in the Contract.
- (3) Furnish and place gabions and revet mattresses.

**B Filter Material**

The Contractor shall place filter material over the entire area on which the gabions and revet mattresses are to be placed.

- B1 Granular Filter ..... 2511.3
- B2 Geotextile Filter ..... 2511.3

The Contractor may place geotextile filter material under gabions and revet mattresses on slopes without stepping when specified in the Contract or approved by the Engineer.

**C Baskets and Fasteners**

**C1 Documentation**

The Contractor shall provide:

- (a) Certification that the baskets and fasteners meet the requirements.
- (b) Manufacturer's drawings of the baskets and fasteners.
- (c) Manufacturer's assembly recommendation and instructions for the baskets and fasteners.

**C2 Construction**

The Contractor shall install the baskets to the dimensions, profile, and alignment shown in the Contract or ordered by the Engineer.

The Contractor shall:

- (a) Assemble the baskets according to the manufacturer's recommendations unless the following requirements, 3602, or the Plan state otherwise.
- (b) Place and fasten the diaphragms in the baskets to the side and bottom mesh so that cell dimensions are not more than 1 m (**3 feet**).
- (c) Fasten adjoining empty baskets together at their perimeters.
- (d) Place stones in the cells of baskets in a manner that will minimize voids, does not allow sharp edges to protrude through the mesh, and maintains the basket in the dimensions shown in the Plans. This will require some stones to be hand-placed.
- (e) Generally fill cells in 300 mm (**12 inch**) lifts. Fill cells of up to 300 mm (**12 inches**) in one lift. Fill cells of up to 450 mm (**18 inches**) in two equal lifts. Do not fill cells more than 300 mm (**12 inches**) higher than stone layers in adjacent cells or baskets.

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- (f) For twisted wire gabions place horizontal connecting wires on top of the stone layer in both directions where there is not a supporting basket, to prevent the sides from bulging. For welded wire gabions install preformed stiffeners across the corners of the gabions before filling. Two rows of stiffeners (4 per cell) are required for the front face and the side faces. A single row of stiffeners (2 per cell) is required on the back face. No stiffeners are required in interior cells. Preformed stiffeners shall have a nominal length of 450 mm (**18 inches**). The stiffeners should be hooked at crossing wires. Lacing wire may be used as a stiffener.
- (g) Fold the top of baskets shut and fasten to the ends, sides, diaphragms, and adjacent baskets, after the basket is filled.
- (h) Stack empty baskets on filled baskets and fasten to the filled baskets at front, exposed sides, and back before filling.
- (i) Blank
- (j) Stagger the vertical joints between the baskets of adjacent rows and layers unless otherwise shown in the Contract.
- (k) Blank
- (l) Backfill behind a gabion structure simultaneously with the cell filling operation.

**C3 Fasteners**

The Contractor may use either lacing wire, an approved alternative fastener, or a combination, to fasten the baskets.

**C3a Lacing Wire**

The Contractor shall place lacing wire at each joint alternating single and double loops every 75 to 150 mm (**3 to 6 inches**).

**C3b Alternative Fastener**

The Contractor shall place alternative fasteners at each joint at every mesh opening. If spiral binders are used they shall be adequately secured at the ends to prevent unwinding.

**D Acceptance**

The Engineer may consider the work as unacceptable if visible baskets have a variation of more than 150 mm (**6 inches**) from the profile or alignment shown in the Plans or as directed by the Engineer.

**2512.4 METHOD OF MEASUREMENT**

**A Gabion and Revet Mattress**

The Engineer will measure the gabion and revet mattress construction by volume, based on the nominal basket dimensions and the number of baskets incorporated into the work.

**B Filter Materials ..... 2511.4**

**2512.5 BASIS OF PAYMENT**

The Department will make payment for gabions and revet mattresses at the Contract price per unit of measure as full

**2512.5**

compensation for all costs of furnishing the required materials, excavating and preparing the foundations, furnishing and installing filter materials, and constructing and filling the gabions and revet mattresses as specified.

The Department will make separate compensation for filter materials only when the Contract contains the appropriate pay items as listed in 2511.

The Department will pay as follows:

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2512.517	Gabion .....	cubic meter <b>(cubic yard)</b>
2512.519	Revet Mattress .....	cubic meter <b>(cubic yard)</b>

**2514**  
**Slope Paving**

**2514.1 DESCRIPTION**

This work shall consist of paving embankment slopes and waterways with Portland cement concrete or crushed aggregate, as specified, to provide erosion protection.

**2514.2 MATERIALS****A Concrete ..... 2461**

Unless otherwise specified, the concrete shall meet the requirements for Mix Designation 3A34, except that the slump requirement may be adjusted as approved by the Engineer to achieve the desired results.

**B Reinforcement Bars ..... 3301**

Reinforcement shall be either Grade 300 or Grade 420 (**Grade 40 or Grade 60**) deformed billet Steel, of ASTM A 615/A 615M.

**C Preformed Joint Filler ..... 3702****D Bituminous Material ..... 3151**

Bituminous material for stabilizing aggregate slope paving shall be Liquid Asphalt, Grade MC-250, MC-800, or Emulsified Asphalt, Grade CSS-1, CSS-1H, RS-1, or CRS-2.

**E Aggregate**

The material for aggregate slope paving shall conform to 3137 for gradation class CA-1, CA-2, or CA-3, except that the fourth paragraph of 3137.2E (multiple fraction requirement) shall not apply.

**2514.3 CONSTRUCTION REQUIREMENTS****A Foundation Preparations**

The foundation upon which the paving material is to be placed shall be prepared as necessary to achieve the specified paving dimensions and surface elevations as indicated in the Plans or directed by the Engineer. Foundation preparations shall include the excavating of high spots and the filling and compacting of low spots until the foundation conforms to the required elevation and slope and is of uniform density.

In the event the rough grading was performed by others under another contract and the Engineer determines that there is either a shortage or excess of material to construct to the planned foundation elevations, the Engineer may make such minor adjustments in grade to balance out the available material or may order the placement of additional material from other sources or the removal and outside disposal of excess material, as may be required to achieve acceptable foundation elevations. The furnishing and placing of additional material and the removal and outside disposal of excess material by order of the Engineer will be compensated for as Extra Work to the extent that loading and hauling of the material is necessary. Excess material disposed of on areas adjoining the slope paving as directed by

### 2514.3

the Engineer, without loading and hauling, will not be compensated for separately as Extra Work but will be considered as being incidental to the slope paving item.

#### **B Aggregate Slope Paving**

The aggregate shall be deposited, spread, consolidated, and shaped by mechanical or hand methods that will provide uniform depth and density and produce uniform surface appearance. Liquid asphalt shall be applied when ambient air temperature is not less than 5°C (40°F), at an approximate rate of 8 L/m<sup>2</sup> (1.8 gallons per square yard). Emulsified asphalt shall be applied when ambient air temperature is not less than 10°C (50°F), at an approximate rate of 11 L/m<sup>2</sup> (2.5 gallons per square yard). Bituminous materials shall penetrate to a depth of not less than one-half the required thickness of the aggregate slope paving. Adjacent structure surfaces shall be protected against bituminous splatter.

#### **C Concrete Slope Paving**

Construction shall be in accordance with the applicable provisions of 2401. The concrete shall be placed, consolidated, struck-off, and hand floated as will secure dense pavement relatively free of voids and cavities and produce uniform surface appearance. Side forms shall be so set and supported and the concrete so finished as to result in surfaces that do not deviate from a true plane and the prescribed grade by more than plus or minus 13 mm (½ inch). Metal reinforcement and preformed filler material shall be placed as required by the Plans and shall be suitably supported to maintain correct position during concrete placement.

Toe walls and side walls shall be formed and cast prior to placing concrete for contiguous slope paving. The subgrade shall be moist at the time of concrete placement, and care shall be taken to prevent subgrade displacement and contamination of the concrete. The slope paving shall either be placed in equally spaced alternate strips running in the direction of maximum slope, or in full width sections when mechanical equipment adequate for such placement and finishing is provided.

Immediately after placement the concrete shall be consolidated and struck off. When the concrete has set sufficiently to maintain shape, the surface shall be struck off again, after which the surface shall be given a final finish by hand floating with a cork or wood float and then broomed to produce a uniform texture and appearance.

After the final floating, all edges not formed with v-strip inserts shall be finished with a suitable edging tool and all panel lines shall be cut with suitable grooving tools or they may be sawed as directed by the

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Engineer. All edging and grooving flange trails shall be obliterated by floating to secure uniform surface appearance.

After completion of the concrete finishing operations, all exposed surfaces shall be given curing protection in accordance with 2401.3G until a strength gain of at least 30 percent has been attained.

**2514.4 METHOD OF MEASUREMENT**

Slope paving of each type will be measured separately by area of top surface, bounded by the outside edges of abutment faces, toe walls, side walls or timber planks, as constructed and accepted for payment.

**2514.5 BASIS OF PAYMENT**

Payment for slope paving of each type specified at the Contract price per unit of measure of surface area will be compensation in full for all costs of constructing the work complete in place as specified.

Payment for slope paving will be made on the basis of the following schedule:

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2514.501	Concrete Slope Paving .....	square meter ( <b>square yard</b> )
2514.503	Aggregate Slope Paving .....	square meter ( <b>square yard</b> )

**2520**

**Lean Mix Backfill**

**2520.1 DESCRIPTION**

This work shall consist of placing a lean cementitious backfill into utility and culvert trenches, or other such excavations, where the use of conventional compacting equipment is deemed inappropriate or impractical. It is neither a low strength concrete nor a soil cement, but is a controlled-density backfill material.

**2520.2 MATERIALS**

<b>A</b>	<b>Cement</b> .....	<b>3101</b>
<b>B</b>	<b>Fly Ash</b> .....	<b>3115</b>
<b>C</b>	<b>Fine Aggregate</b> .....	<b>3126</b>
<b>D</b>	<b>Coarse Aggregate</b> .....	<b>3137</b>

The provisions of 3137.2C and 3137.2D shall not apply.

<b>E</b>	<b>Water</b> .....	<b>3906</b>
<b>F</b>	<b>Admixtures</b> .....	<b>3113</b>

**2520.3 MIX REQUIREMENTS**

**A Mix Design and Control**

Lean mix backfill design shall be governed by the absolute volume relationships; and basic mix proportions set forth herein for the control of cement, fly ash, water, and aggregate content; and the degree of workability necessary for proper placement.

**2520.3**

**A1 Tentative Material Proportioning**

The proportions shall be such as to obtain the flowability, workability, and consistency required for the Project. Once the Contractor provides the Concrete Engineer with the source of materials, the Concrete Engineer will, within 10 days, furnish a mix design for the use on this Project. This design will be based on the following proportions per unit batch (volume approximately 1 m<sup>3</sup> (**cubic yard**)).

Cement ..... 75 kg (**125 lbs**)  
Fly Ash..... 150 kg (**250 lbs**)  
Water..... 225 kg (**375 lbs**)

The remaining volume\* will consist of:

Fine Aggregate .....50%  
Coarse Aggregate .....50%

Gradation Range 6 as shown in 2461.3B4

\*Up to 30 % of the aggregate by volume may be replaced by pre-formed foam. The foaming agent shall comply with ASTM C-869 when tested in accordance with ASTM C-796. Other admixtures may be used when specifically approved by the mix designer and Mn/DOT's Concrete Engineer.

**A2 Mix Requirements**

Slump 250 mm ± 25 mm (**10 inch ± 1 inch**)

Unconfined Compressive Strength:

Minimum desirable: 500 kPa (**75 psi**) at 28 days

Maximum desirable: 2750 kPa (**400 psi**) at 28 days

**A3 Job Mix Proportions**

The tentative job mix will be designed based on the above proportions for use at the start of construction and until the required water content and strengths can be determined. Experience from previous work using the same material sources may be used to modify the tentative proportions.

**A4 Mix Adjustments**

The Department reserves the right to make adjustments in the mix any time as may be found necessary to maintain the specified consistency and strengths.

**B Production Controls**

The production shall meet the requirements of 2461.4 A1, A2, A3, and A5 except where the word concrete is used it shall be understood to mean lean mix.

**C Batching and Mixing Requirements**

**C1 Proportioning Methods**

Lean mix batch materials shall be proportioned by mass (weight) except where volumetric proportioning is authorized in writing by the Engineer.

## 2520.5

### C2 Other Batching and Mixing Requirements

These requirements shall meet 2461.4 B2, B3, B4, B5, and 2461.4C except that the word concrete shall be understood to mean lean mix.

### D Ready-Mixed Lean Mix Backfill

The provisions of 2461.4D, Ready-Mix Concrete, shall apply except that the word concrete shall be understood to mean lean mix.

### E Construction Requirements

The mix has a very high slump, flowability and workability, that eliminates the need for labor-intensive vibration and compaction. The mix consistency is similar to that of a slurry and as such will seek its own level; therefore, it is the responsibility of the Contractor to plug openings below the level of the desired backfill that would permit escape of the mix. The lean mix shall be placed so that it flows around and beneath such footings, foundations, walls, pipes, or other structures it was designed to support. When properly placed, the material is self-compacting, self-densifying, and has sufficient plasticity that compaction or mechanical vibration is not required. Air pockets that water would normally fill must be vented or otherwise eliminated so as to preclude voids remaining in the completed backfill.

### E1 Curing and Protection

The air in contact with lean mix backfill surfaces should be maintained at temperatures above freezing for a minimum of 72 hours.

There is a substantial water gain (bleeding) on the surface that is normal. Once this water has evaporated no other means of curing is deemed necessary.

## 2520.4 METHOD OF MEASUREMENT

Only when payment is prescribed under the following provision will the quantity of lean mix backfill produced and furnished be measured as a separate pay item. Then, the volume of the lean mix backfill will be measured as the computed, theoretical volume based on the mass of the individual batch ingredients. The quantities so determined will be reduced for payment by all accountable waste.

## 2520.5 BASIS OF PAYMENT

In general payment for lean mix backfill will be considered as incidental to other work as would common backfill.

Should the Department determine a need exists for such a pay item, it will be shown in the Plans. Payment will be made at the Contract price per unit of measure. This will be compensation in full for all costs of producing and furnishing the lean mix backfill and for all costs of forming, plugging, placing, venting, protecting as required except for such costs that are specifically compensated for under other Contract items.

**2520.5**

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2520.501	Lean Mix Backfill .....	cubic meter ( <b>cubic yard</b> )

**2521  
Walks**

**2521.1 DESCRIPTION**

This work shall consist of bituminous or concrete walkway construction in accordance with these Specifications and close conformity with the lines and grades indicated in the Plans or established by the Engineer.

**2521.2 MATERIALS**

<b>A</b>	<b>Concrete, Mix No. 3A32.....</b>	<b>2461</b>
	<b>Concrete, Mix No. 3A36.....</b>	<b>2461</b>
<b>B</b>	<b>Preformed Joint Filler.....</b>	<b>3702</b>
<b>C</b>	<b>Blank</b>	
<b>D</b>	<b>Concrete Treating Oil .....</b>	<b>3917</b>
<b>E</b>	<b>Bituminous Mixture, Type as Specified .....</b>	<b>2360</b>
<b>F</b>	<b>Curing Materials</b>	
F1	Curing Paper.....	3752
F2	Plastic Sheeting .....	3756
F3	Membrane Curing Compound .....	3754
F4	Extreme Service Membrane Cure .....	3755
<b>G</b>	<b>Granular Materials .....</b>	<b>3149</b>

**2521.3 CONSTRUCTION REQUIREMENTS**

**A Foundation Preparations**

The foundation shall be excavated, shaped, and compacted to a firm, uniform bearing surface, conforming to the planned section and established grade. Unsuitable subgrade soils shall be removed and replaced as directed. Granular material, as specified and where required by the Plans, shall be furnished, placed, and compacted thoroughly to the required depth.

**A1 Sawing Concrete Walk**

This work shall consist of sawing existing concrete walk to produce a neat line from which to extend the new work.

**B Forms**

Forms shall be of wood or metal, coated on the contact face with form treating material, and in a condition that will allow proper finishing and subsequent form removal. The form height shall be at least that of the planned walk thickness.

**C Concrete**

**C1 Placing and Finishing Concrete**

The foundation and forms shall be thoroughly wetted immediately prior to the placing of the concrete. The concrete shall be placed,

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consolidated to fill all voids, struck off to the required grade, and floated smooth. After the water sheen has disappeared, the joints shall be edged and the surface lightly brushed to a uniform texture.

The surface shall not vary more than 5 mm (**3/16 inch**) from a 3 m (**10 foot**) straight edge, and the formed concrete shall be within 13 mm (**½ inch**) of the required location.

Forms shall remain in place for a minimum 12 hours after placing the concrete therein unless earlier removal is authorized by the Engineer.

#### C1a Exposed Aggregate Finish

Concrete Mix No. 3A36, modified for exposed aggregate construction shall conform to the requirements of Mn/DOT 3137 CA-50 and be multi-colored rounded stone.

Provide an exposed aggregate finish using surface retardation to produce a medium to deep exposure, so that the aggregate becomes the dominant surface feature. Embedment or top seeding of aggregate is not permitted.

Apply retardant coating as soon after the concrete surface has been screeded, edged, and jointed. Retardant shall be applied in accordance with the manufacturer's instructions to produce a 6 mm ( $\pm 2$  mm) (**1/4 inch ( $\pm 1/8$  inch)**) etch of mortar removal after final set.

Surface mortar shall be removed by washing with water under pressure. Avoid excessive pressure which loosens individual aggregate particles.

Following approval of the exposed aggregate finish obtained, a 10 percent muratic acid wash shall be applied to the exposed aggregate surfaces. Surfaces shall be flushed thoroughly with water following a 5 to 10 minute interaction period between the acid solution and the surface.

Curing of the concrete shall be continued by covering with white polyethylene sheeting. Any staining or streaking of the exposed aggregate surface resulting from the moist curing shall be removed before applying the sealer.

The exposed aggregate finish shall be sealed with two coats of a clear acrylic based compound with 18 percent minimum solids conforming to ASTM C309.

#### C2 Joint Construction

The walk shall be divided into panels of uniform size, outlined with contraction or expansion joints as required by the Plans. The panels shall be square where practicable and generally have not more than 3 m<sup>2</sup> (**36 square feet**) of area.

Joints shall be vertical and straight, and be parallel with or at right angles to the walk centerline where possible. The joints shall align with

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like joints in adjoining work unless the work is isolated by 13 mm (**½ inch**) preformed joint filler.

All joints and edges of the walk shall be rounded with a 6 mm (**¼ inch**) radius edging tool.

Contraction joints shall extend to at least 30 percent of the walk thickness and shall be approximately 3 mm (**1/8 inch**) wide.

Expansion joints shall be 13 mm (**½ inch**) wide and shall be equal in depth to the full thickness of the walk.

Joint construction at locations where a fixed object or structure extends through the walk shall be modified to the extent deemed necessary by the Engineer. Preformed joint filler material, 13 mm (**½ inch**) thick, shall be placed adjacent to all fixed objects so as to separate the object from the abutting concrete edges.

#### C3 Concrete Curing and Protection

After the finishing operations have been completed and as soon as the set of the concrete permits, the concrete shall be cured for a minimum period of 72 hours. The curing shall be in accordance with one of the methods prescribed herein. Where side forms are used, the edges shall receive the curing media within 30 minutes after removal of the forms. During cold weather, the Contractor shall protect the concrete from frost damage prior to and throughout the duration of the cure.

After September 15<sup>th</sup>, in that part of the State which is north of the 46 degree Parallel, and after October 1<sup>st</sup> in that part of the State which is south of the 46 degree Parallel, or before April 15<sup>th</sup>, only the blanket curing or extreme service membrane methods of curing will be permitted.

With the blanket method, after being cured the prescribed minimum period of 72 hours, the concrete shall be treated with two applications totaling approximately 1 L/4 m<sup>2</sup> (**1 gallons per 150 square feet**) of Type II concrete treating oil or extreme service membrane curing compound applied over all concrete surfaces that will remain exposed in the completed work. The concrete shall be clean and dry when the treating oil is applied.

#### C3a Blanket Curing Method

The concrete shall be covered with waterproof paper or plastic sheeting as soon as possible (without marring the concrete) after completion of the finishing operations. The curing blankets shall be in such condition and be utilized in such manner as to envelop the exposed concrete and prevent loss of water vapor.

#### C3b Membrane and Extreme Service Membrane Curing Method

All Surfaces exposed to air at the time of cure shall be coated with membrane curing compound within 1 hour after finishing the concrete

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surfaces. The compound shall be applied by an approved airless spraying machine at the approximate rate of 1 L/4 m<sup>2</sup> (**1 gallon per 150 square feet**) of surface curing area.

As conditions for approval, the spraying machine shall have as essential elements; a recirculating bypass system that provides for continuous agitation of the reservoir material; separate hose and nozzle filters; and a multiple or adjustable nozzle system that will provide for variable spray patterns.

Before application, the curing compound as received in the shipping container shall be agitated until a homogeneous mixture is obtained. Application shall be such that a uniform coating is obtained. Any areas that, by visual inspection, appear to have received too light a coating shall be resprayed immediately. Also, should the membrane film become damaged at any time within the required curing period, the damaged areas shall be repaired immediately by respraying. Wherever the initial or corrective spraying is such as to result in unsatisfactory curing, the Engineer may require use of the blanket curing method at no additional cost to the Department.

### **D Bituminous**

The bituminous mixture shall be placed on the compacted foundation material in one or more courses as indicated in the Plans, so as to give the required thickness.

### **E Backfilling**

Following removal of the forms, the area adjacent to the walk shall be finished in a neat and workmanlike manner using material obtained from the excavation. Surplus excavated materials shall be disposed of by the Contractor in a manner satisfactory to the Engineer.

### **2521.4 METHOD OF MEASUREMENT**

Each uniform thickness item will be measured separately by top surface area.

Measurement for sawing concrete walk will be made by the length of concrete walk sawed.

### **2521.5 BASIS OF PAYMENT**

Payment for the concrete or bituminous construction provided for herein, at the Contract prices per unit of measure, will be compensation in full for all costs of furnishing the materials and constructing the work complete in place as specified, except that any granular materials furnished and placed by order of the Engineer in the absence of specific Plan requirements will be paid for separately under 2451.5. Payment for sawing concrete walk shall be compensation in full for all costs relative thereto.

Concrete and Bituminous walk construction will be paid for on the basis of the following schedule:

**2521.5**

<b>Item No. Item</b>	<b>Unit</b>
2521.501 ___mm (___inch) Concrete Walk	
.....	square meter ( <b>square foot</b> )
2521.503 ___mm ( <b>inch</b> ) Concrete Terrace	
.....	square meter ( <b>square foot</b> )
2521.511 ___mm ( <b>inch</b> )Bituminous Walk	
.....	square meter ( <b>square foot</b> )
2521.513 ___mm ( <b>inch</b> )Bituminous Terrace	
.....	square meter ( <b>square foot</b> )
2521.515 ___Sawing Concrete Walk	meter ( <b>linear foot</b> )

**2531**

**Concrete Curbing**

**2531.1 DESCRIPTION**

This work shall consist of constructing cast-in-place concrete curbs, curb and gutter, medians, driveway pavement, pedestrian ramps, and other similar traffic delineation or service items.

**2531.2 MATERIALS**

**A Concrete** ..... **2461**

Mix designations shall be as given below for the method of placement:

A1 Manual Placement ..... Mix No. 3A32  
A2 Slip-form Placement ..... Mix No. 3A22

**B Reinforcement Bars**..... **3301**

**C Steel Fabric** ..... **3303**

**D Preformed Joint Filler**..... **3702**

**E Blank**

**F Concrete Treating Oil** ..... **3917**

**G Curing Materials**

G1 Curing Paper ..... 3752

G2 Plastic Sheeting ..... 3756

G3 Membrane Curing Compound ..... 3754

G4 Extreme Service Membrane Cure ..... 3755

**H Granular Materials** ..... **3149**

**2531.3 CONSTRUCTION REQUIREMENTS**

**A Foundation Preparations**

The foundation shall be excavated, shaped, and compacted to a firm, uniform bearing surface, conforming to the planned section and established grade. Unsuitable subgrade soils shall be removed and replaced as directed. Granular material, as specified and where required by the Plans, shall be furnished, placed and compacted thoroughly to the required depth.

**B Forms**

Forms shall be of metal, wood, or other suitable material, and shall be capable of sustaining the concrete in its proper position until set. Face forms for curbing shall conform to the required shape and design. Side forms shall have a depth at least equal to the edge thickness of the concrete being formed. The forms shall be fully supported on the foundation and be adequately restrained at the proper line and grade.

Approved flexible or curved forms of proper radius shall be used on curves having a radius of 45 m (**150 feet**) or less.

The contact surfaces of all forms shall be coated with form treating material conforming to 3902, prior to placing the concrete.

**C Joint Construction**

Transverse expansion joints, filled with 13 mm (**½ inch**) preformed joint filler material, shall be placed at the ends of all curved sections; and at the ends of the curved portions of entrance and street returns. Longitudinal expansion joints shall be placed as shown in the Plans. Expansion joints with filler material shall also be placed at locations where the concrete surrounds or adjoins any existing fixed objects such as fire hydrants, building foundations, and other rigid structures.

Contraction joints shall be provided at 3 m (**10 foot**) intervals in curb or curb and gutter construction when adjacent to bituminous mainline and at 6 m (**20 foot**) intervals in solid median construction, except as otherwise provided in the Plans. The contraction joints shall match the adjacent concrete pavement joints. The contraction joints shall generally be formed to the full depth of the concrete, using 3 mm (**1/8 inch**) thick removable inserts conforming to the cross sectional shape of the concrete. Where practicable, such as in driveway pavement or where a curb machine is used, the contraction joints may be formed or sawed as approved by the Engineer to a depth of at least 50 mm (**2 inch**) from all exposed surfaces.

Joints shall be constructed perpendicular to the subgrade and shall align with similar joints in adjoining work when practicable. Transverse joints shall be placed at right angles to the longitudinal axis of the work unless otherwise indicated in the Contract.

Longitudinal construction joints between a concrete median or gutter section and a concrete pavement shall have a surface groove, either formed or sawed, that is approximately 10 mm (**3/8 inch**) wide and at least 13 mm (**½ inch**) in depth.

**D Metal Reinforcement**

Metal reinforcement shall be provided and placed as required by the Plans and in conformance with the applicable provisions of 2472.

### 2531.3

#### **E Placing and Finishing Concrete**

Immediately before placing the concrete, the inside faces of the forms shall be wetted and the foundation moistened with water.

The concrete shall be placed in a manner that will prevent segregation; consolidated by hand tamping or internal vibrating to fill all voids; struck off to the required grade; and floated smooth. Curb face forms and contraction joint inserts shall be removed as soon as the concrete has set sufficiently to retain its molded shape.

The top surface and face of curbs shall be hand-floated with a suitable trowel as soon after the face forms have been removed as the condition of the concrete will permit.

After the water sheen has disappeared, joints and edges shall be rounded to the radii shown in the Plans or as directed by the Engineer, and all concrete surfaces exposed to view shall be lightly brushed to a uniform texture.

Side forms shall remain in place for at least 12 hours after the concrete has been cast. All cavities shall be filled with mortar, upon removal of the side forms.

#### **F Slipform Machine Placement**

Instead of using fixed side forms, concrete may be placed and formed to the required shape by using an approved type of extrusion machine that will produce a finished product meeting the standards for dimension, quality, workmanship, and appearance as would be achieved with fixed-form construction provided for herein. Hand finishing will be required only to the extent necessary to obtain the specified surface finish and texture.

#### **G Concrete Curing and Protection**

After the finishing operations have been completed and as soon as the set of the concrete permits, the concrete shall be cured for a minimum period of 72 hours. The curing shall be in accordance with one of the methods prescribed herein. Where side forms are used, the edges shall receive the curing media within 30 minutes after removal of the forms. During cold weather, the Contractor shall protect the concrete from frost damage prior to and throughout the duration of the cure.

After September 15<sup>th</sup>, in that part of the State that is north of the 46 degree Parallel, and after October 1<sup>st</sup> in that part of the State that is south of the 46 degree Parallel, or before April 15<sup>th</sup>, only the blanket curing or extreme service membrane methods of curing will be permitted.

With the blanket method, after being cured the prescribed minimum period of 72 hours, the concrete shall be treated with two applications totaling approximately 1 L/4 m<sup>2</sup> (1 gallon per 150 square feet) of

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Type II concrete treating oil or extreme service membrane cure applied over all concrete surfaces that will remain exposed in the completed work. The concrete shall be clean and dry when the treating oil is applied.

#### G1 Blanket Curing Method

The concrete shall be covered with waterproof paper or plastic sheeting as soon as possible (without marring the concrete) after completion of the finishing operations. The curing blankets shall be in such condition and be utilized in such manner as to envelop the exposed concrete and prevent loss of water vapor.

#### G2 Membrane and Extreme Service Membrane Curing Method

All surfaces exposed to air at the time of cure shall be coated with membrane curing compound within 1 hour after finishing the concrete surfaces. The compound shall be applied by an approved airless spraying machine at the approximate rate of 1 L/4 m<sup>2</sup> (**1 gallon per 150 square feet**) surface curing area.

As conditions for approval, the spraying machine shall have as essential elements, a recirculating bypass system that provides for continuous agitation of the reservoir material; separate hose and nozzle filters; and a multiple or adjustable nozzle system that will provide for variable spray patterns.

Before application, the curing compound as received in the shipping container shall be agitated until a homogeneous mixture is obtained. Application shall be such that a uniform coating is obtained. Any areas that, by visual inspection, appear to have received too light a coating shall be resprayed immediately. Also, should the membrane film become damaged at any time within the required curing period, the damaged areas shall be repaired immediately by respraying. Wherever the initial or corrective spraying is such as to result in unsatisfactory curing, the Engineer may require use of the blanket curing method at no additional cost to the Department.

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#### **J Backfill Construction**

As soon as possible without subjecting the concrete work to damaging stresses, the required backfill or embankment construction shall be completed to the elevations indicated in the Plans, using selected materials from the excavations where no other material is provided by the Contract. Placement and compaction of the material shall be in accordance with the applicable provisions of 2451.

All surplus excavated materials shall be disposed of by the Contractor in a manner satisfactory to the Engineer.

### 2531.3

#### **K Workmanship and Finish**

The complete concrete work shall give the appearance of uniformity in surface contour and texture, and shall be accurately constructed to line and grade.

Edge and surface alignment on curved construction shall conform closely to the planned curvature, and the flow line surface of gutters shall be finished as necessary to eliminate low spots and avoid entrapment of water.

Concrete edges and surfaces designed to straight lines or grades will be checked with a 3 m (**10 foot**) straightedge, and any deviations therefrom in excess of 8 mm (**5/16 inch**) will be considered to be unacceptable work.

Unacceptable work shall be removed and be replaced with acceptable work as ordered by the Engineer. In the absence of an order to remove and replace, the Contractor shall have the option of so doing or may elect to leave the unacceptable work in place and accept the following price reductions:

- (1) For 10 to 14 mm (**3/8 to 9/16 inch**) deviation, payment at 75 percent of Contract price.
- (2) For deviation over 14 mm (**9/16 inch**), payment at 50 percent of Contract price.

#### **2531.4 METHOD OF MEASUREMENT**

The construction provided for herein will be measured, as indicated in the Proposal, by the length, area, or volume. No deductions will be made for any castings or minor fixtures encompassed in the work.

##### **A Length**

Length measurements on curbs and curb and gutter will be made along the face of the curb at the gutter line. In the case of transitions from one size or design to another, the entire transition will be measured for payment under the item bid at the higher unit price of the two involved.

Length measurements on solid medians and other construction having uniform width and symmetrical cross section will be made along the center of the longitudinal axis. Unless a variance from the basic design results in increased cross sectional area, short sections of modified design (such as tapers and depressions) will be included for payment with the basic design if there is no separate item provided therefore.

At entrances and alleys, any curbing constructed beyond the curb returns or driveway pavement will be measured for payment as shown in the Plans.

2531.5

**B Area**

When measurement is by area, computations will be based on the length as staked and the extreme width between outside faces as shown in the Plans or otherwise authorized, without regard to variations in concrete thickness caused by integral construction such as curbs, drainage openings, etc. However, driveway pavement of each specified thickness, and other items of different design will be measured separately as provided for in the Contract.

**C Volume**

When measurement is by volume, computations will be based on the length as staked and the cross sectional dimensions shown in the Plans or otherwise authorized.

All concrete structures not otherwise designated for payment by type or design will be included for payment under the item of structural concrete.

**D Pedestrian Curb Ramps**

Measurement for pedestrian curb ramps will be made by the number of pedestrian curb ramps constructed as specified.

Measurement for pedestrian curb ramps Type will be made by the top surface area. The measurement will be taken from the outer most edge of the concrete walk, curb, or curb and gutter.

**2531.5 BASIS OF PAYMENT**

Payment for the concrete construction provided for herein, at the Contract prices per unit of measure, will be compensation in full for all costs of furnishing the materials and constructing the work complete in place as specified, except that any granular materials furnished and placed by order of the Engineer in the absence of specific Plan requirements will be paid for separately under 2451.5.

Payment for concrete curbing, median, and driveway construction will be made on the basis of the following schedule:

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2531.501	Concrete Curb and Gutter, Design.....	meter ( <b>linear foot</b> )
2531.502	Concrete Curb, Design .....	meter ( <b>linear foot</b> )
2531.503	Concrete Median .....	square meter ( <b>square yard</b> )
2531.505	Concrete Median .....	meter ( <b>linear foot</b> )
2531.507	___mm ( <b>inch</b> ) Concrete Driveway Pavement .....	square meter ( <b>square yard</b> )
2531.511	Concrete (Type of Structure).....	cubic meter ( <b>cubic yard</b> )
2531.521	Structural Concrete .....	cubic meter ( <b>cubic yard</b> )
2531.530	Concrete Entrance Nose, Design 7107 .....	each
2531.531	Concrete Entrance Nose, Design 7108 .....	each
2531.532	Pedestrian Curb Ramp (Type ___) .....	each

**2531.5**

2531.533 Pedestrian Curb Ramp (Type \_\_\_)  
.....square meter (**square yard**)

**2533**

**Concrete Median Barriers**

**2533.1 DESCRIPTION**

This work shall consist of constructing or reconstructing cast-in-place or precast median barriers built for the purpose of providing traffic lane separation.

**2533.2 MATERIALS**

**A Concrete ..... 2461**

A1 3Y32 concrete shall be used for all fixed form cast-in-place concrete median barriers.

A2 3Y12 concrete shall be used for all slipform concrete median barriers.

A3 3Y32 concrete shall be used for all precast concrete median barriers.

**B Reinforcement Bars ..... 3301**

**C Precast Concrete Median Barrier ..... 3630**

**2533.3 CONSTRUCTION REQUIREMENTS**

**A General**

The Engineer may permit a combination of cast-in-place and precast concrete construction for those structures where a type of construction is not specified and where structural strength and/or continuity are maintained.

Where a new median barrier will join to an existing barrier the connection shall be interlocked by a tongue and groove joint with tied reinforcement bars or other positive connection, acceptable to the Engineer, to prevent movement.

The foundation shall be excavated, shaped, and compacted to a firm, uniform bearing surface, conforming to the planned section and established grade. Unsuitable subgrade soils shall be removed and replaced as directed by the Engineer. Granular material, when specified in the Plans or required by the Engineer, shall be furnished, placed, and compacted thoroughly to the required depth.

**B Cast-In-Place Fixed Form Construction**

Forms shall be of metal, wood or other suitable material, and shall be capable of sustaining the concrete in its proper position until set. All forms shall conform to the required shape and design. The forms shall be fully supported on the foundation and be adequately restrained at the proper line and grade.

Immediately before placing the concrete, the inside faces of the forms shall be wetted and the foundation moistened with water.

### 2533.3

The concrete shall be placed in a manner that will prevent segregation; consolidated by internal vibration to fill all voids; struck off to the required grade; and floated smooth. Forms for the roadway face of the median barrier may be removed as soon as the concrete can retain its molded shape. Non-roadway face forms shall remain in place for at least 12 hours after the concrete has been cast.

After roadway face forms have been removed all edges shall be rounded to the radii shown in the Plans or as directed by the Engineer.

#### **C Cast-In-Place Slipform Construction**

Concrete may be placed and formed to the required shape by using an approved type of extrusion machine that will produce a finished product meeting the standards for dimension, quality, workmanship and appearance as would be achieved with fixed form construction provided for herein. Hand finishing will be required only to the extent necessary to obtain the specified surface finish and texture.

#### **D Surface Finishes**

##### **D1 Cast-In-Place**

Cast-In-Place concrete median barriers shall receive an Ordinary Surface Finish as specified in 2401.3. The ordinary surface finish shall start immediately after the removal of the forms and shall be carried on continuously to completion. As the ordinary surface finish progress, it shall be followed by immediately rubbing the surface with a cork float or fine carborundum stone (depending on the set of the concrete) to produce a paste on the surface and to expose and fill all depressions and all surface cavities. The paste shall be floated to a smooth surface free of coarse texture, swirls, and ridges and before it is set, shall be brushed lightly with a fine bristled brush until all cement films present are removed and the surface has a uniform, fine grained sanded texture.

Concrete placement, form removal, and finishing operation shall be planned and carried out so that the surface finishing of the formed surface can be completed within 48 hours after concrete placement of that section has been completed.

##### **D2 Precast**

Precast concrete median barriers shall receive the special surface finish as specified in 2401.3. The object of this operation is to obtain a surface that is reasonably smooth and uniform in texture and appearance and blends in with any cast-in-place concrete median barrier.

The Contractor shall not apply the special surface finish on the precast concrete median barrier until the barrier is placed in its final location and the Engineer has approved the surface condition of the barrier.

**2533.3**

**E Concrete Curing and Protection**

Newly placed concrete shall be properly cured by providing protection against rapid loss of moisture, freezing temperatures, high temperatures, abrupt temperature changes, vibrations, shock waves, and prematurely applied loads. This protection shall be provided when directed by the Engineer, and for a period of time that is not less than that specified in 2401.3, Concrete Curing and Protection.

**F Workmanship and Finish**

Irregularities in any 3 m (**10 feet**) length of the finished concrete median barrier shall not exceed 6 mm (**¼ inch**) (horizontal and vertical). Surfaces and edges not meeting this tolerance shall be considered to be Unacceptable Work. Unacceptable Work shall be removed and replaced with acceptable work when so ordered by the Engineer. Extensive areas with deviations greater than 13 mm (**½ inch**) shall be removed and replaced. In the absence of an order to remove and replace, the Unacceptable Work may be left in place with the following price adjustments:

- (1) For 8 to 13 mm (**5/16 to ½ inch**) deviations, payment at 75 percent of the Contract price.
- (2) For minor areas with deviations over 13 mm (**½ inch**), payment at 50 percent of Contract price.

**2533.4 METHOD OF MEASUREMENT**

The concrete median barrier will be measured on the top of the barrier along the centerline of Type A barriers and 75 mm (**3 inches**) back of the front face of Type AA barriers. In the case of transitions, special and modified barriers, the length will be measured on the top of the barrier and 75 mm (**3 inches**) back of the front face. Each concrete median barrier will be measured separately.

**2533.5 BASIS OF PAYMENT**

Payment for the concrete median barriers provided for herein, at the Contract prices per unit of measure, will be compensation in full for all costs of furnishing the materials, placement of the work to the lines and grade of the Plan and surface finish as specified.

Payment for the concrete median barrier will be made on the basis of the following schedule:

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2533.501	Concrete Median Barrier, Design (1) Type (2) ..... meter	<b>(linear foot)</b>
2533.506	Concrete Median Barrier & Glare Screen, Design (1) Type (2).....	meter <b>(linear foot)</b>
2533.507	Portable Precast Concrete Barrier, Design (1) .....	meter <b>(linear foot)</b>

**2533.5**

2533.508 Relocate Portable Precast Concrete Barrier, Design (1)  
.....meter (**linear foot**)

- (1) Current Standard Plate
- (2) Type A, AA, AL, Transition, A Step, or AA Step

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**2535**

**Bituminous Curb**

**2535.1 DESCRIPTION**

This work shall consist of constructing bituminous curbing composed of a mixture of aggregate and bituminous material.

**2535.2 MATERIALS**

The bituminous mixture for the curb shall be produced in accordance with the requirements for wearing course mixtures as provided in 2360, subject to the following provisions:

- (a) The mixture shall be of the same type as that used in the wearing course upon which the curb is to be constructed, unless the use of another type is specified or approved by the Engineer.
- (b) The bitumen content of the mixture may be increased if necessary, at the discretion of the Engineer. The Engineer may require the substitution of a lower penetration asphalt cement for the specified grade.

**2535.3 CONSTRUCTION REQUIREMENTS**

Bituminous curb shall be placed under the same restrictions as those that apply to the wearing course construction 2360. If so directed by the Engineer, a tack coat shall be applied to the area on which the curb is to be constructed, as provided for in 2357.

The bituminous mixture shall be placed by an approved automatic curb machine that shapes and compacts the mixture to the specified cross section. The use of manual methods of placement will only be permitted where machine placement is not feasible, and then in a manner approved by the Engineer.

The alignment of the finished curb shall be true to line and grade, within reasonable tolerances. The finished curb shall be uniform in appearance and texture.

**2535.4 METHOD OF MEASUREMENT**

Bituminous curb will be measured by length along the face of curb at the gutter line.

**2535.5 BASIS OF PAYMENT**

Payment for bituminous curb at the Contract price per unit of measure will be compensation in full for all costs of its construction, including the costs of producing and furnishing the bituminous mixture.

Payment for bituminous curb will be made on the basis of the following schedule:

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2535.501	Bituminous Curb .....	meter ( <b>linear foot</b> )

2545

**2545**

**Electric Lighting Systems**

**2545.1 DESCRIPTION**

**A General**

This work includes constructing complete and operational electric lighting systems, electric power systems, sign lighting systems, or the required portion thereof, as specified in the Contract.

**B Definitions**

Abbreviations and definitions of words and phrases pertaining to electric lighting systems or related type work shall be as defined in 1101, 1103, these Specifications, or in the Special Provisions.

**C Electrical Distribution System**

The distribution circuits of the electric lighting system shall be of the multiple type consisting of three conductors plus equipment ground. The three conductors shall constitute two photoelectric controlled 120 volt or 240 volt circuits as indicated in the Plan. Both lighting circuits and the equipment ground shall be installed complete to each standard.

The Power Company requires that the cabinet be opened for visual inspection before making the service connection. The Contractor's electrician shall be present when the Power Company makes the visual inspection.

**2545.2 MATERIALS**

**A General**

**A1 Regulations and Code**

The Contractor shall furnish electrical equipment in accordance with 2565.2, and in conformance to IES, ANSI, ICEA, AASHTO, and ASTM; whichever is applicable.

All electrical conductors for electric lighting systems shall be copper or aluminum as specified in the Contract and all wire sizes shall be based on the American Wire Gage (AWG).

A2 Materials and Electrical Equipment..... 2565.2

A3 Material Samples for Testing..... 2565.2

A4 Tests ..... 2565.2

A5 Warranties, Guarantees, and Instruction Sheets

Warranties, Guarantees, and Instruction Sheets shall be in accordance with 2565.2 except that the first paragraph of (b) is modified as follows:

(b) The Contractor shall warrant and guarantee satisfactory in-service operation of all materials and electrical equipment for a period of one (1) year. The one (1) year in-service warranty period shall begin with the "turn-on" of the electric lighting system. "Turn-on" shall be defined as the time when the complete and operational electric lighting system meets all installation, operational and testing requirements of the

Contract. The in-service warranty is in addition to individual warranties provided by product Manufacturers.

**B Hardware**

All ferrous metal hardware, except stainless steel, shall be galvanized according to 3392.

B1 Fasteners ..... 3391

B2 Anchor Rods ..... 3385

B2a Lighting Service Cabinet Anchorages

High strength bolts, nuts and washers for lighting service cabinet installation shall be in accordance with 3391; shall be galvanized in accordance with 3392; and shall be sized in accordance with 3850.

B2b Lighting Unit Anchorages

Anchor rods, nuts and washers for lighting unit installation on concrete foundations shall be in accordance with 3385; Type A – Carbon Steel Anchor Rods; shall be galvanized the top 300 mm (**1 foot**) of the anchor rod and nuts; and shall be sized as specified in the Contract.

Threaded studs and nuts for lighting unit installation on steel screw-in foundations shall be in accordance with 3391; shall be galvanized in accordance with 3392; and shall be sized as specified in the Contract.

B2c Rust Inhibitor

Threaded portions of all anchor rods above concrete foundations shall be coated with a rust inhibitor before installation of lighting service cabinets, lighting units, or other type cabinets on the anchor rods.

B3 Cap Screws, Set Screws, and Tap Bolts

Cap screws, set screws, and tap bolts shall be made of commercial brass or bronze. Washers shall be made of galvanized steel or commercial brass.

**C Conduit and Accessories**

C1 Rigid Steel Conduit (RSC) ..... 3801

C2 Intermediate Metal Conduit (IMC)..... 3802

C3 Non-metallic Conduit (NMC)..... 3803

C4 Conduit Fixtures

Fixtures for metal conduit, where required, shall be made of cast or malleable iron, galvanized according to 3394, and shall have threaded connections. All access covers shall be made of the same material as the fixture and shall provide a watertight fit.

Fixtures for NMC shall be non-metallic intended for use with the type of conduit used.

C5 Expansion Fittings ..... 3839

2545.2

**D Electrical Cables and Conductors**

Conductors for main circuits shall be No. 8 or larger, and those for single lamp branch circuit shall be No. 10 or larger.

D1 Armored Underground Cable, Polyethylene ..... 3815  
D2 Electrical Conductors ..... 3815  
D3 Overhead Light Cable..... 3815

**E Light Standards ..... 3811**

Light standards shall be of the style and type specified in the Contract.

**F Light Fixtures**

Light fixtures shall be of the style and type specified below or in the Contract.

F1 Roadway Lighting Luminaires ..... 3810  
F2 Sign Lighting Fixtures ..... 3810  
F3 Underpass Lighting Fixtures..... 3810  
F4 Lamps ..... 3810

Lamps for the luminaires or fixtures shall be the wattage and type specified in the Contract, and shall be universal or base-down to horizontal burning type.

**G Concrete ..... 2461**

**G1 General**

Concrete for light standard foundations shall be Mix. No. 3Y43.

Concrete for equipment pad foundations shall be Mix. No. 3A32.

Concrete meeting the requirements for Type 3, Grade A shall be furnished where use of a specific mix designation is not specified in the Contract.

Concrete pavement or base removed because of trenching or construction operations shall be constructed or replaced with Mix. No. 3Y43 high early strength concrete.

G2 Reinforcement Bars ..... 3301

**H Service Equipment..... 3837**

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**J Lighting Service Cabinet..... 3850**

**K Electrical Junction Boxes ..... 3838**

**L Wood Poles..... 3840**

**M Handholes**

Handholes shall be of the type specified in the Contract.

**N Photoelectric Control ..... 3812**

**O Blank**

**P Miscellaneous Materials**

Materials and electrical equipment for which no requirements are included in the Contract shall be in accordance with the best standard

practices and workmanship. All materials and electrical equipment shall be approved by the Engineer before installation.

**Q Safety Switch ..... 3837**

**R Lighting Units**

Lighting Units shall be of the style and type specified below or in the Contract.

Lighting units shall consist of a light standard, mast arm(s), 50 mm (2 inch) slipfitters, luminaire(s), lamps, wire holder, and all miscellaneous equipment required fro a complete lighting unit installation.

Lighting units shall be as specified in the Contract, and conform to the requirements of 3810, 3811, and 3812.

Within 15 days after the Contract approval notice mailing date, the Contractor shall furnish evidence to the Engineer, in writing, that orders have been place for all components of the lighting units required on the project.

**2545.3 CONSTRUCTION REQUIREMENTS**

**A General**

The locations of component parts, as indicated in the Contract, are approximate only. The exact locations will be established at the job site by the Engineer.

The Contractor shall perform no work on the job site until all underground utilities are located in accordance with 1507. Electrical cable damaged, due to Contractor's negligence, shall be replaced between handholes and light poles within 24 hours at no expense to the Department. Damaged electrical cable shall not be spliced underground.

Highways, streets, and roads shall be kept open to traffic during construction, subject to 1404. Any openings or uncompleted work that may, after working hours or during construction, cause a hazard to vehicle or pedestrian traffic shall be suitably protected to the satisfaction of the Engineer.

A1 Compliance with Electrical Codes and Standards ..... 2565.3

A2 Permits and Inspections ..... 2565.3

A3 Utility Property And Service ..... 2565.3

**B Existing Electrical Systems ..... 2565.3**

**C Excavation and Backfill ..... 2565.3**

**D Conduit and Fitting Installation ..... 2565.3**

**E Handhole Installation ..... 2565.3**

### 2545.3

#### **F Concrete Foundation Installation**

##### F1 General

Light foundations (light bases and equipment pads) shall be constructed in accordance with 2565.3, as specified in the Contract, and the following:

##### F2 Light Bases

Light bases shall contain one 50 mm (**2 inch**) NMC 90 degree elbow for each direct buried cable that enters the base, and one spare 50 mm (**2 inch**) NMC 90 degree elbow, capped at each end, for expansion of the lighting system. These conduit elbows are in addition to extra conduit elbows called for in the Contract.

Where light bases are located in a cut section or a fill section, the Contractor shall shape the backslope or mound the foundation excavation around the base, to ensure that the light base breakaway supports meet AASHTO Stub Height Requirements for Breakaway Supports.

Where the required ground rod electrode is separated from the light base, a 25 mm (**1 inch**) NMC elbow having bushings at each end shall be installed to carry the grounding wire. The electrode shall be 75 mm to 150 mm (**3 to 6 inches**) below the ground line, within 300 mm (**1 foot**) of the foundation.

Where ground rod electrodes are installed in concrete foundations, the top of the ground rod electrode shall extend not more than 75 mm (**3 inches**) nor less than 50 mm (**2 inches**) above the foundation.

##### F3 Equipment Pad

Where the required ground rods are separated from the equipment pad, NMC elbows of the size indicated in the Contract, having threads and bushings at each end shall be installed to carry the grounding wire. The electrode shall be 75 to 150 mm (**3 to 6 inches**) below the ground line within 300 mm (**1 foot**) of the foundation.

Where ground rod electrodes are installed in concrete foundations, the top of the ground rod electrode shall extend not more than 75 mm (**3 inches**) nor less than 50 mm (**2 inches**) above the foundation.

#### **G Wiring and Conductor Installation**

##### G1 General

The installation of wiring and conductors shall be in accordance with the applicable provisions of 2565.3, and the following:

Service conductors shall be run in a separate conduit system from all other conductors.

Separate lighting branch circuits may be placed in a single conduit but shall be electrically independent. All conductors of a lighting branch circuit shall be run in a single conduit.

## G2 Underground Wiring

Armored cable shall be installed by trenching or plowing methods and shall be installed at a depth of not less than 610 mm (**2 feet**). Where solid rock or other obstructions are encountered, installation of the cable shall be permitted at a depth of not less than 460 mm (**18 inches**) provided a 50 mm (**2 inch**) thick concrete slab is placed in the trench over the cable. Installation of the cable shall be permitted at a depth of not less than 153 mm (**6 inches**) provided the cable is run through rigid steel conduit and a 50 mm (**2 inch**) thick concrete slab is placed above the cable and conduit.

Armored cable shall be installed at the same distance behind the bituminous shoulder or back of curb as the light bases. An additional 600 mm (**2 feet**) of slack armored cable shall be installed near the light base before the cable enters the base conduit.

Armored cable shall extend at least 600 mm (**2 feet**) above the light base foundation with a minimum of 100 mm (**4 inches**) of the outer jacket extending above the conduit.

Wiring in conduit shall be installed with sufficient slack to allow for contraction.

An independent grounding wire shall be run through all non-metallic conduit systems and electrically connected to all metal fixtures and equipment along the run.

For all expansion sleeves in metallic conduit, a No. 8 grounding jumper shall be installed internally between conduit sections.

All pulling of wires through conduit or raceways shall be done by hand and without damage to the wires or their covering. The conduit shall be clean and dry at the time the wiring is installed. The cable or conductors shall be dry and clean, except powdered graphite or soapstone that may be used to ease the pulling.

## G3 Above Ground Wiring

Within roadway lighting standards, unless otherwise specified, the wires connecting the luminaire to the underground cable or base mounted ballast shall be 14-2 UF cable with ground and a 6 A cartridge type fuse. The fuse shall be mounted in an inline molded fuse connector/holder with casing that shall be located at the level of the handhole. Fuses in breakaway poles shall be of the breakaway type. Sufficient excess conductor length shall be provided to allow withdrawal of the connected fuse holder. The neutral and grounding wires shall not be fused.

Neutral-supported aluminum cable, conforming to 3815 may be used to provide temporary power distribution through aerial lines. The overhead cable shall be attached to the poles in a manner acceptable to

**2545.3**

the Engineer. Overhead light cable shall not be supported by the luminaires.

G4 Splices ..... 2565.3

No underground splices will be permitted that are not called for in the Contract or authorized in writing by the Engineer. When underground splices are permitted, the underground splices shall be the type as specified in the Contract.

G5 Terminal Blocks ..... 2565.3

**H Lighting Standard Installation**

Light standards with balanced fixtures or luminaires shall be set plumb. Standards with unbalanced fixtures or bracket arms, or standards that act as supports for overhead wires or guy lines, shall be set with a rake sufficient to counterbalance lateral deflection.

Standards shall be adjusted to the proper position by shims or double nuts before being anchored in position.

Damage to the lighting standard, mast arm, brackets, or other appurtenances to the light standard shall be repaired and restored to the satisfaction of the Engineer.

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**J Sign Lighting Installation**

J1 General

Construction of sign lighting shall be as specified in the Contract and the applicable sections of this Specification.

Power distribution to the sign structure shall, unless otherwise required, be by trench laid cable.

J2 Safety Switch

Install the safety switch in a vertical upright position.

J3 Safety Switch Wiring

Install No. 12 conductors in 21 mm (**¾ inch**) RSC between the switch and the fixtures. All splicing shall be accomplished with a wire nut and waterproof coating. All conduit connections shall be rain tight.

Install a No. 12 green conductor in 21 mm (**¾ inch**) RSC between safety switch and fixtures, to provide ground. The No. 12 conductor shall be connected to the grounding lug attached to the safety switch enclosure (enclosure isolated from the neutral terminal) and the grounding screw attached to each fixture housing.

Wiring installed between the sign post and the safety switch shall be run in 21 mm (**¾ inch**) RSC. Install No. 12 conductors between the switch and the sign base.

Splice the existing or new power conductors to the conductors from the safety switch with split bolt type connectors as detailed in the Contract. The splices shall be insulated to the level of insulation of the power conductors and shall be waterproofed. The splices shall be

### 2545.3

dressed in the center of the post and up from the base plate with sufficient excess conductor length provided to permit withdrawal of the splices through the handhole.

Upon completion of new or modified sign lighting system(s) for each feed point, a burn test shall be performed as specified in 2545.3K2.

#### J4 Feed Point Identification Plate

Furnish and install a feed point identification plate for each new lighted overhead sign in accordance with the details shown in the Contract. The plate shall incorporate the feed point identification number appearing in parenthesis directly below or along side the sign number in the Contract.

Strap mount the plate to the overhead sign post in accordance with the details in the Contract. The plate shall be installed on the right post when looking in the direction of traffic flow. When signs face both directions of travel on a single structure, two plates will be required. The plate shall be installed at a height of approximately 2.2 m (**7 feet**) above the base plate elevation and facing traffic.

For bridge mounted signs, the feed point identification plate shall be installed on a 3 kg/m (**2 pound per foot**) delineator post in accordance with 3401. The feed point identification plate and post should be installed as close to the bridge as possible and behind the guardrail, if present. If no guardrail is in place, the feed point identification plate and post shall be installed at least 3.7 m (**12 feet**) outside the edge of the shoulder or face of curb. The bottom of the FPID plate shall be approximately 2.2 m (**7 feet**) above the edge of the pavement.

#### J5 Safety Cable

The Contractor shall furnish and install brackets, aircraft cable and all necessary hardware, in accordance with the applicable provisions of 2564, to assemble and attach a safety cable as detailed in the Plan.

### **K Electrical System Testing and Acceptance**

Before completion of the work, the Contractor shall test the entire system for unwanted grounds and conduct a 12-hour burn test for each feed point.

#### K1 Megohm meter test (Test for unwanted grounds)

A megohm meter test, at 500 VDC, indicating the insulation resistance of each circuit shall be made. The megohm tester shall be energized for 15 s on the circuits to check if any break down of the circuits occurs. The Contractor shall furnish the Engineer with a written report of the megohm meter readings for the permanent record. The report shall contain the following information:

- (a) PROJECT NUMBER AND LOCATION
- (b) FEEDPOINT NUMBER - As indicated in the Plans.

### 2545.3

- (c) BRANCH CIRCUIT - Identify each lighting branch circuit being tested by indicating the number of the first light connected to that circuit, as indicated in the Plans.
- (d) PHASE CONDUCTOR INSULATION RESISTANCE - Measure the resistance between the phase conductors, and the resistance between each phase conductor and the equipment ground bar in the service cabinet with the fuses removed from the inline fuse connectors in the lighting poles. The resistance shall not be less than 100 M $\Omega$ .
- (e) NEUTRAL CONDUCTOR INSULATION RESISTANCE - Measure the resistance between each neutral conductor and the equipment ground bar in the service cabinet with the fuses removed from the inline fuse connectors in the lighting poles. The resistance shall not be less than 100 M $\Omega$ .
- (f) CIRCUIT INSULATION RESISTANCE - Measure the resistance between each phase conductor and the equipment ground bar in the service cabinet with all fuses in place in the lighting poles. The resistance shall not be less than 100 M $\Omega$ .

The Contractor shall make sure that the circuit's conductors are connected to the circuit breaker of the opposite phases (some manufacturers alternate every other breaker with opposite phases, and other manufacturers split the top and bottom halves of the circuit breaker with opposite phases).

All tests shall be made at the service cabinet, in the presence of the Engineer, with all grounding connections in place. The phase and neutral conductors shall be disconnected at the service cabinet for the insulation resistance tests.

Where test results indicate faulty insulation or a faulty connection within the circuit, all necessary corrections shall be made and the circuit retested, all at no expense to the Department. No additional payment will be made for replacing any part of or the entire circuit as required to make the circuits meet the test requirements.

#### K2 12-Hour Burn Test

Upon completion of a feed point and before no more than 90 percent of the feed point cost is paid, the service cabinet must be energized and the entire electrical system must operate successfully without interruption for 12 hours, during daylight hours only. The Contractor shall pay all power costs incurred and all such costs shall be incidental to the cost of the Project.

#### L Lighting Service Cabinet Installation

Pad mounted lighting service cabinets shall be securely bolted to the concrete foundation.

All components of the lighting service cabinet shall be installed in a workable first class condition and shall include all miscellaneous hardware required for a complete lighting service cabinet installation. The Contractor shall coordinate with the power company for connection of power to the lighting service cabinet.

**M Painting**

Painting of all nongalvanized ferrous metalwork, except for stainless steel, shall be in accordance with the applicable requirements of 2478.

Painting of all galvanized ferrous metalwork, shall be in accordance with 2478.

For steel lighting service cabinets, unless otherwise specified in the Contract, the finish coats shall be two field coats of Dark Green Acrolon 218, or approved equivalent polyurethane finish coat matching Color Number 14062 of the Federal Standard 595B.

The finish coats shall be applied by brush or spray application. The inside of light standard shafts need not be painted.

Aluminum service cabinets, unless otherwise specified, shall be anodized to match Duranodic finish #311.

If a manufacturer's shop coat paint is accepted or specified in the Contract, the Contractor shall make every effort during erection of a painted pole to protect the factory applied finish. The collar used for handling the pole shall be lined with a felt pad and the protective wrapping on the pole shall be left on at the lift point area to protect the finish of the pole. Any nicks, scratches, paint chips or other damage to the finish shall be repaired and restored to the satisfaction of the Engineer.

**N Restoration and Cleanup ..... 2565.3**

**O Blank**

**P Light Standard, Light Fixture, and Lighting Service Cabinet Numbering**

The Contractor shall number the light standards or light units (underpass luminaires, tunnel luminaires, high mast luminaires, special luminaires, etc.) and the outside of lighting service cabinets with decals in accordance with the numbering shown in the Plans.

Pole numbering shall consist of the feed point numbers and letters placed immediately above the pole number at a height of 1.8 m (**6 feet**) above the concrete base at an angle of 45 degrees facing oncoming traffic.

Each letter and number shall be black, 50 mm (**2 inches**) high on a 38 x 64 mm (**1 ½ x 2 ½ inches**) gray background.

Decals shall be self-sticking acrylic with optical lens elements, 127 µm (**5 mil**) low temperature permanent acrylic adhesive with a

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-23°C (-10°F) rating, and a service temperature rating of -48°C (-55°F) to +34°C (94°F).

A sample decal shall be submitted to the Engineer for approval before the decals are installed.

The pole shaft shall be "lightly sanded" to remove oxidation, and wiped with isopropyl alcohol before applying numbers and letters.

Wood pole lighting standards shall be numbered to the satisfaction of the Engineer.

Underpass lighting units shall be numbered with the last letter of the feed point and with the luminaire number.

Branch circuit breakers on the interior of the lighting service cabinets shall be labeled indicating the color of the circuit conductor (Red or Black) and the luminaire number. The Contractor shall ensure that the type of labeling used is legible and has sufficient durability to withstand the environment involved.

#### **Q Luminaire Installation**

The Contractor shall install and level luminaires in accordance with the manufacturer's recommendations and to the satisfaction of the Engineer.

Place a level on the area provided on the top of the luminaire, and level in a side to side and front to back direction. Adjust the luminaire as required to completely level the luminaire.

#### **R Bonding and Grounding**

All bonding, grounding, ground rod electrodes, grounding electrode conductors, and grounding connections shall be in accordance with the applicable provisions of 2565.3, the NEC and the following:

All metal poles, conduit, service cabinets, service equipment, and other non-current-carrying metal surfaces shall be made mechanically and electrically secure to form a continuous, bonded, grounded system and to provide a low impedance path from any exposed metal surface to the system ground at the service cabinet or service equipment.

Any equipment grounding conductor in the armored cable, bronze tape armor of the armored cable, equipment grounding conductor in conduit, rigid steel conduit, the grounding lug of the light standard or sign post, and ACSR equipment ground messenger of overhead light cable indicated in the Plans shall be bonded together and used as the equipment ground. The bonding and grounding jumper shall be a copper conductor no less than No. 6. The neutral conductor shall be grounded only at the feedpoint.

The grounding and bonding jumper shall be connected to the bronze tape armor with a bronze or copper lug type connector or bolt. Other attachments of the grounding and bonding jumper shall be by means of

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cast clamps or grounding bushings with a bronze or integral lug to accommodate the jumper.

Where indicated in the Contract, a supplemental ground rod electrode shall be installed. Ground rods used for this purpose shall be copper coated, have a minimum diameter of 16 mm (**5/8 inch**) and be 3 m (**10 feet**) in length.

Ground rod electrodes shall be provided at every other light base and the light base located at both ends of a run, unless otherwise indicated in the Contract.

All main switch cabinets, control cabinets, or service cabinets shall have a direct grounding connection to a ground rod. When installed on bridges or buildings, each cabinet or metal structure shall be bonded to the bridge or building grounding system. Grounding conductor runs shall be as short as possible.

**S Service Equipment Installation** ..... 2565.3

**T Existing Materials and Electrical Equipment**

Existing materials and electrical equipment required by the Contract or as directed by the Engineer to be removed, salvaged, reinstalled, or stockpiled shall be in accordance with 2565.3.

**U Wood Pole Installation** ..... 2565.3

**V Lighting Units**

All components of lighting units shall be installed in a workable first class condition and shall include all miscellaneous hardware required for a complete lighting unit installation.

**2545.4 METHOD OF MEASUREMENT**

**A Complete Systems**

When separate items are listed in the Contract for various types of complete electrical systems, each separate system will be measured in accordance with the following:

A1 Electric Lighting System

Each separate electric lighting system will be measured as a single unit, complete in place.

A2 Electric Power System

Each separate electric power system will be measured as a single unit, complete in place.

A3 Sign Lighting System - \_\_\_ Fixtures

Each separate sign lighting system - \_\_\_ fixtures, will be measured as an integral unit, complete in place.

A4 Sign Lighting System Bridge Mounted - \_\_\_ Fixtures

Each separate sign lighting system bridge mounted - \_\_\_ fixtures, will be measured as an integral unit, complete in place.

#### 2545.4

A5 Conduit System

Each separate conduit system will be measured as an integral unit, complete in place.

**B Electrical System Components**

When separate Items are listed in the Contract for the various component parts of an electrical system, they will be measured in accordance with the following:

B1 Lighting Units

Lighting units of each type of mounting and fixture design will be measured separately by the number of units of each type, complete in place.

B2 Luminaires

Luminaires of each type and wattage will be measured separately by the number of luminaires complete in place.

B3 Light Bases

Concrete bases of each design for lighting units will be measured separately as integral units, complete in place.

B4 Conduit

Conduit of each kind and diameter will be measured separately by the length between end terminals along the centerline of the conduit as actually installed.

B5 Underground Wire

Underground wire of each kind and size will be measured separately by the length between end terminals along the centerline of the wire as actually installed.

B6 Armored Cable

Armored cable of each kind and size will be measured separately by the length between end terminals along the centerline of the cable as actually installed.

B7 Overhead Light Cable

Overhead light cable of each kind and size will be measured separately by the length between end terminals along the centerline of the wire as actually installed.

B8 Service Cabinets

Service cabinets of each type will be measured separately by the number of cabinets, complete in place.

B9 Equipment Pads

Equipment pads of each type will be measured separately by the number of equipment pads complete in place.

B10 Junction Boxes

Junction boxes will be measured by the number of junction boxes complete in place.

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### B11 Handholes

Handholes of each design will be measured separately by the number of handholes complete in place.

### B12 Underpass Lighting Fixtures

Underpass lighting fixtures of each design will be measured separately by the number of underpass lighting units complete in place.

### B13 Wood Poles

Wood poles will be measured by the number of wood poles complete in place.

## **2545.5 BASIS OF PAYMENT**

Payment for lighting systems, power systems, sign lighting systems, modify sign lighting systems, and conduit systems at the appropriate Contract price per system will be compensation in full for all costs of furnishing and installing the complete system as specified.

Payment for lighting units of each type at the Contract price per unit will be compensation in full for furnishing and installing the lighting unit as specified, including lamps, luminaire, ballast, pole base, pole and bracket, inline fuse, wiring between pole base and fixtures, luminaire wire holder, splice to power circuit, numbering of the light standard, and all other miscellaneous items required for a complete installation.

Payment for luminaires of each type and wattage at the Contract price per luminaire will be compensation in full for furnishing and installing the luminaire as specified, including the housing, reflector, glassware, lamp, ballast, mounting, mounting hardware, wiring, connections, numbering of the luminaire if not installed on a light standard, and all other miscellaneous items required for a complete installation.

Payment for light bases of each design at the Contract price per base will be compensation in full for furnishing and installing the light base as specified, including excavation, concrete, reinforcement, anchor rods, ground rod, ground lead, grounding connections, conduit elbows and bushings, and all other miscellaneous items required for a complete installation.

Payment for conduit of each kind and diameter at the Contract price per unit of measure will be compensation in full for furnishing and installing the conduit as specified, including the conduit, trenching, jacking, augering, conduit sleeves, couplings, weatherheads, elbows, bushings, sealing around the conduit where it enters a pull box, sealing conduit ends in concrete foundations and in pull boxes, grounding and bonding of conduit, backfilling and restoring sod, sidewalks, pavements, and the like, and all other miscellaneous items required for a complete installation of the conduit.

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Payment for underground wire of each kind and size at the Contract price per unit of measure will be compensation in full for furnishing and installing the wire as specified, including the wire, pulling, splicing, terminals, making required connections, testing, and all other miscellaneous items required for complete installation of the wire.

Payment for armored cable of each kind and size at the Contract price per unit of measure will be compensation in full for furnishing and installing the cable as specified, including the cable, trenching, armor grounding, connections, fittings, fastenings, hangers, backfilling and surface restoration, testing, and all other miscellaneous items required for a complete installation of the cable.

Payment for overhead light cable of each kind and size at the Contract price per unit of measure will be compensation in full for furnishing and installing the cable as specified, including the cable, grounding of the messenger wire, connections, fastenings, hangars, testing, and all other miscellaneous items required for a complete installation of the cable.

Payment for service cabinet of each type at the Contract price per cabinet will be compensation in full for furnishing and installing the lighting service cabinet as specified, including panelboard enclosure, circuit breakers, switches, relays, photoelectric control, internal wiring, service entrance circuit, service entrance conduit and weatherhead for wood pole mounted cabinets, mounting hardware, grounding, painting, sealing around cabinet base, numbering of the service cabinet, and all miscellaneous items required for a complete installation.

Payment for equipment pads of each type at the Contract price per equipment pad will be compensation in full for furnishing and installing the equipment pads as specified, including excavation, concrete, reinforcement, anchoring hardware within the pad, conduits within the pad, ground rods, grounding connections, mounting brackets, mounting hardware, surface restoration, and all other miscellaneous items required for a complete equipment pad installation.

Payment for junction boxes at the Contract price per box will be compensation in full for furnishing and installing the boxes as specified, including the junction box, bushings, covers, gaskets, and all appurtenances required for a complete installation.

Payment for handholes of each design at the Contract price per handhole will be compensation in full for furnishing and installing the handholes as specified, including the handhole, metal frame and cover, excavation, aggregate drain bed, backfilling, sealing conduit entrances, surface restoration, and all miscellaneous items required for a complete installation.

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Payment for underpass lighting fixtures of each type and wattage at the Contract price per unit will be compensation in full for furnishing and installing the underpass lighting unit as specified, including the housing, reflector, glassware, lamp, ballast, mounting, mounting hardware, wiring, connections, numbering of the lighting fixtures, and all other miscellaneous items required for a complete installation.

Payment of wood poles at the Contract price per wood pole will be compensation in full for furnishing and installing wood poles as specified, including class of wood pole, surface restoration, and all other miscellaneous items required for a complete installation.

Payment for electrical systems will be made on the basis of the following schedule:

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2545.501	Electric Light System .....	lump sum
2545.503	Electric Power System .....	lump sum
2545.505	Sign Lighting System - ____ Fixtures .....	system
2545.506	Sign Lighting System Bridge Mounted - ____ Fixtures.....	system
2545.509	Conduit System .....	lump sum
2545.511	Lighting Unit, Type ____ .....	each
2545.513	Luminaire .....	each
2545.514	Underpass Lighting Fixture, Type ____ .....	each
2545.515	Light Base, Design ____ .....	each
2545.521	____ mm ( <b>inch</b> ) Rigid Steel Conduit .....	meter ( <b>linear foot</b> )
2545.522	____ mm ( <b>inch</b> ) Intermediate Metal Conduit .....	meter ( <b>linear foot</b> )
2545.523	____ mm ( <b>inch</b> ) Nonmetallic Conduit.....	meter ( <b>linear foot</b> )
2545.531	Underground Wire, ____ Conductor No. ____ .....	meter ( <b>linear foot</b> )
2545.533	Armored Cable, ____ Conductor No. ____ .....	meter ( <b>linear foot</b> )
2545.537	Overhead Light Cable, ____ Conductor No. ____ .....	meter ( <b>linear foot</b> )
2545.541	Service Cabinet, ____ Type ____ .....	each
2545.542	____ m (____ <b>foot</b> ) Wood Pole, Class ____ .....	each
2545.545	Equipment Pad .....	each
2545.551	Junction Box.....	each
2545.553	Handhole .....	each

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**Traffic Management System**

**2550.1 SCOPE**

This work includes furnishing and installing Traffic Management System (TMS) components including communications system components, traffic control system components, surveillance system components and motorist information system components.

Communication system components include the cable plant (fiber optic cables, electronic/telephone cables), conduit, hand holes, splice cabinets, equipment cabinets, equipment shelters, fiber distribution equipment (splice panels, patch panels, and fiber distribution frame), fiber optic cable pulling vaults, fiber optic splice vaults, and outdoor fiber splice enclosures.

Traffic control system components include ramp meters, lane control signals, control cabinets, control cable and power cable.

Surveillance system components include CCTV system hardware and vehicle detection devices. CCTV system hardware includes the folding television standard (pole), lightning protection, video cable, control cable, power cable, pole-mounted control cabinet, and junction box. Vehicle detection devices include detector loops (preformed and saw cut), lead-in cable, and loop/lead splice encapsulator).

Motorist information system components include variable message signs and guide signs.

Electrical service is also provided for TMS components.

Each bidder shall submit a written statement with the bid. The statement shall comply with 1201 and shall identify all subcontractors.

**Acronyms**

BD-4	TWP Distribution Pedestal (Splice Cabinet)
BD-7	TWP Distribution Pedestal (Splice Cabinet)
C-C	Center to Center
CAD	Computer Aided Drafting
CMS	Changeable Message Sign
CTS	Clear To Send
DIP	Dual In-line Package
DSX	Digital Signal Crossconnect
EIA	Electronics Industry Association
FC-PC	Fiber Connector
FDF	Fiber Distribution Frame
FNBT	Facing NSEW Bound Traffic
FO	Fiberoptic
HD	Heavy Duty
JB	Junction Box
LD	Light Duty

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LED	Light Emitting Diode
MM	Multimode Cable
NMS	Network Management System
OH	Overhead sign
OTDR	Optical Time Domain Reflectometer
PC	Printed Circuit
PCB	Printed Circuit Board
PDA	Power Distribution Assembly
p-p	peak to peak
PTZ	Pan Tilt and Zoom
SM	Singlemode Cable
ST	Fiber Connector
TIA	Telecommunication Industry Association
TWP	Twisted Wire Pair
ZDS	Zero Dispersion Slope
ZDW	Zero Dispersion Wavelength

**2550.2 MATERIALS**

**A General**

All materials, work methods, and equipment shall comply with the standards of the National Electrical Manufacturers Association; the Electronic Industries Association; the Underwriters Laboratory, Inc; the National Electrical Code; local codes and ordinances; these specifications; and with the requirements of the Contract.

Each component is designed for 10 years of industrial use. The Contractor warrants all materials and workmanship for 6 months after completion and acceptance of the Contract. The warranty period begins on the date all construction obligations of the Contractor are completed as documented by the final completion date on the change in construction status report.

During the warranty period the Contractor shall, at no cost to the Department, make repairs to all equipment and devices furnished and installed during the Project. The Engineer will notify the Contractor that a warranted item needs repair. The Contractor will acknowledge the notification within 24 hours and furnish the repair with 48 hours. The repair must satisfy the Engineer.

<b>B</b>	<b>Foundations.....</b>	<b>3951</b>
<b>C</b>	<b>Conduit and Accessories .....</b>	<b>3952</b>
C1	Conduit .....	3952
C2	Handhole .....	3952
C3	Junction Box.....	3838
C4	Locator Ball.....	3952

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C5	Locator Ball Detector .....	3952
C6	Fiberoptic Splice Vault.....	3953
C7	Outdoor Fiber Splice Enclosure.....	3954
<b>D</b>	<b>Electrical Cable and Conductors.....</b>	<b>3815</b>
D1	Armored Cable .....	3815
D2	Signal Control Cable .....	3815
D3	Power Cable .....	3815
D4	Loop Detector Conductor.....	3815
D5	Loop Detector Lead-in Cable .....	3815
D6	Telephone Cable.....	3815
D7	Video Cable .....	3815
D8	Radio Frequency Transmission Cable .....	3815
D9	Camera Control Cable .....	3815
D11	Optical Pigtails and Patch Cord.....	3815
<b>E</b>	<b>Fiberoptic Cables.....</b>	<b>3815</b>
E1	Trunk Cables .....	3815
E2	MM Pig Tails .....	3815
E3	MM Patch Cord .....	3815
E4	Armored Pigtails .....	3815
<b>F</b>	<b>Cabinets.....</b>	<b>3826</b>
F1	334Z Series Cabinet .....	3826
F3	336 Series Cabinet.....	3826
F4	Shelter Cabinet .....	3826
F5	480 mm (19 inch) EIA Cabinet .....	3826
F6	Splice Cabinet (BD-4 and BD-7).....	REA approved
<b>G</b>	<b>TMS Electric Service.....</b>	<b>3964</b>
<b>H</b>	<b>Ramp Control Signal and Advance Flasher ....</b>	<b>3965/Plan</b>
H1	Signal Pedestal .....	3832/Plan
H2	Signal Face .....	Plan
H3	Lane Control Signal.....	3836
H4	Advance Flasher .....	3965/Plan
<b>I</b>	<b>BLANK</b>	
<b>J</b>	<b>Closed Circuit Television Assembly</b>	
J1	Standard.....	3827/Plan
<b>K</b>	<b>Changeable Message Sign</b>	
<b>L</b>	<b>Buried Cable Sign.....</b>	<b>3973</b>
<b>M</b>	<b>Fiberoptic Components</b>	
M1	Fiber Distribution Frame .....	3974
<b>N</b>	<b>System Integration.....</b>	<b>3976</b>
<b>O</b>	<b>Blank</b>	
<b>P</b>	<b>Loop Detector</b>	
P1	Loop Detector.....	3966
P2	Loop Detector Splice.....	3967

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### 2550.3 CONSTRUCTION REQUIREMENTS

The Contractor shall do the work, or ensure that the work is completed as follows.

#### A Cable Installation

The Contractor shall place conduit and direct buried cables in the same trench only when the cable is installed 900 mm (**36 inches**) deep, 150 mm (**6 inches**) of fill is added, and the conduit is installed on the fill.

Install direct burial cable by trenching or by plowing, as far from the paved portion of the roadway as practical. Install direct burial cable under bituminous or concrete surfaces in conduit.

Permanently secure 6 mm (**¼ inch**) character labels to each cable in each handhole and in each cabinet. The Department will provide the cable identifiers.

#### A1 Cable Installed In Conduit

The Contractor shall pull cable into conduit by hand or machine. Use a limiting device to prevent exceeding the pulling tension specified by the manufacturer.

The Contractor shall: apply a material compatible, industry accepted lubricant to the cables to reduce pulling tension; install each cable with enough slack to compensate for contraction; and permanently secure 6 mm (**¼ inch**) character labels to the cable(s) in each handhole and cabinet with the identification provided by the Department. Damaged cable is not acceptable. Remove abandoned cable(s) from each conduit. The operating TMS must remain active while the cables are removed.

#### A2 Direct Buried Cables

Trench or plow direct buried cables at a minimum of 900 mm (**36 inches**) deep. Locate the cable route as far from the paved portion of the roadway as practical.

Install an 80 mm (**3.15 inches**) wide, stretchable, orange, warning tape, between 460 mm (**18 inches**) above the cable and 300 mm (**12 inches**) below the surface. The tape bears the permanent legend "CAUTION: Mn/DOT CABLE BELOW".

Place buried cable warning signs, described in 3973, at less than 150 m (**500 foot**) intervals, offset 1 m (**3 feet**), along the cable route.

Install an orange-colored plastic resin sheath to enhance the visibility of buried cable signposts. The plastic resin sheath is:

- (a) Triangular in shape, having a wall thickness of 2.03 ± 0.25 mm (**0.08 ± 0.01 inches**) with a 84.07 ± 0.51 mm (**3.31 ± 0.02 inch**) width of each side;
- (b) Temperature stable from -40 °C (**-40 °F**) to 65 °C (**150 °F**),
- (c) UV resistant;

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- (d) Made of Polypropylene; and
- (e) Installed on the above ground portion of each post below the bottom of the sign.

#### A3 Copper Cable Installation

The Contractor has full and immediate responsibility to repair every existing TMS cable damaged by Contractor activity. The repair includes everything needed for a complete repair. The quality of the repair must satisfy the project Engineer.

- (a) Replace damaged radio frequency (RF) transmission cable with new cable between the existing terminations. Splices in RF transmission cable or telephone cable are not allowed between existing terminations. Below ground splices are never allowed.
- (b) Terminate RF transmission cables (COAX and telephone cables) \_\_\_\_\_/PR No. 19 in above ground cabinets to amplifiers, or with connectors designed for use with that specific cable.
- (c) Install the cables inside CCTV standards to the cable supports.
- (d) Test power cables in accordance with 2545.
- (e) Splice telephone cables in BD-4 and BD-7 cabinets with a weather resistant, crimp connector designed to splice three No. 19 conductors.

#### A4 Fiberoptic Cable Installation

The Contractor shall submit a plan detailing each fiberoptic cable installation, the installation method, and the calculated pulling tension. The cable is taken up at intermediate pulling points with a device made for that purpose. The cable pulls are continuous and steady between pull points.

The Contractor shall:

- (a) Accomplish direction changes of fiberoptic cable before entering a handhole or other conduit access point. Do not change the direction of fiberoptic cables in handholes.
- (b) Install fiberoptic cable in split conduit through the handholes. Extend the conduit 50 mm (**2 inches**) beyond the wall of each handhole and seal the conduit to the handhole with duct seal.
- (c) Splice optical fibers only in outdoor fiber splice enclosures and fiber splice panels. Splices between cabinets and splice vaults are not allowed.
- (d) Continuously monitor the tensile load on the cable. The fiberoptic cable route is pre-ripped to prevent harm to plowed-in cable.
- (e) Place 150 mm (**6 inches**) of aggregate that complies with 3149.2G, beneath cables placed in a trench before backfilling the trench. The backfilling shall comply with 2451.
- (f) Provide a smooth transition from one elevation to the other when installing fiberoptic cable in existing conduits, that are in existing

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handholes. This may require re-installing existing conduits and is incidental to the cable installation.

- (g) Label the destination of each trunk cable onto the cable in each vault. The Contractor shall label the fiberoptic patchcords and pigtailed at terminations with their source, destination, and cable function. The labels are permanent and have 6 mm (**¼ inch**) characters.

#### **B Cabinet Installation**

##### **B1 Cabinet Labels**

Label each control cabinet with permanent 40 mm (**1.6 inch**) high characters, using the cabinet name provided by the Department.

##### **B2 Two Days Notice**

The Contractor shall notify the TMC Operations Supervisor 2 days before removing an active cabinet from service.

##### **B3 Secure and Seal**

Secure the cabinets to the concrete foundation with anchor rods, nuts and washers.

Seal the cabinet base to the foundation with a 6 mm (**¼ inch**) high x 50 mm (**2 inch**) wide, one piece neoprene gasket.

##### **B4 Conduit**

Install conduits at the center of the cabinet base and 80 mm (**3.15 inches**) above the foundation.

#### **C Changeable Message Signs (CMS)**

The changeable message sign structures and mounting hardware shall comply with 2564.

The electrical equipment located on the sign structure shall not protrude over the walkway, shall not interfere with moving the walkway safety rail or with opening the sign door.

The Contractor installs 120/240 VAC to the sign within 1 week after installation to enable operating the ventilation units.

#### **D Lane Control Signals (LCS)**

Make the clearance between the bottom of the lane control signal and the pavement at least 5.3 m (**17 feet**). The mounting hardware complies with 2564.

#### **E Restore Shrubs and Bushes**

The Contractor shall restore all shrubs and bushes damaged by Contractor activities, in accordance with 1712.

#### **F Handholes (HH)**

Make all openings in the side of handholes water tight with a material compatible compound.

Cast the Light Duty metal cover frame and the heavy duty metal cover frame in concrete.

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Fill Handholes abandoned in sodded areas, with tamped granular material that complies with 3149.2E. Salvage useable handhole covers from abandoned Handholes, to Department's Electrical Services Section.

Secure the HH ball to an eye bolt with a 6 mm (¼ **inch**) wide wire wrap. The HH ball is located within 0.3 m (**1 foot**) of the HH cover.

**G Ramp Control Signal (RCS)**

Cover each installed RCS and keep it covered until the beginning of the system operational test.

**H Conduit**

Conduit installation complies with 2565.3D and the following additions.

H1 Conduit on Bridges

Conceal conduit on bridges behind the fascia girder, in a location not readily visible to motorists. Install deflecting expansion joints, as per NEC requirements.

H2 Factory Bends

Factory bends in 76 mm (**3 inches**) and larger conduit are greater than 900 mm (**36 inch**) radius.

H3 Foundation Locations

The Contract foundation locations are approximate. The Engineer stakes the actual locations, outside the clear zone, as far from the paved portion of the roadways as practical.

**I Blank**

**J Bonding and Grounding.....2565.3J**

Each foundation includes a ground rod.

J1 Insulated Cable

Insulated cable may be used instead of bare ground cable if 300 mm (**12 inches**) of the cable is wrapped with green electrical tape in the cabinet and in each handhole through which the cable passes.

J2 Shield Continuity

Maintain the electrical continuity of the cable shields while terminating and splicing cables. The shield bonding conforms to REA splicing Standard PC-2, Section 3.3. The bonding connectors comply with REA Specification PE-33 for Cable Shield Connectors. Bond and ground the cable sheaths to a 4.6 m (**15 feet**) long x 16 mm (**5/8 inch**) diameter ground rod.

**K Loop Detector Installation**

Loop Detector Installation complies with the Contract detail and these requirements.

K1 Loop Detector Conductors

Loop Detector Conductors end in the near handhole. Splice the conductors to the lead-in cable with a soldered butt splice. Wrap the

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splice with one wrap of electrical tape before placing it into the splice encapsulator device.

#### K2 Detector Test

Test all detectors in the presence of a Department inspector and furnish all items required for the test. Use copies of the Loop Detector Test Report, detailed in the Contract, when recording the Loop Detector values.

#### L Fiberoptic System

The system integrator proves the fiberoptic system functions as specified before the operations test begins.

L1 Blank

L2 Blank

L3 Ensure that each outdoor fiber splice enclosure:

- (a) Is bonded to the cable armor by a cable clamp;
- (b) Is bonded to the closest ground rod by a 1/C No. 6 ground wire and clamp;
- (c) Has non-oxidizing coating on all connections.

L4 Fiber Splice Panel

Mount the fiber splice panel where indicated in the Contract. Secure the fiberoptic cable(s) and pigtail(s) to the panel. Bond the shields to the splice panel ground lug.

L5 Fiberoptic Splice Vault

Place the fiberoptic splice vault on 300 mm (**12 inches**) of filter aggregate complying with 3149.2H. Seal and flash test the vault as per the manufacturer recommendations.

Coil 18 m (**60 feet**) of cable in each vault containing splices. This allows moving the splice enclosure to the splicing vehicle.

L6 Optical Link Attenuation Test

The test equipment includes a light source emitting light at the required wavelength and an optical power meter. Calibrate the light source and the power meter at the beginning of each day of testing and after every 20 measurements. Design the light source and power meter to couple to an optical fiber through an ST or FC-PC connector, or through a bare fiber adapter to fibers that have no connector.

To calculate the attenuation, subtract the difference in the received power from the light source before and after measurement through the link.

Record these values during the Optical Link Attenuation tests:

- (a) The length of the link.
- (b) The attenuation of each splice (0.3 dB maximum).
- (c) The mean attenuation of each splice in the link.
- (d) The attenuation of each MM link at 1300 nm.
- (e) The attenuation of each SM link at 1550 nm.

### 2550.3

Label optical links with the identifier, the source, and the destination of each cable.

#### **M CCTV Assembly Installation**

Do not degrade the existing CCTV signals during CCTV Assembly installation.

Orient the environmental housing lightning protection away from the road at approximately 90 degrees to centerline. Install the horizontal lockout for the pan and tilt unit over the lightning rod support and set the vertical lockout to 30 degrees above horizontal. The housing mounting bolts do not hit the pan and tilt unit cover in any tilt position.

#### **N Blank**

### 2550.4 METHOD OF MEASUREMENT

The Engineer will only measure items for payment that are completed and accepted.

#### **A Complete Systems**

Measure \_\_\_\_\_ system separately by the number of systems installed.

#### **B Traffic Management System Components**

The Engineer will measure the various system components by the units of measure listed in the Contract.

### 2550.5 BASIS OF PAYMENT

The Department will:

- (a) Retain 10 percent of the amounts payable on each partial estimate, in accord with 1906.
- (b) Pay for material on hand.
- (c) Pay the remaining percentage retained upon completion of the work to the Engineer's satisfaction.

The Department will make payment according to the following:

Payment for \_\_\_\_\_ system, at the Contract price, is compensation in full for all costs incidental to furnishing and installing the system specified, complete in place.

Payment for system integration at the Contract price, is full compensation for all costs incidental to incorporating the work and material of the Contract, into the existing system. Payment is based on the percent of the Contract completed, as indicated on the project progress chart. When the chart indicates 10 percent of the Contract has been completed, 10 percent of the systems integration item bid price is paid.

Payment for \_\_\_\_\_ foundation, at the appropriate Contract price per unit of measure, includes all work materials and costs involved in furnishing and installing the foundation specified.

**2550.5**

When the cabinet foundation is part of a larger pad, the cabinet foundation includes the concrete and conduit under and adjacent to the cabinet.

When the service foundation is part of a larger pad, the service foundation includes the concrete, conduit and conductors under and adjacent to the service equipment.

Payment for each of the pay items at the appropriate Contract price per unit, is compensation in full for all costs incidental to furnishing and installing that item.

Payment for TMS is made on the basis of this schedule:

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2550.501	__ System .....	lump sum
2550.509	Systems Integration .....	lump sum
2550.511	__ Foundation .....	each
2550.512	Handholes, Type __ .....	each
2550.513	Junction Box .....	each
2550.514	Fiberoptic Splice Vault .....	each
2550.515	Outdoor Fiber Splice Enclosure .....	each
2550.516	Buried Cable Sign .....	each
2550.519	Truck Pad .....	each
2550.521	__ mm ( <b>inch</b> ) Rigid Steel Conduit .....	meter ( <b>linear foot</b> )
2550.523	__ mm ( <b>inch</b> ) Non metallic Conduit .....	meter ( <b>linear foot</b> )
2550.524	__ mm ( <b>inch</b> ) Pushed Conduit .....	meter ( <b>linear foot</b> )
2550.531	__ Cable __ Pr. No. __ .....	meter ( <b>linear foot</b> )
2550.532	__ Cable __ Conductor No. __ .....	meter ( <b>linear foot</b> )
2550.533	__ Cable .....	meter ( <b>linear foot</b> )
2550.534	Fiberoptic Trunk Cable __ MM __ SM .....	meter ( <b>linear foot</b> )
2550.535	Armoured Fiberoptic Pigtail .....	each
2550.541	__ m ( <b>foot</b> ) X __ m ( <b>foot</b> ) Loop Detector, Design __ .....	each
2550.542	Loop Detector Splice .....	each
2550.551	Ramp Control Signal, Design __ .....	each
2550.552	Flasher Signal .....	each
2550.553	Lane Control Signal .....	each
2550.561	Closed Circuit Television Assembly .....	each
2550.562	Changeable Message Sign, Design __ .....	each
2550.571	__ Cabinet .....	each
2550.572	Service .....	each
2550.581	Loop Detector Module .....	each

2554

**2554**  
**Traffic Barriers**

**2554.1 DESCRIPTION**

This work shall consist of the installation of guardrail, barrier, end treatments, barrier fencing, permanent barricades, and similar devices that protect or prohibit traffic at the locations indicated in the Plans or as directed by the Engineer. It shall also include the installation of posts, guide posts, and the resetting of existing barriers.

**2554.2 MATERIALS**

<b>A</b>	<b>Metal Posts</b>	
A1	Flanged Channel Sign Post.....	3401
A2	Structural Metal Posts.....	3406
<b>B</b>	<b>Blank</b>	
<b>C</b>	<b>Wood Posts</b> .....	<b>3412</b>
<b>D</b>	<b>Timber Plank, S4S</b> .....	<b>3426</b>
<b>E</b>	<b>Wire Rope</b> .....	<b>3381</b>
<b>F</b>	<b>Steel Beams</b>	
F1	Steel Plate Beams .....	3382
F2	Rub Rail .....	3306
<b>G</b>	<b>Hardware and Fittings</b> .....	<b>3381, 3382</b>
<b>H</b>	<b>Paints, as specified in the Contract</b>	
<b>I</b>	<b>Blank</b>	
<b>J</b>	<b>Concrete</b> .....	<b>2461</b>

Concrete for anchor blocks and bearing blocks shall develop a compressive strength of not less than 19 MPa (**2750 psi**) at 14 days. No air entrainment will be required.

<b>K</b>	<b>Anchorage Rods</b> .....	<b>3385</b>
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**2554.3 CONSTRUCTION REQUIREMENTS**

**A Excavation and Foundations**

Post holes may be dug by hand or mechanical methods. The depth of each excavation shall be that required to place the rail elements at the specified height above the ground surface and meet the requirements for post top and side alignment. Anchorage excavations shall be made in a manner that will provide bearing on firm, undisturbed earth at the proper depth.

The foundation of line, guide, and permanent barricade posts shall be the natural soil at the bottom of the excavation, tamped to provide firm bearing. End posts and posts at intermediate guardrail anchorages shall be founded on concrete bearing blocks of the dimensions shown in the Plans, which shall be installed firmly on a properly prepared foundation.

**B Installing Posts**

Posts of the required size and type shall be installed at the intervals indicated in the Plans and to the staked lines. Post tops shall be within 10 mm (**3/8 inch**) of the required elevation and grade.

Type A guide posts shall be 140 mm (**5 ½ inch**) nominal diameter (120 to 160 mm (**4 ¾ to 6 ¼ inch**) by 1.8 m (**6 feet**) long, treated wood conforming to 3412, and installed with the top of the post 760 mm (**30 inches**) above the shoulder P.I. elevation, unless otherwise indicated.

Type B guide posts (culvert markers) shall be flanged channel steel posts with a mass of 3.0 kg/m (**2 pounds per foot**) of length conforming to 3401 and shall be installed as shown in the Plans.

Mechanical driving of posts, where required or permitted, shall be accomplished by means that will give the necessary accuracy of placement without damage.

Required backfill materials shall be installed and consolidated thoroughly in a manner that will maintain the post plumb and in the correct position.

**C Installing Barriers**

Traffic barriers of the required design shall be installed as shown in the Plans. Proprietary barrier items shall be installed per manufacturers specifications.

Holes drilled in wood posts shall be the same diameter as the bolts or fittings to be accommodated. In metal posts, drilled holes for bolts or other fittings shall have a diameter no more than 1.6 mm (**1/16 inch**) greater than that of the bolt or fitting. Field cuts in treated wood shall be given two applications of copper naphthenate or another compatible preservative material meeting AWPAC Standard M4, with a minimum time lapse of 2 hours between applications. Field bored holes may be left untreated.

Bolt length shall not be any longer than necessary to allow full nut contact after tightening at the overall nominal depth of the assembled parts, plus reasonable allowance for oversize components. Wherever vehicle contact is possible, bolt end projections beyond the rail contact face shall be avoided, or the excess length shall be cut off within 15 mm (**9/16 inch**) of the nut head.

**C1 Wire Rope Installations**

Except where cable clips are permitted, free ends of wire rope shall be wire wrapped to prevent unraveling.

At intermediate anchorages, the cables shall be properly spaced to prevent contact between the separate cables.

### 2554.3

#### C2 Steel Plate Beam Barriers

When offset blocks are required, the blocks shall be of treated timber or other material on the approved list on file with the Materials Engineer. The Contractor shall treat field cuts on treated wood according to 2554.3C.

Rail and end sections shall overlap the adjacent section in the direction of traffic.

End treatments shall be installed in accordance with the details as shown in the Plans and as staked in the field. Proprietary end treatments shall be installed per manufacturers specifications. Installation of the required guardrail end treatments shall be done concurrently with the installation of the guardrail.

#### C3 Chain Link Fence Barriers

Installation shall be in accordance with the Plans. Tension on the fence shall be that which will allow no visible sag of the fence between supports.

#### C4 Permanent Barricades

Permanent barricades shall be fabricated as shown in the Plans.

#### **D Painting and Field Repairs**

Steel that is not coated according to 3406 and is above the ground shall be given two coats of paint as shown in the Plans and in accordance with the applicable provisions of 2479. The Contractor shall make other field repairs according to the manufacturer's recommendations.

#### **E Disposal of Surplus Excavated Material**

All surplus excavated material shall be disposed of by the Contractor, at no expense to the Department, and in a manner satisfactory to the Engineer.

### 2554.4 METHOD OF MEASUREMENT

#### **A Traffic Barriers**

Traffic barriers of each design designation will be measured by length, to the nearest 0.3 m (**1 foot**), between the centers of end posts in each continuous section, with no deduction for expansion assemblies.

#### **B Permanent Barricades**

Permanent Barricades will be measured by length, to the nearest 0.3 m (**1 foot**), from end to end of the planks of each unit.

#### **C Guide Posts**

Guide posts will be measured by the number of posts placed. Each type, as indicated in the Plans, will be measured separately.

#### **D Anchorage Assemblies**

Anchorage assemblies will be measured by the number of assemblies installed. Each assembly shall consist of the anchor and the fittings required to connect it to the end post.

2554.5

**E End Treatments**

End treatments will be measured by the number of units of each type installed complete-in-place.

**2554.5 BASIS OF PAYMENT**

Payment for the installation of traffic barriers at the Contract price per unit of measure for each design specified will be compensation in full for furnishing all required materials and installing the barrier as specified, except that anchorage assemblies will be paid for as separate items, complete as shown in the Plans.

Payment for the installation of end treatments of each type at the Contract price per unit of measure will be compensation in full for furnishing and installing steel plate beam rail, all necessary posts, appropriate anchorage, offset blocks, hardware, and required materials as specified.

Payment for the installation of guide posts at the Contract price per unit of measure for each type specified will be compensation in full for all costs of furnishing and installing the posts as specified.

Payment for the installation of traffic barriers or guide posts at the Contract price per unit of measure will be compensation in full for all costs of installing the work as specified, using materials furnished by the Department.

Payment for permanent barricades at the Contract price per unit of measure will be compensation in full for all costs of furnishing the required materials and installing the barricades complete-in-place as specified.

Payment for traffic barriers and barricades will be made on the basis of the following schedule:

<b>Item No.</b>	<b>Item</b>	<b>Unit</b>
2554.501	Traffic Barrier, Design ____ .....	meter ( <b>linear foot</b> )
2554.505	Permanent Barricades .....	meter ( <b>linear foot</b> )
2554.509	Guide Post, Type ____ .....	each
2554.511	Install Traffic Barrier, Design ____ .....	meter ( <b>linear foot</b> )
2554.515	Install Guide Post, Type ____ .....	each
2554.521	Anchorage Assembly.....	each
2554.523	End Treatment - ____ .....	each