

**DIVISION 600****INCIDENTAL CONSTRUCTION****SECTION 601 - CULVERTS AND STORM DRAINS**

**601.01 DESCRIPTION.** This work shall consist of the construction, cleaning, and reconditioning or reconstruction of culverts and storm drains, hereinafter referred to as pipe.

**601.02 MATERIALS.** Materials shall meet the requirements of the following Subsections:

Mortar, Type II .....	707.02
Rubber Gaskets .....	707.11
Reinforced Concrete Pipe .....	710.01
Reinforced Concrete Pipe End Sections .....	710.02
Corrugated Polyethylene Pipe .....	710.03
Corrugated Steel Pipe, Pipe Arches, and Underdrains.....	711.01
Corrugated Aluminum Alloy Pipe, Pipe Arches, and Underdrains ..	711.02
Polymeric Coated Corrugated Steel Pipe and Pipe Arches.....	711.03
Bituminous Paving for Pipe Inverts.....	711.04
Coal-Tar Based Coating .....	711.05

Manufacturing plants may be inspected periodically for compliance with specified manufacturing methods.

All units in a given pipe or pipe arch installation, including elbows, end sections, coupling bands, and reducer units, shall be of the same material, except that corrugated steel pipe end sections shall be used with polymeric coated corrugated steel pipe and pipe arches.

All materials will be subject to inspection for acceptance prior to or during incorporation of materials in the work.

When either corrugated steel pipe or pipe arches with 125 by 25 mm (5 × 1 inch) corrugations are shown on the Plans, the Contractor may substitute pipe or pipe arches of the same thickness with 75 by 25 mm (3 × 1 inch) corrugations at no additional compensation.

**601.03 GENERAL.** Care shall be exercised when unloading pipe from delivery trucks and moving pipe to its final position. If the Engineer rejects damaged pipe, new pipe shall be furnished by the Contractor at no additional cost to the Agency.

Unless otherwise directed by the Engineer, the Contractor shall provide for the temporary diversion of water to permit the installation of the pipe in a reasonably dry trench.

The location of all pipe installation shall be approved by the Engineer.

Where existing pipe is to be retained or relaid and it becomes damaged due to the fault of the Contractor, it shall be replaced with new pipe at the Contractor's expense.

Aluminum, aluminized, or aluminum-zinc alloy coated pipe that is to be in contact with concrete or mortar shall have the contact surfaces thoroughly coated with an approved barrier coating recommended by the pipe manufacturer or approved by the Agency's Materials and Research Section, which shall be allowed to dry before installation.

Where the protective coating has been removed from the metal, either by cutting, burning, welding, placing, or any other means, it shall be repaired by thoroughly cleaning with a wire brush and treating the damaged areas as follows:

- (a) in accordance with AASHTO M 36M.
- (b) for damaged polymeric coating, application of a coal-tar based or other polymeric coating as recommended by the manufacturer.

601.04 EXCAVATION. Where pipe is to be laid below the existing ground line, a trench shall be excavated to the required depth and to a width sufficient to allow for joining of the pipe and compaction of the bedding and backfill material under and around the pipe.

The completed trench bottom shall be firm for its full length and width. The invert grade shall be cambered by an amount to be determined by the Engineer.

If shown on the Plans or directed by the Engineer, unsuitable foundation material encountered below the normal grade of the culvert bed shall be removed and replaced with Granular Backfill for Structures, or other specified or approved material.

Ledge rock, rocky or gravelly soil, hard pan, or other unyielding foundation material encountered at the normal grade of the culvert bed shall be removed and replaced with Granular Backfill for Structures having a width measurement of the inside width of the pipe plus 600 mm (24 inches) and to a minimum depth of 300 mm (12 inches) below the pipe grade, unless otherwise shown on the Plans or directed by the Engineer.

601.05 BEDDING. Unless otherwise specified, the bed shall be shaped and compacted to fit the pipe for a depth of not less than 10 percent of its total height. Recesses to receive the bell shall be formed when applicable.

601.06 PLACEMENT. No pipe shall be placed until the trench and the prepared foundation have been approved by the Engineer.

Placement shall begin at the outlet end. The lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or grooved ends of rigid pipes and the outside circumferential laps of flexible pipe shall be placed facing upstream. The longitudinal laps or seams of riveted pipe shall be at the sides.

Pipe with paved inverts shall be laid so that the paved segment is centered at the bottom of the pipe.

The handling holes in concrete pipes shall be filled with a precast plug, sealed, and covered with mastic or mortar.

601.07 JOINING PIPE.

- (a) Concrete Pipe. Concrete pipe shall be of bell and spigot or tongue and groove design, or as specified. Pipe sections shall be joined so that the ends are fully entered and the inner surfaces are reasonably flush and even.

Joints shall be made with portland cement mortar, portland cement grout, rubber gaskets, oakum and mortar, oakum and joint compound, a combination of these types, or any one type as specified and approved by the Engineer. Joints in concrete pipe should be thoroughly wetted before mortar or grout is applied.

Mortar joints shall be made with an excess of mortar to form a bead around the outside of the pipe and finished smooth on the inside. For grouted joints, molds or runners shall be used to retain the poured grout. Rubber ring gaskets shall be installed so as to form a flexible watertight seal. Where oakum is used, the joint shall be caulked with this material and then sealed with the specified materials.

When portland cement mixtures are used, the completed joints shall be protected against rapid drying by suitable curing materials, and protected from freezing until adequate set and strength have been reached, as determined by the Engineer.

The first three sections, at ends of culverts that are not restrained by drop inlets or catch basins, shall be connected together at the springline on each side of the pipe to restrain movement of the sections. If an end section is used, it shall be one of the three sections to be connected together.

The connecting devices shall be at least 3.7 m (12 feet) in length when used with 2.3 m (7.5 foot) minimum length sections and at least 3 m (10 feet) in length when used with 1.8 m (6 foot) minimum length sections. Each device shall be securely anchored to the pipe, with minimum slack in the device and the joints. The anchoring points shall be a minimum of 450 mm (18 inches) from the end of the pipe sections and the flared end sections. Each end of the device shall be anchored with an M24 (1 inch) bolt with a nut and washer, or its equivalent, through the section wall.

Each device shall be a steel strap with an effective cross-sectional area of  $150 \text{ mm}^2$  ( $0.23 \text{ in}^2$ ) for all pipe 1200 mm (48 inches) in diameter or smaller. For pipe larger than 1200 mm (48 inches) in diameter, the required steel area for restraining devices shall be as shown on the Plans.

Alternate designs of restraining devices and anchoring hardware will be considered for approval as long as they provide equivalent restraining properties and durability.

Restraining devices may be placed on either the inside or outside of the pipe. If placed on the inside, the device shall not protrude from the wall to the degree that flow would be obstructed. Any bending of the device for proper installation shall be done by the cold bending method. Holes in the pipe and end sections, required for the anchor bolts, may be drilled in the field.

- (b) Metal Pipe. Metal pipes shall be firmly joined by coupling bands.

Pipes with an effective diameter greater than 900 mm (36 inches) shall be joined by coupling bands that fully engage the second full corrugation from the end of each pipe.

Pipes on steep grades (greater than 14 percent) will be joined either by 600 mm (24 inches) wide coupling bands or by bands additionally equipped with silo rods or cables for positive attachment.

In all cases, ends of pipes joined by coupling bands shall be as close together as the corrugations will allow.

- (c) Corrugated Polyethylene Pipe. Corrugated Polyethylene pipe shall be joined by a system designed and approved by the pipe manufacturer. Couplings and fittings shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints.

601.08 BACKFILLING. Installed pipe will be inspected and approved before any backfill is placed. Any pipe found to be damaged or out of alignment shall be removed and replaced or re-laid without additional compensation.

Unless otherwise shown on the Plans or directed by the Engineer, the backfill material shall be selected fine compactable soil from excavation when available, or Granular Backfill for Structures. This material shall be placed to a height of 600 mm (24 inches) over the pipe. No stones in excess of 75 mm (3 inches) in diameter shall be placed in contact with the pipe. Rock fill or boulders shall not be placed within 600 mm (24 inches) of the outside of the pipe.

The backfill material shall be placed in 150 mm (6 inch) thick layers and compacted in accordance with Subsection 203.11(d) using air or mechanical tampers. Care shall be exercised to thoroughly compact the material under the haunches of the pipe. The backfill shall be placed evenly on both sides of the pipe for its full length. In embankment sections the fill shall be compacted for a width on each side of the pipe equal to at least twice the horizontal inside diameter of the pipe or 4 m (12 feet), whichever is less. Fill at the sides of the pipe may be compacted by operating compaction equipment longitudinally parallel with the pipe, provided care is taken to avoid displacement or injury to the pipe.

All pipe shall be protected by a 1.2 m (4 foot) cover of fill before heavy equipment or traffic is permitted to cross during construction of the roadway. Whenever this cover extends above the subgrade the Contractor shall temporarily place earth which shall be removed when necessary to complete the work in accordance with the details shown on the Plans or as directed by the Engineer. Any deviation from this practice shall have prior approval by the Engineer. However, compliance with the 1.2 m (4 foot) protective cover requirement shall not relieve the Contractor of any responsibility concerning damage to the pipe.

601.09 CLEANING OF CULVERTS. Pipe culverts at the locations shown on the Plans, or as directed by the Engineer, that contain silt, debris, and other material within the barrel and appurtenances shall have the silt, debris, and other material removed and disposed of by methods that do not damage the pipe.

With the approval of the Engineer, all or part of a pipe designated to be cleaned in place may be removed, cleaned, and relaid in accordance with these specifications. In these cases, the Contractor shall furnish all material required to replace damaged pipes and joints, perform all excavation and backfill, and re-lay the pipe, all at the Contract unit price for the Contract item Cleaning Culvert Pipe, In Place.

However, if the Engineer determines that the pipe must be replaced, through no fault of the Contractor, replacement will be paid for under the appropriate Contract items.

601.10 METHOD OF MEASUREMENT. The quantities of culverts and storm drains to be measured for payment will be the number of meters (linear feet) used in the complete and accepted work, as shown on the Plans or ordered by the Engineer. No allowance will be made for "growth" in length at joints when this increase exceeds the ordered length.

When it is necessary to cut pipe in the field, the quantity of pipe to be measured for payment will be the length necessary, rounded to the next whole meter (2 foot) increment.

The quantity of Re-laying Pipe Culverts to be measured for payment will be the number of meters (linear feet) of re-laid pipe in the complete and accepted work.

The quantities of pipe Elbows, End Sections, and Concentric Reducer Sections to be measured for payment will be the number of each size and type of unit installed in the complete and accepted work.

The quantity of Cleaning Culvert Pipe, In-Place to be measured for payment will be the total length of pipe for each pipe acceptably cleaned, as determined along the flow line of the pipe. The cost to clean material from pipes as the result of on-project construction activities shall be at the Contractor's expense.

601.11 BASIS OF PAYMENT. The accepted quantities of culverts and storm drains of the type and size specified will be paid for at the respective Contract unit price per meter (linear foot).

The accepted quantity of Re-laying Pipe Culverts will be paid for at the Contract unit price per meter (linear foot).

The accepted quantities of pipe Elbows, End Sections, and Concentric Reducer Sections of the type and size specified will be paid for at the respective Contract unit price each.

The cost of vertical risers, when shown on the Plans, shall be included in the Contract unit price per meter (linear foot) for each culvert to which a riser is attached. Each vertical riser pipe shall be bid as a separate unit.

Payment will be full compensation for fabricating, furnishing, transporting, handling, and placing the material specified to include bituminous or other coating, coupling bands, joint material, cutting when necessary, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation, including backfill operations and the disposal of excavated material (excess or unsuitable for backfill), will be paid as follows:

- (a) For all pipes, pipe arches, elbows, end sections, or concentric reducers of 1200 mm (48 inches) in diameter and under, at the Contract unit price per cubic meter (cubic yard) for Trench Excavation.
- (b) For all pipes, pipe arches, elbows, end sections, or concentric reducers of over 1200 mm (48 inches) in diameter, at the Contract unit price per cubic meter (cubic yard) for Structure Excavation.
- (c) When material is required to replace poor foundation material below the normal grade of the culvert, it will be paid for at the Contract unit price per cubic meter (cubic yard) for the type of backfill specified.

- (d) When Granular Backfill for Structures is required for backfill material, it will be paid for at the Contract unit price per cubic meter (cubic yard).

Anchor bolts, required in construction of headwalls, will not be paid for separately but will be considered incidental to the Contract unit price for the pipe on which they are required.

The accepted quantity of Cleaning Culvert Pipe, In-Place will be paid for at the Contract unit price per meter (linear foot) for the specified size of pipe. Payment will be full compensation for cleaning the pipe; for excavating, backfilling, and re-laying the pipe, if necessary; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
601.0000 to 601.0199 CSP	Meter (Linear Foot)
601.0200 to 601.0399 CAAP	Meter (Linear Foot)
601.0400 to 601.0599 PCCSP	Meter (Linear Foot)
601.0600 to 601.0799 PCCSP(PI)	Meter (Linear Foot)
601.0800 to 601.0899 RCP	Meter (Linear Foot)
601.0900 to 601.0999 CPEP	Meter (Linear Foot)
601.2000 to 601.2199 CSP(SL)	Meter (Linear Foot)
601.2200 to 601.2399 CAAP(SL)	Meter (Linear Foot)
601.2400 to 601.2599 PCCSP(SL)	Meter (Linear Foot)
601.2600 to 601.2799 CPEP(SL)	Meter (Linear Foot)
601.3000 to 601.3199 CSPA	Meter (Linear Foot)
601.3200 to 601.3399 CAAPA	Meter (Linear Foot)
601.3400 to 601.3599 PCCSPA	Meter (Linear Foot)
601.3600 to 601.3799 PCCSPA(PI)	Meter (Linear Foot)
601.4000 to 601.4199 CSPA(SL)	Meter (Linear Foot)
601.4200 to 601.4399 CAAPA(SL)	Meter (Linear Foot)
601.4400 to 601.4599 PCCSPA(SL)	Meter (Linear Foot)
601.5000 to 601.5199 CSP Elbow	Each
601.5200 to 601.5399 CAAP Elbow	Each
601.5400 to 601.5599 PCCSP Elbow	Each
601.5600 to 601.5799 PCCSP Elbow (PI)	Each
601.5800 to 601.5999 CPEP Elbow	Each
601.6000 to 601.6199 CSPES	Each
601.6200 to 601.6399 CAAPES	Each
601.6800 to 601.6899 RCPES	Each
601.7000 to 601.7099 CPEPES	Each
601.8000 to 601.8199 CSPAES	Each



601.8200 to 601.8399 CAAPAES	Each
601.98 Concentric Reducer Section	Each
601.99 Re-laying Pipe Culverts	Meter (Linear Foot)
601.995 Cleaning Culv. Pipe, In-Place [0 to 600 mm (24 in.), incl.]	Meter (Linear Foot)
601.996 Cleaning Culv. Pipe, In-Place [Greater than 600 mm (24 in.)]	Meter (Linear Foot)

SECTION 602 - MASONRY

602.01 DESCRIPTION. This work shall consist of furnishing materials and constructing walls, and other masonry of the types and sizes specified, or rebuilding, repairing, or repointing of existing masonry.

602.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Stone for Masonry .....	706.01
Stone for Masonry Facing.....	706.02
Mortar, Type II .....	707.02
Dowels and Ties.....	713.01
Bar Reinforcement.....	713.01

Materials for Rebuilt and Repairing Stone Masonry shall be approved by the Engineer prior to use. New stone, as required, shall match as closely as practical the existing stone masonry color, texture, and size. If required to match the existing stone masonry, chemical treatment processes to aid in providing stone of similar color shall be investigated by the Contractor.

Concrete for headwalls shall meet the requirements of Section 541 for Concrete, Class B.

Concrete for copings, bridge seats, and backwalls, unless otherwise specified, shall meet the requirements of Section 501 for Concrete, High Performance Class B.

Backfill material shall meet the requirements of Section 204 for Granular Backfill for Structures.

602.03 MIXING OF MORTAR. The fine aggregate and cement shall be mixed in a clean, tight box until a mixture of uniform color is produced, after which clean water shall be added in such quantity as to form a mortar with the consistency of stiff paste. If desired, the Contractor will be permitted to use a batch mixer of an approved size and type. Mortar which has been mixed for more than 45 minutes shall not be used, and retempering of mortar will not be permitted.

602.04 PLACING OF STONE. The placing and shaping of stone shall be the same for dry or cement masonry.

The bed shall be clean and well moistened just prior to the placement of the stone. The stone shall be thoroughly saturated with water, well bedded into the mortar and carefully settled in place before the mortar has set. No spalls will be permitted in the bed. Joints and beds shall not average over 25 mm (1 inch) in thickness.

The masonry shall be laid in full mortar beds to the lines shown on the Plans and in approximately level courses. The bottom or foundation courses shall be composed of large selected stones.

All courses shall be laid with bearing beds parallel to the natural bed of the materials. The larger stone shall be used near the bottom and the smaller stone near the top of the masonry, the latter corresponding, as nearly as possible, to the minimum thickness of the masonry at its top.

The construction of stone masonry will not be permitted in freezing weather or when frost is in the stone, except by written permission of the Engineer and subject to conditions as the Engineer may require.

In walls where the thickness is over 1.2 m (4 feet), the stones used as headers for the purpose of holding in the heart of the wall shall extend not less than 1.2 m (4 feet) into the core and shall occupy not less than 20 percent of the front and back surface area of the wall.

In walls where the thickness is 1.2 m (4 feet) or less, the stones used as headers shall extend entirely through the wall.

The break in joints of the stone shall be at least 150 mm (6 inches) on the exposed faces of the wall and the backing stones shall be laid so that the joints are broken. The rear face of the wall shall present an approximately plane surface.

The stone shall be roughly squared on joints, beds, and faces, and shall be pitched to line, at all angles and ends of walls. All shaping or dressing of stones shall be done before the stone is laid in the wall, and no dressing or hammering that would tend to loosen the stones already set will be permitted after their placement. Any stone around which the bond has become broken shall be removed, the mortar shall be thoroughly cleaned from the bed and joints, and the stone shall be reset in fresh mortar.

602.05 WEEP HOLES. Weep holes shall be constructed as shown on the Plans or as ordered by the Engineer.

602.06 REBUILT AND REPAIRING STONE MASONRY.(a) General.

- (1) Rebuilt Stone Masonry. The stone masonry of the existing substructure and wingwalls shall be mapped, removed, and rebuilt as indicated and specified in the Contract Documents.

Following backfill excavation, the existing stones, tree stumps, roots, and other foreign matter shall be removed in the areas shown on the Plans or where directed by the Engineer. The existing stones shall be re-set in their original locations, removing any gaps that occurred due to previous damage to the walls. Rebuilt Stone Masonry shall match securely into adjacent masonry.

- (2) Repairing Stone Masonry. Earth, minor vegetation, and other foreign matter shall be removed and cavities in the stone substructure and wingwalls filled as indicated and specified in the Contract Documents.

(b) Construction Requirements.

- (1) Rebuilt Stone Masonry. The work shall be performed by a stone mason who is highly knowledgeable and experienced in the construction of dry stone masonry walls and fascia. The Contractor's stone mason performing the work must demonstrate at least five years experience in the construction of dry stone masonry walls. Documentation of experience, including a list of previous projects and references, shall be submitted to the Engineer prior to commencement of the work.

The existing stone masonry in the areas of reconstruction shall be mapped out and documented. Each stone size and location shall be noted. The Contractor, prior to stone removal, shall submit documentation to the Engineer for approval.

Special care and precautions shall be taken during removal and storage of the existing stone masonry to ensure that the stone is not damaged.

All stones shall be carefully removed in the areas shown on the Plans. The Contractor shall shore the remaining portions of the walls to ensure that they do not shift during construction.

The existing stones shall be replaced in their original locations, removing any gaps that occurred due to previous damage to the walls. All joints in the reconstructed stone walls shall be no larger than 19 mm (3/4 inch) between stones. Any existing stones that are not suitable for replacement or missing shall be replaced by the Contractor with stones of similar size and appearance.

(2) Repairing Stone Masonry.

- a. Examination. The Contractor and Engineer shall jointly examine the abutments and wingwalls to field verify the extent of the work.

All work shall be performed by stonemasons with a minimum of three (3) years experience with similar work.

- b. Repair. Gaps between horizontal faces of existing stones less than 25 mm (1 inch) shall not be repaired. The size of these gaps shall equal the approximate diameter of a 22 mm (7/8 inch) diameter steel dowel bar.

Gaps between horizontal faces of existing stones between 25 mm (1 inch) and 150 mm (6 inches) shall have small stone blocks added, with the depth of the blocks as large as possible for good bearing. The minimum width of said blocks shall be 100 mm (4 inches).

Gaps between horizontal faces of existing stones greater than 150 mm (6 inches) shall have crushed gravel and stone blocks added. The crushed gravel shall be placed at the back of the stone and compacted in place up to 300 mm (12 inches) of the exposed wall face. The crushed gravel shall be compacted by tamping rods or other methods acceptable to the Engineer. Stone block(s) shall then be added to achieve a tight fit. New stone blocks shall not extend beyond the face of the stone wall.

602.07 POINTING AND REPOINTING. All joints shall be filled with mortar, well driven in, and finished with an approved pointing tool for a distance of 15 mm (1/2 inch) back from the surface of the stone.

When joints are in old masonry, they shall be cleaned of all loose mortar and dirt for a depth in from the face of the wall of at least twice the width of the joint and moistened.

All mortar shall be cleaned from the face of the stones after the pointing is completed and the work has cured for a period of three days.

602.08 DOWELS AND TIES. Where required, bonding of various portions of the work shall be accomplished with dowels and ties of the shapes and dimensions shown on the Plans or approved by the Engineer. They shall be placed, as shown or required, in the stone so as to clear the bed of the succeeding course.

Dowel holes shall be drilled into each stone, to match dowels already set, before the stone is placed. No drilled holes will be permitted in the exposed top surfaces.

602.09 BACKFILLING. Spaces excavated for masonry structures, but not occupied by these structures, shall be backfilled. The backfill shall be placed in horizontal layers of not more than 150 mm (6 inches) in depth. Each layer shall be thoroughly compacted by means of air or mechanical tampers in a manner approved by the Engineer.

602.10 METHOD OF MEASUREMENT. The quantities of Cement Masonry and Dry Masonry to be measured for payment will be the number of cubic meters (cubic yards) used in the complete and accepted work, measured in accordance with the dimensions shown on the Plans or ordered by the Engineer.

The quantities of Stone Masonry Facing and Repointing Masonry to be measured for payment will be the number of square meters (square yards) performed in the complete and accepted work, measured as follows:

- (a) The quantity of Stone Masonry Facing will be the height of the front face plus the width of the capstones times the length of the stone masonry facing. No deductions will be made for weep holes, drain pipes, or other openings of less than  $0.2 \text{ m}^2$  ( $2 \text{ ft}^2$ ).
- (b) The quantity of Repointing Masonry will be the total surface area of the masonry repointed.

The quantity of Rebuilt Stone Masonry to be measured for payment will be the number of cubic meters (cubic yards) of stone masonry rebuilt in the complete and accepted work, measured in accordance with the dimensions shown on the Plans or as determined by the Engineer.

The quantity of Repairing Stone Masonry to be measured for payment will be the number of square meters (square yards) of stone masonry repaired in the complete and accepted work, measured as the total surface area of the repaired masonry.

602.11 BASIS OF PAYMENT. The accepted quantities of Cement Masonry, Dry Masonry, Stone Masonry Facing, and Repointing Masonry will be paid for at the Contract unit price per cubic meter (cubic yard) or square meter (square yard) for the item specified. Payment will be full compensation for furnishing, transporting, handling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The dowels and ties required for constructing stone masonry facing will not be paid for separately but will be considered incidental to the Contract unit price per square meter (square yard) for Stone Masonry Facing.

Excavation will be paid for as Trench Excavation, unless otherwise shown on the Plans.

The accepted quantity of Rebuilt Stone Masonry will be paid for at the Contract unit price per cubic meter (cubic yard). Payment will be full compensation for mapping, documenting, and removing existing stone masonry; furnishing new stone as needed; furnishing, transporting, handling, and placing the materials specified; backfilling when not paid under a separate Contract item; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation adjacent to Rebuilt Stone Masonry and disposal of excess or unsuitable excavated material will be paid for at the Contract unit price per cubic meter (cubic yard) for Structure Excavation. Excavation shall be backfilled with material acceptable to the Engineer. When Granular Backfill for Structures is required for backfill material, it will be paid for at the Contract unit price per cubic meter (cubic yard).

The accepted quantity of Repairing Stone Masonry will be paid for at the Contract unit price per square meter (square yard). Payment will be full compensation for removing material specified from the face of stone masonry; filling cavities; furnishing, transporting, handling, and placing the materials specified; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
602.15 Cement Masonry	Cubic Meter (Cubic Yard)
602.20 Dry Masonry	Cubic Meter (Cubic Yard)
602.25 Stone Masonry Facing	Square Meter (Square Yard)
602.30 Repointing Masonry	Square Meter (Square Yard)
602.35 Rebuilt Stone Masonry	Cubic Meter (Cubic Yard)
602.40 Repairing Stone Masonry	Square Meter (Square Yard)

**SECTION 604 - DROP INLETS, CATCH BASINS, AND MANHOLES**

604.01 DESCRIPTION. This work shall consist of the construction, rehabilitation, or adjustment to grade of drop inlets, catch basins, and manholes; and the furnishing and placing of cast iron or steel grates and cast iron or precast concrete covers.

604.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Clay or Shale Sewer Brick .....	705.01
Concrete Masonry Blocks .....	705.02
Precast Drop Inlets, Catch Basins, and Manholes.....	705.04
Mortar, Type II .....	707.02
Reinforced Concrete Pipe .....	710.01
Vitrified Clay Pipe .....	710.04
Bar Reinforcement .....	713.01
Welded Steel Wire Fabric .....	713.05
Cast Iron Frame, Grate, and Cover .....	715.01(b)
Ductile Iron Frame and Cover .....	715.01(c)



Unless otherwise specified, cast-in-place concrete shall conform to the requirements of Section 541 for Concrete, Class B.

Material for steel grates shall meet the requirements of ASTM A36/A36M. For steel grates, a Type D certification shall be furnished in accordance with Subsection 700.02.

Pipe stubs for precast reinforced concrete curb drop inlets shall meet the requirements of Section 601.

The term "cast iron," as used in these Specifications, or in various Contract items, when used in conjunction with covers and frames, shall be understood to mean "cast iron or ductile iron." The Contractor may use ductile iron covers and frames meeting the requirements of Subsection 715.01(c) instead of cast iron covers and frames. Steps or ladder rungs in drop inlets, catch basins, or manholes shall be plastic, complying with all applicable OSHA dimensional and structural requirements. Unless otherwise shown on the Plans, the rungs shall be cast into the fresh concrete, except that for precast units, the rungs may be grouted into preformed voids with a non-shrink grout approved by the Engineer after the concrete has cured.

604.03 GENERAL CONSTRUCTION REQUIREMENTS. The excavation shall be to the depth shown on the Plans or ordered by the Engineer, and carefully shaped and graded.

The footings for drop inlets, catch basins, and manholes may be either precast or cast-in-place concrete.

For construction of drop inlets, catch basins, or manholes, the bricks used on top of the concrete to adjust the top to the correct elevation shall meet the requirements of Subsection 705.01(c).

Unless directed otherwise by the Engineer, when adjusting the elevation of the tops of existing drop inlets, catch basins, sewer manholes, or manholes, the Contractor shall remove all existing bricks and replace them with new bricks meeting the requirements of Subsection 705.01(c) as part of the work and costs included in the Contract item Changing Elevation of Drop Inlets, Catch Basins, or Manholes or the Contract item Changing Elevation of Sewer Manholes.

Channels, inverts, and floor areas for sewer manholes shall be constructed of brick and mortar or Class C concrete conforming to Section 541. Inverts shall have the exact shape of the sewer to which they are connected and any change in size or direction shall be gradual and even. All construction of sewer manholes must be carried out to ensure

watertight work. Any leaks in manholes shall be repaired to the satisfaction of the Engineer, or the entire structure shall be removed and rebuilt. Leakage testing shall be performed in accordance with Subsection 628.08.

In the construction of baffled drop inlets, the angle attaching bolts may be inserted into anchors cast into the fresh concrete, or expansion anchors drilled and set into the concrete after the form work has been removed. Expansion anchors shall not be drilled and placed until a minimum of eight days after the day of the pour has passed.

Prior to rehabilitating or changing the elevation of any drop inlet, catch basin, or manhole, the Contractor shall completely clean out the interior of the unit, including cleaning at least 300 mm (12 inches) but not more than 600 mm (24 inches) into any openings in the walls for inspection to determine the extent of the work that will be required.

Except for components cast using the dry cast process, precast concrete components shall not have the forms removed until a minimum compressive strength of 15 Mpa (2000 psi) has been achieved. Precast components shall not be moved until two hours after they have been cast and until a minimum compressive strength of 15 Mpa (2000 psi) has been achieved. Concrete cylinders shall be made, in accordance with AASHTO T 23, at the last placement of the day.

Reinforced precast sections shall not be shipped from the manufacturing facility until the eighth day from the date of manufacture, except when the supplier provides test results demonstrating that the design strength has been achieved.

#### 604.04 CONSTRUCTION OF DROP INLETS, CATCH BASINS, AND MANHOLES.

- (a) Concrete Drop Inlet, Catch Basin, or Manhole. The concrete walls shall be constructed on the approved footing to the lines, grades, and dimensions shown on the Plans or directed by the Engineer.

The required courses of brick shall be placed on top of the concrete to the elevation shown on the Plans or directed by the Engineer. Brick shall be laid in a professional manner by a competent mason. After the bricks are laid, the joints on the inside of the brick masonry shall be neatly pointed. The outside surface of the brick shall be covered with mortar of the same quality as used for laying the bricks so that a reasonably smooth surface is obtained.

The top section may be precast or cast-in-place.

The cast iron frame shall be set in the concrete tops as shown on the Plans. When tops are precast, they shall be placed in a full mortar bed. The grate or cover shall be properly placed in the frame.

- (b) Precast Reinforced Drop Inlet, Catch Basin, or Manhole. The precast reinforced concrete risers shall be set reasonably close to line and grade on the previously placed concrete footing. The top section shall be capped with courses of mortared brick.

The cast iron frame shall be placed in a full mortar bed on the brick masonry and the cast iron cover or grate shall be placed on top of the frame.

- (c) Precast Reinforced Concrete Pipe Drop Inlet. The precast reinforced concrete pipe sections shall be set on a concrete base as shown on the Plans or as directed by the Engineer.

A precast concrete cover or a cast iron grate shall be placed as shown on the Plans.

- (d) Precast Reinforced Concrete Curb Drop Inlet. The precast reinforced concrete curb drop inlet shall be set to the line and grade as shown on the Plans or as directed by the Engineer.

The brick masonry, concrete top, and grate shall conform to the requirements of Subsection 604.04(a).

- (e) Changing Elevation of Drop Inlets, Catch Basins, or Manholes. Existing drop inlets, catch basins, and manholes that are to be altered or adjusted in elevation of the existing top shall be reconstructed to the required grade using the existing grates, frames, covers, or tops as specified. If the existing grates, frames, covers, and/or tops are not suitable for reuse, this Contract item shall not be used.

Should any grate, frame, cover, or top become broken through carelessness on the part of the Contractor, it shall be replaced at the Contractor's expense.

The existing structure shall be dismantled sufficiently to allow elevation adjustment as shown on the Plans or as directed by the Engineer. The existing grates, frames, covers, or tops to be reused shall be thoroughly cleaned of mortar before being reused. Any deteriorated brick, mortar, or missing brick in the structure, including any curb portions of the tops, shall be repaired or replaced by the Contractor.

Granite or concrete curbs, curb board, and bituminous fillet disturbed for this work shall be replaced. New treated timber curb board required shall meet the requirements of Subsection 729.06. Bituminous fillet shall conform to the applicable requirements of Section 406, for the type of mix specified by the Engineer and, after installation, shall be sealed in accordance with Subsection 616.08(d). Concrete curb and granite curb shall conform to the applicable requirements of Section 616. The cost of this curb replacement will not be paid for directly, but will be considered incidental to the Contract item Changing Elevation of Drop Inlets, Catch Basins, or Manholes.

Where the unit is to be raised and the change in elevation is less than 50 mm (2 inches), concentric structural steel rings of nominally 13 mm (1/2 inch) thick material properly welded to the frame may be used.

The Contract unit price bid for the Contract item Changing Elevation of Drop Inlets, Catch Basins, or Manholes shall include all the work and costs involved in cutting pavements and excavating around the top of the unit and the bricks to provide room to accomplish the work, and shall also include all costs of backfilling around the elevation reset unit up to the bottom of pavement or the upper surface of the unit top, as appropriate to the individual location.

If excavating through paved surfaces is required, the edges of the excavated area shall be saw cut to a minimum depth of 40 mm (1 1/2 inches).

- (f) Cast Iron Cover with Frame. The covers with frames shall be properly installed at the locations shown on the Plans or directed by the Engineer.

Covers for sanitary sewer manholes shall have the word "SEWER" cast into the top surface. Covers for storm sewer manholes shall have the word "STORM" cast into the top surface.

- (g) Grates. The grates shall be properly installed at the locations shown on the Plans or directed by the Engineer.
- (h) Sanitary Sewer Manhole. Sanitary sewer manholes shall be precast sewer manholes of the type and diameter shown on the Plans and shall meet the requirements of Subsection 705.04 except that all barrel joints shall contain an o-ring seal. Steps shall meet OSHA requirements for new construction. The exterior of the entire manhole shall be coated with a bitumastic or other watertight sealant meeting the approval of the sewer line owner. All joints between pipes and the manhole shall be made using an approved watertight boot.
- (i) Changing Elevations of Sewer Manholes. Existing sewer manholes that are to be altered or adjusted shall be reconstructed in accordance with Subsection 604.04(e), except that all exterior surfaces disturbed by the necessary reconstruction shall be coated or recoated with a watertight sealant approved by the sewer line owner. Necessary steps, pipe joints, and barrel joints shall conform to the requirements of Subsection 604.04(h).

The Contractor may be required to provide a specific step to match the existing steps as part of the work and costs included in this Contract item.

- (j) Rehabilitation of Drop Inlets, Catch Basins, or Manholes. Existing drop inlets, catch basins, and manholes that are to be altered, adjusted, or reconstructed shall be constructed to the required grade using existing grates, frames, covers, or tops, if useable, as specified. If necessary, this work shall include removal of the existing structure and the complete replacement of the drop inlet, catch basin, or manhole with a unit meeting current standards.

This work shall belong to one of three classes. Class I shall include all work down to a depth of 1 m (3 feet). Class II shall include all work greater than 1 m (3 feet) in depth down to a depth of 2 m (6 feet). Class III shall include all work greater than 2 m (6 feet) in depth.

If the existing grates, frames, covers, or tops are suitable for reuse, but the remainder of the top requires replacement, the Contractor shall carefully remove the frame from the existing top and cast a new top utilizing the existing grate, frame, or cover. If the existing grates, frames, covers, or tops are unsuitable for reuse, new ones shall be furnished as required. Unless otherwise specified, the replacement shall match the existing grate, frame, or cover in size and design.

Should any useable, existing grate, frame, cover, or top become broken through carelessness on the part of the Contractor, it shall be replaced at the Contractor's expense.

The existing structure shall be dismantled sufficiently to allow rehabilitation as shown on the Plans for completed drop inlets, catch basins, and manholes. Any existing grate, frame, cover, or top to be reused shall be thoroughly cleaned of mortar before being reused. Any deteriorated brick, concrete, reinforcement, steps, mortar, or missing brick in the structure, including any curb portions of the tops, shall be repaired or replaced by the Contractor as directed by the Engineer.

If the rehabilitation proceeds to a point where the culverts or other pipes entering and/or exiting the unit are within the area of rehabilitation and/or replacement, the necessary pipe stubs and collars, to connect the existing piping to the rehabilitated unit, shall be provided and installed by the Contractor. If the Contract includes a Contract item for the pipe, the pipe stubs will be paid for under the appropriate Section 601 or Section 605 Contract item in the Contract. If the Contract does not include a Contract item for the pipe, the pipe stubs and collar will not be paid for directly, but will be considered incidental to the Contract item Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I, II, or III, as appropriate.

Granite, bituminous, or concrete curbs, curb board, and bituminous fillet disturbed for this work shall be replaced. New treated timber curb board required shall meet the requirements of Subsection 729.06 Bituminous fillet shall conform to the applicable requirements of Section 406 for the type of mix specified by the Engineer and, after installation, shall be sealed in accordance with Subsection 616.08(d). Concrete, bituminous, and granite curb shall conform to the applicable requirements of Section 616. The costs of this curb replacement will not be paid for directly, but will be considered incidental to Contract items Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I; Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class II; or Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class III, as appropriate.

Where the unit is to be raised and the change in elevation is less than 50 mm (2 inches), concentric structural steel rings of nominally 13 mm (1/2 inch) thick material properly welded to the frame may be used.

The Contract unit price bid for the Contract items Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I, II, or III shall include all the work and costs involved in cutting pavements and excavating around the top of the unit and the bricks, to provide room to accomplish the work, and shall also include all costs of backfilling around the rehabilitated unit up to the bottom of pavement or the upper surface of the unit top, as appropriate to the individual location.

Unless otherwise directed by the Engineer, the Contractor shall saw all pavements to a minimum depth of 40 mm (1 1/2 inches).

- (k) Rehabilitation of Sewer Manhole. Rehabilitation of sewer manholes shall consist of removing the existing top with cover, with or without frame, and rehabilitation of the existing unit to a safe and useful structure, satisfactory to the Engineer. If necessary, this Contract item shall include the complete reconstruction of the sewer manhole to current standards.

This work shall consist of replacing broken or deteriorated bricks, mortar, concrete, reinforcement, frames, and covers with new materials. New barrel sections shall be precast of the type and diameter existing or as shown on the Plans and shall meet all requirements of Subsection 705.04 except that all barrel joints shall contain an o-ring. Steps, if required, shall meet OSHA requirements for new construction. The exterior of the entire manhole shall be coated with a bitumastic or other water-tight sealant meeting the approval of the sewer line owner. All joints between pipes and the manholes shall be made using an approved watertight boot.

604.05 CURING AND PROTECTION. After the masonry work is completed, it shall be kept moist and protected from the elements in a satisfactory manner for a period of at least 48 hours. Concrete shall be cured in accordance with Subsection 541.17.

Precast concrete shall be cured using membrane curing compound. The curing compound shall be applied to the concrete surface after finishing, as soon as the free water on the surface has disappeared and no water sheen is visible, but not so late that the liquid curing compound will be absorbed into the concrete. When curing compound cannot be applied as specified herein, the manufacturer shall instead immediately begin wet curing the unit until curing compound can be applied. When this method is used in conjunction with the dry cast process, the curing room shall be kept at 100% humidity until a minimum compressive strength of 15 Mpa (2000 psi) has been obtained.

When the forms are removed prior to 7 days, the exposed concrete surfaces shall be wet with water within one half hour of form removal and shall be kept wet until the curing compound is applied. Before application, the concrete shall be allowed to reach a uniformly damp appearance with no free water on the surface, and then the compound shall be applied immediately.

Precast concrete drainage components shall not be subjected to freezing temperatures prior to attaining the specified 28 day compressive strength. Components which are exposed to freezing before reaching the required 28 day compressive strength shall be rejected without further cause. Any additional testing on the rejected components as determined by the Engineer to gain acceptance will be at the expense of the manufacturer.



604.06 BACKFILLING. Backfilling shall not begin until the end of the curing period. Backfill material shall be approved by the Engineer and placed in layers not exceeding 150 mm (6 inches) in depth. Each layer shall be thoroughly tamped using mechanical tampers. Special care shall be taken to ensure adequate compaction around the inlet and outlet pipes.

604.07 METHOD OF MEASUREMENT. The quantities of new structures to be measured for payment will be the number of units of the respective types used in the complete and accepted work. Cast Iron Grates or Cast Iron Cover with Frames, and Cast Iron Grates and Steel Grates, when used and not included in a specific unit, will be measured as the number of each type specified.

The quantity of Changing Elevation or Rehabilitating of Drop Inlets, Catch Basins, or Manholes to be measured for payment will be the number of units modified in the complete and accepted work.

604.08 BASIS OF PAYMENT. The accepted quantities of new Drop Inlets, Catch Basins, or Manholes will be paid at the Contract unit price per unit each for the specified types. Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified, including concrete, concrete risers, top sections, reinforcing steel, steps, vitrified clay tile pipe, mortar, brick, frames, grates, covers, coatings, pipestubs, weep holes, underdrain ends, curb board, and bituminous fillets, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Changing Elevation of Drop Inlets, Catch Basins, or Manholes and Rehabilitating Drop Inlets, Catch Basins, or Manholes will be paid for at the Contract unit price each for the specified unit or class. Payment will be full compensation for all necessary cleaning of the interior of the unit to determine the extent of the work; for excavating, cutting of pavement, and backfilling; for removing deteriorated materials and designated materials; for furnishing all materials, including backfill material, concrete, concrete risers, top sections, reinforcing steel, steps, concrete block, brick, mortar, frames, grates, covers, coatings, pipe stubs, weep holes and underdrain ends required for reconstructing the unit as shown on the Plans or directed by the Engineer; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation for new drop inlets, catch basins, and manholes will be paid for as Trench Excavation of Earth or Trench Excavation of Rock, as appropriate.

Excavation associated with the rehabilitation or changing elevation of existing drop inlets, catch basins, and manholes will not be paid for separately, but will be considered incidental to the appropriate Contract items.

Backfill material for backfilling around elevation adjusted and rehabilitated drop inlets, catch basins, and manholes shall meet the requirements of Subsection 704.08, unless otherwise directed by the Engineer.

The Contract items Sanitary Sewer Manhole, Changing Elevation of Drop Inlets, Catch Basins, or Manholes and Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I, Class II, and Class III are mutually exclusive. Only one of these Contract items will be paid at any designated location.

The Contract item Changing Elevation of Drop Inlets, Catch Basins, or Manholes will include adjusting the elevation of an existing top, including replacement of deteriorated bricks and mortar, only. The Contract item Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I will include adjusting the elevation of the top and all rehabilitation or reconstruction work on an existing unit down to a maximum depth of 1 m (3 feet) below the elevation of the upper surface of the unit top. The Contract item Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class II will include adjusting the elevation of the top and all rehabilitation or reconstruction work on an existing unit extending below a depth of 1 m (3 feet) to a maximum depth of 2 m (6 feet) below the elevation of the upper surface of the unit top. The Contract item Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class III will include adjusting the elevation of the top and all rehabilitation or reconstruction work on an existing unit extending below a depth of 2 m (6 feet) below the elevation of the upper surface of the unit top.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
604.10 Concrete Catch Basin with Cast Iron Grate	Each
604.11 Concrete Manhole with Cast Iron Cover	Each
604.18 Precast Reinforced Concrete Drop Inlet with Cast Iron Grate	Each
604.20 Precast Reinforced Concrete Catch Basin with Cast Iron Grate	Each
604.21 Precast Reinforced Concrete Manhole with Cast Iron Cover	Each
604.22 Sanitary Sewer Manhole	Each

604.25	Precast Reinforced Concrete Pipe DI with Cast Iron Grate	Each
604.26	Precast Reinforced Concrete Pipe DI with Concrete Cover	Each
604.30	Precast Reinforced Concrete Curb DI with Cast Iron Grate	Each
604.40	Changing Elevation of Drop Inlets, Catch Basins, or Manholes	Each
604.412	Rehab. Drop Inlets, Catch Basins, or Manholes, Class I	Each
604.415	Rehab. Drop Inlets, Catch Basins, or Manholes, Class II	Each
604.418	Rehab. Drop Inlets, Catch Basins, or Manholes, Class III	Each
604.42	Changing Elevation of Sewer Manholes	Each
604.45	Cast Iron Grate with Frame, Type A	Each
604.46	Cast Iron Grate with Frame, Type B	Each
604.47	Cast Iron Grate with Frame, Type D	Each
604.48	Cast Iron Grate with Frame, Type E	Each
604.49	Cast Iron Grate, Type C	Each
604.50	Steel Grate	Each
604.55	Cast Iron Cover with Frame	Each
604.56	Cast Iron Cover with Frame, Sewer	Each

SECTION 605 – UNDERDRAINS

605.01 DESCRIPTION. This work shall consist of constructing drainage systems using underdrains, underdrain outlets, flushing basins, and risers.

605.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Granular Backfill for Structures .....	704.08
Drainage Aggregate.....	704.16
Corrugated Polyethylene Underdrain .....	710.03
PVC Plastic Underdrain .....	710.06
Corrugated Steel Pipe and Underdrains.....	711.01
Corrugated Aluminum Alloy Pipe and Underdrains .....	711.02
Cast Iron Cover .....	715.01(b)
Geotextile for Underdrain Trench Lining.....	720.01

If the Contract does not specify a particular type of underdrain or carrier pipe, the Contractor may furnish underdrain and carrier pipe of the diameter indicated and in any one of the following materials:

605

- (a) Perforated Corrugated Steel
- (b) Perforated Corrugated Aluminum Alloy
- (c) Perforated Corrugated Polyethylene
- (d) Perforated PVC Plastic

Each system of underdrain, carrier pipes, and underdrain risers shall be constructed of the same material.

605.03 PROTECTION OF MATERIALS. Corrugated polyethylene or PVC plastic pipe stored on the job site prior to use shall be protected from prolonged exposure to sunlight. The Engineer may require impact or other strength tests of the pipe prior to installation when ultraviolet light degradation is suspected.

605.04 INSTALLATION.

- (a) Excavation. Trenches for underdrain shall be excavated to the dimensions and grade shown on the Plans or as directed by the Engineer. The surface of the trench shall be prepared to a smooth condition free of debris, depressions, or obstructions which may damage the geotextile.

Trenches for carrier pipe shall be excavated to a width 600 mm (24 inches) greater than the inside diameter of the pipe. Proper bedding material shall be provided where excavation is in solid rock or other unyielding material.

- (b) Placing Geotextile. The geotextile fabric shall be placed loosely with no wrinkles or folds. Care shall be taken to ensure direct contact with the soil such that there are no voids between the geotextile and the trench. The geotextile shall be overlapped a minimum of 300 mm (12 inches) at the top of the trench. Additional overlap or anchoring may be required as determined by the Engineer. The upstream geotextile shall be overlapped over the downstream. Drainage aggregate shall be placed to a depth of 150mm (6 inches) to provide a bed and uniform slope for underdrain pipe placement.
- (c) Placing Underdrain. The underdrain pipe shall be placed in the center of the trench and firmly embedded in the drainage aggregate. Placing shall be started at the outlet end and proceed toward the inlet end. The underdrain shall be placed with the perforations down, unless otherwise directed by the Engineer.

6-28

The joints between sections shall be made by fitting the ends as tightly as practical. Corrugated steel or aluminum alloy underdrain shall be joined with an approved coupling. Polyethylene or PVC plastic underdrain shall be joined with approved fittings.

Inlet ends of all underdrain pipe installations shall be closed with suitable plugs to prevent entry of soil material.

Underdrain flushing basins, consisting of corrugated steel or aluminum alloy pipe of the length and diameter shown on the Plans, and cast iron cover shall be installed at locations shown on the Plans or as directed by the Engineer.

Underdrain risers shall be installed as shown on the Plans or as directed by the Engineer.

- (d) Placing Carrier Pipes. Carrier pipes used in an underdrain system placed at road crossings, outlets, or as directed by the Engineer shall be placed on a firm bed and joined in the same manner as underdrain. Unless otherwise directed, non-perforated pipe shall be used.
- (e) Backfill. After an underdrain pipe installation has been inspected and approved, material meeting the requirements of drainage aggregate shall be placed to a height of 300 mm (12 inches) above the top of the underdrain and the layer compacted. Care shall be taken not to displace the underdrain pipe. The remainder of the backfill material shall be placed in uniform layers of not more than 150 mm (6 inches) in thickness and thoroughly compacted by use of air or mechanical tampers. The geotextile fabric shall be closed over the drainage aggregate as specified in Subsection 605.04(b)

After inspection and approval of a carrier pipe installation, the trench shall be backfilled with suitable material placed in layers not more than 150 mm (6 inches) in thickness and thoroughly compacted. Unless otherwise specified, this material shall be from trench or roadway excavation.

The backfill material shall not be placed directly in the trench by dumping from haul vehicles or by pushing material into trenches by bulldozers, graders, or other equipment. Placing shall be limited to the use of hand shovels, backhoes, front end loaders, or other similar types of equipment as approved by the Engineer.

- (f) Flushing. Prior to the acceptance of the project, each underdrain system shall be thoroughly flushed with water to remove any accumulation of silt, sand, or other debris.

605.05 METHOD OF MEASUREMENT. The quantity of the specified size of Underdrain or Carrier Pipe to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work. When it is necessary to cut underdrain or carrier pipe in the field, the quantity of underdrain or carrier pipe to be measured for payment will be the length necessary, rounded to the next whole meter (2 foot) increment.

The quantity of Underdrain Flushing Basin to be measured for payment will be the number of units installed in the complete and accepted work including the corrugated pipe and the cast iron cover.

605.06 BASIS OF PAYMENT. The accepted quantities of each type and size of Underdrain or Carrier Pipe will be paid at the respective Contract unit price per meter (linear foot).

Underdrain Flushing Basins will be paid at the respective Contract unit price for each. Underdrain used for vertical stand pipes at flushing basin locations or risers will be paid as Underdrain Carrier Pipe.

Payment will be full compensation for fabricating, furnishing, transporting, handling, and placing the material specified, including coupling bands and fittings, drainage aggregate, geotextile fabric, and the necessary backfill material to an elevation 2 m (7 feet) above the flowline, and for furnishing of all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation for all underdrain, carrier pipe, flushing basins, vertical stand pipes, and risers will be paid for as Trench Excavation.

Backfill placed above an elevation of 2 m (7 feet) over the flowline will be paid for as Granular Backfill for Structures as ordered by the Engineer.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
(a) <u>Underdrain pipe.</u>	
605.10 150 mm (6 inches)	Meter (Linear Foot)
605.11 200 mm (8 inches)	Meter (Linear Foot)
605.12 250 mm (10 inches)	Meter (Linear Foot)
605.13 300 mm (12 inches)	Meter (Linear Foot)
(b) <u>Underdrain Carrier Pipe.</u>	
605.20 150 mm (6 inches)	Meter (Linear Foot)
605.21 200 mm (8 inches)	Meter (Linear Foot)
605.22 250 mm (10 inches)	Meter (Linear Foot)
605.23 300 mm (12 inches)	Meter (Linear Foot)
605.95 Underdrain Flushing Basin	Each

#### SECTION 607 - ROADWAY PATROL MAINTENANCE

607.01 DESCRIPTION. This work shall consist of the maintenance of any section of roadway that is open to public travel and the maintenance of detours in a reasonably smooth and passable condition. The work shall be limited to those roadways within the construction area and any detours shown on the Plans or as directed by the Engineer.

607.02 SCOPE OF WORK. Roadway patrol maintenance shall include only the leveling and smoothing of sections of the roadway or detours within the construction areas that are not subject to the influence of the Contractor's operations.

This work shall be performed by means of a road grader or other approved equipment. Snow shall be removed by use of an approved grader or other approved plowing equipment. The material and equipment required to maintain the roadway and the furnishing and spreading of sand necessary for winter maintenance shall be included in the Contract unit price for roadway patrol maintenance, unless otherwise directed by the Engineer.

607.03 METHOD OF MEASUREMENT. The quantity of Roadway Patrol Maintenance to be measured for payment will be the number of hours actually worked in performing roadway patrol maintenance.

607.04 BASIS OF PAYMENT. The accepted quantity of Roadway Patrol Maintenance will be paid for at the Contract unit price per hour. Payment will be full compensation for performing the work specified and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
607.10 Roadway Patrol Maintenance	Hour

#### SECTION 608 - EQUIPMENT RENTAL

608.01 DESCRIPTION. This work shall consist of furnishing, operating, and supervising the use of equipment for performance of work shown on the Plans, in accordance with these Specifications or as directed by the Engineer.

608.02 GENERAL REQUIREMENTS. Equipment shall be maintained in good mechanical condition and shall be operated by capable and experienced operators.

Equipment that is to operate on paved surfaces shall be equipped with rubber tires or smooth street plates. Tracked equipment used to draw any other equipment shall be of a type that will not damage the work being done and has sufficient power to operate the drawn equipment effectively.

Equipment used under this Section shall meet the following specific requirements as to type, size, capacity, power, or dimensions.

In determining whether a particular piece of equipment is classified as Type I or Type II in parts (a), (c), (d), or (g) below, the make and model number shall be referenced against an equipment guide book.

Whenever certain size equipment is requested by the Engineer and the Contractor supplies a larger size, payment will be for the size requested.

- (a) Bulldozer. The tractor shall be a crawler type furnished with an angle type blade and power operated controls. The machine shall be classified by size as follows:
  - (1) Type I. Type I bulldozers shall have a net engine or flywheel power rating of less than 112 kW (150 horsepower).



- (2) Type II. Type II bulldozers shall have a net engine or flywheel power rating of not less than 112 kW (150 horsepower).
- (b) Grader. The power grader shall be self propelled with pneumatic tire wheels, power operated controls, and a wheel base of at least 5.50 m (18 feet).
- (c) Dragline. The dragline shall be the full revolving type equipped with a dragline bucket, clamshell bucket, or approved drop ball as required by the Engineer. One set of mats shall be included with each dragline when necessary. The machine shall be classified by size as follows:
  - (1) Type I. Type I draglines shall have a rated bucket capacity of less than 1.50 m<sup>3</sup> (2 yd<sup>3</sup>).
  - (2) Type II. Type II draglines shall have a rated bucket capacity of not less than 1.50 m<sup>3</sup> (2 yd<sup>3</sup>).
- (d) All Purpose Excavator. The machine shall be a hydraulic excavator and may be self propelled, truck mounted, or crawler mounted. It shall include all attachments required by the Engineer to efficiently perform the work for which it is rented. The machine shall be classified by size as follows:
  - (1) Type I. Type I all purpose excavators shall have a rated bucket capacity of at least 0.40 m<sup>3</sup> (1/2 yd<sup>3</sup>) but less than 0.75 m<sup>3</sup> (1 yd<sup>3</sup>).
  - (2) Type II. Type II all purpose excavators shall have a rated bucket capacity of not less than 0.75 m<sup>3</sup> (1 yd<sup>3</sup>).
- (e) Power Broom. Power Broom shall provide a sweeping path of not less than 2 m (80 inches). It shall be capable of maintaining a speed of 6.50 km/h (4 miles per hour) when sweeping. The sweeping operations shall be under the control of the Engineer at all times. Sweeping shall take place at locations and times directed by the Engineer. The disposal of all sweepings shall meet with the approval of the Engineer. All hand labor required in connection with a sweeping operation shall be included.
  - (1) Type I. Type I power brooms shall be self-propelled or a towed type including the tow vehicle.

- (2) Type II. Type II power broom shall consist of furnishing a pickup sweeper and accessory equipment and utilizing it for removal of earth and or other dust producing materials from paved surfaces for the purpose of allaying dust conditions. This equipment shall include suitable provisions for the application of water ahead of the sweeping brooms to prevent dusting, for the pickup, internal storage and removal of sweepings, and for the cleaning of areas of heavy accumulation beyond the capacity of the sweeper.
- (f) Truck. The truck may be the highway type or off-highway type with a minimum capacity of 5 m<sup>3</sup> (6 1/2 yd<sup>3</sup>). The capacity of the truck shall be determined by three-dimensional measurement of the body.
- (g) Loader. The loader may be the wheel or crawler type, straight or articulated, and shall be furnished with a standard bucket. The machine shall be classified by size as follows:
- (1) Type I. Type I loaders shall have a rated bucket capacity of at least 0.75 m<sup>3</sup> (1 yd<sup>3</sup>) but less than 3.0 m<sup>3</sup> (4 cubic yards).
- (2) Type II. Type II loaders shall have a rated bucket capacity of not less than 3.0 m<sup>3</sup> (4 yd<sup>3</sup>).
- (h) Truck-Mounted Attenuator. Truck-Mounted Attenuator (TMA) is a crash cushion designed to smoothly decelerate an impacting vehicle. The TMA may be mounted on either trailers or trucks; the unit on which the TMA is mounted must weigh at least 45 kN (10 kips) with a heavier unit being preferable. The unit on which the TMA is mounted shall be used as a barrier vehicle as described in the MUTCD. All such attenuators shall meet the requirements of the National Cooperative Highway Research Program (NCHRP) Report 350 Test Level 3. The TMA shall be placed in accordance with the Contract Documents and as directed by the Engineer.

608.03 METHOD OF MEASUREMENT. The Engineer will issue written orders to the Contractor for work to be performed by the specified equipment.

The quantity of equipment to be measured for payment will be the number of hours each piece of equipment actually worked, including necessary travel time within the project limits.

608.04 BASIS OF PAYMENT. The accepted quantity of the specified equipment will be paid for at the Contract unit price per hour. Payment will be full compensation for performing the work specified; for furnishing, operating, and supervising the use of this equipment, including fuel, repairs, attachments, and transportation of the equipment to and from the project; and for furnishing all labor, tools, other equipment, and incidentals necessary to complete the work.

The Contract unit price for the item Truck-Mounted Attenuator shall also include all costs of furnishing the unit on which the attenuator is mounted, solely for the purpose of the attenuator.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
608.10 Bulldozer Rental, Type I	Hour
608.11 Bulldozer Rental, Type II	Hour
608.15 Power Grader Rental	Hour
608.20 Dragline Rental, Type I	Hour
608.21 Dragline Rental, Type II	Hour
608.25 All Purpose Excavator Rental, Type I	Hour
608.26 All Purpose Excavator Rental, Type II	Hour
608.30 Power Broom Rental, Type I	Hour
608.31 Power Broom Rental, Type II	Hour
608.37 Truck Rental	Hour
608.40 Loader Rental, Type I	Hour
608.41 Loader Rental, Type II	Hour
608.45 Truck-Mounted Attenuator	Hour

SECTION 609 - DUST AND ICE CONTROL

609.01 DESCRIPTION. This work shall consist of treating traveled areas to control dust or reduce ice hazard on the project.

609.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Water .....	745.01
Calcium Chloride .....	746.01
Sodium Chloride.....	747.01

609.03 DUST CONTROL WITH WATER. Water shall be applied to traveled areas as the Engineer may designate. The number of applications and the amount of water used shall be based upon field and weather conditions and as ordered in writing by the Engineer.

The equipment for water application shall be equipped with an adequate shutoff valve control in the cab and shall be approved by the Engineer. The equipment shall be available at all times in readiness to perform the work at any time, including Sundays and Holidays, upon written order of the Engineer.

609.04 DUST AND ICE CONTROL WITH CALCIUM CHLORIDE. Calcium chloride shall be applied in such a manner and by such devices that uniform distribution is obtained over the entire area on which it is ordered in writing by the Engineer.

Unless otherwise authorized in writing by the Engineer, calcium chloride shall be applied at the rate of  $270 \text{ g/m}^2$  (1/2 pound per square yard) for dust and ice control. It shall not be used on surfaces on which bituminous material will be applied, unless directed by the Engineer.

When used on granular surfaces on which bituminous material will be applied, the surface shall be reworked by grading or other means to ensure that the surface is sufficiently free of excess calcium chloride as determined by the Engineer.

Sodium chloride may be substituted for calcium chloride for ice control when approved in writing by the Engineer.

609.05 METHOD OF MEASUREMENT. The quantity of Dust Control with Water to be measured for payment will be the number of cubic meters (1000 gallons) of water actually used in the complete and accepted work. The Contractor shall provide equipment meeting the approval of the Engineer for measuring the quantity of water applied.

The quantity of Dust and Ice Control with Calcium Chloride to be measured for payment will be the number of metric tons (tons) of calcium chloride actually used in the complete and accepted work. When calcium or sodium chloride is delivered in bulk, the quantity will be determined from load tickets.

When sodium chloride is used instead of calcium chloride for ice control, the quantity measured for payment will be the total quantity used multiplied by 0.50.

609.06 BASIS OF PAYMENT. The accepted quantity of Dust Control with Water will be paid for at the Contract unit price per cubic meter (1000 gallons). The accepted quantity of Dust and Ice Control with Calcium Chloride will be paid for at the Contract unit price per metric ton (ton). Payment will be full compensation for furnishing, measuring the load, transporting, handling, and placing the material specified, including any reworking of granular surfaces as specified, and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
609.10 Dust Control with Water	Cubic Meter (Thousand Gallons)
609.15 Dust and Ice Control with Calcium Chloride	Metric Ton (Ton)

SECTION 612

THIS SECTION RESERVED

SECTION 613 - STONE FILL, RIPRAP, AND SLOPE PAVING

613.01 DESCRIPTION. This work shall consist of furnishing and placing protective materials.

613.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Sand Borrow and Cushion.....	703.03
Gravel Backfill for Slope Stabilization.....	704.07
Concrete Units for Slope Paving .....	705.03
Stone for Riprap, Heavy Type.....	706.03(a)
Stone for Riprap, Light Type.....	706.03(b)
Stone for Stone Fill, Type I .....	706.04(a)
Stone for Stone Fill, Type II.....	706.04(b)
Stone for Stone Fill, Type III.....	706.04(c)
Stone for Stone Fill, Type IV .....	706.04(d)
Stone for Slope Paving .....	706.05

613.03 PREPARATION. The areas to be protected shall be constructed and graded to the lines shown on the Plans or as directed by the Engineer and, if a fill area, shall be compacted. All slopes shall be maintained to the neat lines shown on the Plans prior to the placing of filter or bedding material, stone fill, riprap, or slope paving.

Sand borrow shall be placed and graded as bedding material for slope paving.

613.04 PLACING.

- (a) Stone Fill. The specified stone fill shall be placed in one course thickness as shown on the Plans in a manner that will result in a reasonably well graded surface. Care shall be taken in the placing to avoid displacing the underlying material.

The stones shall be so placed and distributed that there will be no accumulations of either the larger or smaller sizes of stone.

Rearrangement of the stone fill by hand labor or mechanical equipment may be required to obtain the specified results.

When stone fill and filter blanket are to be placed as part of an embankment, the protective materials shall be placed concurrently with the construction of the embankment, unless otherwise directed by the Engineer.

Where stone fill and filter blanket are to be placed under water, methods shall be used that will minimize segregation and ensure that the required thickness of protective material will be obtained.

- (b) Riprap. The stones shall be placed on the prepared slope or filter blanket so that there will be a minimum of space between the stones. The depth of each stone shall be equal to the thickness of the course shown on the Plans. The voids between the stones shall be chinked with smaller stones to produce a relatively smooth and uniform surface.
- (c) Slope Paving. The slope paving shall be placed on a minimum 50 mm (2 inch) thick bed of sand borrow in such a manner that the finished paving will present a smooth appearance.

When concrete units are used, the courses shall be laid from the bottom or toe of slope upward, with close joints and with consecutive courses breaking joints. The minimum dimension side of block shall be perpendicular to the slope and the long dimension approximately horizontal. Half blocks shall be used at the edge of the paved area when required.

When field or quarry stone is used, the stones shall be placed from the bottom or toe of slope upward, with close joints approximately perpendicular to the slope. Open joints shall be filled with spalls or gravel so that the entire paved surface will be firmly locked and keyed. Consecutive courses of quarry stone shall break joints and shall be so joined and butted that no part of the joints shall exceed 50 mm (2 inches) in width.

613.05 METHOD OF MEASUREMENT. The quantities of Stone Fill and Riprap to be measured for payment will be the number of cubic meters (cubic yards) of the material specified installed in the complete and accepted work, measured within the limits shown on the Plans or as directed by the Engineer.

The quantity of Slope Paving to be measured for payment will be the number of square meters (square yards) installed in the complete and accepted work, measured using slope measurements.

613.06 BASIS OF PAYMENT. The accepted quantities of Stone Fill and Riprap of the type specified will be paid for at the Contract unit price per cubic meter (cubic yard). The accepted quantities of Slope Paving of the type specified will be paid for at the Contract unit price per square meter (square yard). Payment will be full compensation for furnishing, transporting, and placing the specified material and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation required for placing stone fill, riprap, slope paving, and the filter blanket or bedding material will be paid for at the Contract unit price per cubic meter (cubic yard) for the same type of excavation removed directly above the face of the protective materials, except that when no other type of excavation has been removed, excavation will be paid for under an appropriate excavation Contract item.

Unless otherwise shown on the Plans, the filter blanket will be paid for under the Contract item Gravel Backfill for Slope Stabilization.

Bedding material of sand borrow will not be paid separately, but will be considered incidental to the Contract unit price for Slope Paving, unless otherwise specified.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
613.10 Stone Fill, Type I	Cubic Meter (Cubic Yard)
613.11 Stone Fill, Type II	Cubic Meter (Cubic Yard)
613.12 Stone Fill, Type III	Cubic Meter (Cubic Yard)
613.13 Stone Fill, Type IV	Cubic Meter (Cubic Yard)
613.15 Riprap, Heavy Type	Cubic Meter (Cubic Yard)
613.16 Riprap, Light Type	Cubic Meter (Cubic Yard)
613.20 Slope Paving	Square Meter (Square Yard)

SECTION 616 - CURBS AND GUTTERS

616.01 DESCRIPTION. This work shall consist of the construction, resetting, or removal of curbs and gutters.

616.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Performance-Graded Asphalt Binder (Prepared from Petroleum)	702.02
Emulsified Asphalt .....	702.04
Tar Emulsion .....	702.05
Sand Borrow and Cushion.....	703.03
Mortar, Type I .....	707.01
Mortar, Type IV.....	707.03
Joint Sealer, Hot Poured .....	707.04(a)
Preformed Joint Filler, Cork .....	707.08
Preformed Joint Filler, Bituminous Type .....	707.14
Timber Preservative.....	726.01
Vertical Granite Curb .....	729.01
Granite Bridge Curb .....	729.02
Granite Slope Edging.....	729.03
Precast Reinforced Concrete Curb.....	729.04
Bituminous Concrete Curb .....	729.05
Treated Timber Curb .....	729.06

All cast-in-place concrete for curbing and gutters shall conform to the requirements of Section 541 for Concrete, Class B. There shall be a mineral admixture substitution for portland cement of 20% fly ash or 25% GGBFS.



Bituminous material for curbs, gutters, and traffic islands of the type specified by the Engineer shall meet the requirements of Section 406 or 490.

Concrete, bituminous mixes, and precast concrete curbing materials will be subject to inspection and tests at the plants for compliance with quality requirements.

616.03 GRANITE CURBING AND SLOPE EDGING.

- (a) Excavation. Excavation shall be made to the required depth. The base material on which the curb is to be set shall be compacted to a firm, even surface. All soft and unsuitable material shall be removed and replaced with suitable material that shall be thoroughly compacted.
- (b) Installation. The curb and slope edging shall be set so that the front top arris line is in close conformity to the line and grade required. All space under the curbing shall be filled and thoroughly tamped with material meeting the requirements of the material for the bed course.
- (c) Joints. The curb and slope edging shall be laid and fitted so there will be no open joints exceeding 25 mm (1 inch) between stones. Joints between stones shall be carefully filled with Mortar, Type I and neatly pointed on the top and exposed front portions. After pointing, the stone shall be satisfactorily cleaned of all excess mortar and the joints kept moist until the mortar has set.
- (d) Backfilling. After the joints have set, any remaining excavated areas shall be filled and tamped with approved material placed in layers not exceeding 150 mm (6 inches) in depth.

616.04 GRANITE BRIDGE CURB. Prior to beginning work, the Contractor shall receive the Engineer's approval of the proposed fabrication plan. Working Drawings shall be submitted in accordance with Section 105.

Curb stones shall be carefully set and shimmed to the line and grade shown on the Plans. The space under the curb shall be completely filled with concrete or mortar. When shown on the Plans, the mortar shall be removed from the front 50 mm (2 inches) under the curb stone. The curb stones shall be anchored as shown on the Plans with anchors grouted into the curb with Mortar, Type IV or an approved bonding compound. The

curb shall be firmly held in position to prevent sliding or tipping until the concrete has been placed and is sufficiently set.

Long and short lengths of curb stone shall be alternated, unless otherwise directed by the Engineer. The curb shall be set so that joints between curb stones coincide with joints in the concrete deck.

The anchorage and the alignment of the curb shall be approved by the Engineer prior to placing the adjacent concrete.

The joints between the stones shall be raked out to a 50 mm (2 inch) depth and then carefully filled with an approved mortar. The joints shall be neatly pointed on the top and exposed front surfaces with a 5 mm (1/4 inch) recess. The space beneath the stones shall be raked out and filled with an approved mortar as shown on the Plans.

Joints in curb at concrete deck joints shall be treated as shown on the Plans.

The Contractor shall protect curb stones against damage or discoloration of exposed surfaces until completion of the Contract.

#### 616.05 THIS SUBSECTION RESERVED

#### 616.06 CAST-IN-PLACE CEMENT CONCRETE CURB.

- (a) Excavation. Excavation and bedding shall conform to the requirements of Subsection 616.03(a).
- (b) Forms. Forms shall be of wood or metal, straight or curved as required, free from warp and shall be in accordance with Subsection 541.09. Form construction shall be such that there will be no interference to the inspection of grade or alignment. All forms shall extend for the entire depth of the curb and shall be braced and secured sufficiently so that no deflection from alignment or grade will occur during the placing of the concrete.
- (c) Mixing and Placing. Compaction of concrete placed in the forms shall be by spading or other approved methods. Forms shall be left in place for 24 hours or until the concrete has set sufficiently so that they can be removed without injury to the curbing. Upon removal of the forms, the exposed curbing face shall be finished in accordance with Subsection 541.16(a).
- (d) Sections. Curbing shall be constructed in sections having a uniform length of 3 m (10 feet), unless otherwise specified.

Sections shall be separated by open joints 3 mm (1/8 inch) wide except at expansion joints.

- (e) Expansion Joints. Expansion joints shall be formed at the intervals shown on the Plans using a preformed expansion joint filler having a thickness of 6 mm (1/4 inch). They shall be constructed at 6 m (20 feet) intervals or as directed by the Engineer. When the curb is constructed adjacent to or on concrete pavement, expansion joints shall be located opposite or at expansion joints in the pavement.
- (f) Curing. Curbs shall be cured in accordance with Subsection 541.17.
- (g) Backfilling. After the concrete has set sufficiently, the spaces in front and back of the curb shall be filled to the required elevation with layers of not more than 150 mm (6 inches) of the same material as the bedding and thoroughly tamped.
- (h) Curb Machine. With the approval of the Engineer, the curb may be constructed by a curb forming machine.

#### 616.07 PRECAST CONCRETE CURB.

- (a) Excavation. Excavation and bedding shall conform to the requirements of Subsection 616.03(a).
- (b) Installation. Precast concrete curb shall be installed in accordance with Subsection 616.03(b).
- (c) Joints. Unless otherwise shown on the Plans or directed by the Engineer, expansion joints shall be placed every 6 m (20 feet). The curb sections shall be placed and fitted so that there will be no open joints between them exceeding 3 mm (1/8 inch) in width.

Expansion joints shall be filled with preformed expansion joint filler having a thickness of 6 mm (1/4 inch).

Joints in curb at concrete deck joints shall be treated as shown on the Plans.

The Contractor shall protect the curb against damage or discoloration of the exposed surfaces until completion of the Contract.

- (d) Backfilling. The space in front and back of the curb shall be filled and compacted in layers not exceeding 150 mm (6 inches) with the same material as the bedding, unless otherwise specified.

**616.08 BITUMINOUS CONCRETE CURB.**

- (a) General. The plant and equipment necessary for this work shall be in conformance with the requirements of Section 406 or 490.
- (b) Preparation of Bed. The bituminous concrete curb shall be placed on bituminous concrete pavement or other hard surface. The surface shall be thoroughly cleaned of all dirt, dust, sand, or other loose material and treated with a tack coat of Type RS-1 emulsified asphalt applied at a rate of from 225 to 450 mL/m<sup>2</sup> (6 to 13 ounces per square yard) prior to placing the curb. All exposed surfaces not to be treated shall be protected against spattering of the bituminous material.
- (c) Placing. After the tack coat has cured and become tacky, the mix for the curb shall be placed with an automatic bituminous concrete curb laying machine approved by the Engineer. The machine shall form curbing that is uniform in texture, shape, and density.

The Engineer may permit the construction of curbing by means other than the automatic curber or machine, when short sections or sections with short radii are required, or for such other reasons as may be warranted. The resulting curbing shall conform in all respects to the curbing produced by the use of the machine.

- (d) Sealing. After the curb has been in place seven days, the exposed surface shall be treated with two coats of emulsified asphalt or tar emulsion.

**616.09 TREATED TIMBER CURB.** The treated timber, bituminous fillet, and granular material behind the curb shall be installed as shown on the Plans. The fillet will be sealed as specified in Subsection 616.08(d).

**616.10 REMOVING AND RESETTING CURB.**

- (a) Salvage of Curbing. The Contractor shall carefully remove, store, and clean any curbing specified for resetting. Any existing curbing to be reset that is lost, damaged, or destroyed as a result of the Contractor's operations, or failure to store and protect it in a manner that would prevent its loss or damage, shall be replaced at the Contractor's expense.

- (b) Placing. Excavation, setting joints, and backfilling shall be in accordance with specifications for the type of curb being removed and reset.
- (c) Cutting and Fitting. Cutting, fitting, or dressing may be necessary in order to install the curbing at the locations directed.
- (d) Joints. All sections shall be placed so that the maximum opening between sections is not more than 25 mm (1 inch) wide for the entire top and face. Any dressing of the ends of the curbing necessary to meet this requirement shall be done by the Contractor.  
  
Joints shall be completely filled with mortar and kept moist until the mortar has been set.
- (e) Backfilling. After the joints have set, any remaining excavated areas shall be filled and tamped with approved material placed in layers not exceeding 150 mm (6 inches) in depth.

616.11 REMOVAL OF EXISTING CURB. The Contractor shall remove existing curb at locations shown on the Plans or as directed by the Engineer. When shown in the Contract Documents that the curb will remain the property of the State or municipality, the Contractor shall exercise care to avoid damage to the curb during removal. Salvaged curb shall be carefully and neatly stacked with wooden spacers at locations specified in the Contract or as directed by the Engineer.

616.12 PORTLAND CEMENT CONCRETE GUTTER.

- (a) Requirements for Forms. Forms shall be of wood or metal, straight or curved as required, free from warp, and shall be in accordance with Subsection 541.09.
- (b) Preparation of Bed. The bed shall be prepared and shaped at the proper depth in accordance with the dimensions shown on the Plans. All soft, yielding, or unsuitable material below the subgrade shall be removed and replaced with approved material. The foundation course, when required, shall be placed, compacted thoroughly, and finished to a firm, smooth surface.
- (c) Construction of Gutters. The foundation shall be moistened prior to the placing and consolidation of the concrete. The surface shall be smoothly and evenly finished with a wooden float and shaped to conform to the required dimensions of the gutter.

The gutter shall be constructed in alternate sections, each having a uniform length of 4 m (13 feet). The abutting face and adjacent edges of the gutter sections shall be painted with a bituminous material approved by the Engineer. The length of sections may be shortened where necessary for closures but no section less than 1 m (3 feet) in length will be permitted.

During construction, the first alternate sections shall be allowed to set at least 24 hours before the intermediate sections are placed. Forms shall not be removed until 24 hours after the concrete has been placed.

The edges of the gutter shall be finished with an approved edging tool having a radius of not more than 6 mm (1/4 inch).

Immediately upon completion of the finishing of the concrete, it shall be cured in accordance with Subsection 541.17. The method and details of curing shall be subject to the approval of the Engineer.

Expansion joints shall be formed at intervals of 8 m (26 feet) or as shown on the Plans using a preformed expansion joint filler having a thickness of 19 mm (3/4 inch). When the curb is constructed adjacent to or on concrete pavement, expansion joints shall be subject to the approval of the Engineer.

The expansion joints shall be properly sealed with approved joint sealer following completion of the gutter and pavement.

After the forms have been removed, the sides of the gutter shall be backfilled to the required elevation as shown on the Plans or as directed by the Engineer.

#### 616.13 BITUMINOUS CONCRETE GUTTERS AND TRAFFIC ISLANDS.

- (a) General. The plant and equipment necessary for this work shall conform to the requirements of Section 406 or 490.
- (b) Preparation of Bed. The bed upon which the bituminous concrete surface is to be placed shall be thoroughly compacted to the lines, grades, and shape shown on the Plans or directed by the Engineer. In the case of gutters, all soft, yielding, or unsuitable material below the bed shall be removed and replaced with suitable material and compacted to a firm, smooth surface.

- (c) Construction of Gutter. The bituminous concrete shall be laid in two courses. Each course shall be rolled with a roller with a mass of (weighing) at least 68 kg (150 pounds). The finished gutter shall be uniform in appearance, free from irregularities, and present a smooth surface.

All joints adjacent to pavements, curbs, and structures shall be painted with Type RS-1 emulsified asphalt.

616.14 METHOD OF MEASUREMENT. The quantities of Granite Slope Edging; Vertical Granite Curb; Granite Bridge Curb; Granite Bridge Curb, Median Slope Edge; Precast Reinforced Concrete Curb of the type specified; Cast-in-Place Concrete Curb of the type specified; Bituminous Concrete Curb of the type specified (linear measure); Treated Timber Curb; and Removing and Resetting Curb to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, as determined along the face of the finished curb.

The quantities of Bituminous Concrete Curb of the type specified (volume measure) and Bituminous Concrete Gutters and Traffic Islands to be measured for payment will be the number of metric tons (tons) installed in the complete and accepted work, as determined from the load tickets.

The quantity of Removal of Existing Curb to be measured for payment will be the number of meters (linear feet) removed in the complete and accepted work, measured along the face of the curb in its original position.

The quantity of portland Cement Concrete Gutter to be measured for payment will be the number of cubic meters (cubic yards) of Concrete, Class B installed in the complete and accepted work.

616.15 BASIS OF PAYMENT. The accepted quantities of Granite Slope Edging; Vertical Granite Curb; Granite Bridge Curb; Granite Bridge Curb, Median Slope Edge; Precast Reinforced Concrete Curb of the type specified; Cast-in-Place Concrete Curb of the type specified; Bituminous Concrete Curb of the type specified (linear measure); Treated Timber Curb; Removing and Resetting Curb; and Removal of Existing Curb will be paid for at the Contract unit price per meter (linear foot) of curb placed, removed, or removed and reset.

The accepted quantities of Bituminous Concrete Curb of the type specified (volume measure) or of Bituminous Concrete Gutters and Traffic Islands will be paid for at the Contract unit price per metric ton (ton).

The accepted quantity of portland Cement Concrete Gutter will be paid for at the Contract unit price per cubic meter (cubic yard).

Payment will be full compensation for furnishing, transporting, handling, and placing the specified materials, including all excavation, providing, placing and compacting backfill material when not otherwise specified, mortar for the bed and joints of curbs, joint material for curbs and gutters, anchors for bridge curbs, cleaning, cutting, fitting, dressing or stockpiling of curb, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Tack, prime, or seal coats of bituminous material required for the construction of Bituminous Concrete Curb of the type specified and Treated Timber Curb will not be paid for separately, but will be considered incidental to the Contract unit price for the specific item.

The bituminous fillet shown on the Plans to be placed in front of timber curb will not be paid for separately, but will be considered incidental to the Contract unit price for Treated Timber Curb.

The removal of treated timber curbing, including the bituminous concrete fillet, from installations where the existing guardrail is removed will not be paid for separately but will be considered incidental to the Contract item Removing and Resetting Guardrail or Removal and Disposal of Guardrail, as appropriate.

When shown on the Plans, concrete radius curb installed in conjunction with vertical granite curb will be measured and paid for as Vertical Granite Curb.

Foundation materials for Portland Cement Concrete Gutter and Bituminous Concrete Gutters and Traffic Islands will be paid for separately as specified in the Contract.



Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
616.20 Granite Slope Edging	Meter (Linear Foot)
616.21 Vertical Granite Curb	Meter (Linear Foot)
616.22 Granite Bridge Curb	Meter (Linear Foot)
616.23 Granite Bridge Curb, Median Slope Edge	Meter (Linear Foot)
616.25 Precast Reinforced Concrete Curb, Type A	Meter (Linear Foot)
616.26 Precast Reinforced Concrete Curb, Type B	Meter (Linear Foot)
616.27 Cast-in-Place Concrete Curb, Type A	Meter (Linear Foot)
616.28 Cast-in-Place Concrete Curb, Type B	Meter (Linear Foot)
616.30 Bituminous Concrete Curb, Type A	Metric Ton (Ton)
616.305 Bituminous Concrete Curb, Type A	Meter (Linear Foot)
616.31 Bituminous Concrete Curb, Type B	Metric Ton (Ton)
616.315 Bituminous Concrete Curb, Type B	Meter (Linear Foot)
616.35 Treated Timber Curb	Meter (Linear Foot)
616.40 Removing and Resetting Curb	Meter (Linear Foot)
616.41 Removal of Existing Curb	Meter (Linear Foot)
616.45 Portland Cement Concrete Gutter	Cubic Meter (Cubic Yard)
616.47 Bituminous Concrete Gutters and Traffic Islands	Metric Ton (Ton)

SECTION 617 – MAILBOXES

617.01 DESCRIPTION. This work shall consist of the removal and relocation of existing mailboxes to permanent locations. The work shall include the replacement of any non-conforming boxes, supports, or attachment hardware.

As used in this Section, the term “mailbox” shall include the actual box, post or other support, and attachment hardware.

617.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Timber Preservative, Type IV .....	726.01
Metal Hand Railing .....	732.01
Aluminum Posts .....	750.01(b)
Wood Posts.....	750.01(c)

Steel tubing produced to ASTM A 500, Grade B specifications will be considered acceptable for steel posts.

Brackets and platforms shall be made of pre-galvanized steel sheets. Holes shall be neatly punched or drilled.

Fasteners shall be galvanized and meet the requirements of ASTM A307.

New boxes must meet the approval of the U.S. Postal Service.

Certifications will not be required for materials supplied under this Section.

617.03 GENERAL. Mailboxes designated to be relocated shall be carefully removed and reinstalled as shown on the Plans. Any materials in the existing mailbox installation which do not conform to the Plans or Subsection 617.02 shall be replaced with new, conforming materials. Materials not reused shall remain the property of the owner.

It is the Contractor's responsibility to ensure that each completed relocation has the approval of the mail carrier.

617.04 RELOCATION. Posts may be set in holes or they may be driven as long as the posts or any attached anti-twist devices are not damaged. The installed posts shall be plumb and placed to the depth shown on the Plans. The space around the posts set in holes shall be backfilled with suitable granular material in 150 mm (6 inch) layers. The backfill material shall be thoroughly tamped.

Mailboxes shall be attached to the posts using the mountings and hardware shown on the Plans. All fasteners shall be drawn sufficiently tight so the mailboxes do not pivot or otherwise move.

Existing nameplates shall be attached to any new mailboxes. Names and rural box numbers lettered on existing mailboxes shall be copied onto new mailboxes using good commercial quality stick-on letters acceptable to the Engineer.

617.05 METHOD OF MEASUREMENT. The quantity of Relocate Mailbox to be measured for payment will be the number of each type (Single or Multiple Support) relocated in the complete and accepted work, as determined by the Engineer.

617.06 BASIS OF PAYMENT. The accepted quantity of Relocate Mailbox of the type specified will be paid for at the Contract unit price each. Payment will be full compensation for removing the existing mailbox, installing the mailbox in its permanent location, excavating as necessary, backfill, and furnishing all new materials including mailbox, supports, support hardware, and lettering and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Any temporary relocation of mailboxes due to project construction will not be paid under this Section. The costs of this temporary work will be considered incidental to other Contract Items.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
617.10 Relocate Mailbox, Single Support	Each
617.12 Relocate Mailbox, Multiple Support	Each

SECTION 618 – SIDEWALKS

618.01 DESCRIPTION. This work shall consist of the construction of bituminous or portland cement concrete sidewalks and curb ramps.

618.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Emulsified Asphalt .....	702.04
Preformed Joint Filler, Cork and Asphalt-Treated Felt ..	707.08
Preformed Joint Filler, Bituminous Type .....	707.14
Detectable Warning Surface.....	751.08

Concrete for sidewalks shall conform to the requirements of Section 541 for Concrete, Class B. There shall be a mineral admixture substitution for portland cement of 20% fly ash or 25% GGBFS.

The type of bituminous materials for sidewalks shall be specified by the Engineer. The material shall meet the requirements of Section 406.

Portland cement and bituminous mixes will be subject to inspection and tests at the mixing plants for compliance with quality requirements.

Detectable Warning Surfaces shall be either a cast-in-place or surface applied product. Stamping or imprinting systems will not be accepted.

618.03 PORTLAND CEMENT CONCRETE SIDEWALK.

- (a) Excavation and Foundation. Excavation shall be made to the required depth and to a width that will permit placing of bed course material and the installation and bracing of the forms. Bed course material shall be placed as shown on the Plans. When the depth of bed course required exceeds 150 mm (6 inches), two layers of approximately equal depth shall be placed, and each layer thoroughly compacted so that it is hard and unyielding. The wetting of bed course material may be necessary to obtain the required compaction.
- (b) Forms. Forms shall meet the applicable requirements of Subsection 541.09. Forms shall be wood or metal and shall extend for the full depth of the concrete. All forms shall be straight or curved as required and free from warp.
- (c) Placing Concrete. The forms and foundation shall be wetted immediately prior to the placing of the concrete.

The concrete shall be deposited within the forms to such a depth that, after being consolidated and finished, it is of the full thickness required. The concrete shall be consolidated using a method approved by the Engineer.

- (d) Finishing. The surface shall be finished with a wooden float. No plastering will be permitted. The edges shall be rounded with an edger having a radius of 6 mm (1/4 inch). Before the concrete has taken its initial set, it shall be tested for waves or irregularities with a straightedge at least 3 m (10 feet) long. Deviations of 6 mm (1/4 inch) or more, either above or below the general contour of the surface, shall be immediately remedied.

The surface of the sidewalk, after the floating and screeding process is completed, shall be finished with a broom of a type approved by the Engineer, drawn over the surface parallel to the transverse joints.

- (e) Joints. Unless otherwise shown on the Plans or directed by the Engineer, expansion joints shall be placed every 6 m (20 feet).

Expansion joints shall be formed around all appurtenances such as manholes, utility poles and other obstructions extending into and through the sidewalk. Preformed joint filler with a thickness of 6 mm (1/4 inch) shall be installed in these joints. Expansion joint filler of the thickness indicated shall be installed between concrete sidewalks and any fixed structure such as a building or bridge. This expansion joint material shall extend for the full depth of the sidewalk.

Between the expansion joints, the sidewalk shall be divided at intervals of 1.5 m (5 feet) by dummy joints formed by a jointing tool or other acceptable means to provide grooves approximately 3 mm (1/8 inch) wide and at least 33 percent of the total sidewalk depth.

When the sidewalk is constructed next to a concrete or granite curb, asphalt treated felt shall be placed between the sidewalk and curb for the total depth of the sidewalk.

- (f) Curing. Concrete shall be cured in accordance with Subsection 541.17. During the curing period, all traffic, both pedestrian and vehicular, shall be excluded. Vehicular traffic shall be excluded for such additional time as the Engineer may direct.
- (g) Backfilling. After sidewalk construction has been completed, the space on each side shall be backfilled to the required elevation with suitable material as shown on the Plans or as directed by the Engineer.

#### 618.04 BITUMINOUS CONCRETE SIDEWALK.

- (a) Excavation and Foundation. Excavation and foundation shall conform to the requirements of Subsection 618.03(a).
- (b) Forms. Where no headers, curbing, or other suitable supports are provided, grade control forms shall be installed when hand methods are utilized to assist in obtaining proper alignment and adequate compaction of the sidewalk course. The alignment and grade of all forms set shall be approved by the Engineer immediately prior to placing any material against them. The forms shall be cleaned thoroughly each time they are used. String or wire lines staked to grade will not be accepted as a substitute for grade control forms. When a suitable abutting curb or header is available and is approved by the Engineer as in conformity with the intended grade, it may be utilized as a grade control form.

- (c) Placing Bituminous Sidewalk Material. Bituminous sidewalk material shall be placed on the compacted bed course as directed by the Engineer by either mechanical or hand spreading methods in a manner that the required depth will result after rolling. When placing over an existing surface, the surface shall be cleaned and emulsified asphalt applied before the bituminous concrete is placed.
- (d) Compaction. Compaction shall be accomplished by means of a hand operated or power roller of a type and mass acceptable to the Engineer. In areas inaccessible to the roller, hand tamping will be permitted. In any case, the bituminous sidewalk material shall be uniformly compacted and shall present a smooth, even surface.

#### 618.05 DETECTABLE WARNING SURFACE

- (a) General. Detectable Warning Surfaces shall be furnished and installed as indicated in the Contract and in conformance with ADA Accessibility Guidelines
- (b) Surface Treatment. The Detectable Warning Surface shall be a pattern of truncated domes that meets the dimensional and spacing requirements shown in the Contract.
- (c) Handling. Detectable Warning Surface materials shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings.
- (d) Installation. The Detectable Warning Surface shall be installed in accordance with all applicable supplier and manufacturer requirements and recommendations for environmental conditions, surface preparation, installation procedures, curing procedures, and materials compatibility.

The Contractor is responsible for removing any material spatters. The Contractor shall repair any damage to the surface resulting from either installation or clean-up of surface materials. This work shall be performed at no additional cost to the State.

618.06 METHOD OF MEASUREMENT. The quantity of portland Cement Concrete Sidewalk to be measured for payment will be the number of square meters (square yards) of the specified depth of sidewalk installed in the complete and accepted work.

The quantity of Bituminous Concrete Sidewalk to be measured for payment will be the number of metric tons (tons) of material installed in the complete and accepted work, as determined from load tickets.

The quantity of Detectable Warning Surface to be measured for payment will be the number of square meters (square feet) of approved material installed in the complete and accepted work.

618.07 BASIS OF PAYMENT. The accepted quantities of portland Cement Concrete Sidewalk will be paid for at the Contract unit price per square meter (square yard) for the specified depth. The accepted quantity of Bituminous Concrete Sidewalk will be paid for at the Contract unit price per metric ton (ton). The accepted quantity of Detectable Warning Surface will be paid for at the Contract unit price per square meter (square foot). Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified, including expansion joint material, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The cost of cleaning an existing surface before placing a bituminous concrete sidewalk and the application of emulsified asphalt will not be paid for directly but will be considered incidental to the Contract item Bituminous Concrete Sidewalk.

Bed course material will be paid for under the appropriate Contract item in Section 301.

Excavation, unless otherwise specified, will be paid for under the appropriate Contract item in Section 203.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
618.10 Portland Cement Concrete Sidewalk, 125 mm (5 inch)	Square Meter (Square Yard)
618.11 Portland Cement Concrete Sidewalk, 200 mm (8 inch)	Square Meter (Square Yard)
618.15 Bituminous Concrete Sidewalk	Metric Ton (Ton)
618.30 Detectable Warning Surface	Square Meter (Square Foot)

SECTION 619 – MARKERS

619.01 DESCRIPTION. This work shall consist of furnishing and placing boundary markers, marker posts, and bollards and removing and resetting of existing property markers.

619.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Crushed Gravel for Subbase .....	704.05
Mortar, Type I.....	707.01
Paint Materials and Mixed Paints .....	708.01
Bar Reinforcement.....	713.01
Wood Posts .....	728.01(a)
Steel Posts and Post Accessories .....	728.01(c)
Yielding Marker Posts .....	751.01(a)

Concrete shall meet the requirements of Section 541 for Concrete, Class B.

619.03 PLACING.

- (a) General. Boundary markers, marker posts, and bollards of the dimensions shown in the Contract shall be placed vertically in holes to the depths indicated and shall be backfilled with suitable material placed and compacted in layers not more than 150 mm (6 inches) in depth.

Marker posts and bollards may be driven if suitable caps and driving equipment are used to prevent damage to the post.

Yielding marker posts shall be 2 m (6.5 feet) long and shall be embedded to a depth of 1 m (3 feet) in the ground.

- (b) Boundary Markers. When the marker point falls on ledge, a steel rod marker shall be placed in a hole of the diameter and depth shown on the Plans or as directed by the Engineer. The rod shall be securely wedged into the hole and cut off to the required elevation. The space around the rod shall be filled with Type I mortar.
- (c) Bollards. Bollards shall be installed as shown on the Plans or as directed by the Engineer.



- (d) Removing and Resetting Property Markers. Prior to the removal of any property marker, the Contractor shall verify that the Engineer has located and properly referenced the marker location.

The Contractor shall remove, properly identify, and store the property markers to be reset prior to beginning any other construction in the immediate vicinity.

If the property marker is to be installed at a new location, the hole after removal shall be properly backfilled with suitable material. Each property marker shall be reset at the location directed and shall be 150 mm (6 inches) above the ground, sidewalk, or other surface unless otherwise directed by the Engineer.

When the marker point falls on ledge and the use of a steel rod marker is directed by the Engineer, it shall be set in accordance with Subsection 619.03(b).

619.04 METHOD OF MEASUREMENT. The quantity to be measured for payment will be the number of in-place Markers, Bollards, or Posts and the number of Property Markers removed and reset in the complete and accepted work.

619.05 BASIS OF PAYMENT. The accepted quantity of each type of Marker, Bollard, or Post, and Property Markers removed and reset will be paid for at the Contract unit price each. Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified, including object markers, retroreflective sheeting, paint, locking devices, excavation, backfill, mortar, concrete, subbase and for furnishing all labor, tools, materials, equipment, and incidentals necessary to complete the work.

The Contract unit prices for the items of Wood Marker Posts, Steel Marker Posts, and Yielding Marker Posts will also include the costs of removing the remaining portion of the existing marker post, when the designated new marker post is used as a replacement of an existing marker post.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
619.10 Boundary Markers	Each
619.14 Bollards	Each
619.15 Wood Marker Posts	Each
619.16 Steel Marker Posts	Each
619.17 Yielding Marker Posts	Each
619.20 Removing and Resetting Property Markers	Each

SECTION 620 – FENCES

620.01 DESCRIPTION. This work shall consist of the construction of fences and gates.

620.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type I .....	707.01
Copper Napthenate Solution.....	726.04
Woven Wire Fence .....	727.01
Barbed Wire .....	727.01(b)
Chain-Link Fence .....	727.02
Grounding Electrodes.....	753.05

When chain-link fence is specified in the Plans but the material is not, the Contractor may elect to use galvanized, vinyl coated, or aluminum coated steel fabric for the fence as long as it conforms to the design shown on the Plans.

The materials for snow barrier shall conform to the requirements of this Subsection and the details shown on the Plans.

The wire fabric for the snow barrier shown on the Plans shall be a 25 mm (1 inch) mesh, aluminum-coated, steel chain-link fabric conforming to the requirements of Subsection 727.02.

Hardware for the snow barrier shall be hot-dip galvanized or mechanically galvanized using a mechanically deposited process conforming to the requirements of AASHTO M 298, Class 110.

The fabric shall be installed on the traffic side of the support system.

The Contractor may use preformed 1.6 mm by 9.5 mm (1/16 inch × 3/8 inch) flat aluminum wire bands to attach the chain-link fabric to the galvanized pipe support framework. The bands shall be made of 5052-H32 alloy having a minimum tensile strength of 205 MPa (30 ksi), and an approved closure, as an alternate to the stainless steel clips shown on the Plans.

Concrete shall meet the requirements of Section 541 for Concrete, Class B.

620.03 GENERAL. All trees, brush, and other obstructions which interfere with proper grade, alignment, and construction of fences shall be removed and disposed of as specified in Section 201, unless otherwise directed by the Engineer. Modification of the alignment may be made as directed by the Engineer to preserve valuable trees or other features.

Posts shall be set plumb at the spacing and depth shown on the Plans and, when used for property line fence, shall be erected parallel to and 150 mm (6 inches) inside the right-of-way line. The wire shall be placed on the far side of the posts with respect to the transportation facility.

Existing cross fences shall be connected to the new fences. Corner posts with braces for every direction of strain shall be placed at the junction with existing fences, and the wire in both fences shall be properly fastened to the posts.

At bridges, cattle passes, and large culverts, the fence shall be installed as shown on the Plans or as directed by the Engineer. In no case shall the fence be connected to a structure.

620.04 ERECTION OF WOVEN WIRE FENCE. Where the ground is too soft to hold the post firmly and in depressions where stresses will tend to pull posts from the ground, a second post shall be installed to such depth as necessary and the two posts tied together securely as shown on the Plans.

Wood posts shall be set with the large end down in previously dug holes and backfilled with approved material. When tops of treated posts are cut as shown on the Plans or directed by the Engineer, the cut end shall be treated with two coats of copper naphthenate solution.

Steel posts shall be set with anchor plates down, except that when set in rock the anchor plates shall be omitted. When driving posts, the tops shall be protected by driving caps.

When ledge rock is encountered, steel posts shall be used instead of wood posts. The posts shall be set in drilled holes to the depth shown on the Plans and grouted with Mortar, Type I so that they are firmly held in position. When boulders are encountered, they shall be removed, the hole backfilled with suitable materials, thoroughly compacted, and the holes redrilled before installing the posts in the usual manner.

The fence shall be braced as shown on the Plans or directed by the Engineer, with one brace at each end post, including end posts at gates and two braces at each intermediate post, or pull post, and at corner posts where the change in horizontal alignment is in excess of 15 degrees. The maximum distance between braces shall be 180 m (600 feet).

The posts and braces for steel corner, end, and pull posts shall be set in concrete as shown on the Plans. The concrete may be mixed by hand.

The woven wire fence shall be stretched taut and attached to the posts so that the bottom wire is approximately 75 mm (3 inches) above the ground.

When wood posts are used, each horizontal wire shall be fastened to the posts with 3.76 mm (No. 9 gage) galvanized or aluminum coated staples 38 mm (1 1/2 inches) long. When steel posts are used, each horizontal wire shall be fastened to the posts with aluminum bars, galvanized steel bars, or 3.05 mm (No. 11 gage) rust resistant spring wire clips. Instead of the fasteners, posts equipped with fastening studs approximately 13 mm (1/2 inch) high and 57 mm (2 1/4 inches) apart may be used.

Barbed wire shall be installed at river crossings only, as shown on the Plans or as directed by the Engineer. The installation of barbed wire at river crossings will be considered installation of woven wire fence.

620.05 ERECTION OF CHAIN-LINK FENCE. Posts shall be set in concrete bases of the dimensions shown on the Plans.

Where the ground is too soft to firmly hold the line, end, corner, pull, or gate posts, a post of sufficient length shall be used to obtain stability as directed by the Engineer.

Where rock is encountered, the posts shall be set in drilled holes to the depth shown on the Plans and grouted with Mortar, Type I so they are firmly held in position. When boulders are encountered, they shall be removed, the hole backfilled with suitable materials, thoroughly compacted, and the hole redrilled before installing the posts in the usual manner.

The wire fabric shall be properly stretched, without sags or buckles, and attached to the posts as shown on the Plans. Tension wires shall be installed top and bottom as indicated. After erection, any galvanized parts or fittings that have been abraded so that the base metal is exposed shall be painted with two coats of an approved coating.

Any abrasions on aluminum coated steel chain-link fence and the contacting surface of aluminum alloy, or aluminum coated steel chain-link fence with concrete, stone, or masonry shall be thoroughly coated with an approved coating. Abraded areas shall receive a second coat of aluminum paint. The paint shall be allowed to dry thoroughly before installation of the fence.

Where chain-link fence is used in the areas of bicycle paths, the top selvedge shall be knuckled.

620.06 REMOVING AND RESETTING FENCE. Existing fence and posts shall be carefully removed at locations shown on the Plans. Any material damaged while being removed, hauled, or stored and during the process of resetting, due to carelessness on the part of the Contractor as determined by the Engineer, shall be replaced with new materials at the Contractor's expense.

The posts shall be reset in the same manner as posts for new fence and to the same depth and spacing of the fence before removal.

The material used for fencing between posts shall be securely fastened to the posts in their new locations as shown on the Plans for the type of fence being installed.

620.07 REMOVAL OF EXISTING FENCE. Existing fence and posts shall be removed at locations shown on the Plans. When fence is to be salvaged for future use, the Contractor will exercise care during removal to prevent damage and will stockpile the fence at locations indicated in the Contract or as directed by the Engineer. When fence is not to be salvaged, it shall become the property of the Contractor and will be removed from the project area in a manner acceptable to the Engineer.

620.08 GATES. The gates shall be of the design shown on the Plans and shall be completed in a neat and professional manner. The gate hold backs and center stops shall be set in concrete similar to the design and specifications for chain-link fence line posts. The top rail of the gates shall be level along the entire top of the gates.

620.09 METHOD OF MEASUREMENT. The quantity of Fence of the type and size specified and Snow Barrier to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work. Measurement will be along the top of the fence from outside to outside of end posts for each continuous run of fence. Measurement will include fence at bracing assemblies but not at gates.

The length of barbed wire fence installed at a river crossing will be measured for payment as an equal length of Woven Wire Fence.

The quantity of Gate of the type and size specified to be measured for payment will be the number of meters (linear feet) of clear distance between gate posts in the complete and accepted work.

The quantity of Bracing Assembly for Chain-Link Fence of the type and size specified to be measured for payment will be the number of bracing assemblies installed for end, gate, corner, and pull posts in the complete and accepted work.

The quantity of Brace for Woven Wire Fence of the type specified to be measured for payment will be the number of braces installed in the complete and accepted work. If double braces are installed on a post, two units will be measured for payment.

The quantity of Removing and Resetting Fence and Removal of Existing Fence to be measured for payment will be the number of meters (linear feet) of fence in its original position, measured outside of its end posts for each continuous run of fence, including gates.

620.10 BASIS OF PAYMENT. The accepted quantities of Fence, Gate, and Snow Barrier installed or removed and reset, will be paid for at the Contract unit price per meter (linear foot) of the type and size specified.

Barbed wire fence installed at a river crossing will be paid for as Woven Wire Fence.

Bracing Assembly and Braces will be paid for at the Contract unit price for each type specified.

Removing and Resetting Fence will be paid for at the Contract unit price per meter (linear foot).

Removal of Existing Fence will be paid for at the Contract unit price per meter (linear foot). Payment will include compensation for stockpiling or disposal, as appropriate.

Payment will be full compensation for furnishing, transporting, handling, assembling, and placing the materials specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The costs of clearing and grubbing, excavation, backfilling, concrete bases, brace plates, anchor plates, electrical grounding, drilling of rock, grouting of holes, extra length posts, and countersunk posts will not be paid for directly but will be considered incidental to the Contract items involved.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
620.11 Chain-Link Fence, 1.2 m (4 feet)	Meter (Linear Foot)
620.12 Chain-Link Fence, 1.8 m (6 feet)	Meter (Linear Foot)
620.13 Chain-Link Fence, 2.4 m (8 feet)	Meter (Linear Foot)
620.15 Gate for Chain-Link Fence, 1.2 m (4 feet)	Meter (Linear Foot)
620.16 Gate for Chain-Link Fence, 1.8 m (6 feet)	Meter (Linear Foot)
620.17 Gate for Chain-Link Fence, 2.4 m (8 feet)	Meter (Linear Foot)
620.20 Bracing Assembly for Chain-Link Fence, 1.2 m (4 feet)	Each
620.21 Bracing Assembly for Chain-Link Fence, 1.8 m (6 feet)	Each
620.22 Bracing Assembly for Chain-Link Fence, 2.4 m (8 feet)	Each
620.25 Woven Wire Fence with Steel Posts	Meter (Linear Foot)
620.26 Woven Wire Fence with Wood Posts	Meter (Linear Foot)
620.30 Drive Gate for Woven Wire Fence	Each
620.40 Steel Brace for Woven Wire Fence	Each
620.41 Wood Brace for Woven Wire Fence	Each
620.50 Removing and Resetting Fence	Meter (Linear Foot)
620.55 Removal of Existing Fence	Meter (Linear Foot)
620.75 Snow Barrier	Meter (Linear Foot)

#### SECTION 621 - TRAFFIC BARRIERS

621.01 DESCRIPTION. This work shall consist of the furnishing, assembling, removing, and/or resetting of guardrail, median barriers, and guide posts.

621.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Emulsified Asphalt .....	702.04
Tar Emulsion .....	702.05
Grease Rustproofing Compound .....	708.04
Coatings for Wood .....	708.05
Posts and Post Accessories .....	728.01
Rail Elements .....	728.02
Hardware .....	728.03
Delineation Devices.....	728.04
Concrete Anchors .....	728.05
Manufactured Terminal Sections.....	728.06
Energy Absorption Attenuators.....	728.07

Materials for Terminal Connector for Steel Beam Guardrail shall conform to the requirements shown on the Plans.

Concrete shall meet the requirements of Section 501 for Concrete, High Performance Class A.

Reinforcing steel shall meet the requirements of Section 507.

Materials for Removing and Resetting Guardrail, Replace Guardrail Post Assembly, Replace Guardrail Beam Unit, and Adjust Height of Guardrail shall consist of the acceptable rails, posts, offset blocks, bolts, and other hardware of the existing guardrail together with the necessary new replacement parts. The new replacement parts shall match as close as possible the existing components they replace.

All welding shall conform to the requirements of Subsection 506.10.

621.02A FABRICATION DRAWINGS. The Fabricator of guardrail approach sections furnished under this Section shall submit detailed Fabrication Drawings in accordance with Section 105.

621.03 POSTS AND OFFSET BLOCKS. Posts may be set in holes, or they may be driven if suitable caps and driving equipment are used to prevent damage to the posts. The installed posts shall be plumb, accurately aligned, spaced as shown on the Plans and placed to the full depth indicated. Round posts shall be set or driven with the larger post cross-section facing downward. The space around the posts shall be backfilled with suitable material in 150 mm (6 inch) layers and tamped thoroughly with air or mechanical tampers.



Posts for Steel Backed Timber Guardrail shall be driven into pilot holes that have been punched or drilled. The dimensions of the pilot hole shall not exceed the dimensions of the post by more than 25 mm (1 inch). If impenetrable material is encountered while placing the post, the pilot shall be enlarged to provide not less than 150 mm (6 inches) of clearance on all sides and a minimum depth of 760 mm (2.5 feet). The post shall be set in concrete, the type as approved by the Engineer, to within 150 mm (6 inches) of the top of the hole. The remaining 150 mm (6 inches) shall be backfilled with a suitable material and compacted to the satisfaction of the Engineer.

The guardrail designated to be removed and reset shall be carefully removed, temporarily stored when necessary and reinstalled at the new location. Materials damaged or lost shall be replaced with new material by the Contractor without compensation. The new materials shall be equal to or better than the material of the existing guardrail.

Guardrail posts and anchors shall be installed prior to placing the adjacent top course of pavement unless otherwise directed by the Engineer.

For the guardrail system specified, posts and offset blocks shall be of the type and dimensions shown on the Plans.

#### 621.04 RAIL ELEMENTS.

- (a) Beam Rail. Rail elements shall be erected in a manner resulting in a smooth, continuous installation. All bolts, except adjustment bolts, shall be drawn tight. Bolts shall be of sufficient length to extend beyond the nuts.
- (b) Cable Rail. Cable guardrail shall be installed as shown on the Plans.  
  
Splicing of cable will be permitted when necessary, but no single piece of cable shall be less than 15 m (50 feet) in length.
- (c) Cedar Log Rail. Cedar log guardrail shall be constructed as shown on the Plans. All cuts and notches on rails and posts shall be made in a manner to provide uniform bearing and close joints. The rails shall be attached to posts by steel straps and lag screws.
- (d) Steel Backed Timber Rail. Timber rails shall be cut to produce a close fit at all joints. Field cuts shall be treated with an approved material as determined by the Engineer.

621.05 CONCRETE MEDIAN BARRIER (CMB).

- (a) General. The Contractor shall notify the Engineer at least three working days prior to the date that casting of the units is to begin, in order that arrangements for plant inspection may be made by Agency personnel.

Once casting has begun, it shall be done on a relatively continuous basis. Casting on a piecemeal basis will not be acceptable.

- (b) Fabrication. CMB shall be precast in accordance with Section 540 and shall conform to the shape and size shown on the Plans. The Contractor shall produce units that are uniform in appearance.

The length of individual precast sections shall not exceed 6 m (20 feet), unless otherwise specified. The Contractor may need to cast sections of odd lengths to meet field conditions. However, in no case will sections less than 3 m (10 feet) in length be permitted.

- (c) Repair. CMB sections having map or craze cracking or large spalls are not acceptable and shall not be repaired. CMB sections having any cracks that go through the section are not acceptable and shall not be repaired.

- (d) Installation. The precast sections shall be installed at the location(s) and in accordance with the details shown on the Plans. The sections shall be firmly butted against each other; any subbase or other material between units shall be removed. Units shall be joined with suitable connectors, where necessary, to prevent differential lateral movements of individual units as a result of vehicle impact.

- (e) Sealing. Prior to backfilling and paving, the lower vertical faces of the CMB shall be treated by the Contractor with a uniform protective coat of asphalt or tar emulsion. Care shall be taken to ensure that the bituminous material used is not applied, smeared, or spattered on portions of the barrier other than the vertical faces. The bituminous material and application method shall both be approved in advance by the Engineer.

At some time prior to final project completion, the Contractor shall apply a water repellent/sealant approved by the Engineer to all exposed surfaces of the CMB for its entire length.

- (f) Alternate Designs. Instead of the design shown on the Plans, the Contractor may submit an alternate design, including reinforcing details, to the Engineer for approval prior to construction. Ultimate acceptance of a design utilizing less concrete and/or steel may be contingent upon a reduction in the unit bid price, at the discretion of the Engineer.

It is the responsibility of the Contractor to ensure that the time required for submittal, review, and approval of alternate CMB designs does not jeopardize the timely completion of the Contract. A request for a Contract time extension on this basis will be denied.

621.06 ENERGY ABSORPTION ATTENUATOR. Temporary or permanent energy absorption attenuators proposed for use on the project shall receive the approval of the Engineer a minimum of six weeks prior to installing the attenuators on the project.

The Energy Absorption Attenuator(s) proposed by the Contractor shall meet the requirements of the most recent edition of the *AASHTO Roadside Design Guide*.

The installation of the temporary and permanent traffic barrier that the attenuator is to protect shall not begin until complete Energy Absorption Attenuator(s), ready to be installed, are at the project site.

Should an attenuator, or component thereof, in service on the project become damaged and require replacement, as determined by the Engineer, the damaged attenuator, or component thereof, shall be replaced immediately with a backup attenuator, or component thereof, stored on the project in order that there is minimal disruption to incorporating a fully functional attenuator as required by the project traffic control plan.

621.07 TEMPORARY TRAFFIC BARRIER. Temporary traffic barrier shall be one of the barriers included under FHWA's Roadside Hardware Policy and Guidance for crashworthy longitudinal barriers, at the Contractor's discretion, unless otherwise specified. The type of temporary traffic barrier shall be provided to the Engineer prior to use. All temporary traffic barrier and corresponding connections shall meet, unless otherwise specified in the Plans, Test Level 3 (TL-3) criteria as defined in NCHRP Report 350 or the *AASHTO Manual for Assessing Safety Hardware* (MASH). The appropriate resource shall be determined as described in the MASH publication.

Temporary traffic barrier components shall be in a condition satisfactory to the Engineer prior to placement on the project and maintained as such until removed from the project.

The Contractor shall provide to the Engineer verification that the barrier deflection distance is appropriate for the intended use. Where appropriate, temporary traffic barrier shall be adequately anchored to prevent movement if impacted.

Temporary Traffic Barrier shall be erected in accordance with details shown on the Plans or as directed by the Engineer. Unless otherwise specified, Temporary Traffic Barrier shall be removed when no longer needed on the project as determined by the Engineer, and shall remain the property of the Contractor. The area from which the barrier was removed shall be restored to a satisfactory condition where and when no other construction activities are indicated.

621.08 REMOVE AND RESET TEMPORARY TRAFFIC BARRIER.

Temporary traffic barrier and required appurtenances shall be removed and reset as shown on the Plans or as ordered in writing by the Engineer.

621.09 TERMINALS. Guardrail and median barrier terminals shall be constructed and installed as shown on the Plans. Concrete anchors associated with terminals shall be constructed in accordance with Subsection 621.10.

621.10 ANCHORS. Anchors for guardrail shall be placed at the locations and depths shown on the Plans. The backfill material shall be placed in layers of not more than 150 mm (6 inches) and shall be thoroughly compacted by use of air or mechanical tampers.

Cable, when required, shall be drawn taut and fastened securely to the anchor assemblies as shown on the Plans and adjusted to equalize the stresses.

621.11 DELINEATION. Delineation devices shall be of the design and materials shown on the Plans and shall be securely fastened to traffic barriers or guide posts as shown on the Plans or as directed by the Engineer.

Delineation devices for use on CMB shall be one of the devices on the Approved Products List on file with the Agency's Materials and Research Section.

621.12 FIELD PAINTING. Galvanized components that have been cut, abraded, or damaged such that base metal is exposed shall be cleaned and painted with two coats of an approved coating.

Wherever guardrail panels are nested, the surfaces on both panels that will be in contact with each other shall be coated with grease rustproof compound.

621.13 REPLACEMENT, ADJUSTMENT, REMOVAL, AND DISPOSAL OF GUARDRAIL OR GUIDE POSTS.

Existing guardrail which is to remain in place on the project shall be inspected by the Engineer for damage, unsuitability, and conformance to present guardrail standards. The Engineer shall mark post assemblies and panel units which are to be replaced. The guardrail shall then be checked for height conformance.

Those sections in which height non-conformance over an extensive portion of the section is greater than 25 mm (1 inch) above or 75 mm (3 inches) below the present height standard shall be adjusted to conform to the current requirements for guardrail height. Sections which in general conform for height but have a large number of variations due to erosion or filling of the shoulder from normal mechanisms shall have the shoulder graded to the proper typical before being checked for height conformance. After adjustment is complete, the existing rail shall conform to current design standards for height as appropriate for the type of guardrail being adjusted.

When guardrail height adjustment is performed in an area of the project where a bituminous pavement overlay is also being placed, suitable allowance shall be made for the pavement thickness remaining to be placed. While adjusting the height of the guardrail, the Contractor shall repair or replace all damaged, broken, or missing components in order that the final adjusted product is a complete, workmanlike, and properly functioning installation conforming to current height requirements. All questions concerning repair or replacement shall be decided by the Engineer.

When post assembly replacement or guardrail beam replacement occur in the same location that guardrail height is being adjusted, the work for all pay items shall be performed by the Contractor as one continuous operation.

The finished appearance of the rehabilitated rail shall be a continuous smooth line without abrupt dips and guardrail shall be adjusted to give a smooth rail line over the entire section meeting the approval of the Engineer.

Unless otherwise specified in the Contract, material to be removed shall become the property of the Contractor. Materials to be salvaged shall be carefully disassembled in a manner to save as much useable material as possible. Materials to be disposed of shall be dismantled in a manner best suited to the Contractor's operations and shall be removed from the project limits and disposed of properly at the end of each work day.

Unless otherwise indicated, anchors which are designated for removal and disposal, not removal and salvage, may have the anchor or anchor block abandoned in place with the anchor rod or anchor cable cut in such a manner that no portion of the anchor assembly is within 300 mm (1 foot) of the ground, shoulder, or roadway surface. The materials resulting from the removal of anchors which are to be removed and disposed of shall be removed from the project limits at the end of each work day.

If posts or anchors are removed from an area where there is no other excavation or embankment work, the resulting holes shall be backfilled with suitable material matching as closely as possible the surface, subbase and other materials in both type and depth. The backfill shall be placed in layers not more than 150 mm (6 inches) in depth and thoroughly compacted using air or mechanical tampers, and the area shall be seeded in accordance with Section 651.

Existing materials to be salvaged shall be protected from damage and/or loss by the Contractor during construction operations. Materials lost or damaged shall be replaced with new materials by the Contractor without compensation. New materials shall be equal to, or better than, the materials in the existing guardrail.

621.14 METHOD OF MEASUREMENT. The quantity of Plank Rail to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work measured from end to end of plank rail.

The quantity of Cedar Log Rail to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, measured from end to end of log rail.

The quantity of Cable Guardrail to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, measured from center to center of end posts. The distance from end posts to the anchors will not be included for payment. The measured quantity of Cable Guardrail will be multiplied by factors as follows:

<u>Post Spacing</u>	<u>Factor</u>
4.9 m (16 ft.)	1.0
3.7 m (12 ft.)	1.1
1.8 m (6 ft.)	1.5
1.2 m (4 ft.)	1.8

The quantity of Steel Backed Timber Guardrail to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, measured from end to end along the face of rail, including terminal sections. The measured length will be multiplied by a pay factor of 1.4 for a post spacing of 1.5 m (5 feet).

The quantities of Steel Beam Guardrail, Heavy Duty Steel Beam Guardrail, and Thrie Beam Guardrail to be measured for payment will be the number of meters (linear feet) of each kind specified installed in the complete and accepted work, measured center to center of end posts to which rail is attached. The measured quantity will not include those portions of the installation within the pay limits for Manufactured Terminal Section or Terminal Connector for Steel Beam Guardrail. Where terminal end sections are installed, an additional 600 mm (2 feet) of guardrail will be included for each end section. W-beam to thrie beam transition sections will be paid for as an equal length of thrie beam guardrail. The measured quantities of Steel Beam Guardrail, Heavy Duty Steel Beam Guardrail, and Thrie Beam Guardrail will be multiplied by factors as follows:

<u>Post Spacing</u>	<u>Factor</u>
1.9 m (6 ft., 3 in.)	1.0
1.3 m (4 ft., 2 in.)	1.2
1.0 m (3 ft., 1 1/2 in.)	1.4

The quantity of Box Beam Guardrail to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, measured from center to center of end posts. An additional 300 mm (1 foot) of guardrail will be allowed for each overhang.

The quantities of Steel Beam Median Barrier and Thrie Beam Median Barrier to be measured for payment will be the number of meters (linear feet) of each kind specified installed in the complete and accepted work, measured from center to center of end posts to which rail is attached, excluding terminals.

The quantity of Concrete Median Barrier to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, measured from end to end along the top of the barrier, including depressed or ramped end sections.

The quantities of Terminal Sections, Terminal Connectors, Terminals, Anchors, Approach Sections, and Guide Posts to be measured for payment will be the number of units of each type specified, installed in the complete and accepted work.

The quantity of Energy Absorption Attenuator to be measured for payment will be the number of units, with a unit consisting of a complete attenuator installed when needed and removed when no longer required. Energy Absorption Attenuator will be paid separately and will not be included in the measurement for Temporary Traffic Barrier.

The Contract quantity for Energy Absorption Attenuator includes one backup attenuator to be provided by the Contractor and stored on the project in the event an attenuator, or component thereof, in service is damaged and needs replacement.

The quantity of Remove and Reset Guardrail to be measured for payment will be the number of meters (linear feet) reset in the complete and accepted work, measured in accordance with the type of guardrail specified.

The quantity of Replace Guardrail Post Assembly to be measured for payment will be the number of individual posts replaced.

The quantity of Replace Guardrail Beam Unit to be measured for payment will be the number of 3.81 meter (12.5 foot) rail panels replaced. Those rail panels that are longer or shorter than 3.81 meters (12.5 feet) in length shall be converted to an equivalent number of 3.81 meter (12.5 foot) rail panels. The quantity of Replace Guardrail Beam Unit will not be factored for post spacing.

Minor repairs and replacement of parts for anchorage devices, such as tightening nuts, adjusting turn buckles, replacing nuts and/or bolts, rethreading rod ends, etc. will be considered incidental to the other Section 621 pay items in the Contract.



The quantity of Adjust Height of Guardrail to be measured for payment will be the number of meters (linear feet) of adjusted guardrail complete in place measured from center to center of the end posts to which the rail elements are attached. Payment will not include measurement of any rail element or anchorage which extends beyond the last post to which the rail elements are attached, nor will any factor based on post spacing distances be applied to the measured distance.

The quantity of Removal and Disposal of Guardrail to be measured for payment will be the number of meters (linear feet) removed in the complete and accepted work, measured from end post to end post to which rail was attached.

The quantity of Removal and Disposal of Guide Posts to be measured for payment will be the number of posts removed in the complete and accepted work.

The quantity of Temporary Traffic Barrier to be measured for payment will be the number of meters (linear feet) installed and removed in the complete and accepted work, measured from end to end of each installation, including terminals. Energy Absorption Attenuator(s) will be paid separately and will not be included in the measurement for Temporary Traffic Barrier.

The quantity of Remove and Reset Temporary Traffic Barrier to be measured for payment will be the number of meters (linear feet) removed and reset, measured from end to end of the allowable length as described herein, as shown on the Plans or as directed by the Engineer. Any barrier removed and not reset will not be measured for payment, but will be considered incidental to the original installation of the barrier. No measurement for payment will be made for barrier that is removed and reset for the convenience of the Contractor, for minor adjustments of 600 mm (2 feet) or less in any direction, or for any removal and resetting that was not authorized as described herein.

621.15 BASIS OF PAYMENT. The accepted quantities of Rail, Guardrail, or Median Barrier, new or reset, permanent or temporary, will be paid for at the Contract unit price per meter (linear foot) for the Contract item specified.

The accepted quantity of Manufactured Terminal Section of the type specified will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, detailing, transporting, handling and installing the terminal section(s) used, including but not limited to excavation, backfill, regrading the installation area as necessary, delineation devices, restraining devices, hardware, and preservative treatment, and for furnishing all labor, tools, equipment, and incidentals necessary for installing a complete and properly functioning unit.

The accepted quantities of Terminal Connectors, Terminals, Anchors, Approach Sections, and Guide Posts will be paid for at the Contract unit price for each for the Contract item specified.

The accepted quantity of Removal and Disposal of Guardrail will be paid for at the Contract unit price per meter (linear foot). Removed guardrail that is not reset will be paid for as Removal and Disposal of Guardrail.

The accepted quantity of Removal and Disposal of Guide Posts will be paid for at the Contract unit price for each.

Payment for Removal and Disposal of Guardrail and Removal and Disposal of Guide Posts will include full compensation for removing and disposing of materials, and for restoration of the old installation site when required.

Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. For Steel Backed Timber Guardrail, enlarging holes as necessary for placement of posts, furnishing and placing concrete fill and backfill material, and compacting backfill to the satisfaction of the Engineer will not be paid for separately, but will be considered incidental to the unit price bid for Contract item 621.18.

Payment for CMB will be full compensation for furnishing, transporting, handling, and placing the material specified, including the protective coat of asphalt or tar emulsion and the water repellent/sealant. Excavation and backfill required for installation of CMB will be paid for separately under the appropriate Sections.

The accepted quantity of Energy Absorption Attenuator will be paid for at the Contract unit price for each. Payment will be full compensation for fabricating, furnishing, transporting, handling, and installing the materials required including all hardware, any necessary manufacturer's supervision, the furnishing of all labor, tools, equipment, and incidentals necessary for installing the attenuator complete in place, for maintaining and repairing the attenuator as necessary while it is in place, and for removing and disposing of the attenuator when it is no longer needed.

Payment will be made as follows:

- (a) 70 percent of the Contract unit price will be paid when the attenuator is installed and functioning to the satisfaction of the Engineer.
- (b) The remaining 30 percent of the Contract unit price will be paid when the Engineer has determined that the attenuator is no longer required for use at the original installed location.

Payment for the backup attenuator will be made as follows:

- (a) 50 percent of the Contract unit price will be paid when the backup attenuator is delivered to and placed in storage at the project site to the satisfaction of the Engineer.
- (b) The remaining 50 percent of the Contract unit price will be paid when the stored attenuator, or component thereof, is installed on the project and/or removed from the project site, when no longer required, as determined by the Engineer.

Payment for Remove and Reset Guardrail will be full compensation for removing, transporting, storing, reassembling all parts necessary, cutting, furnishing of new parts when necessary, reinstalling at the new locations, furnishing and applying stain, paint, and preservative material and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Payment will also include removing and replacing anchors and terminal ends when required.

The removal of treated timber curbing, including the bituminous concrete fillet, from installations where the existing guardrail is removed will not be paid for directly, but will be considered incidental to Remove and Reset Guardrail and Removal and Disposal of Guardrail.

The accepted quantity of Replace Guardrail Post Assembly (whether for cable, steel beam, box beam, or aluminum rail) will be paid for at the Contract unit price for each. Payment will be full compensation for removing and disposing of the designated post and accessories; for any necessary excavation and backfill, including proper compaction; for furnishing, transporting, handling, and installing the replacement components needed, including new post, offset block and/or backup plate if required; new reflector or other delineation if required; new bolts, nuts and/or washers and any other necessary hardware; steel strapping as necessary; stain, paint, and preservative; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Replace Guardrail Beam Unit (whether for steel beam, box beam, or aluminum rail) will be paid for at the Contract unit price for each. Payment will be full compensation for removing and disposing of the designated beam panel; for furnishing, transporting, handling, and installing the replacement components needed, including new rail beam unit of the required length, replacement backer plate if required and not covered under another Contract item, new reflectors or other delineation if required and not part of the item Replace Guardrail Post Assembly, and new bolts, nuts, and/or washers and any other necessary hardware; for drilling holes as required to complete the installation of the replacement panel; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Adjust Height of Guardrail will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for adjusting the height of the existing guardrail to conform to current standards; for any necessary excavation and backfill, including proper compaction; for furnishing, transporting, handling, and installing necessary cable terminal hardware, turn buckles, tension springs, splicing units, steel strapping, stain, paint, preservatives, and all other components which are necessary to make the adjusted guardrail a complete installation and which are not part of any other pay item in the Contract; for disposing of removed components which are not reused; and for furnishing the labor, tools, equipment, and incidentals necessary to complete the work.

Any post not suitable for reinstallation, as determined by the Engineer, shall be replaced under the item Replace Guardrail Post Assembly.

Payment for Temporary Traffic Barrier will be full compensation for furnishing and installing barrier and any required terminals or protective end devices, and for removal and site restoration where required. Temporary Traffic Barrier on a temporary bridge and its approaches will be considered incidental to the work under Section 528.

Payment will be made as follows:

- (a) 50 percent of the accepted quantity upon the satisfactory installation of the barrier.
- (b) 50 percent of the accepted quantity upon the final removal of the barrier.

Payment for Remove and Reset Temporary Traffic Barrier will be full compensation for removing, transporting, storing, reassembling all parts necessary, cutting, furnishing of new parts when necessary, reinstalling at the new locations, reinstalling required terminals or protective end devices, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Payment will also include removing and replacing anchors. Partial payment will be made as follows:

- (a) 50 percent of the accepted quantity upon the removal of the originally installed barrier.
- (b) 50 percent of the accepted quantity upon the satisfactory reinstallation of the barrier.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
621.15 Plank Rail	Meter (Linear Foot)
621.16 Cedar Log Rail	Meter (Linear Foot)
621.17 Cable Guardrail	Meter (Linear Foot)
621.18 Steel Backed Timber Guardrail	Meter (Linear Foot)
621.20 Steel Beam Guardrail, Galvanized	Meter (Linear Foot)
621.205 Steel Beam Guardrail, Galvanized w/2.4 m (8 feet) Posts	Meter (Linear Foot)
621.206 Steel Beam Guardrail, Galvanized/Nested	Meter (Linear Foot)
621.207 Steel Beam Guardrail, Galvanized/Nested w/2.4 m (8 feet) Posts	Meter (Linear Foot)
621.21 HD Steel Beam Guardrail, Galvanized	Meter (Linear Foot)
621.215 HD Steel Beam Guardrail, Galvanized w/2.4 m (8 feet) Posts	Meter (Linear Foot)
621.216 HD Steel Beam Guardrail, Galvanized/Nested	Meter (Linear Foot)
621.217 HD Steel Beam Guardrail, Galvanized/Nested w/2.4 m (8 feet) Posts	Meter (Linear Foot)
621.25 Thrie Beam Guardrail	Meter (Linear Foot)
621.30 Box Beam Guardrail	Meter (Linear Foot)
621.35 Steel Beam Median Barrier	Meter (Linear Foot)

621.40 Thrie Beam Median Barrier	Meter (Linear Foot)
621.45 Concrete Median Barrier	Meter (Linear Foot)
621.50 Manufactured Terminal Section, Flared	Each
621.51 Manufactured Terminal Section, Tangent	Each
621.53 Terminal Connector for Steel Beam Guardrail	Each
621.55 Median Barrier Terminal	Each
621.56 Energy Absorption Attenuator	Each
621.57 Energy Absorption Attenuator, Sand-Filled Plastic Barrel	Each
621.59 Energy Absorption Attenuator, Liquid Filled	Each
621.60 Anchor for Steel Beam Rail	Each
621.61 Anchor for Steel to Box Beam Transition	Each
621.65 Anchor for Cable Rail	Each
621.66 Anchor for Cable Rail at Openings	Each
621.72 Guardrail Approach Section, Galvanized 2 Rail Box Beam	Each
621.725 Guardrail Approach Section, Galvanized 3 Rail Box Beam	Each
621.73 Guardrail Approach Section, Galvanized 4 Rail Box Beam	Each
621.746 Guardrail Approach Section to Concrete Bridge Railing, TL-2	Each
621.747 Guardrail Approach Section to Concrete Bridge Railing, TL-3	Each
621.75 Remove and Reset Guardrail	Meter (Linear Foot)
621.76 Replace Guardrail Post Assembly	Each
621.77 Replace Guardrail Beam Unit	Each
621.79 Adjust Height of Guardrail	Meter (Linear Foot)
621.80 Removal and Disposal of Guardrail	Meter (Linear Foot)
621.81 Removal and Disposal of Guide Posts	Each
621.85 Guide Posts	Each
621.90 Temporary Traffic Barrier	Meter (Linear Foot)
621.95 Remove and Reset Temporary Traffic Barrier	Meter (Linear Foot)

SECTION 622 - INSULATION BOARD

622.01 DESCRIPTION. This work shall consist of furnishing and installing extruded expanded polystyrene insulation board on a prepared surface.

622.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

- Sand Borrow..... 703.03
- Polystyrene Insulation Board..... 735.01

Skewers shall conform to the requirements of the insulation manufacturer.

622.03 PREPARATION OF SURFACE. The surface shall be prepared as follows:

- (a) The surface on which insulation board is to be placed shall be shaped as shown on the Plans. Any unsuitable material shall be replaced with satisfactory material. The surface shall be compacted to attain at least 95 percent of the maximum dry density and the in-place moisture content shall be not more than 2 percent above the optimum moisture content, as determined by AASHTO T 99, Method C.
- (b) When sand borrow is required, it shall be spread and compacted to a minimum depth of 75 mm (3 inches) just prior to the placement of the insulation board.
- (c) Compaction shall be performed in accordance with Subsection 203.11(d).

622.04 PLACEMENT OF INSULATION. The insulation board shall be placed and secured as follows:

- (a) The boards shall be placed in such a manner that the transverse joints will be staggered. If two layers of insulation are used, the second shall be placed to cover the joints of the first layer.
- (b) Means will be provided to ensure a straight alignment of the boards.
- (c) A minimum of two skewers, as approved by the Engineer, shall be used to hold each insulation board in place. The skewers shall be driven at an angle of less than 90 degrees from the horizontal until flush with the surface of the insulation boards.

Skewers shall be used for each layer when more than one layer of material is used.

622.05 PLACEMENT OF MATERIAL ON THE INSULATION BOARD. Special care shall be taken that the equipment used in placing the material does not operate directly upon the installed insulation board.

The first layer of material shall be placed to a minimum depth of 200 mm (8 inches), loose measurement, by dumping in piles and then moving it forward onto the insulation board by approved equipment.

The first layer of material shall be compacted to the satisfaction of the Engineer. The compaction of subsequent layers shall be made with the same construction procedures required for the type of material being placed.

Any insulation board that becomes displaced or damaged prior to or during placing of the material shall be repositioned or removed and replaced with new board at the Contractor's expense.

622.06 METHOD OF MEASUREMENT. The quantity of Insulation Board to be measured for payment will be the number of cubic meters [thousand feet board measure (MFBM)] installed in the complete and accepted work, based on the nominal dimensions of material. No allowance will be made for waste.

622.07 BASIS OF PAYMENT. The accepted quantity of Insulation Board will be paid for at the Contract unit price per cubic meter [thousand feet board measure (MFBM)]. Payment will be full compensation for furnishing, transporting, handling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work, except that:

Sand will be paid for at the Contract unit price per cubic meter (cubic yard) for sand borrow under Contract item Sand Borrow.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
622.10 Insulation Board	Cubic Meter (MFBM)



SECTION 625 - SLEEVES FOR UTILITIES

625.01 DESCRIPTION. This work shall consist of the furnishing and installation of sleeves for public or private utilities. Sleeves are hereby defined as encasements for utility lines and are also known as ducts, casings, and conduits.

625.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Emulsified Asphalt, RS-1 .....	702.04
Brick .....	705.01
Mortar, Type II .....	707.02
Mortar, Type IV .....	707.03
Joint Sealer, Hot Poured .....	707.04(a)
Preformed Joint Filler, Cork and .....	707.08
Asphalt-Treated Felt	
Polyvinyl Chloride (PVC) Waterstop .....	707.10
Asphaltic Plug Bridge Joint .....	707.15
Reinforced Concrete Pipe .....	710.01
ABS Plastic Pipe .....	710.05
PVC Plastic Pipe .....	710.06
Corrugated Steel Pipe, Pipe Arches, .....	711.01
and Underdrains	
Corrugated Aluminum Alloy Pipe, Pipe Arches, .....	711.02
and Underdrains	

Bituminous concrete pavement shall conform to the requirements of Section 406.

Steel bar reinforcement shall conform to the requirements of Section 507.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

All wood blocks (skids) shall be oak or maple structural lumber #2 Grade or better.

Stainless steel strapping shall meet the requirements of ASTM A 666.

Sleeves for power, telephone, cable TV, and metal pipes shall be nonmetallic.

625.03 INSTALLATION. Sleeves shall be installed using the same methods specified for culverts as in Section 601, unless otherwise specified in the Contract. Nonmetallic pipe shall be positively joined in accordance with standard procedures.

Unless otherwise specified, any sleeve installed for future use is to be fitted with plugs or caps at both ends and shall contain a suitable pull wire or pull cord accessible from both ends.

Carrier pipe (water, sewer, gas) greater than 50 mm (2 inches) in diameter shall be installed in a sleeve of at least 300 mm (12 inches) larger than the diameter of the carrier pipe.

Utilities (power, cable, phone) greater than 50 mm (2 inches) in diameter shall be installed in a conduit of at least 100 mm (4 inches) larger than the diameter of the utility.

For utilities 50 mm (2 inches) and smaller, the inside diameter of sleeves shall be as follows:

Power Lines:	100 mm (4 inches)
Telephone Lines:	100 mm (4 inches)
Cable TV Lines:	100 mm (4 inches)
Water Pipe:	150 mm (6 inches)
Water service lines, DN20-DN25 (¾ inch – 1 inch)	100 mm (4 inches)
Sewer Pipe:	150 mm (6 inches)
Gas Pipe:	150 mm (6 inches)

625.04 METHOD OF MEASUREMENT. The quantity of Sleeves for Utilities to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work.

625.05 BASIS OF PAYMENT. The accepted quantity of Sleeves for Utilities will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for fabricating, furnishing, transporting, handling, saw cutting, and placing all materials, including pull wire and end caps, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Blocking (skids), stainless steel straps, bituminous concrete pavement, portland cement concrete pavement, reinforcing steel, emulsion, subbase materials, brick end walls, and other materials required in conjunction with sleeves will be considered incidental to the Contract item Sleeves for Utilities.

Excavation and backfill of trenches and boring or jacking pits for the placement of sleeves for utilities will be considered incidental to the Contract item Sleeves for Utilities.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
625.10 Sleeves for Utilities	Meter (Linear Foot)

SECTION 626 - WELLS AND CASINGS

626.01 DESCRIPTION. This work shall consist of constructing a well, to the depth required, by driving or drilling using either cable or rotary type machines. This work also includes furnishing and installing the well casing and fittings; sealing and capping the casing, and performing pump or bail tests, or other approved methods of water measurement.

626.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Well Casing .....	741.01
Chlorine Solution .....	742.01
Water .....	745.01

626.03 GENERAL. The Contractor shall notify the Engineer at least two days in advance of the time that work is expected to begin on a specific well drilling site. Unless otherwise specified, the well shall be constructed to a depth necessary to obtain the required rate of flow of water and shall be cased with a well casing of at least 150 mm (6 inches) in diameter. Drilling beyond the estimated depth specified in the Contract shall not be performed unless authorized by the Engineer.

All wells shall be constructed in accordance with these specifications and with the latest edition of the Vermont Water Supply Rule, Chapter 21 of the Environmental Protection Rules published by the Vermont Agency of Natural Resources' Department of Environmental Conservation.

The Contractor shall construct the well with a minimum of disturbance to the property owners and surrounding areas. The well driller shall not use materials or procedures that may adversely affect the public health, the drill site, or groundwater. Wastewater and cuttings shall be disposed of in a manner approved by the Engineer.

The Contractor shall furnish all necessary water for driving or drilling purposes at the site of the well. All water used in drilling, driving, or servicing water wells shall be potable water.

If at any time the Engineer should decide that it is essential to discontinue drilling a particular well for any reason such as excessive depth, insufficient flow of water, or contamination, the Engineer will notify the Contractor in writing.

The well casing shall extend not less than 500 mm (18 inches) above the highest ground surface immediately adjacent to the casing. The Contractor shall take every possible precaution to prevent any foreign material or ground or surface water from entering the well casing.

Upon completion of the well, the top of casing shall be securely capped to prevent the introduction of any foreign material into the well.

All cuttings, waste, and surplus material shall be removed and disposed of; all ruts and damage to lawns, landscaping, or drives shall be repaired, and the site shall be left in a clean and presentable condition.

626.04 DRILLING WELL. The well shall be started with a 200 mm (8 inch) diameter hole, and where bedrock is encountered, extend a minimum of 3 m (10 feet) into competent bedrock, or more when directed by the Engineer. A minimum of 6 m (20 feet) of well casing shall be used in all wells. The 150 mm (6 inch) diameter casing shall be placed and drilling continued with a 150 mm (6 inch) drilling head for approximately 300 mm (12 inches) before seating the casing to provide a proper seal against outside contamination. A standard drive shoe shall be used on the well casing, unless otherwise directed by the Engineer.

After the casing has been sealed, the drilling shall continue until the required well production, as specified in the Contract has been obtained. If the Engineer determines that the well will not be productive, drilling shall be discontinued.

In some instances, such as when the annular space cannot be filled with native materials or drill cuttings, or when additional protection is required due to insufficient isolation distances, the well casing may need to be grouted. The grouting shall be in accordance with the latest edition of the Vermont Water Supply Rule, Chapter 21, Appendix A, Part 12.3.4.

When a rotary drill type machine is used, the water ejection mechanism shall be turned on and shall deliver water through the drill stem at all times when drilling in solid rock.

After the required rate of flow of water has been obtained, drilling shall be continued for approximately 5 m (15 feet) in additional depth, or to the depth directed by the Engineer, to provide a sump for collection of sediment. When this depth has been completed, the well will be considered drilled to its full depth. The well shall be cleaned by continuous blowing or bailing until all fines are removed from the well hole and the water obtained is reasonably clean and clear.

When drilling is proceeding through a water bearing strata of porous material of sufficient depth for development of a well in a gravel formation, the Engineer may order in writing the cessation of further drilling to make preparations for development of the well in the gravel formation.

626.05 DEVELOPMENT OF WELL IN GRAVEL FORMATION. The development of a well in a gravel formation shall be in accordance with the latest edition of the standard specifications of the American Water Works Association, Section A 100-97, and as directed by the Engineer.

The casing shall extend at least 3 m (10 feet) below the anticipated maximum drawdown elevation.

626.06 MEASUREMENT OF FLOW. The Contractor shall determine the flow of water at all water bearing strata encountered while constructing the well and shall perform any additional measuring tests that may be ordered by the Engineer. This work shall not be construed as part of the pump test for yield, but shall be included in the item for a driven or drilled well.

During the time of the well construction, the Contractor shall furnish the Engineer with all tools, equipment, and materials needed to determine the amount of flow and quality of water.

When the flow test shows that the required output of the well has not been obtained, drilling shall resume and continue until sufficient flow has been obtained or the Engineer determines that the well should be abandoned.

626.07 DISINFECTING. The Contractor shall disinfect the well with a chlorine solution after the drilling is completed.

626.08 PUMP TEST FOR YIELD. The Contractor shall perform a pump test for yield on all wells, unless otherwise directed by the Engineer. The Contractor shall install a pump with necessary power and connections capable of pumping the required rate of flow of water for each well.

The test shall be conducted continuously for at least four hours, and up to a maximum of 72 hours, as specified by the Engineer, to determine that the well is capable of continuously producing the required rate of flow of water.

Suitable means shall be provided for determining the water level during the pumping operations.

Readings of the water level in the well and the well output shall be taken and recorded at 30 minute intervals . The Contractor shall furnish a copy of the test records in tabular form to the Engineer.

When the ordered length of pump test for yield is eight hours or less, the pumping shall be started at an hour that will allow completion of the test not later than 5:00 p.m. of the same day, unless otherwise directed by the Engineer prior to beginning the test.

626.09 SAMPLING. In order to determine that the quality of the water obtained from the new well is suitable for domestic use or the intended consumption, the Engineer will submit water samples for analysis to a testing laboratory approved by the Vermont Department of Health. Sample bottles shall be obtained from the same laboratory.

626.10 METHOD OF MEASUREMENT. The quantity of Driven or Drilled Well to be measured for payment will be the number of meters (linear feet) driven or drilled in the complete and accepted work, measured as the difference in elevation between the bottom of the hole and the ground level. However, a minimum depth of 12 m (40 feet) will be measured for each well.

The quantity of Well Casing Pipe to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, measured from end to end of casing.

The quantity of Grouting of Well Casing Pipe to be measured for payment will be the number of meters (linear feet) of well casing grouted in place, measured from the bottom of well casing to the top of grout.

The quantity of Development of Well in Gravel Formation to be measured for payment will be the number of hours actually worked.

The quantity of Pump Test for Yield to be measured for payment will be the number of hours actually consumed, while pumping continuously, measured from the time pumping is started, to the completion of the pump test for yield. No allowance will be made for time lost due to breakdown.

626.11 BASIS OF PAYMENT. The accepted quantity of Driven or Drilled Well will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for furnishing, transporting, and handling the equipment; driving or drilling the well; sealing the well casing when required; measuring flow; disinfecting and chlorinating the well; sampling the water; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work, including disposal of surplus materials and the cleaning of the site following completion of the construction operations.

The accepted quantity of Well Casing Pipe will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for furnishing, transporting, and installing the casing; for capping the well; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Grouting of Well Casing Pipe will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for furnishing, transporting, and installing the grout mixture, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Development of Well in Gravel Formation will be paid for at the Contract unit price per hour. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Pump Test for Yield will be paid for at the Contract unit price per hour. Payment will be full compensation for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
626.15 Driven or Drilled Well	Meter (Linear Foot)
626.20 Well Casing Pipe	Meter (Linear Foot)
626.22 Grouting of Well Casing Pipe	Meter (Linear Foot)
626.25 Development of Well in Gravel Formation	Hour
626.30 Pump Test for Yield	Hour

SECTION 627 - PUMP AND TANK INSTALLATION

627.01 DESCRIPTION. This work shall consist of furnishing and installing a complete water system of the capacity, size, and type specified.

627.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Flexible Plastic Water Pipe .....	740.01
Rigid PVC Plastic Water Pipe .....	740.02
Seamless Copper Water Tube.....	740.04
Galvanized Steel Water Pipe .....	740.05
Water Pumps .....	741.02
Water Storage Tanks .....	741.03
Chlorine Solution .....	742.01
Topsoil.....	755.02
Seed .....	755.04

The Contractor shall furnish to the owner the manufacturer’s warranties for the installed pump, tank, pipe, and necessary fittings and connections.

627.03 INSTALLATION.

- (a) Pumps, General. The diameter of the water pipe used shall be that recommended by the manufacturer for the size pump being installed.

All pipes installed between the well and building entrance shall be located below the frost line and in no case shall the depth be less than 1.5 m (5 feet) below ground level, unless otherwise directed by the Engineer.

If the rated capacity of the pump is equal to or greater than the yield of the well, a low pressure cutoff or low-flow switch shall be installed as directed by the Engineer. In the case of a jet pump installation, a flow control valve may be used.

If an overflowing well is encountered, the overflow will be drained using a pitless adapter, check valve, and water pipe sized to contain the flow. The pipe shall be plastic or as approved by the Engineer. The pitless adapter and connections shall be either bronze or brass.



- (b) Jet Pump System. Jet pumps shall be installed using flexible plastic pipe of at least 1.1 MPa (160 psi) working pressure, Schedule 80 rigid plastic or galvanized steel pipe between the ejector assembly and the well cap or pitless adapter. The same type of pipe shall be installed between the well and the storage tank, unless otherwise specified in the Contract.

A tailpiece of rigid pipe, 9 m (30 feet) in length, shall be installed with a foot valve of non-corrosive metal.

No splices will be allowed when flexible plastic pipe is installed between the well cap and the injector assembly.

- (c) Submersible Pump System. Submersible pumps shall be installed using galvanized steel pipe, rigid plastic pipe, or flexible plastic pipe as specified. The installation will be in accordance with the manufacturer's recommendations.

If rigid plastic pipe is specified, the hanger pipe between the pump and the certified pitless adapter shall have threaded couplings. Schedule 40 plastic pipe may be used to a depth of 60 m (200 feet). For a pump setting between 60 and 120 m (200 and 400 feet) of depth, Schedule 80 plastic pipe shall be used. For a pump setting between 120 and 245 m (400 and 800 feet) of depth, galvanized pipe shall be used. When Schedule 40 or 80 plastic pipe is used, it will have threaded male and female adapters that shall be securely cemented to opposite ends of each length of pipe. A torque arrester shall be attached to the first length of riser pipe at the top of the pump to protect the unit from damage by vibration. The torque arrester shall be expanded to a tight fit of the well diameter and locked in place using stainless steel clamps. The motor leads shall run through the torque arrester so that they will be protected from disturbance. The pump cable shall be firmly taped to the riser pipe at intervals of approximately 3 m (10 feet).

Pipe used between the well head and the pressure tank shall have a pressure rating of at least 1.1 MPa (160 psi). This pipe shall be either galvanized steel, Schedule 40 rigid plastic or flexible plastic.

A 4.5 kN (1000 pound) safety cable shall be furnished and installed when plastic hanger pipe is used.

A pump lightning arrester shall be furnished and installed.

- (d) Shallow Well Pump System. Shallow well pumps shall be installed using galvanized steel pipe, Schedule 40 rigid plastic pipe, or flexible plastic pipe of at least 700 kPa (100 psi) working pressure. The suction line shall extend a minimum of 9 m (30 feet) below the pump intake and shall be fitted with a foot valve of non-corrosive metal. The same type of pipe shall be installed between the pump and storage tank.

627.04 WELL CAP. The well casing shall be capped with a watertight, non-corrodible, vented cap.

627.05 THIS SUBSECTION RESERVED

627.06 CONNECTION TO EXISTING SYSTEM. The connection between the storage tank and existing water system shall be made with seamless copper water tube of adequate size, except that galvanized steel pipe shall be used if the existing plumbing system is galvanized steel pipe.

627.07 STORAGE TANK. The capacity, material, construction requirements, and installation (vertically or horizontally) of the storage tank shall be as specified in the Contract or as ordered by the Engineer.

The tank will be provided with a check valve, pressure relief valve, pressure gauge, and a hose threaded drain cock. A gate/ball valve shall be installed at the tank outlet.

The storage tank shall be supported on stone, brick, concrete blocks, or by use of a tank frame to allow air to circulate freely under the tank. In no case shall the storage tank rest directly in contact with the existing floor or ground.

627.08 ELECTRICAL WORK. This work shall include the furnishing and installation of electric service cables, the pump switch, a fuse or breaker box, the pump control box, a control switch to connect the pump with the power source, and all incidentals required to provide a working pump system. All work shall be completed in a competent and professional manner.

Both the materials and installation methods of all electrical wiring connections, switches, and grounds shall conform to the provisions of the National Electrical Code, and shall be in accordance with all State and local electrical ordinances. Electrical materials approved by the Underwriters' Laboratories, Inc. shall be used wherever standards have been established by that agency.

The electrical feeder circuit shall be sufficient in size to limit the voltage drop to 3 percent or less. A manually operable disconnect switch shall be inserted in the circuit.

Automatic controlling switches and devices as recommended by the manufacturer of the pump unit shall be installed in accordance with the National Electrical Code.

Overcurrent protection for the motor shall be provided to effectively protect the motor against overload or short circuit conditions. The type of fuse or breaker shall be a time lag device which shall allow the passage of momentary starting current but which will open the circuit when exposed to other than normal operating current. The overcurrent protection device shall be located as near the master switch control as possible.

627.09 GROUNDING. Grounding shall be installed remote from the system to prevent the possibility of current feedback.

All water piping, pressure tank and associated metal frames, electrical switches, and control devices shall be effectively grounded by means of a grounding conductor attached thereto and connected to the "ground wire" or "ground buss" at the service entrance switch.

627.10 CELLAR INSTALLATIONS. Unless otherwise required to meet field conditions, storage tanks, jet pumps, shallow well pumps, and electrical control boxes shall be located in the cellar.

627.11 CHLORINATION OF SYSTEM. The Contractor shall disinfect the complete water system by adding an approved chlorine solution at the well head prior to making the water system operative. After the system is operative, the Contractor shall run water through the system for a sufficient time to ensure that all taste, odor, and coloring has been removed and that the water is clear and suitable for use. The owner may assume responsibility of this clearing operation in order to allow the chlorine solution to remain for a longer period in the existing plumbing system for more complete decontamination.

627.12 ALTERATIONS TO PROVIDE ACCEPTABLE WATER. If the water as available from the installation provided under this Section is not potable according to the Vermont Department of Health test results, or is not acceptable because of hardness, iron content, or other unusual conditions as determined from the representative samples taken from the system, the Contractor agrees to furnish adequate conditioning equipment to provide potable and acceptable water. This work shall be done as Extra and Force Account Work, as specified in Section 109. All equipment for water conditioning shall be approved by the Engineer.

627.13 LANDSCAPING. Contingent upon the backfilling operation, the site shall be properly graded to blend with the undisturbed present ground. Topsoil, to a depth of 75 mm (3 inches), shall be placed in area(s) formerly covered with grass and the area seeded in accordance with Section 651. Upon completion of the work, the Contractor shall properly clean up the worksite and leave the area in a neat, presentable condition.

627.14 METHOD OF MEASUREMENT. The quantity to be measured for payment will be on a unit basis for the specified type of Pump System installed in the complete and accepted work.

Acceptance date for completion will be the date of the satisfactory report or reports of the Vermont Department of Health Laboratory's Division of Environmental Health, or other testing laboratory approved by the Vermont Department of Health, indicating potable and acceptable water samples collected after the installation is completed.

627.15 BASIS OF PAYMENT. The accepted quantity will be paid for at the Contract lump sum price for the type of Pump System specified, including a pressure or storage tank, the water pump, water piping, electrical connections, connection to the existing system, and all related fittings. Payment will be full compensation for furnishing; transporting; handling; and placing the material specified including excavation, backfill, gravel, topsoil, or similar materials as needed for grading and seeding; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Any alterations of the pump installation required to provide acceptable water will be paid for as Extra Work and Force Account Work as specified in Section 109.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
627.20 Double Pipe Jet Pump System	Lump Sum
627.25 Submersible Pump System	Lump Sum
627.30 Shallow Well Pump System	Lump Sum

#### SECTION 628 - SANITARY SEWER SYSTEMS

628.01 DESCRIPTION. This work shall consist of the construction or reconstruction of sanitary sewer lines and appurtenances.

628.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Granular Backfill for Structures .....	704.08
Rubber Gaskets.....	707.11
Reinforced Concrete Pipe.....	710.01
Vitrified Clay Pipe.....	710.04
ABS Plastic Pipe .....	710.05
PVC Plastic Pipe .....	710.06
Ductile Iron Pipe, Cement Lined.....	740.07

Concrete shall conform to the requirements of Section 541 for Concrete, Class B unless otherwise specified.

Sleeves shall conform to the requirements of Section 625.

628.03 GENERAL. Care shall be exercised by the Contractor to avoid disrupting the operation of existing sanitary sewer facilities without prior written approval of the Engineer.

When existing underground utilities not scheduled for removal or abandonment are encountered in the excavation, they shall be adequately supported and protected from damage. Any damage to utilities shall be repaired promptly in accordance with Subsection 107.13 at no additional cost to the Agency.

The Contractor shall be responsible for the unloading, storing, hauling, and distribution of all materials. All materials that are damaged, destroyed, or lost during and after unloading shall be replaced at the Contractor's expense. All pipe, pipe fittings, and accessories shall be handled so as to avoid shock. Pipes having factory applied joint material shall be stacked and blocked to prevent damage to the joint material. Material not needed for immediate use shall be stored in a safe manner at places provided by the Contractor and approved by the Engineer.

The Contractor's attention is called to the fact that sewer pipe and fittings are comparatively brittle. Care shall be taken in handling and laying to avoid damaging the pipe and fittings.

The location of all pipes shall be approved by the Engineer.

628.04 EXCAVATION. Where pipe is to be laid below the existing ground line, a trench shall be excavated to the required depth and to a width sufficient to allow for joining of the pipe and compaction of the bedding and backfill material under and around the pipe. Where feasible, trench walls shall be vertical.

The completed trench bottom shall be firm for its full length and width.

If shown on the Plans or directed by the Engineer, poor foundation material encountered below the normal grade of the pipe bed shall be removed and replaced with granular backfill for structures.

Where ledge rock, rocky or gravelly soil, hardpan, or other unyielding foundation materials are encountered in the trench excavation at the normal grade of the pipe bed, the trench shall be excavated to a width equal to the inside diameter of the pipe plus 600 mm (24 inches), and to a depth of 300 mm (12 inches) below the pipe grade. This area shall be backfilled with granular backfill for structures.

The length of trench to be opened at one time shall be kept within reasonable limits unless otherwise permitted or directed by the Engineer.

No tunneling will be permitted except by written approval of the Engineer. Permission to tunnel will be granted only in short sections where, in the opinion of the Engineer, the pipe can be safely and properly installed and the backfill properly compacted.

During construction, the Contractor shall conduct operations so as to prevent at all times the accumulation of water, ice, and snow in excavations or in the vicinity of excavated areas, and to prevent water from interfering with the progress or quality of the work. Under no conditions shall water be allowed to rise in open trenches after pipe has been placed.

Accumulated water, ice, and snow shall be promptly removed and disposed of by pumping or other approved means. Disposal shall be carried out in a manner which will not create a hazard to public health; cause injury to public or private property, work completed or in progress, or public streets; or cause any interference in the use of streets and roads by the public. Pipes under construction shall not be used for drainage of excavations.

Where pipes are to be placed in an embankment, excavation for the pipe shall be made after the embankment has been completed to the specified height above the designed grade for those pipes shown on the Plans.

Sheeting and bracing required for trenches shall be removed to the elevation of the pipe but no sheeting will be allowed to be pulled, removed, or disturbed below the pipe.

628.05 BEDDING FOR PIPE. Unless otherwise specified, the bed shall be shaped to fit the pipe for a depth of not less than 10 percent of its total height and shall have recesses to receive the bell.

Concrete cradle bedding shall be installed on approved subgrades when shown on the Plans or directed by the Engineer.

628.06 LAYING PIPE. No pipe shall be placed until the trench and the prepared foundation have been approved by the Engineer.

The laying shall begin at the outlet end and the lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or grooved ends of rigid pipes and the circumferential laps of flexible pipe shall be placed facing upstream. The longitudinal laps or seams of flexible pipe shall be at the sides.

All pipe and fittings shall be carefully examined for defects and no pipe or fittings shall be laid which are known to be defective. If any defective piece is discovered after laying, it shall be removed and replaced at the Contractor's expense. All pipes and fittings shall be cleaned before they are laid and shall be kept clean until accepted in the completed work.

The pipe shall be laid to conform to the lines and grades shown on the Plans or as directed by the Engineer. Each pipe shall be so laid as to form a close joint with the next adjoining pipe and to bring the inverts continuously to the required grade.

Each length of pipe shall be shoved home against the pipe previously laid and held securely in position. Joints shall not be "pulled" or "cramped" without approval of the Engineer.

Before any joint is made, the pipe shall be checked to ensure that a closed joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.

The Contractor shall take all necessary precautions to prevent flotation of the pipe in the trench.

When pipe laying is not in progress, the open ends of the pipe shall be closed with temporary watertight plugs. If water is in the trench when work is resumed, the plug shall not be removed until all danger of water entering the pipe is eliminated.

The sewers and manholes shall be made as nearly watertight as practicable and leakage measurements shall be made wherever possible.

Concrete reaction blocking shall be provided as detailed at all bends deflecting 22.5 degrees or more. At the Contractor's option, retainer glands may be used at bends instead of concrete blocking. Retainer glands shall also be provided at all joints within three pipe lengths each side of the bends.

628.07 JOINING PIPE. Sewer pipe shall be joined in accordance with the detailed instructions of the manufacturer.

Sewer pipe with premolded gaskets shall be driven completely home and the gasket checked for proper positioning. Where poured joints are used, the pipe shall be properly positioned and the joint completely filled with oakum and joint sealer in accordance with the accepted practice for that type of sewer joint. The sealer shall be allowed to cool completely before the runner is removed.

Where recommended by the manufacturer, the Contractor shall furnish coupling pullers for joining the pipe. Gasket feeler gages shall be available for use by the pipe layer and the Engineer for checking the position of the rubber gaskets in the completed joint, if so directed by the Engineer.

Any fittings showing a crack, and any fitting or pipe that has received a severe blow which may have caused a fracture, even though no fracture can be seen, shall be marked as rejected and removed at once from the work.

Sewer pipe shall be cut by means of a handsaw, "metal-inserted" abrasive wheels, or by pipe cutters with blades, not rollers, doing the cutting. All cut ends shall be examined for possible cracks caused by cutting.

628.08 TESTING OF SYSTEM. The Contractor shall provide all necessary equipment and instrumentation required for proper completion of the flushing and testing. Quality of water, testing procedures, and method of disposal of water shall be approved by the Engineer. Prior to testing, the system shall be flushed with water to remove construction debris.

All tests shall be made in the presence of the Engineer. Preliminary tests made by the Contractor without being observed by the Engineer will not be accepted. The Engineer will be notified at least eight hours before any work is to be inspected or tested.

All defects in the system shall be corrected and retested until acceptable to the Engineer. Repairs shall be made to achieve the standard of quality specified for the entire system.



Sections of the system may be tested separately, but any defect that may develop in a section previously tested and accepted shall be promptly corrected and retested.

Test data shall be recorded on a form acceptable to the Engineer. A copy of all test data shall be submitted to the Engineer at the completion of testing.

All piping shall be tested in accordance with the following test methods, in addition to any test required by State and local codes or building authorities:

(a) Gravity Sewer Testing.

- (1) General. The Contractor shall have the option of using the air test or water test for testing sewers. Manholes must be tested by a water test.

The maximum sewer length to be tested at one time shall be that length between any two successive manholes.

Pipe trenches shall be backfilled prior to performing the test.

All service laterals, stubs, and fittings shall be plugged or capped and adequately braced to withstand thrust forces.

The depth of groundwater above the pipe section to be tested shall be determined.

Portions of sewer lines in conflict with water mains shall be tested as ordered by the Engineer.

- (2) Air Testing. Low pressure air testing shall be conducted in accordance with the following procedures:

- a. Each end of the test section shall be plugged, capped, and braced. Necessary safety precautions shall be taken to prevent blowouts and possible injury.
- b. An air hose shall be connected to a tapped plug used for an air inlet. The hose shall be connected to the air control equipment, which shall include valves and pressure gauges.

These shall allow air to enter the sewer test line, monitor air pressure in the sewer, shut off air, and provide pressure reduction and 0 to 70 kPa (0 to 10 psi) relief. The monitoring pressure gauge shall have a range of 0 to 100 kPa (0 to 14.5 psi) with divisions of 1 kPa (0.10 psi), and an accuracy of 0.25 kPa (0.05 psi).

- c. The air compressor and air supply shall be connected to the test line and the test section filled slowly until a constant pressure of 25 kPa (3.5 psi) is maintained.
- d. A pressure above 20 kPa (3 psi) shall be maintained for at least five minutes to allow the temperature to stabilize. A check for leaks shall be made and if any are found, the pressure shall be released and the fitting replaced or repaired.
- e. After the stabilization period, the pressure shall be adjusted to 25 kPa (3.5 psi) and the air supply disconnected.
- f. Measure and record the time interval for the test line pressure to drop from 20 to 15 kPa (3 to 2.5 psi).
- g. If the groundwater table is above the pipe, increase above test pressures 4 kPa (0.6 psi) for each 300 mm (1 foot) the groundwater is above the invert of the pipe.
- h. The minimum time required for a pressure drop of 4 kPa (0.6 psi) using the air test shall be 15 seconds per 5 mm (75 seconds per inch) of diameter of the main sewer being tested.
- i. Any line tested that does not hold the minimum specified pressure for the time specified will be considered to have failed the pressure test and shall be repaired and retested. The Contractor may have the option of conducting a water test in accordance with these specifications if the air test has failed.

- (3) Exfiltration Test. An exfiltration test measures the amount of water leaking out of the sewer while maintaining a low pressure on the entire sewer being tested.

The exfiltration test procedure shall be as follows:

- a. A tapped plumbers plug should be inserted in the downstream manhole inlet sewer. The water supply connection is made at this point, but never directly from a public water supply system or hydrant.
- b. A stand pipe shall be tightly connected at the upstream end of the sewer. The height of the stand pipe shall be as directed but in all cases shall be 600 mm (24 inches) higher than any point in the sewer or 600 mm (24 inches) higher than the highest known groundwater table, whichever is higher, and shall be not higher than 7.5 m (25 feet) above the lowest point in the section being tested.
- c. Water shall be added at the downstream connection in order to avoid air pockets. The line shall be filled to the elevation designated in the stand pipe. A manhole may be used as a stand pipe. The Engineer may require the manholes to be tested independently in accordance with procedures specified in this Subsection.
- d. The line shall be allowed to stand with water for at least four hours in order that air may escape and absorption may take place.
- e. The lines shall be filled to the reference mark, and the drop or loss that occurs during a 15-minute period shall be measured. The minimum head shall be maintained throughout the test, adding any volume of water required and including that volume in the leakage measurements. The test shall be repeated as directed.

- f. The reading shall be recorded, and the leakage shall be converted to liters per millimeter of pipe diameter per kilometer of sewer per 24-hour day (gallons per inch of pipe diameter per mile of sewer per 24-hour day).
- g. Allowable leakage shall be 10 L/mm/km/day (100 gallons/inch/mile/ day).

- (4) Infiltration Test. If the groundwater table is at least 600 mm (24 inches) above the entire sewer section to be tested, the Engineer may allow the Contractor to perform an infiltration test.

The infiltration test procedure shall be as follows:

- a. The upstream end of the section shall be plugged or taped.
  - b. The measuring device shall be installed in the downstream end. If a V-notch weir is used, it must be installed so as to maintain a watertight seal between the weir and the interior surface of the pipe. The weir shall meet the approval of the Engineer.
  - c. Sufficient time shall be allowed for infiltrating water to develop a steady, uniform flow.
  - d. The reading shall be recorded, and the leakage shall be converted to liters per millimeter of pipe diameter per kilometer of sewer per 24-hour day (gallons per inch of pipe diameter per mile of sewer per 24-hour day).
  - e. Allowable leakage shall be 10 L/mm/km/day (100 gallons/inch/mile/ day).
- (b) Manhole Leakage Test. Each manhole shall be tested by means of a water test. If the water test was used on the sewer line and the manhole was tested with the sewer, and the line passed, the Engineer may not require an independent manhole test. In any case, there shall be no visible leakage into the base or walls of a completed manhole.

All pipes and other openings into the manhole shall be suitably plugged and the plugs braced to prevent blowout.

The manhole shall then be filled with water to the top of the cone section. With the approval of the Engineer, a period of time may be permitted to allow for absorption. At the end of this period, the manhole shall be refilled to the top of the cone, if necessary, and the measuring time of at least four hours begun. At the end of the test period, the manhole shall be refilled to the top of the cone, measuring the volume of water added. This amount shall be converted to liters per vertical meter of depth per 24-hour day (gallons per vertical foot of depth per 24-hour day). The leakage for each manhole shall not exceed 10 L/m/day (1 gallon/foot/day). If leakage exceeds the allowable rate, repairs shall be made as approved by the Engineer and the manhole retested.

If the Contractor elects to backfill prior to testing, the testing shall be at the Contractor's own risk, and it shall be incumbent upon the Contractor to determine the reason for any failure of the test. No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorption, etc. It will be assumed that all loss of water during the test is a result of leaks through the joints or through the concrete. Furthermore, the Contractor shall take any steps necessary to assure the Engineer that the groundwater table is below the bottom of the manhole throughout the test.

If the groundwater table is above the highest joint in the manhole, and if there is no leakage into the manhole as determined by the Engineer, this test can be used to evaluate the watertightness of the manhole. However, if the Engineer is not satisfied, the Contractor shall lower the groundwater table and carry out the test as described above.

(c) Pressure Pipe Testing.

- (1) General. All force mains shall pass the hydrostatic pressure test and leakage test described below.

Prior to testing, all anchors and braces shall be installed. All concrete thrust blocks and restraints shall be in place and cured for at least seven days. All buried pipes shall be backfilled. Suitable test plugs shall be installed and air release valves shall be installed at the high points.

(2) Hydrostatic Test. The following procedure shall be used:

- a. All air release valves shall be opened and the pipe shall be filled with water at a rate not to exceed the venting capacity of the air release valves.
- b. The water pressure shall be raised to 150 percent of the designed operating pressure and adjusted to the lowest point of the section being tested.
- c. The pressure shall be maintained for ten minutes and for an additional period as is required for the Engineer to complete inspection; however, the manufacturer's suggested time duration at the test pressure should not be exceeded.
- d. Any defects noted shall be repaired and the test repeated.
- e. Upon successful completion of the hydrostatic test, the leakage test will be performed.

(3) Leakage Test. The following procedure shall be used:

- a. The water pressure in the section shall be brought up to the designed operating pressure and adjusted to the lowest point of the section. This pressure shall be maintained within a maximum variation of 5 percent for the test duration of two hours minimum.
- b. The amount of leakage shall be measured by means of a water meter installed on the supply side of the pump, and the leakage converted to liters per hour (gallons per hour).

- c. The allowable leakage is as follows:
1. No leakage will be allowed for exposed piping; buried piping with flanged, threaded, or welded joints; or buried pipe in conflict with potable water lines.
  2. Leakage for buried pipe with slip-type or mechanical joints shall not exceed the rate determined by the following formula:

$$L = 0.00102 \times N \times D \times \sqrt{P}$$

where:

- $L$  = Maximum allowable leakage in liters per hour (gallons per hour).
- $N$  = Number of gasketed joints in the line under test.
- $D$  = Nominal internal diameter of the pipe in millimeters (inches).
- $P$  = The average test pressure on the line being tested in kilopascals gauge (pounds per square inch gauge).

#### 628.09 BACKFILLING.

- (a) General. Immediately prior to backfilling, all debris, forms, and similar materials shall be removed from the excavation. Backfilling shall not be done in freezing weather, with frozen materials, or when materials already placed are frozen.
- (b) Pipe Bedding Area. Prior to laying pipe, bedding material shall be placed to the limits of the excavation and to a depth beneath the pipe as specified. This material shall be sand, gravel, or crushed stone and shall not contain large lumps and stones over 25 mm (1 inch) in diameter. The Engineer may direct the use of material meeting the requirements for Granular Backfill for Structures. As the pipe is laid, bedding material shall be

extended to the spring line of the pipe and leveled along the width of the trench.

The pipe installation is to be inspected and approved by the Engineer before being covered.

- (c) Pipe Envelope Area. The pipe envelope consists of selected suitable material placed from the spring line of the pipe to a depth of 300 mm (12 inches) over the top of the pipe. The material shall be carefully placed and spread over the width of the trench and compacted using an approved tamper.

The Contractor shall take all necessary precautions during placement and compaction of the bedding and pipe envelope materials to prevent either damage to or displacement of the pipe.

- (d) Above Envelope Area. Unless otherwise shown on the Plans, material used for backfilling trenches above the envelope area shall be suitable material that was removed during excavation or obtained from borrow, and when compacted shall make a dense stable fill. The material shall not contain vegetation, porous matter, masses of roots, individual roots more than 500 mm (18 inches) long or 15 mm (1/2 inch) thick, or stones greater than 20 kg (50 pounds) or larger than 150 mm (6 inches) in the widest dimension.

If additional material is required, it shall be furnished from approved sources.

Backfill material shall be evenly spread and compacted in lifts not more than 300 mm (12 inches) thick or as approved by the Engineer. Previously placed or new materials shall be moistened by sprinkling, if required, to ensure proper bond and compaction.

Whatever method of compacting backfill is used, care shall be taken that stones and lumps shall not become nested and that all voids between stones shall be completely filled with fine material.

No compacting shall be done when the material is too wet to be compacted properly. If the material is too wet, the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compaction, or until other precautions are taken as necessary to obtain proper compaction.



Backfill material shall be compacted to the following percentages of maximum dry density and the in place moisture content shall be not more than 2 percent above the optimum moisture content, as determined by AASHTO T 180, Method C:

Around all structures, under roadway paving, shoulders, and embankments	95 percent
All other areas	90 percent

628.10 HOUSE CONNECTIONS. In general, the Engineer will require new house connections for each existing residential and commercial structure. The actual location of each new house connection shall be determined in the field by the Engineer.

Stub-outs for future connections shall be a minimum of 600 mm (24 inches) long and shall have ends closed with suitable approved plugs specially made for the purpose. All joints and spaces shall be thoroughly filled with mortar. Plugs shall be installed so as to be readily removable without damage to the pipe when future connections are made.

628.11 MANHOLES. Manholes shall conform to the requirements of Section 604.

628.12 TRANSFER OF EXISTING SYSTEM TO NEW SYSTEM. The Contractor shall maintain existing sewage flows during construction of the new sanitary sewer systems and during connection of the new system to the existing system. The Contractor shall submit and receive approval of a detailed construction schedule and procedure for transferring service from the existing system to the new system prior to beginning work on the system.

Prior to making the connection, the Contractor shall notify the owner and the Engineer three days in advance in writing of the date when the Contractor will be ready to complete the work.

After this connection is made, the Contractor shall divert the sewage flow to the new sewer, transfer the house services from the existing system to the new sewer, and abandon the existing system as shown on the Plans or directed by the Engineer.

Where existing manholes and other underground structures are to be abandoned, the Contractor shall remove the frame and cover, remove the top a minimum of 600 mm (24 inches) below subgrade or final slope grade, whichever is greater, plug the pipes with Class C concrete, and

backfill with suitable material. Frames and covers shall remain the property of the owner of the system. Material placed in the manholes and other structures shall be compacted to the requirements of the surrounding subgrade material.

**628.13 WATER MAIN - SEWER SEPARATION.** Where water mains and sewer lines are in the same area as a result of work under the Contract, parallel installations or crossings of such installations shall conform to the requirements as specified in the “Ten States Standards” for Water and Sewer Works and as specified below.

In addition, all reconstruction or relocation of existing water or sewer facilities shall be as approved by the utility owner. Such approval shall be obtained for scheduling, materials, and configuration of the reconstruction or relocation.

- (a) **Parallel Installation.** Under normal conditions, water mains shall have a separation of at least 3 m (10 feet) horizontally from sewers, storm drains, or manholes whenever possible; the distance shall be measured edge-to-edge.

When local conditions prevent a horizontal separation of 3 m (10 feet), a water main and sewer may be laid closer to each other provided that:

- (1) Special written approval is obtained from the Department of Health.
  - (2) The bottom of the water main is at least 500 mm (18 inches) above the top of the sewer main.
  - (3) Where this vertical separation cannot be obtained, the sewer shall be constructed of materials and with joints that are equivalent to water main standards of construction and shall be pressure tested to ensure that it is watertight prior to backfilling.
- (b) **Crossings.** Under normal conditions, water mains crossing house sewers, storm sewers, or sanitary sewers shall be laid above the sewer line with a separation of at least 500 mm (18 inches) between the bottom of the water main and the top of the sewer pipe.

When local conditions prevent such a vertical separation, the following construction shall be used:

- (1) Sewers passing over or under water mains shall be constructed of materials and joints that are equivalent to water main standards of construction, such as cast or ductile iron pipe with push-on or mechanical joints, or approved equal.
- (2) In addition, water mains passing under sewers shall be protected by providing the following:
  - a. A vertical separation of at least 500 mm (18 inches) between the bottom of the sewer and the top of the water main;
  - b. Adequate structural support for the sewers to prevent excessive deflection of joints and settling on and breaking of the water mains;
  - c. The length of water pipe shall be centered at the point of crossing so that the joints will be equivalent and as far as possible from the sewer.

The Contractor shall assume the responsibility of identifying all crossings that may exist. All crossings, whether identified by the Engineer or the Contractor, shall be constructed in accordance with these specifications and as approved by the Engineer.

**628.14 METHOD OF MEASUREMENT.** The quantity of Sewer Pipe of the type and size specified to be measured for payment will be the number of meters (linear feet) of sewer line installed in the complete and accepted work, as measured along the flow line of the pipe.

The quantity of Relaying Sewer Pipe to be measured for payment will be the number of meters (linear feet) of sewer pipe relayed in the complete and accepted work, as measured along the flow line of the pipe.

The quantity of Transfer to New System, Sanitary Sewer to be measured for payment will be on a unit basis for each transfer performed in the complete and accepted work.

**628.15 BASIS OF PAYMENT.** The accepted quantity of Sewer Pipe of the type and size specified will be paid for at the Contract unit price per meter (linear foot). Payment shall be full compensation for furnishing, transporting, handling, installing, and testing the materials specified; for making all necessary connections; and for furnishing all labor, equipment, tools, and incidentals necessary to complete the work.

The accepted quantity of Relaying Sewer Pipe will be paid for at the Contract unit price per meter (linear foot). Payment shall be full compensation for furnishing all labor, equipment, tools, and incidentals necessary for relaying sewer pipe at the locations specified in the Contract and as directed by the Engineer.

Excavation, including backfill, and disposal of excavated material not suitable for backfill, will be paid for at the Contract unit price per cubic meter (cubic yard) for Trench Excavation of Earth or Trench Excavation of Rock, as specified in Section 204. When material is required to replace poor foundation material below the normal grade of the pipe it will be paid for as Granular Backfill for Structures. Concrete shown on the Plans or directed by the Engineer will be paid for as Concrete, Class B, unless otherwise specified. Sheeting left in place will be paid for as incidental to the appropriate excavation Contract item.

The accepted quantity of Transfer to New System, Sanitary Sewer will be paid for at the Contract lump sum price bid. Payment will be full compensation for furnishing all labor, materials, equipment, tools, and incidentals suitable for effecting the transfer of systems as specified. Items for payment under this lump sum amount include, but are not limited to, maintenance of existing sewage flows, excavation and location of the new connection point, diversion of sewage flow from the connection point, associated pumping/dewatering of connection area, making the physical connection including all fittings and appurtenances, transfer of sewage flow to the new system, abandonment of existing system, and furnishing all labor, equipment, tools, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
628.20 ABS Sewer Pipe Solid Wall	Meter (Linear Foot)
628.21 ABS Sewer Pipe Composite	Meter (Linear Foot)
628.22 Reinforced Concrete Sewer Pipe	Meter (Linear Foot)
628.25 Cast Iron Soil Pipe, Extra Heavy	Meter (Linear Foot)
628.26 Cast Iron Pipe, Cement-Lined	Meter (Linear Foot)
628.27 Vitrified Clay Pipe, Extra Strength	Meter (Linear Foot)
628.28 Ductile Iron Pipe, Cement-Lined	Meter (Linear Foot)
628.30 Relaying Sewer Pipe	Meter (Linear Foot)
628.35 PVC Sewer Pipe	Meter (Linear Foot)
628.42 Transfer to New System, Sanitary Sewer	Lump Sum

SECTION 629 - WATER SYSTEMS

629.01 DESCRIPTION. This work shall consist of the construction or reconstruction of water lines and appurtenances.

629.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Crushed Stone Bedding .....	704.02
Granular Backfill for Structures .....	704.08
Plastic Water Pipe, Flexible .....	740.01
Plastic Water Pipe, Rigid (PVC) .....	740.02
Copper Water Tube, Seamless.....	740.04
Steel Water Pipe, Galvanized .....	740.05
Ductile Iron Pipe, Cement Lined.....	740.07
Pipe Insulation .....	740.08
Extension Service Box, Cast Iron.....	740.09
Curb Stop, Brass.....	740.10
Gate Valves .....	740.11
Tapping Sleeve .....	740.12
Hydrant.....	740.13
Corporation Stops.....	740.14
Chlorine Solution .....	742.01

Concrete shall be Class B, unless otherwise specified, and shall conform to the requirements of Section 541.

Sleeves shall conform to the requirements of Section 625.

Crushed stone used for pipe bedding shall meet the gradation requirements of Table 704.02B.

Ductile iron fittings shall be so-called compact or short-bodied fittings.

The Engineer will approve corporation stops for use on a project after consultation with the utility owner but prior to the stops being ordered by the Contractor.

629.03 GENERAL. Care shall be exercised by the Contractor to avoid disrupting the operation of existing water facilities without prior written approval of the Engineer.

When existing underground utilities, which are not scheduled for removal or abandonment, are encountered in the excavation, they shall be adequately supported and protected from damage. Any damage to utilities shall be repaired promptly in accordance with Subsection 107.13 at no additional cost to the Agency.

Any work associated with existing water lines or appurtenances shown on the Plans to be removed or abandoned in place shall be performed as an incidental item of construction.

The Contractor shall be responsible for the unloading, storing, hauling, and distribution of all materials. All such material that is damaged, destroyed, or lost during and after unloading shall be replaced at the Contractor's expense. All pipe, pipe fittings, and accessories shall be handled so as to avoid shock. Pipe having factory-applied joint material shall be stacked and blocked to prevent damage to the joint material. Material not needed for immediate use shall be stored in a safe manner at locations selected by the Contractor and approved by the Engineer.

The Engineer will approve the location of all pipes.

629.04 EXCAVATION. Where the pipe is to be laid below the existing ground line, a trench shall be excavated to the required depth and to a width sufficient to allow for joining of the pipe. The bedding and backfill material under and around the pipe shall be compacted according to the applicable material specification. Where feasible, trench walls shall be vertical.

The completed trench bottom shall be firm for its full length and width.

If shown on the Plans or directed by the Engineer, poor foundation material encountered below the normal grade of the pipe bed shall be removed and replaced with Granular Backfill for Structures.

Ledge rock, rocky or gravelly soil, hardpan, or other unyielding foundation material encountered at the normal grade of the pipe bed shall be removed and replaced with Granular Backfill for Structures. The width of the pipe bed shall be equal to the inside diameter of the pipe plus 600 mm (24 inches). The minimum depth shall be 300 mm (12 inches) below the pipe grade, unless otherwise shown on the Plans or directed by the Engineer.

No tunneling will be permitted except by written approval of the Engineer. Permission to tunnel will be granted only in short sections where, in the opinion of the Engineer, the pipe can be safely and properly installed and the backfill properly compacted.

The Contractor, at all times, shall conduct operations so as to prevent the accumulation of water, ice, and snow in excavations or in the vicinity of excavated areas, and to prevent water from interfering with the progress or quality of the work. Under no conditions shall water be allowed to rise in open trenches after pipe has been placed.

Accumulated water, ice, and snow shall be promptly removed and disposed of by pumping or other approved means. Disposal shall be carried out in a manner which will not create a hazard to public health; cause injury to public or private property, work completed or in progress, or public streets; or cause any interference in the use of streets and roads by the public. Pipes under construction shall not be used for drainage of excavations.

Where pipes are to be placed in embankment fill, the excavation shall be made after the embankment has been completed to a height of 1 m (3 feet) plus one pipe diameter above the designed grade of the pipe.

Sheeting and bracing required for trenches shall be removed to the elevation of the pipe, but no sheeting will be allowed to be pulled, removed, or disturbed below the pipe.

629.05 BEDDING FOR PIPE. Ductile iron pipe shall be laid on suitable soil and backfilled and compacted to the centerline of the pipe with select material. Select material shall be sand, gravel, or suitable material excavated from the trench free from rocks, foreign materials, and frozen earth.

Concrete cradle bedding shall be installed on approved subgrades when shown on the Plans or directed by the Engineer.

629.06 LAYING PIPE. Installation of all water lines shall be in accordance with ANSI/AWWA C 600, "Ten States Standards," and as specified.

Pipe laying shall begin at the outlet end. The lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or grooved ends of rigid pipes and the circumferential laps of flexible pipe shall be placed facing upstream. The longitudinal laps or seams of flexible pipe shall be at the sides.

All pipe and fittings shall be carefully examined for defects, and no pipe or fittings that are known to be defective shall be laid. If any defective piece is discovered after laying, it shall be removed and replaced at the Contractor's expense. All pipes and fittings shall be cleaned before they are laid and shall be kept clean until accepted in the completed work.

The pipe shall be laid to conform to the lines and grades indicated on the Plans or as directed by the Engineer. Each pipe shall be so laid as to form a closed joint with the next adjoining pipe and to bring the inverts continuously to the required grade.

Each length of pipe shall be driven home against the pipe previously laid and held securely in position. Joints shall not be "pulled" or "cramped."

Before any joint is made, the pipe shall be checked to ensure that a closed joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.

The Contractor shall take all necessary precautions to prevent flotation of the pipe in the trench.

When pipe laying is not in progress, the open ends of the pipe shall be closed with temporary watertight plugs. If water is in the trench when work is resumed, the plug shall not be removed until all danger of water entering the pipe is eliminated.

The use of concrete reaction blocking shall be limited to caps, tees, hydrants, and bends of 22.5 degrees and greater. Blocking shall be placed only on the sides of each fitting in the direction of thrust and not underneath for use as a foundation or support. All other bends less than 22.5 degrees shall be restrained by use of retainer glands at each bend and at all joints within three pipe lengths on each side of the bend.

Separation of water mains and sewers shall conform to the requirements of Subsection 628.13.

629.07 JOINING PIPE. Water pipe shall be joined in accordance with the detailed instructions of the manufacturer.

Where recommended by the manufacturer, the Contractor shall furnish coupling pullers for joining the pipe. Gasket feeler gauges shall be available for use by the pipe layer and the Engineer for checking the position of the rubber gaskets in the completed joint, if so directed by the Engineer.

The electrical conductivity of the pipeline and attached services shall be maintained at all joints, couplings, valves, and fittings through the use of three brass wedges at each joint, or with conduction straps. No couplings shall be made at any point on the pipeline or attached services without incorporating provisions to maintain electrical conductivity.



Any fittings showing a crack, and any fitting or pipe which has received a severe blow that may have caused a fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.

Water pipe shall be cut by means of a handsaw, "metal-inserted" abrasive wheels, or by pipe cutters with blades, not rollers, doing the cutting. All cut ends shall be examined for possible cracks caused by cutting.

629.08 SETTING OF VALVES AND FITTINGS. Valves, fittings, plugs, and caps shall be set and joined to pipe in the manner specified above for laying and joining pipe.

A valve box or masonry pit shall be provided for every valve.

A valve box shall be provided for every valve that has no gearing or operating mechanism or in which the gearing or operating mechanism is fully protected with a gear case. The valve box shall not transmit shock or stress to the valve and shall be centered and plumb over the wrench nut of the valve, with the box cover flush with the surface of the finished pavement or other such level as directed by the Engineer.

A masonry valve pit shall be provided for every valve that has exposed gearing or operating mechanisms. The valve nut shall be readily accessible for operation through the opening in the manhole, which shall be set flush with the surface of the finished pavement or such other level as specified by the Engineer. Pits shall be constructed so as to permit minor valve repairs and afford protection to the valve and pipe from impact where they pass through the pit walls.

Mains shall be drained through drainage branches or blowoffs to dry wells from which the water can be pumped. Drainage branches, blowoffs, air vents, and appurtenances shall be provided with valves and shall be located and installed as shown on the Plans.

Drainage branches or blowoffs shall not be connected to any sewer, submerged in any stream, or be installed in any other manner that will permit back siphonage into the distribution system.

All dead ends of new mains shall be closed with plugs or caps; such dead ends shall be equipped with suitable blowoff facilities.

Corporation stops shall, in all instances, be tapped into the main on the side in a horizontal position or in such a position as will provide a minimum of 1.5 m (5 feet) of cover over the connecting service line. The main shall be tapped by skilled workers and the stop installed in

accordance with the manufacturer's recommendations at the locations shown on the Plans or as directed the Engineer. The stops may be installed at a later date, at which time the main may be tapped under pressure. All defective taps shall be repaired or replaced at the Contractor's expense.

Prior to installation, the Contractor shall thoroughly clean all exposed portions of any valves, removing all labels and all traces of foreign substance using only a cleaning solution approved by the manufacturer of the valve and being careful to avoid all damage to surfaces and coatings.

629.09 SETTING OF HYDRANTS. Hydrants shall be located as shown on the Plans or as directed so as to provide complete accessibility and minimize the possibility of damage from vehicles or injury to pedestrians.

When placed behind the curb, the hydrant barrel shall be set so that no portion of the pumper or hose nozzle cap is less than 150 mm (6 inches) or more than 300 mm (12 inches) from the gutter face of the curb.

When set in the lawn space between the curb and the sidewalk, or between the sidewalk and the property line, no portion of the hydrant or nozzle cap shall be within 150 mm (6 inches) of the sidewalk.

All hydrants shall stand plumb and shall have their nozzles parallel with, or at right angles to, the curb, with the pumper nozzle facing the curb, except that hydrants having two hose nozzles 90 degrees apart shall be set with each nozzle facing the curb at an angle of 45 degrees. Hydrants shall be set to the established grade, with nozzles at least 300 mm (12 inches) above the ground, as shown or as directed by the Engineer.

Each hydrant shall be connected to the main with a 150 mm (6 inches) or larger branch controlled by an independent gate valve, unless otherwise specified.

If, as determined by the Engineer, the waste opening of any hydrant will be below the normal sub-surface water elevation, the waste opening shall be securely plugged and no drainage pit will be required.

Wherever a dry-barrel hydrant is set in soil that is pervious, drainage shall be provided at the base of the hydrant by placing coarse gravel or crushed stone mixed with coarse sand, from the bottom of the trench to at least 150 mm (6 inches) above the waste opening in the hydrant, and to a distance of 300 mm (12 inches) around the elbow. No drainage system shall be connected to a sewer.

Wherever a dry-barrel hydrant is set in clay or other impervious soil, a drainage pit 600 by 600 mm by 1 m deep (24 × 24 inches by 3 feet deep) shall be excavated below each hydrant and backfilled with coarse gravel or crushed stone mixed with coarse sand, and compacted under and around the elbow of the hydrant to a level of 150 mm (6 inches) above the waste opening. No drainage pit shall be connected to a sewer.

629.10 ANCHORAGE. The bowl of each hydrant shall be well braced against unexcavated earth at the end of the trench with stone slabs or concrete backing, or the hydrant shall be tied to the pipe with suitable metal tie rods or clamps as shown on the Plans or directed by the Engineer.

All plugs, caps, tees, and bends, unless otherwise specified, shall be provided with a reaction backing, or movement shall be prevented by attaching suitable metal rods or clamps as shown or specified.

Concrete reaction backing shall be placed between solid ground and the fitting to be anchored; the area of bearing on the pipe and on the ground in each instance shall be that shown on the Plans or directed by the Engineer. The backing shall, unless otherwise shown or directed, be placed in such a manner as to contain the resultant thrust forces in such a way that the pipe and fitting joints will be accessible for repair.

A metal harness of tie rods or clamps of adequate strength to prevent movement may be used instead of concrete backing, as directed by the Engineer. Steel rods or clamps shall be galvanized or otherwise rustproofed, or shall be painted as shown or directed by the Engineer.

629.11 PRESSURE AND LEAKAGE TESTS. Except as otherwise directed, all pipelines shall be tested. Pipelines laid in excavation or bedded in concrete shall be tested prior to field painting. Pipe to be insulated shall be tested prior to installing insulation.

The Contractor shall furnish all gauges, testing plugs, caps, and all other necessary equipment and labor to perform leakage and pressure tests in sections of an approved length. Each valved section or a maximum length of 300 m (1000 feet) of pipe shall be tested. The Contractor shall provide and bear the costs of any additional taps to the waterline necessary to perform the pressure and leakage test between valves.

All water required for testing shall be potable. All testing shall be conducted in the presence of the Engineer.

The Contractor shall make the necessary provisions to tap the pipe at the high point to release all air and shall plug the pipe after completing the test. Hydrants or blowoffs located at high points may be used for air release instead of taps if approved by the Engineer.

For the pressure test, the Contractor shall develop and maintain for two hours, 150 percent of the working pressure measured in kilopascals (pounds per square inch). Failure to hold the designated pressure for the two-hour period will constitute a failure of the section tested.

The leakage test shall be performed for a duration of two hours, only after the pressure test has been satisfactorily completed. During the leakage test, the Contractor shall measure the quantity of water required to maintain the maximum operating pressure of the main. Leakage shall not exceed allowable values for leakage presented in Table 6B of ANSI/AWWA C 600 latest revision. All testing shall be conducted in accordance with ANSI/AWWA C 600 latest revision.

Should any section of pipe fail either the pressure or leakage test, the Contractor shall do everything necessary to locate and repair or replace the defective pipe, fittings, or joints at no expense to the Agency.

If for any reason the Engineer should alter the foregoing procedure, the Contractor shall remain responsible for the tightness of the line within the above requirements.

629.12 DISINFECTING. Before being placed in service, the pipeline, valves, hydrants, etc., shall be chlorinated in accordance with ANSI/AWWA C 651, latest revision. The entire procedure of chlorinating the pipes shall be approved by the Engineer two weeks prior to the time the work is to be done. The methods to be employed shall be fully satisfactory to the Engineer before they are applied. The location of chlorination and sampling points is to be determined by the Engineer in the field.

The general procedure for chlorination shall be to first flush out the lines until all dirty or discolored water has disappeared, then to apply the chlorine in approved dosages through a tap at one end of the line while water is being drawn at the other extremity of the line until the entire line contains chlorine solution. The chlorine solution shall remain in the pipeline for a period of 24 hours.

Within 24 hours following the chlorination period, all treated water shall be flushed from the lines or portions thereof at their extremities and replaced with water from the distribution system.

Special disinfecting procedures shall be used as directed by the Engineer where the above outlined method is not practical, and when making connections to existing mains. The Contractor shall provide all necessary apparatus, materials, and labor for disinfecting the mains and shall make the required taps for this purpose. Disinfection of the mains shall be under the immediate direction of the Engineer during all phases of the work.

Prior to being placed in operation for domestic use, all new portions of the system shall be flushed, pressure tested, disinfected, and flushed again. Following this procedure, at least two water samples shall be collected from representative sample points and sent to the Vermont Department of Health Laboratory's Division of Environmental Health, or other testing laboratory approved by the Vermont Department of Health, for bacteriological testing. Passing sample results are required before the system may be placed on line for drinking. Sample bottles shall be obtained from the same laboratory.

629.13 HOUSE CONNECTIONS. Service lines disrupted within the construction limits shall be replaced as ordered by the Engineer. The actual location of each ordered house connection shall be determined in the field by the Engineer.

All service lines shall be seamless copper water tube from the corporation stop to the curb stop. The copper tubing shall be attached to the corporation stop and curb stop in a manner satisfactory to the Engineer. Sufficient slack shall be left adjacent to the corporation stop and curb stop to prevent damage to the copper tubing by movement of the pipeline. Care shall be exercised in the placing and laying of copper tubing to be sure that the pipe does not have kinks or lie directly on sharp stones or ledge which would cause damage to the pipe. The Contractor shall place at least 150 mm (6 inches) of selected material as approved by the Engineer, adjacent to, above, and below the tubing.

In making cuts in copper service pipe, a hacksaw, preferably used with a miter box, shall be used to cut the tubing. A cutter or tool designed for tube cutting may also be used. The tubing shall be reamed, and after placing the coupling nut on the pipe, the pipe shall be flanged, using a flanging tool designed particularly for this purpose.

All services shall be tested for leakage, and in all instances, the corporation stops shall be left in the open position upon completion of the installation.

The Contractor shall install the curb stop and the curb box at the end of the service line, usually at the approximate property line, or as shown on

the Plans and connect the stop to the water main with new copper tubing. The curb box shall be installed vertically and centered over the operating key, with the elevation of the top adjusted to conform to the finished grade. The Contractor shall adequately support the box during backfilling to maintain its vertical alignment. The Contractor shall also ensure that the curb box does not rest on the curb stop owner's services and furnish any adapters and/or special couplings needed for these connections. Any necessary piping from the curb stop to the existing service shall match the existing service line, unless otherwise directed by the Engineer. If no service exists, the Contractor shall furnish a curb stop for connection to a copper service line.

Iron pipe threads shall be supplied under the tube nuts of curb stops and corporation stops.

629.14 BACKFILLING.

- (a) General. Immediately prior to backfilling, all debris, forms, and similar materials shall be removed from the excavation. Backfilling shall not be done in freezing weather, with frozen materials, or when materials already placed are frozen.
- (b) Pipe Bedding Area. Prior to laying pipe, bedding material shall be placed to the limits of the excavation and to a depth beneath the pipe as specified. This material shall be sand, gravel, or crushed stone and shall not contain large lumps or stones over 25 mm (1 inch) in diameter. The Engineer may direct the use of material meeting the requirements for Granular Backfill for Structures. As the pipe is laid, bedding material shall be extended to the spring line of the pipe and leveled along the width of the trench.

The pipe installation is to be inspected and approved by the Engineer before being covered.

- (c) Pipe Envelope Area. The pipe envelope consists of selected suitable material placed from the spring line of the pipe to a depth of 300 mm (12 inches) over the top of the pipe. The material shall be carefully placed and spread over the width of the trench and compacted using an approved tamper.

The Contractor shall take necessary precautions during placement and compaction of the bedding and pipe envelope materials to prevent either damage to or displacement of the pipe.

- (d) Above Envelope Area. Unless otherwise shown on the Plans, material used for backfilling trenches above the envelope area shall be suitable material that was removed during excavation, or obtained from borrow, and when compacted shall make a dense stable fill. The material shall not contain vegetation, porous matter, or stones larger than 150 mm (6 inches) in the widest dimension.

If additional material is required, it shall be furnished from approved sources.

Backfill material shall be evenly spread and compacted in lifts not more than 300 mm (12 inches) thick or as approved by the Engineer. Previously placed or new materials shall be moistened by sprinkling, if required, to ensure proper bond and compaction.

Whatever method of compacting backfill is used, care shall be taken that stones and lumps shall not become nested and that all voids between stones shall be completely filled with fine material.

No compacting shall be done when the material is too wet to be compacted properly. If the material is too wet, the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compaction, or until other precautions are taken as necessary to obtain proper compaction.

Around all structures, under roadway paving, shoulders, and embankments	95 percent
All other areas	90 percent

Backfill material shall be compacted to the following percentages of maximum dry density and the in-place moisture content shall be not more than 2 percent above the optimum moisture content as determined in accordance with AASHTO T 180, Method C:

629.15 PIPE INSULATION. Pipe insulation shall be installed on water lines where insufficient cover, less than 1.5 m (5 feet), may exist as a result of vertical alignment conflicts with sanitary sewers, storm sewers, etc., as shown on the Plans or as directed by the Engineer. Insulation shall be at least 50 mm (2 inches) thick and shall conform to Subsection 740.08.

Pipe insulation shall be installed only by a factory approved insulation Contractor. Certification from the insulation manufacturer as to the ability of the Contractor to properly install the insulation in accordance with the manufacturer's specifications shall be required before insulation work begins. In addition, the insulation Contractor shall submit detailed Fabrication Drawings for approval in accordance with Section 105 detailing the methods and materials to be used for the insulation along pipe barrels, couplings, fittings, expansion joints, and sleeves. Variance from the approved methods and materials shall not be allowed without written permission of the Engineer. Insulation shall not be installed until the section of water line to be insulated has passed both pressure and leakage tests, unless otherwise directed by the Engineer.

629.16 WATER SYSTEM TRANSFER. The Contractor shall maintain existing water service during construction of the new water distribution systems and during the connection of the new system to the existing system. The Contractor shall submit to the system owner, and where required, to the Vermont Department of Health, a detailed construction schedule and procedure for transferring service from the existing system to the new system and shall receive approval(s) of the submittal prior to beginning work on the system.

Prior to making the transfer, the Contractor shall notify the owner and the Engineer three days in advance in writing that the system is ready to be transferred.

After the new connection is made, the Contractor shall divert the water to the new water main, disinfect the system, transfer affected individual service lines to the new water main, and abandon the existing system as shown on the Plans or directed by the Engineer.

629.17 METHOD OF MEASUREMENT. The quantity of water Pipe to be measured for payment will be the number of meters (linear feet) of the size, type, and class specified installed in the complete and accepted work, as measured along the flow line of the pipe.

The quantity of Extension Service Box and Curb Stop measured for payment will be the number of units of each installed in the complete and accepted work.

The quantity of Valves, Hydrants, Tapping Sleeves and Valve Pits to be measured for payment will be the number of units of each size and type specified installed in the complete and accepted work.



The quantity of Meter Pit measured for payment will be the number of units of each installed in the complete and accepted work including all interior piping and appurtenances.

The quantity of Corporation Stop to be measured for payment will be the number of units of each size and type specified, installed in the complete and accepted work.

The quantity of Expansion Assembly to be measured for payment will be the number of units of each size and type specified, installed in the complete and accepted work.

The quantity of Transfer to New System, Water System to be measured for payment will be on a lump sum basis for each transfer in the complete and accepted work.

The quantity of Pipe Insulation to be measured for payment will be the number of meters (linear feet) of the size and type installed in the complete and accepted work, as measured along the flow line of the pipe.

The quantity of Crushed Stone Bedding to be measured for payment will be the number of metric tons (tons) of material installed in the complete and accepted work, as determined by load tickets.

629.18 BASIS OF PAYMENT. The accepted quantity of Adjust Elevation of Valve Box, Relocate Hydrant, or Remove Hydrant will be paid for at the Contract unit price per each. Payment will be full compensation for the furnishing of all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantities of water Pipe will be paid for at their Contract unit price per meter (linear foot). Payment will be full compensation for furnishing, transporting, handling, installing, testing, and disinfecting the materials specified, including fittings and clamps; for making all necessary connections; for furnishing and placing the concrete or other materials for reaction backing or furnishing and installing tie rods, clamps, and restrained joints; and for furnishing all tools, labor, equipment, and incidentals necessary to complete the work.

The accepted quantities of Extension Service Box and Curb Stop units, Valves, Hydrants, Tapping Sleeves, Valve Pits, and Expansion Assembly will be paid for at their respective Contract unit price each. Payment will be full compensation for furnishing, transporting, handling, installing, and testing all materials, including fittings and clamps, for painting hydrants and constructing drainage pits; for furnishing and placing concrete or stone slabs for reaction backing or furnishing and installing tie rods and

clamps; and for all other costs incidental to the work including any cost involved for shipping, rental, or royalty charges, or for manufacturer's supervision in conjunction with the special work of installing valves.

The accepted quantity of Meter Pit will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing all materials, tools, labor, and equipment suitable for installing the meter pit. The unit price includes, but is not limited to, reinforced concrete, concrete fill, wall sleeves and caulking, insulation, control system, hatch and ladder, interior piping and fittings, pipe supports, gate valves, flow meter or other measuring device, and all other costs incidental to the work including any manufacturer's supervision in conjunction with the special work of installing valves and meters.

The accepted quantity of Corporation Stop will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, transporting, handling, installing, and connecting the stops and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Transfer to New System, Water System will be paid for at the Contract unit price per lump sum. Payment will be full compensation for performing all work items as directed by the Engineer to abandon existing mains, including but not limited to cutting and capping existing mains and laterals, closing existing valves and curb stops, removing existing valve boxes and curb boxes, and removal of any existing main which conflicts with the construction necessary to complete the transfer to the new system, including disinfection; for providing specialized labor, materials, tools, and equipment for effecting the transfer of systems as specified, and for furnishing all tools, labor, equipment, and incidentals necessary to complete the work.

The accepted quantity of Pipe Insulation will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for furnishing, transporting, handling, and installing the materials specified, including all work at couplings, joints, valves, expansion assemblies, an insulation jacket if shown on the Plans, for providing weatherproof seals at required points, and for furnishing all tools, labor, equipment, and incidentals necessary to complete the work.

The accepted quantity of Crushed Stone Bedding will be paid for at the Contract unit price per metric ton (ton). Payment will be full compensation for furnishing, transporting, handling, placing, and grading the material as specified and for the furnishing of all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation, including backfill and disposal of excavated material not suitable for backfill, will be paid for at the Contract unit price per cubic meter (cubic yard) as Trench Excavation of Earth or Trench Excavation of Rock under Section 204. When material is required to replace poor foundation material below the normal grade of the pipe, it will be paid for as Granular Backfill for Structures.

The utility owner will provide the services of a Professional Engineer to oversee construction of the waterline, to ensure that State requirements are met and to sign and stamp all paperwork required by the Water Supply Division of the Department of Environmental Conservation, Agency of Natural Resources. The Professional Engineer shall advise the Engineer, and the Engineer will provide direction to the Contractor.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
629.20 Adjust Elevation of Valve Box	Each
629.23 Seamless Copper Water Tube	Meter (Linear Foot)
629.24 Ductile Iron Pipe, Cement-Lined	Meter (Linear Foot)
629.25 Extension Service Box and Curb Stop	Each
629.26 Gate Valve	Each
629.27 Gate Valve with Valve Box	Each
629.28 Hydrant	Each
629.29 Relocate Hydrant	Each
629.30 Remove Hydrant	Each
629.31 Meter Pit	Each
629.32 Plastic Water Pipe, Flexible	Meter (Linear Foot)
629.33 Plastic Water Pipe, Rigid	Meter (Linear Foot)
629.34 Steel Water Pipe, Galvanized	Meter (Linear Foot)
629.35 Tapping Sleeve and Valve with Valve Box	Each
629.36 Valve Pit	Each
629.39 Corporation Stop	Each
629.40 Expansion Assembly	Each
629.42 Transfer to New System, Water System	Lump Sum
629.44 Pipe Insulation	Meter (Linear Foot)
629.54 Crushed Stone Bedding	Metric Ton (Ton)

SECTION 630 - UNIFORMED TRAFFIC OFFICERS AND  
FLAGGERS

630.01 DESCRIPTION. This work shall consist of furnishing qualified uniformed traffic officers (UTOs) and flaggers for the handling of traffic in, around, and through work zones. UTOs and flaggers collectively are also referred to as traffic control personnel. UTOs and flaggers shall be used to control and protect the traveling public and workers during construction operations as directed by the Engineer. All traffic control operations in, around, and through work zones shall conform to the MUTCD.

- (a) Definitions.
- (1) “Uniformed Traffic Officer” (UTO) means a law enforcement officer who has law enforcement authority at the location where the services are provided.
  - (2) “Flagger” means a person who has completed an approved, four-hour flagger training course given by a certified instructor.
- (b) Certification to Train Flaggers. Certification to train flaggers may be obtained by completing one of the following courses or another course approved by the Agency:
- (1) Associated General Contractors of Vermont, Work Zone Traffic Control Technician/Flagger Trainer Course; or
  - (2) American Traffic Safety Services Association, Worksite Traffic Supervisor Certification Course.
- (c) Duties of Uniformed Traffic Officer. UTOs shall perform the following functions as directed by the Engineer in and around work zones:
- (1) Promote voluntary compliance by motorists with speed and other rules of the road through an obvious presence. This may include the presence of marked law enforcement vehicles displaying law enforcement signal lamps, the presence of a UTO in or near the highway, and/or signage indicating their presence. This presence is generally stationary (fixed post), with a law enforcement vehicle serving as an advanced warning

signal and the UTO usually positioned outside the vehicle, to direct or control traffic as necessary.

- (2) Direct and control traffic. This may include the direction and control of traffic at intersections where signals are not functioning or are malfunctioning.
- (3) Serve as a flagger.
- (d) Use of Flaggers. A flagger shall be used as directed by the Engineer to stop and release traffic within a designated work zone or where the entrance or exit of construction equipment or other construction activity constitutes a hazard to the traveling public. Flaggers shall not be used to direct traffic.
- (e) Use of Railroad Flaggers. Railroad flaggers shall be used within the limits of the project whenever the Contractor's operations are such as to make it necessary as described in the Contract Special Provisions.  
  
Flaggers used in conjunction with railroad operations shall receive approval for use by the operating Railroad. The Contractor may contact the operating Railroad for a listing of approved flaggers.
- (f) Responsibility of Contractor to Protect Public and Workers. Direction or lack of direction by the Engineer to use traffic control personnel shall not release the Contractor from its responsibility to protect the traveling public and workers in and around work zones.

630.02 QUALIFICATIONS. The Contractor shall ensure that all flaggers utilized on the project have successfully completed a four-hour flagger training course given by a certified instructor within the last twenty-four months. The Contractor shall provide to the Engineer a list of the names of all trained flaggers currently on the project, including the date of training for each person listed.

630.03 CLOTHING AND EQUIPMENT.

- (a) For Uniformed Traffic Officers.
  - (1) Every UTO shall wear a uniform approved by his/her law enforcement department with an exposed badge that clearly identifies him/her as a law enforcement

officer; when operating outside the vehicle, the UTO shall wear a High-Visibility, Class 2, reflectorized vest as specified in the MUTCD.

- (2) When employed on the project during the period from sunset to sunrise, a UTO shall be equipped with hand-held, lighted signals that display a red light suitable for directing traffic and with High-Visibility, Class 2, reflectorized vests as specified in the MUTCD.
- (3) Every UTO shall be accompanied by a law enforcement vehicle with operating blue or blue and white, or a combination of these, law enforcement signal lamp(s) conforming in all respects to those permitted under 23 VSA § 1252.
- (4) The signal lamp(s) on a UTO's law enforcement vehicle shall be in operation when and where required by project-specific traffic control plans or as directed by the Engineer when, in the Engineer's opinion, the safety of the traveling public and/or project personnel will be enhanced by the operation of the lamp(s).

(b) For Flaggers.

- (1) Flaggers shall wear safety apparel (reflectorized vests) meeting the requirements of ISEA "American National Standard for High-Visibility Apparel" that is labeled as meeting the ANSI 107-1999 standard performance for Class 2 risk exposure. The apparel background material color shall be either fluorescent orange-red or fluorescent yellow-green as defined in the standard. The retroreflective material shall be either orange, yellow, white, silver, yellow-green, or a fluorescent version of these colors, and shall be visible at a minimum distance of 300 m (1000 ft). The retroreflective safety apparel shall be designed to clearly identify the wearer as a person.
- (2) Flaggers shall wear approved headgear consisting of protective headgear commonly referred to as a "hard hat," a brimmed cap of the type commonly referred to as a "baseball cap," or headgear otherwise required by law, regulation, or governmental policy. The headgear shall be provided in one of the colors designated for high visibility clothing in the MUTCD. Approved

headgear shall have no additions, adornments, or ornamentation, except that on the front of the headgear, above the brim, a small company or governmental logo or name which does not significantly reduce the visibility of the headgear may be displayed.

- (3) Flaggers shall be equipped with a STOP/SLOW paddle signaling device as detailed in part 6E.03 of the MUTCD.
- (4) Flaggers shall at all times be properly dressed, present a neat appearance, and have all reflectorized gear clean and visible to the traveling public. The Engineer's determination as to the suitability of the appearance of any flagger shall be final. An unsuitable appearance shall constitute ineffectiveness in controlling traffic. Any flagger deemed ineffective in controlling traffic by the Engineer shall be removed.

(c) For Railroad Flaggers.

- (1) Railroad flaggers shall be trained, clothed, and equipped in accordance with guidelines, rules, and/or regulations set forth by the operating Railroad.

(d) For All Traffic Control Personnel.

- (1) The Contractor shall equip all traffic control personnel on the project with two-way radios capable of maintaining all necessary communication within the work zone. The traffic control personnel shall use these radios to maintain communication and coordination whenever distance, noise, intervening operations, dust, and/or other existing conditions make it difficult or impossible to communicate on a line-of-sight basis and/or whenever the use of two-way radios is ordered by the Engineer. The Contractor shall at all times keep sufficient spare batteries, parts, and complete units on the project so that no individual performing traffic control is without a working two-way radio for a period longer than 10 minutes. Without exception, when two-way radios are required and a person performing traffic control is without a working two-way radio for more than 10 minutes, that person will either be supplied with a working two-way radio or be considered ineffective,

removed in the manner set forth in Subsection 630.04, and replaced with a person with a working two-way radio.

- (2) The reflectorized vests worn by traffic control personnel shall have the words "TRAFFIC CONTROL" in 50 mm (2 inch) high black letters on front and back reflective panels. Unless the words and the reflective panels on which they are mounted were placed on the vest by the original manufacturer, the layout, dimensions, proportions, and spacing of the letters in the words shall conform to the requirements for Series B Upper Case Letters in the Standard Sign Alphabets for Highway Signs.
- (3) When not actually engaged in traffic control, traffic control personnel shall not wear vests with the traffic control legend.

630.04 STANDARD PROCEDURES. The Contractor or subcontractor supplying uniformed traffic officers and/or flaggers on a project shall designate a person as the responsible person to coordinate the traffic control plan and procedures with the Superintendent and the Engineer.

Any UTO or flagger determined by the Engineer to be ineffective in controlling traffic shall be removed by the Contractor from all traffic control on the project. The Contractor shall immediately comply with the directive from the Engineer and shall suspend operations as necessary until a qualified replacement can be provided. Such a suspension of operations shall not be considered as a basis for a claim or an extension of time.

630.05 METHOD OF MEASUREMENT. The quantities of Uniformed Traffic Officers, Flaggers, and Flaggers, Railroad to be measured for payment will be the number of hours for each as authorized by the Engineer. No additional allowance will be made for premium time (overtime), and no allowance or payment will be allowed for the required four-hour training.

630.06 BASIS OF PAYMENT. The accepted quantities of Uniformed Traffic Officers and Flaggers will be paid for at the Contract unit price per hour. Payment will be full compensation for hiring, training, transporting, and supervising; for furnishing clothing, badges, vehicles, law enforcement signal lamps, signs, lighting devices, reflectorized equipment; for providing all taxes and insurance; and for furnishing all



radios and other equipment, materials, and incidentals necessary to perform this work.

The accepted quantity of Flaggers, Railroad will be paid for at the Contract unit price per hour. Payment will be full compensation for labor hours accrued on the project by a railroad flagger in the employ of the operating Railroad. The unit price shall include the costs of any equipment, clothing, and training required for the railroad flagger(s).

When the Contract item(s) Uniformed Traffic Officers, Flaggers, and/or Flaggers, Railroad is (are) not included in the Contract or when Uniformed Traffic Officers, Flaggers, and/or Flaggers, Railroad are employed by the Contractor without authorization by the Engineer, the cost(s) will not be paid for directly but will be considered incidental to all other Contract items.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
630.10 Uniformed Traffic Officers	Hour
630.15 Flaggers	Hour
630.20 Flaggers, Railroad	Hour

SECTION 631 - FIELD OFFICE

631.01 DESCRIPTION. This work shall consist of furnishing, erecting, equipping, and maintaining field offices and testing equipment. The work shall include cleaning, supplying utility services, office furniture, equipment, and supplies as required for the exclusive use of the Agency engineering staff at locations approved by the Engineer. Upon completion of the project, the field office(s), furniture, accessories, and equipment provided shall remain the property of the Contractor.

The testing equipment and supplies are furnished for the use of the Agency during the term of the Contract and shall be subject to use by Agency personnel to conduct tests of any materials at any location as directed by the Engineer.

The equipment furnished for testing of protective coatings shall be used by the Engineer as required by the Contract.

631.02 FIELD OFFICE, ENGINEERS.(a) Design.

- (1) General. The field office shall be available to the representatives of the State and the Federal Government throughout the duration of the work on the project, shall be independent of other buildings or office space used by the Contractor, and shall be removed when released by the Engineer. The field office, equipment, and supplies shall be maintained in good condition and adequate quantities at all times.

The field office shall be provided with adequate light, heat, potable water, ventilation, and electrical or gas connections as required. The method of heating shall be such that a minimum temperature of 20 °C (68 °F) can be maintained at all times.

The Contractor shall furnish all labor and materials for winterizing field offices.

Sanitary facilities consisting of a flush toilet, chemical or other approved type, including a waterless hand sanitizer, shall be furnished by the Contractor with proper sewage disposal as is necessary to comply with the requirements and regulations of the State and local Boards of Health and VOSHA. Sanitary facilities shall have adequate facilities for washing hands and shall have adequate lighting.

Entrances shall be provided with a 1.2 by 1.2 m (4 × 4 ft) minimum size deck with appropriate steps and railings meeting the requirements of the *VOSHA Safety and Health Standards for Construction*.

Each field office shall be equipped with an exterior security light of 400 W minimum.

- (2) Office Type. The office shall be a commercial type field office trailer of standard commercial quality, or a building, in good condition as determined by the Engineer with a minimum width of 3 m (10 feet) and a minimum floor space of 33 m<sup>2</sup> (360 ft<sup>2</sup>). The fully equipped field office shall be available for use from the

day that work on the project is commenced by the Contractor until 30 days after acceptance of the project, unless otherwise directed by the Engineer.

- (3) Foundation. The field office shall be constructed on a firm foundation that will remain vibration free and that will not be adversely affected by frost action or water runoff.
- (4) Outside Doors. The field office shall have a minimum of two outside doors equipped with dead bolt locks. All keys shall be in the possession of the Engineer or the Engineer's representatives.
- (5) Windows. The field office shall have a minimum of four side windows, one front window, and one rear window, all glassed and screened with provisions for opening and locking. All windows shall be equipped with adjustable louvered blinds.
- (6) Electrical System. The field office shall be equipped with a 110 V AC, 60 Hz, single-phase electrical system with service entrance equipment suitable for power company attachment and with at least twelve properly positioned interior electrical duplex outlets. The materials and installation methods of all electrical wiring, connections, switches, and grounds shall conform to the provisions of the National Electrical Safety Code and shall be in accordance with all State and local electrical ordinances.
- (7) Interior Lights. The field office shall be provided with a minimum of five 1200 mm (48 inch) long fluorescent lighting fixtures, or equivalent, on the ceiling.
- (8) Air Conditioner. The field office shall be equipped with an air conditioner of adequate capacity, unless otherwise specified in the Contract.
- (9) Fire Extinguishers. The field office shall be equipped with at least two fire extinguishers. Each shall be a Halon fire extinguisher, equal in fire fighting capacity to a 2.27 kg (5 pound) carbon dioxide fire extinguisher.

- (b) Office Equipment. Office equipment shall be standard commercial quality office equipment. The minimum required office equipment is as follows. Substitutes may be provided upon approval of the Engineer.

- 1 Standard office desk with drawers, locks, and keys, 1500 by 750 mm (60 × 30 inches) (minimum dimensions).
- 2 Adjustable, ergonomic office chairs that provide extra support and comfort to the lower back, have height adjustment to fit chair user, and have rolling casters.
- 1 Standard drafting table, 1 by 2 m (37 1/2 × 72 inches) (minimum dimensions).
- 2 Adjustable drafting stools.
- 1 Fire resistant, four-drawer, legal-size file cabinet, rated to withstand a one-hour fire, with lock and two keys.
- 1 Storage cabinet, 600 by 600 by 900 mm (2 × 2 × 3 feet) (minimum dimensions).
- 1 Metal, five-drawer, Plan file, 500 h by 710 d by 1010 w mm (20 h × 28 d × 40 w inches) (minimum dimensions).
- 1 Plan rack, 600 by 600 by 600 mm (2 × 2 × 2 feet) (minimum dimensions).
- 1 Locker or closet of sufficient size for storage of surveying equipment.
- 1 Electronic printing calculator, four-function, ten-column with memory.
- 1 Telephone, touch tone dial, compatible with the local telephone service available.

The Contractor shall arrange for the connection of the telephone system and pay the installation charge as part of Contract item 631.10. The Contractor shall also pay the monthly service bill. Upon presentation of the paid monthly service bill to the Engineer, the Engineer will pay the Contractor the cost of the service bill under Contract item 631.25. Connected to the telephone shall be a telephone answering device capable of receiving and storing messages.

- 1 Electric clock having a dial face of at least 200 mm (8 inches) in diameter.
- 1 Outdoor thermometer with an easy to read weatherproof thermometer having a minimum scale range of -40 to 40 °C (-40 to 100°F) in graduations of 1 or 2 degrees.

- 2 110 L (30 gallon) trash cans.
- 1 Potable water system consisting of a sink with faucet within the office, with a continuous supply of pressurized clean potable water for the duration of the project; or (when clean potable water is not available) a commercial bottled drinking water system installed in the office trailer complete with necessary disposable drinking cups (215 ml (8 oz.) size or larger), cup dispenser, and continuous water supply furnished for the duration of the project. The system shall be capable of supplying both hot and cold water. The system and the bottled water shall be furnished by a commercial water service on a regular basis agreeable to the Engineer.
- 1 First Aid Kit Conforming to ANSI Z308.1-1978
- 1 Dry copying machine with the capability of copying at least legal size paper full size and a rated capacity of at least 1,000 copies per month. It shall have an automated paper feed system. The Contractor shall supply all the paper and shall provide all other necessary supplies and maintenance to keep the copier working during the life of the Contract.
- 1 Color Inkjet Printer, furnished, complete and working for use in the Engineer's Field Office for the duration of the Contract. Equipment and supplies shall be provided as follows:
  - a. A color Inkjet Printer, compatible with Microsoft Windows XP and Microsoft Windows 2000, having 2 MB RAM minimum, 600 by 600 dpi black and white resolution, a tray capacity of at least 50 sheets, a print speed of at least 10 pages per minute, and parallel/USB interface capability.
  - b. A Bi-directional PC – type parallel printer cable or USB printer cable – 4.5 meters (15 feet) long.
  - c. A printer stand providing a minimum horizontal space for the printer of 900mm by 600mm (3 feet by 2 feet).
  - d. An anti-static vinyl dust cover.

- e. A good quality commercial surge suppresser to protect against:
  - a. chronic high and low voltage, and
  - b. dangerous voltage spikes and radio frequency interference traveling on the AC power circuits.
  - c. Spare ink cartridges, both color and black.
  - d. Appropriate software drivers and documentation for the printer.
  
- 1 Digital Camera with the following requirements:
  - a. At least 2 Megapixel resolution
  - b. Both LCD and Optical viewfinders
  - c. At least 32 Megabyte storage capacity
  - d. USB Interface capability
  - e. Storage case
  - f. Windows XP/2000 Compatible
  
- 1 Plain paper facsimile machine meeting the following requirements:
  - a. CCITT Group Compatibility - Groups III, II, I
  - b. Transmission Time - 20 seconds per page, maximum Automatic Feed
  - c. Minimum 10 Page Stock Capacity
  - d. Pulse/Tone Dialing
  - e. Speed Dialing - 50 locations, minimum
  - f. Single Touch Dialing - 10 locations, minimum
  - g. Automatic redial - up to 5 times
  - h. Capacity to distinguish between a fax phone call and a telephone call

A combination Copier/Printer/Fax Machine meeting the requirements of the Copier, Printer and Fax Machine described above may be substituted with the permission of the Engineer.

Paper for the fax machine, copier, and printer shall be furnished by the Contractor, to the Engineer as required during the term of the project.

Three telephone lines shall be provided. Telephone jacks will be located at each end of the field office for both telephone lines. The jacks shall be located above the surface of the desks.

The cost of furnishing these separate telephone lines, including installation and removal, will not be paid for directly, but will be considered incidental to Contract item 631.10. The monthly service charges will be paid under Contract item 631.25.

All furnished equipment shall be maintained in good working order. Replacement equipment shall be provided within 48 hours for all equipment that is damaged, stolen, or becomes inoperative in any way.

The Contractor shall provide training to the Engineer in the use of the furnished equipment.

### 631.03 FIELD OFFICE, SOILS AND MATERIALS.

(a) Design and Appendages.

- (1) General. The field office shall be available to the representatives of the State and the Federal Government throughout the duration of the work on the project, shall be independent of other buildings or office space used by the Contractor, and shall be removed when released by the Engineer. The field office, equipment, and supplies shall be maintained in good condition and adequate quantities at all times.

The field office shall be provided with adequate light, heat, potable water, ventilation, and electrical or gas connections as required. The method of heating shall be such that a minimum temperature of 20 °C (68 °F) can be maintained at all times.

The Contractor shall furnish all labor and materials for winterizing field offices.

Sanitary facilities consisting of flush toilet, chemical or other approved type, including a waterless hand sanitizer, shall be furnished by the Contractor with proper sewage disposal as is necessary to comply with the requirements and regulations of the State and local Boards of Health and VOSHA.

Entrances shall be provided with a 1.2 by 1.2 m (4 × 4 ft) minimum size deck with appropriate steps and railings meeting the requirements of the VOSHA *Safety and Health Standards for Construction*.

Each field office shall be equipped with an exterior security light of 400 W minimum.

- (2) Office Type. The field office shall be a commercial type mobile laboratory trailer of standard commercial quality, or a building, in good condition as determined by the Engineer with a minimum floor space of 22 m<sup>2</sup> (240 ft<sup>2</sup>). The fully equipped field office shall be available for use from the day that work on the project is commenced by the Contractor until 30 days after acceptance of the project, unless otherwise directed by the Engineer.
- (3) Foundation. The field office shall be constructed on a firm foundation that will remain vibration free and that will not be adversely affected by frost action or water runoff.
- (4) Outside Doors. The field office shall have a minimum of two outside doors equipped with dead bolt locks. All keys shall be in the possession of the Engineer or the Engineer's representatives.
- (5) Windows. The field office shall have a minimum of four side windows, one front window, and one rear window, all glassed and screened with provisions for opening and locking. All windows shall be equipped with adjustable louvered blinds.
- (6) Electrical System. The field office shall be equipped with a 110 V AC, 60 Hz, single-phase electrical system with service entrance equipment suitable for power company attachment and with at least twelve properly positioned interior electrical outlets. The materials and installation methods of all electrical wiring, connections, switches, and grounds shall conform to the provisions of the National Electrical Safety Code and shall be in accordance with all State and local electrical ordinances.
- (7) Interior Lights. The field office shall be provided with a minimum of five 1200 mm (48 inch) long fluorescent lighting fixtures, or equivalent, on the ceiling.



- (8) Air Conditioner. The field office shall be equipped with an air conditioner of adequate capacity, unless otherwise specified in the Contract.
- (9) Fire Extinguishers. The field office shall be equipped with at least two fire extinguishers. Each shall have a minimum capacity of 2 kg (5 pounds) and shall be either ABC Dry Chemical or Carbon Dioxide fire extinguishers of standard commercial quality.
- (b) Office Equipment. Office equipment shall be standard commercial quality office equipment. The minimum required office equipment is as follows. Substitutes may be provided upon approval of the Engineer.
- 1 Standard office desk with drawers, locks, and keys, 1500 by 750 mm (60 × 30 inches) (minimum dimensions).
  - 2 Adjustable office chairs.
  - 2 Adjustable drafting stools.
  - 1 Electric printing calculator, four-function, ten-column with memory.
  - 1 Four-drawer legal-size file cabinet with lock and two keys.
  - 1 Bench top cabinet, approximately 900 mm (36 inches) high and 600 mm (24 inches) wide with minimum bench area of 3 m<sup>2</sup> (32 ft<sup>2</sup>) and a minimum storage area of 3 m<sup>2</sup> (32 ft<sup>2</sup>) using a suitable combination of fully enclosed shelf space and drawers.
  - 1 Sink with gooseneck faucet within the office, with a continuous supply of pressurized, clean, potable water for the duration of the project.
  - 2 110 L (30 gallon) trash cans.
- (c) Test Equipment and Supplies. The minimum required testing equipment and supplies are as follows. Substitutes may be provided upon approval of the Engineer.
- 1 AASHTO *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*, Parts 1 and 2, latest edition.
  - 1 Balance of 10 kg (20 pound) minimum capacity accurate to 5.0 g (0.2 ounce).
  - 1 Scale of 1 kg (2 pound) minimum capacity accurate to 100 mg (0.004 ounce).

- 1 Double burner electric hot plate with variable temperature controls.
- 1 Electric motorized sieve shaker with either rocking and tapping action or circular and tapping action with a capacity of at least six sieves, cover, and pan of 203 mm (8 inch) diameter, enclosed in a dust retaining enclosure.
- 1 Set of US Standard, brass 203 mm (8 inch) diameter, full height, woven wire sieves meeting the requirements of AASHTO M 92. The required sieves are as follows:
- |                                |                         |
|--------------------------------|-------------------------|
| 1 100 mm (4 inch)              | 1 90 mm (3 1/2 inch)    |
| 1 75 mm (3 inch)               | 1 63 mm (2 1/2 inch)    |
| 1 50 mm (2 inch)               | 1 45 mm (1 3/4 inch)    |
| 1 37.5 mm (1 1/2 inch)         | 1 25.0 mm (1.00inch)    |
| 1 19.0 mm (3/4 inch)           | 1 16.0 mm (5/8 inch)    |
| 1 12.5 mm (1/2 inch)           | 1 9.5 mm (3/8 inch)     |
| 2 4.75 mm (No. 4)              | 2 2.36 mm (No. 8)       |
| 2 2.00 mm (No. 10)             | 2 1.18 mm (No. 16)      |
| 2 600 $\mu$ m (No. 30)         | 2 425 $\mu$ m (No. 40)  |
| 2 300 $\mu$ m (No. 50)         | 2 150 $\mu$ m (No. 100) |
| 4 75 $\mu$ m (No. 200)         |                         |
| 3 203 mm (8 inch) sieve covers |                         |
| 3 203 mm (8 inch) sieve pans   |                         |
- 2 360 mm (14 inch) safety gloves capable of withstanding 600 °C (1110 °F).
- 1 Brass (wire bristle) brush.
- 1 Standard floor broom.
- 1 Round pointed "D" handle shovel.
- 1 Square pointed "D" handle shovel.
- 2 1 by 1.2 m (2 1/2  $\times$  4 ft) heavy canvas for quartering samples.
- 10 Aluminum moisture cans 90 mm (3 1/2 inches) in diameter and 50 mm (2 inches) deep.
- 2 50 mm (2 inch) soft bristle paint brushes.
- 4 50 by 200 mm (2  $\times$  8 inch) table brushes.
- 1 200 mm (8 inch) pointed mason's trowel.
- 4 300 by 360 by 130 mm (12  $\times$  14  $\times$  5 inch) plastic dish pans.
- 8 230 by 230 by 50 mm (9  $\times$  9  $\times$  2 inch) cake pans.
- 1 150 mm (6 inch) grain scoop.
- 1 Spatula with a 250 by 30 mm (10  $\times$  1 1/8 inch) blade.
- 2 300 mm (12 inch) long solid heavy duty plated steel mixing spoons.
- 1 Microwave oven meeting the following requirements:

- (1) A minimum rating of 500 W.
  - (2) A minimum volume of approximately 0.02 m<sup>3</sup> (0.7 ft<sup>3</sup>). The interior dimensions shall be approximately 280 by 280 mm (11 × 11 inches) by an acceptable height. The interior dimensions shall be of adequate size to accept the microwaveable pans listed below.
  - (3) A minimum of ten adjustable power levels.
  - (4) A digital display of power level and time.
- 4 Microwaveable pans with minimum interior dimensions of approximately 200 by 200 by 50 mm (8 × 8 × 2 inches).
  - 1 101.60 mm (4 inch) diameter compaction mold meeting the requirements of AASHTO T 99.
  - 1 2.5 kg (5.5 pound) rammer meeting the requirements of AASHTO T 99.
  - 1 Steel straightedge meeting the requirements of AASHTO T 99.
  - 1 Density apparatus consisting of a sand cone and baseplate and meeting the requirements of AASHTO T 191.
  - 2 4 L (1 gallon) jugs with standard G mason jar top threading with covers.
  - 1 Cushioned carrying box for the two 4 L (1 gallon) mason jugs.
  - 2 4 L (1 gallon) metal cans with moisture proof friction covers and handles, similar to paint cans.
  - 1 Supply of standard Ottawa sand meeting the requirements of ASTM C 778, Section 3.1 (approximately 50 kg (100 pounds) of sand will be used for each 40 000 m<sup>3</sup> (50,000 yd<sup>3</sup>) of embankment).
  - 1 Number 2 rubber mallet with 255 mm (10 inch) handle.
  - 1 Box to contain the compaction testing equipment.

When compaction testing in accordance with AASHTO T 180 is required, the following additional equipment shall be supplied by the Contractor:

- 1 4.54 kg (10 pound) rammer meeting the requirements of AASHTO T 180.

All of the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

All equipment and supplies furnished by the Contractor shall be available prior to beginning any construction for which testing is required.

The equipment to be provided for portland cement concrete testing or bituminous concrete testing, when such equipment is also in the Contract, will not be considered common to the equipment for gradation testing or compaction testing and is not to be used as such.

631.04 COMBINED ENGINEERS AND SOILS OFFICE.

- (a) Design and Appendages. The Contractor shall provide weatherproofed space in which to store and use testing equipment. This space shall have a floor area equal to or greater than 11 m<sup>2</sup> (120 ft<sup>2</sup>). The space shall have a window and a lockable door. Access to the space shall be made available to the Engineer at all times during the construction of the project. If electricity is available at the site, the Contractor shall provide electricity and outlets to run the equipment to be furnished and electric lights for the space. If electricity is not available, the Contractor shall provide a generator having a minimum rating of at least 10 kW and electrical outlets to run the equipment to be furnished and electric lights. The generator shall be maintained ready to go and available to the Engineer at all times. The space shall be provided with a shelf or table approximately 0.6 by 2.0 m (2 × 7 feet) on which the Engineer can write while performing the necessary tests and other tasks the Engineer is required to perform for the project. Other shelves or bases will be required to support the equipment during use. An ABC Dry Chemical or Carbon Dioxide fire extinguisher having a minimum fire fighting capacity of 2 kg (5 pounds) shall be supplied.
- (b) Office Equipment. The minimum required office equipment is as follows:
- 1 Chair or drafting stool suitable for use with the shelf or table supplied.
  - 1 Telephone, rotary or touch tone dial, compatible with the local telephone service available. The Contractor shall arrange for the connection of the telephone system and pay the installation charge as part of Contract item 631.12. The Contractor shall also pay the monthly service bill. Upon presentation of the paid monthly

service bill to the Engineer, the Engineer will pay the Contractor the cost of the service bill under Contract item 631.25. Connected to the telephone shall be a telephone answering device capable of receiving and storing messages.

- 1 Elevated clean water tank having a minimum capacity of 400 L (100 gallons) with a hose or pipe leading to a convenient location near the testing and storage space provided. The Contractor shall provide two 20 L (5 gallon) pails to enable the Engineer to use this water source and shall fill the tank on a daily basis. The outlet end of the hose or pipe shall be fitted with a faucet. The faucet shall be fixed at least 600 mm (24 inches) above the ground.
- 1 110 L (30 gallon) trash can.

(c) Test Equipment and Supplies. The minimum required testing equipment and supplies are as follows. Substitutes may be provided upon approval of the Engineer.

- 1 AASHTO *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*, Parts 1 and 2, latest edition.
- 1 Balance of 10 kg (20 pound) minimum capacity accurate to 5.0 g (0.2 ounce).
- 1 Scale of 1 kg (2 pound) minimum capacity accurate to 100 mg (0.004 ounce).
- 1 Double burner electric hot plate with variable temperature controls.
- 1 Electric motorized sieve shaker with either rocking and tapping action or circular and tapping action with a capacity of at least six sieves, cover, and pan of 203 mm (8 inch) diameter, enclosed in a dust retaining enclosure.
- 1 Set of US Standard, brass, 203 mm (8 inch) diameter, full height, woven wire sieves meeting the requirements of AASHTO M 92. The required sieves are as follows:

1 100 mm (4 inch)	1 90 mm (3 1/2 inch)
1 75 mm (3 inch)	1 63 mm (2 1/2 inch)
1 50 mm (2 inch)	1 45.0 mm (1 3/4 inch)
1 37.5 mm (1 1/2 inch)	1 25.0 mm (1.00 inch)
1 19.0 mm (3/4 inch)	1 16.0 mm (5/8 inch)
1 12.5 mm (1/2 inch)	1 9.5 mm (3/8 inch)

- |    |     |  |   |                             |
|----|-----|--|---|-----------------------------|
|    | 2   | 4.75 mm (No. 4)  | 2 | 2.36 mm (No. 8)             |
|    | 2   | 2.00 mm (No. 10)   | 2 | 1.18 mm (No. 16)            |
|    | 2   | 600 $\mu\text{m}$ (No. 30)   | 2 | 425 $\mu\text{m}$ (No. 40)  |
|    | 2   | 300 $\mu\text{m}$ (No. 50)   | 2 | 150 $\mu\text{m}$ (No. 100) |
|    | 4   | 75 $\mu\text{m}$ (No. 200)   |   |                             |
|    | 3   | 203 mm (8 inch) sieve covers   |   |                             |
|    | 3   | 203 mm (8 inch) sieve pans   |   |                             |
| 2  |     | 360 mm (14 inch) safety gloves capable of withstanding 600 °C (1110 °F).   |   |                             |
| 1  |     | Brass (wire bristle) brush.  |   |                             |
| 1  |     | Standard floor broom.  |   |                             |
| 1  |     | Round pointed "D" handle shovel.   |   |                             |
| 1  |     | Square pointed "D" handle shovel.  |   |                             |
| 2  |     | 1 by 1.2 m (2 1/2 $\times$ 4 ft) heavy canvas for quartering samples.  |   |                             |
| 10 |     | Aluminum moisture cans 90 mm (3 1/2 inches) in diameter and 50 mm (2 inches) deep.   |   |                             |
| 2  |     | 50 mm (2 inch) soft bristle print brushes.   |   |                             |
| 4  |     | 50 by 200 mm (2 $\times$ 8 inch) table brushes.  |   |                             |
| 1  |     | 200 mm (8 inch) pointed mason's trowel.  |   |                             |
| 4  |     | 300 by 360 by 130 mm (12 $\times$ 14 $\times$ 5 inch) plastic dish pans.   |   |                             |
| 8  |     | 230 by 230 by 50 mm (9 $\times$ 9 $\times$ 2 inch) cake pans.  |   |                             |
| 1  |     | 150 mm (6 inch) grain scoop.   |   |                             |
| 1  |     | Spatula with a 250 by 30 mm (10 $\times$ 1 1/8 inch) blade.  |   |                             |
| 2  |     | 300 mm (12 inch) long solid heavy duty plated steel mixing spoons.   |   |                             |
| 1  |     | Microwave oven meeting the following requirements:   |   |                             |
|    | (1) | A minimum rating of 500 W.   |   |                             |
|    | (2) | A minimum volume of approximately 0.02 m <sup>3</sup> (0.7 ft <sup>3</sup> ). The interior dimensions shall be approximately 280 by 280 mm (11 $\times$ 11 inches) by an acceptable height. The interior dimensions shall be of adequate size to accept the microwaveable pans listed below. |   |                             |
|    | (3) | A minimum of ten adjustable power levels.  |   |                             |
|    | (4) | A digital display of power level and time.   |   |                             |
| 4  |     | Microwaveable pans with minimum interior dimensions of approximately 200 by 200 by 50 mm (8 $\times$ 8 $\times$ 2 inches).   |   |                             |

- 1 101.60 mm (4 inch) diameter compaction mold meeting the requirements of AASHTO T 99.
- 1 2.5 kg (5.5 pound) rammer meeting the requirements of AASHTO T 99.
- 1 Steel straightedge meeting the requirements of AASHTO T 99.
- 1 Density apparatus consisting of a sand cone and baseplate and meeting the requirements of AASHTO T 191.
- 2 4 L (1 gallon) jugs with standard G mason jar top threading with covers.
- 1 Cushioned carrying box for the two 4 L (1 gallon) mason jugs.
- 2 4 L (1 gallon) metal cans with moisture proof friction covers and handles, similar to paint cans.
- 1 Supply of standard Ottawa sand meeting the requirements of ASTM C 778, Section 3.1 (approximately 50 kg (100 pounds) of sand will be used for each 40 000 m<sup>3</sup> (50,000 yd<sup>3</sup>) of embankment).
- 1 Number 2 rubber mallet with 255 mm (10 inch) handle.
- 1 Box to contain the compaction testing equipment.

When compaction testing in accordance with AASHTO T 180 is required, the following additional equipment shall be supplied by the Contractor:

- 1 4.54 kg (10 pound) rammer meeting the requirements of AASHTO T 180.

All of the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

All equipment and supplies furnished by the Contractor shall be available prior to beginning any construction for which testing is required.

The equipment to be provided for portland cement concrete testing or bituminous concrete testing, when such equipment is also in the Contract, will not be considered common to the equipment for gradation testing or compaction testing and is not to be used as such.

631.05 TESTING EQUIPMENT, CONCRETE. The following equipment shall be provided to perform concrete field tests:

- 1 Cylinder test set meeting the requirements of AASHTO T-23.
- 1 Slump test set meeting the requirements of AASHTO T 119.

- 1 Platform beam scale sensitive to 5 g (0.01 pound) with a minimum capacity of 50 kg (100 pounds).
- 1 Steel "Contractors" wheelbarrow.
- 1 Square pointed "D" handle shovel.
  
- 1 Pressure air meter meeting the requirements of AASHTO T 152 and all accessory items required for use with the particular design of apparatus used. Accessory items shall include a flat, rectangular, metal plate at least 6 mm (1/4 inch) thick, a glass or acrylic plate at least 13 mm (1/2 inch) thick, or a wire reinforced glass plate at least 6 mm (1/4 inch) thick with a length and width at least 50 mm (2 inches) greater than the diameter of the measuring bowl of the air meter with which it is to be used.
- 1 Concrete curing box. The concrete curing box shall be of standard commercial quality. One or more boxes shall be supplied to meet specimen requirements for the project. The curing box shall maintain an internal water temperature of  $21 \pm 5$  °C ( $70 \pm 10$  °F) and 100 percent humidity.
- 1 Straightedge at least 3 m (10 feet) in length.

For testing Class LW concrete, the following additional testing equipment shall be provided:

- 1 Volumetric air meter meeting the requirements of AASHTO T 196, supplied with a wooden carrying case, syringe, tamping rod, measuring vessel, and baffle.
- 1 One unit mass (weight) measure meeting the requirements of AASHTO T 121, supplied with a flat, rectangular, metal plate at least 6 mm (1/4 inch) thick, a glass or acrylic plate at least 13 mm (1/2 inch) thick, or a wire reinforced glass plate at least 6 mm (1/4 inch) thick with a length and width at least 50 mm (2 inches) greater than the diameter of the measuring bowl of the air meter with which it is to be used.

All of the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

All equipment and supplies furnished by the Contractor shall be available prior to the placing of any concrete.

When the Contractor places concrete at more than one location simultaneously, the necessary testing equipment shall be furnished at each location.



When the equipment to be provided for concrete testing is required by the Contract, it will not be considered common to the equipment for gradation testing, compaction testing, or bituminous concrete testing and is not to be used as such.

631.06 TESTING EQUIPMENT, BITUMINOUS. The following equipment shall be provided:

- 1 Straightedge at least 4.5 m (16 feet) in length.
- 1 3 m (10 foot) straightedge.
- 1 Round pointed "D" handle shovel.
- 1 Electronic hand-held thermometer having a digital display visible under all lighting conditions.

The thermometer shall be at least capable of measuring temperatures between -50 and 650 °C with a resolution of 1 °C and an accuracy of at least  $\pm 1$  °C (-60 and 1200 °F with a resolution of 2 °F and an accuracy of at least  $\pm 2$  °F) and shall provide accurate measurements of 1) the ambient air temperature measured at least 1.2 m (4 feet) above the ground and 8 m (26 feet) from any vehicle or other heat source, and 2) the surface temperature of such materials as bituminous pavement and thermoplastic pavement markings in place, or for placement thereof, on the roadway. The final accurate measurement shall be displayed within one second or less.

The unit shall be provided with an instruction manual and shall have internal protection against meter overload, automatic zero adjustment, and low battery indication if battery powered.

The unit shall be completely self-contained and shall not require external probes or other attachments to perform the required functions.

- 1 Micrometer having a capacity of 0 to 25 mm (0 to 1 inch) and calibrated in micrometers (0.1 mil).
- 1 48 inch electronic building level.
- 1 Mechanical measuring wheel.

The electronic building level shall have bubble indicators as well as a digital readout capable of reading in degrees from 0.0 deg to 90.0 deg, in percent slope from 0.0 percent to 100.0 percent, and in pitch in units (inches) of rise per unit (foot) of run. The electronic level shall have the capability of being recalibrated and be accurate to 1/10 of one degree.

The measuring wheel shall have a minimum wheel circumference of 1 m (3 feet) and shall have a sealed counter capable of measuring to a minimum range of 9 999.9 ft or 9 999.9 m specific to the applicable project (Contract) design units.

Black duct tape and tar paper or asphalt treated felt in adequate amounts for the Engineer to perform necessary thickness and moisture testing.

All of the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

All equipment and supplies furnished by the Contractor shall be available prior to the placing of any bituminous concrete or pavement markings.

When the Contractor places bituminous concrete or pavement markings at more than one location simultaneously, the necessary testing equipment shall be furnished at each location.

When the equipment to be provided for bituminous concrete testing is required by the Contract, it will not be considered common to equipment for gradation testing, compaction testing, or concrete testing and is not to be used as such.

631.07 TESTING EQUIPMENT, PROTECTIVE COATINGS. The following equipment shall be provided:

- 1 Psychrometer kit for measuring dew point. The instrument shall meet the requirements of ASTM E337, Method B, with a range from 1 to 43°C (34 to 110°F) and an accuracy of  $\pm 1$  degree. As a minimum the kit shall include matching thermometers with conversion charts and a thermometer for measuring the surface temperature of the steel object.
- 1 Dry film electronic thickness probe meeting ASTM D1186, Method B. The probe shall be capable of measuring a range of 0 to 1500  $\mu\text{m}$  (0 to 60 mils) with an accuracy of  $\pm 2\%$ .
- 1 Adhesion testing kit meeting ASTM D3359 Adhesion By Tape Test, Method A. As a minimum the kit shall include a cutting tool, a cutting guide, tape, rubber eraser, and an illuminated magnifier.
- 1 Surface profile kit meeting ASTM D4417, Method C. The kit shall include coarse and extra coarse tapes as specified in Section 6.3 and a minimum of one roll (100 pieces) of tape for each range, plus extras as required.

All of the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

The equipment furnished shall have been calibrated within one year or shall have appropriate means of being calibrated in the field.

631.08 METHOD OF MEASUREMENT. The quantity of each type of Field Office and/or Testing Equipment to be measured for payment will be on a unit basis for each type specified and used on the project. Unless otherwise specified in the Contract Documents, no measurement for payment will be made for protective coatings testing equipment provided by the Contractor.

The quantity of Field Office Telephone to be measured for payment will be to the nearest hundredth of a dollar for all telephone service supplied.

The Agency will include in the proposal a quantity of dollars for all telephone service required. However, the Contractor will be reimbursed the actual costs of providing the telephone service as evidenced by the paid bills submitted to the Engineer. Upon entering the cost of the submitted bill into the next biweekly estimate, the Engineer will forward the original paid bill to the Construction Office to be retained with the project records and will place a copy of the paid bill into the field office records.

631.09 BASIS OF PAYMENT. The accepted quantity of each type of Field Office and/or Testing Equipment will be paid for at the Contract lump sum price for the specified type. Payment will be full compensation for performing the work and furnishing all materials, labor, tools, equipment, and incidentals necessary to provide, construct, install, maintain, and remove the type of office and/or testing equipment specified.

Supplies that become exhausted and equipment that becomes unsuitable for use due to normal wear and tear shall be replaced as necessary by the Contractor as part of the Contract item under which these items are furnished.

Payment for this work will be made as follows:

- (a) 25 percent will be paid after each specified office and/or equipment unit has been installed on the project in full working order.

631

- (b) The second payment of 25 percent will be paid when 33 percent of the anticipated construction time has expired.
- (c) The third payment of 25 percent will be paid when 67 percent of the anticipated construction time has expired.
- (d) The fourth and final payment of the remaining 25 percent will be paid upon final acceptance of the project.

The quantity of Field Office Telephone to be paid will be the total of all paid telephone bills for providing service to all telephones, modems, and fax machines supplied in the project field offices by the Contractor, which total will be limited to the total of the paid telephone bills submitted to the Engineer.

The costs of installing and removing the telephone lines in the field office are part of the costs included in the field office Contract items and are not part of the Contract item Field Office Telephone.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
631.10 Field Office, Engineers	Lump Sum
631.11 Field Office, Soils and Materials	Lump Sum
631.12 Combined Engineers and Soils Office	Lump Sum
631.16 Testing Equipment, Concrete	Lump Sum
631.17 Testing Equipment, Bituminous	Lump Sum
631.18 Testing Equipment, Protective Coatings	Lump Sum
631.26 Field Office Telephone	Dollar

SECTION 634 - EMPLOYEE TRAINEESHIP

634.01 DESCRIPTION. This work shall consist of providing on-the-job training for qualified employees in accordance with applicable approved training programs.

634.02 GENERAL. The training requirements specified herein supersede subparagraph 6b, part II, NONDISCRIMINATION, of the REQUIRED CONTRACT PROVISIONS for FEDERAL-AID CONSTRUCTION CONTRACTS, and implements 23 U.S.C. 140 (a).

The Contractor shall provide on-the-job training aimed at developing full journeyman qualifications in the type of trade, craft, or job classification involved.

6-148

The training program shall be carried out in accordance with a training schedule and curriculum devised to give the employee an understanding of the trade, craft, or skill together with instructions in safety operations and performance of the actual specialty covering all aspects of the work involved. The training program shall be one approved by the Agency and the U.S. Department of Transportation.

The required number of employee traineeship hours to be provided by the Contractor is shown in the Contract. In the event that a Contractor subcontracts a portion of the work, the Contractor shall determine how many, if any, of the trainees are to be trained by the subcontractor. However, the Contractor shall retain the primary responsibility for meeting the training requirements specified herein.

634.03 PROCEDURE. The procedures followed in carrying out the training shall be consistent with the approved training program for the particular trade, craft, or skill and the trainee shall be employed insofar as practical in a useful and constructive manner assisting in the work on the project until such time as the Contractor deems the trainee as being qualified to operate independently in the field in which the trainee has been trained. The Contractor shall then give the trainee a certificate of satisfactory completion of apprenticeship training specifying the field of accomplishment.

The Contractor shall maintain payroll records and training records in a manner acceptable to the Engineer as to provide all the information necessary to properly and adequately support progress and final payment for this Contract item, as well as to show the status of training accomplishment.

It is normally expected that a trainee will begin training on the project as soon as feasible after start of work utilizing the skill involved, and remain on the project as long as training opportunities exist in the work classification or until the training program has been completed. It is not required that all trainees be on board for the entire length of the Contract. A Contractor will have fulfilled the requirements of this Contract item if they have provided acceptable training to the number of trainees specified. The number trained shall be determined on the basis of the total number enrolled on the project for a significant period.

634.04 TRAINEES. The number of trainees shall be distributed among the work classifications on the basis of the Contractor's needs and the availability of journeymen in the various classifications within a reasonable area of recruitment. Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training.

Prior to commencing construction, the Contractor shall submit to the Engineer for approval the number of trainees to be trained in each selected classification and training program to be used. Furthermore, the Contractor shall specify the starting time for training in each of the classifications. The Contractor will be credited for each trainee employed on the project that is currently enrolled or becomes enrolled in an approved program and will be reimbursed for such trainees as provided herein.

634.05 RECRUITMENT. Training and upgrading of minorities and women toward journeymen status is a primary objective of this Contract item. Accordingly, the Contractor shall make every effort to enroll minority trainees and women (e.g., by conducting systematic and direct recruitment through public and private sources likely to yield minority and women trainees) to the extent that such persons are available within a reasonable area of recruitment. The Contractor will be responsible for demonstrating the steps taken in pursuance thereof, prior to a determination as to whether the Contractor is in compliance with the requirements of this Contract item. This training commitment is not intended, and shall not be used, to discriminate against any applicant for training, whether a member of a minority group or not.

634.06 TRAINING PROGRAM. The minimum length and type of training for each classification will be as established in the training program selected by the Contractor and approved by the Engineer. The Federal Highway Administration (FHWA) shall approve a program if it is reasonably calculated to meet the equal employment opportunity obligations of the Contractor and to qualify the average trainee for journeyman status in the classification concerned by the end of the training period. Apprenticeship programs registered with the U.S. Department of Labor, Bureau of Apprenticeship and Training, shall also be considered acceptable provided they are being administered in a manner consistent with the equal employment obligations of Federal-Aid highway construction Contracts. Approval or acceptance of a training program shall be obtained from the State prior to commencing work on the classification covered by the program.

It is the intent of these provisions that training is to be provided in the construction crafts rather than clerk-typists or secretarial-type positions. Training is permissible in lower level management positions, such as office engineers, estimators, timekeepers, etc., where the training is oriented toward construction applications. Training in the laborer classification may be permitted provided that significant and meaningful training is provided and approved by the FHWA division office.

Some offsite training is permissible as long as the training is an integral part of an approved training program and does not comprise a significant part of the overall training.

The Contractor may be eligible for reimbursement for training persons in excess of the number of hours specified in the Contract. This reimbursement will be made even though the Contractor receives additional training program funds from other sources, provided such other sources do not specifically prohibit the Contractor from receiving other reimbursement. Reimbursement for offsite training indicated above may only be made to the Contractor where the Contractor does one or more of the following and the trainees are concurrently employed on a Federal-Aid project: contributes to the cost of the training, provides the instruction to the trainee or pays the trainee's wages during the offsite training period.

The Contractor shall furnish the trainee a copy of the program the Contractor will follow in providing the training. The Contractor shall provide each trainee with a certification showing the type and length of training satisfactorily completed.

Trainees will be paid at least 60 percent of the appropriate minimum journeyman's rate specified in the Contract for the first half of the training period, 75 percent for the third quarter of the training period, and 90 percent for the last quarter of the training period, unless apprentices or trainees in an approved existing program are enrolled as trainees on the project. In that case, the appropriate rates approved by the Department of Labor or Transportation in connection with the existing program shall apply to all trainees being trained for the same classification who are covered by these provisions. In no case will the Contractor pay trainees less than the prevailing rate for labor as shown in the Contract wage decision.

634.07 SANCTIONS FOR NON-COMPLIANCE. If the Vermont Agency of Transportation finds the Contractor or subcontractor in non-compliance with the terms of this Contract item it shall:

- (a) Issue a “Show Cause Notice” and notify the Contractor in writing that within 30 days a written Plan outlining the steps that will be taken to bring the Contractor into compliance must be submitted to the Vermont Agency of Transportation by the Contractor. In the event the Contractor fails or refuses to submit the Plan within the specified period, or if the Contractor does not exercise the corrective actions outlined in the Plan, the Agency will commence enforcement proceedings under Executive Order 11246, as amended. Such actions could include:
- (1) The recovery by the Agency from the Contractor of 1/10 of 1% of the Contract award amount or \$1,000.00, whichever sum is greater, as liquidated damages for each week the Contractor fails or refuses to comply. If a subcontractor is in non-compliance, the recovery by the Agency from the Contractor, to be assessed by the Contractor as a back charge against the subcontractor of 1/10 of 1% of the subcontract price, or \$500.00, whichever sum is greater, in the nature of liquidated damages, for each week that such party fails or refuses to comply; and/or
  - (2) The suspension of any payment or part thereof due under the Contract until such time as the Contractor or Subcontractor is able to demonstrate compliance with the terms of the Contract; and/or
  - (3) The termination or cancellation of the Contract, in whole or in part, unless the Contractor or Subcontractor is able to demonstrate within a specified time compliance with terms of the Contract; and/or
  - (4) The denial to the Contractor or Subcontractor of the right to participate in any future Contracts awarded by the Agency for a period of up to three years.



- (b) If at any time after the imposition of sanctions 1 and 2 above, the Contractor is able to demonstrate compliance with the requirements of this Contract item, the Contractor may request the Agency to suspend the sanctions conditionally, pending a final determination by the Agency as to whether the Contractor is in compliance. Following the final determination the Agency will either lift the sanctions or impose them.
- (c) The above sanctions for non-compliance will also apply to the “Standard Federal Equal Employment Opportunity Construction Contract Specifications (Executive Order 11246)”.

634.08 METHOD OF MEASUREMENT. The quantity of Employee Traineeship to be measured for payment will be the number of hours completed in the complete and accepted work.

634.09 BASIS OF PAYMENT. The accepted quantity of Employee Traineeship will be paid for at the Contract unit price per hour. Payment will be full compensation for furnishing all tools, equipment, supervision, and incidentals necessary to provide complete training for each trainee.

If, in the judgment of the Contractor, a trainee becomes proficient enough to qualify as a journeyman before the end of the prescribed training period, and the Contractor so employs such trainee, full credit and full payment to the Contractor will be made provided that the period of training given, plus the length of employment as a journeyman in the classification for which trained, are equal to, or in excess of, the training period specified in the approved training program. If the period of training given plus the period employed as a journeyman does not equal or exceed the training period specified in the approved training program, the Contractor will be paid the Contract amount for each hour the trainee was trained and employed as a journeyman by the Contractor.

In the event of partial employee traineeship, the Contractor will be paid for each hour the trainee was trained and employed as a trainee by the Contractor.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
634.10 Employee Traineeship	Hour

SECTION 635 – MOBILIZATION/DEMobilIZATION

635.01 DESCRIPTION. This work shall consist of preparatory work and operations including, but not limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to and from the project site; for the establishment and removal of all Contractor's field offices, buildings, and other facilities necessary for work on the project; and for all other work and operations that must be performed or costs incurred prior to beginning work and upon completion of Contract items. It shall also include compensation for any costs associated with demobilization, project clean up, establishment of vegetation, and completion of all work that is not associated with acceptance of a specific pay item.

635.02 METHOD OF MEASUREMENT. The quantity of Mobilization/Demobilization to be measured for payment will be on a lump sum basis.

635.03 BASIS OF PAYMENT. The accepted quantity of Mobilization/Demobilization will be paid for at the Contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, materials, equipment, and incidentals necessary to complete the work.

For the purposes of computing payment under the Contract item Mobilization/Demobilization, the adjusted Contract price will be a summation of all items bid, excluding the amount bid specifically for the Mobilization/Demobilization item.

Partial payments will be made as follows:

- (a) The first payment of 50 percent of the lump sum price for Mobilization/Demobilization or 5 percent of the adjusted Contract price, whichever is less, will be made with the first biweekly estimate as determined by work on other Contract items.
- (b) The second payment of 40 percent of the lump sum price for Mobilization/Demobilization or 5 percent of the adjusted Contract price, whichever is less, will be made on the first estimate following the completion of 10 percent of the Contract, excluding Mobilization/Demobilization.
- (c) Payment of any remaining amount bid for Mobilization/Demobilization will be made after the Acceptance Date.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
635.11 Mobilization/Demobilization	Lump Sum

#### SECTION 641 - TRAFFIC CONTROL

641.01 DESCRIPTION. This work shall consist of establishing and maintaining traffic control measures to protect the traveling public (including bicyclists and pedestrians) and construction operations.

The requirements for uniformed traffic officers and flaggers used in conjunction with Traffic Control shall be as specified in Section 630.

641.02 GENERAL CONSTRUCTION REQUIREMENTS. The Contractor shall establish traffic controls to divert traffic from the area of construction operations during working hours in accordance with the Contract or as authorized by the Engineer. Working hours shall be as specified in Subsection 104.04. Should the Contractor desire to divert traffic after sunset or before sunrise, a written request shall be submitted to the Engineer. In the request, the Contractor shall justify the request and detail the enhanced safety procedures the Contractor proposes to provide and pay for to protect the safety of the traveling public and project personnel. The request shall be submitted at least three weeks prior to the date the Contractor plans to divert traffic outside of normal working hours as defined in the Contract.

When work is in progress within an interchange area, no more than one ramp at a time may be closed to traffic. Traffic service that would be eliminated by the closing of a ramp shall be maintained elsewhere as specified in the Contract or authorized by the Engineer.

During hours other than working hours, all highway facilities, including sidewalks, shall be open to the unrestricted flow of traffic, unless otherwise specified. Traffic control devices, equipment and materials shall be removed from the traveled way, auxiliary lanes, ramps, and shoulders. Traffic signs relative to traffic control for construction operations shall be removed, covered, or turned so they are not readable from the highway. All equipment and materials shall be stored outside the travel lanes, shoulders, and clear zone for the facility.

When the Plans contain an Agency-designed traffic control plan that includes, but is not limited to, references to standard sheets, the Contractor may submit an alternate traffic control plan for the project. This alternate plan may be for the entire traffic control plan of the project or for revisions to various phases of the Agency's design in the Plans, including the specific location of the lanes where the traffic will be maintained. Any alternate plan submitted shall conform to the latest edition of the MUTCD.

For an alternate traffic control plan, Construction Drawings shall be submitted in accordance with Section 105. The submitted alternative plan shall include complete construction details, including all aspects of traffic control, to the same extent provided in the Agency design. The Contractor shall allow the Agency 30 calendar days to review and accept the proposed alternative plan before it is to be implemented.

641.03 TRAFFIC CONTROL DEVICES. All traffic control devices shall conform to the requirements of the Contract and the latest edition of the MUTCD. Traffic control devices required in the performance of this work may include lane markings, barricades, signs with yielding posts or portable supports, reflectorized drums, traffic cones, delineators, portable flashing arrow boards, portable changeable message sign(s), traffic signal lights, and street lighting. In addition, flashing warning lights may be required by the Engineer for use on signs and barricades to improve visibility.

The location of traffic control devices shall be adjusted in the field as directed by the Engineer to provide for maximum visibility and usefulness. Traffic control devices shall be kept clean so they are clearly visible at all times. All signs shall be composed of the same retroreflective material. The Contractor shall conduct inspections of both daytime and nighttime operations daily in order to ensure proper placement and operation of all traffic control devices.

Unless protected by guardrail or other positive barrier, mounted traffic control devices shall be erected on yielding or breakaway supports.

When protected by guardrail, these devices shall be placed outside the deflection distance of the particular guardrail in use.

Traffic cones shall be orange, at least 700 mm (28 inches) high, and shall be spaced as shown on the Plans. They shall be weighted or nailed for stabilization. Tires may be used to stabilize the cones only if they have been circumferentially sliced to a minimum of 50 percent of their original thickness.

Portable Changeable Message Signs (PCMSs) shall have three (3) lines of eight (8) characters per line and conform to Section 6F.55 of the MUTCD.

Portable Arrow Boards (PABs) shall conform to Type C requirements in Section 6F.56 of the MUTCD.

The Contractor shall operate and maintain the PCMS(s) or PAB(s) as recommended by the manufacturer. The locations of the units and the messages to be used shall be as specified in the traffic control plan shown in the Plans or as directed by the Engineer. The Contractor shall supply the Engineer with the name and telephone number of the Contractor's responsible person in charge of the placement, maintenance and repair of the PCMS(s) or PAB(s) and their components for the duration of the Contract.

If Portable Changeable Message Sign and/or Portable Arrow Board pay items are included in the Contract, the Contractor shall maintain one spare PCMS unit, or a PAB unit if no PCMS unit is being utilized, on site to replace a non-operational unit if necessary. If any unit becomes non-operational during use, and a replacement unit is not available, the Contractor shall provide flaggers or other approved traffic control methods until the unit is repaired or replaced, at no additional cost to the Agency. Non-operational units shall be repaired or replaced as soon as possible, but no later than twenty-four (24) hours after the Engineer determines that repairs or replacement are necessary.

Time lost due to failure to correct deficient traffic control devices will not be considered justifiable cause for granting an extension of time in accordance with Section 108.

641.04 PERSONNEL. Personnel involved with the placement and use of traffic control devices shall receive orientation and explanation of the requirements of the MUTCD and the special project requirements prior to working on the project. The orientation and explanation are the Contractor's responsibility.

641.05 SPEED ZONE ENACTMENT. If the traffic control plan included in the Plans is based on a recommended speed limit reduction, or if a speed limit reduction is requested by the Contractor, the Agency will obtain the necessary permit for this speed reduction. In either case, the Contractor shall provide the Agency with a written plan of work and a detailed sketch of the work zones that will be the basis for the permit application. The Contractor shall allow three weeks for the permit to be processed. The traffic control plan shall not be implemented until the permit is approved.

641.06 METHOD OF MEASUREMENT. The quantity of Traffic Control to be measured for payment will be on a lump sum basis for providing traffic control in the complete and accepted work.

The quantities of Portable Changeable Message Sign and Portable Arrow Board to be measured for payment will be the number of each type of unit specified and used on the project. A unit shall consist of the designated sign panel (or board) complete with controller, power supply, fuel, backup power supply and trailer installed, maintained and removed as indicated on the Plans and directed by the Engineer.

The quantities of Portable Changeable Message Sign Rental and Portable Arrow Board Rental to be measured for payment will be the number of days of the type specified, as authorized in writing by the Engineer.

641.07 BASIS OF PAYMENT. The accepted quantity of Traffic Control will be paid for at the Contract lump sum price. Partial payments will be made as follows:

- (a) The first 50% of the Contract lump sum price will be paid upon the complete installation of the traffic control devices and any lane markings associated with the traffic control plan.
- (b) The remaining 50% of the Contract lump sum price will be paid on a prorated basis for the estimated duration of the Contract work remaining.

Payment will be full compensation for preparing, implementing, inspecting, maintaining, and removing the applicable traffic control plan and specified traffic control devices, and for furnishing all labor, including traffic patrol vehicle operators if used by the Contractor, tools, materials, equipment, and incidentals necessary to complete the work. Except as otherwise provided below, all other items required to implement the applicable traffic control will not be paid for directly but will be considered incidental to Traffic Control.

Payment for temporary traffic barrier and temporary pavement markings will be made under their respective Contract pay items when included in the Contract.

The accepted quantities of Portable Changeable Message Sign and Portable Arrow Board will be paid for at the Contract unit price for each. There will be no payment for any spare units, as they shall be considered incidental to the unit(s) being utilized and paid for through the Contract.

Partial payment for these items will be made as follows:

- (a) The first 50% of quantity payments will be made upon the erection of complete Portable Changeable Message Sign(s) and Portable Arrow Board(s) as specified in Subsection 641.06.
- (b) The remaining 50% of quantity payments will be paid on a prorated basis for the estimated duration of the Contract work remaining.

The accepted quantities of Portable Changeable Message Sign Rental and Portable Arrow Board Rental will be paid for at the Contract unit price per day. The minimum quantity for payment shall be 5 days.

Payment for the accepted quantities of Portable Changeable Message Sign, Portable Arrow Board, Portable Changeable Message Sign Rental, and Portable Arrow Board Rental shall be full compensation for furnishing, operating, maintaining, transporting and installing the unit specified, for removing the unit when it is no longer needed, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

When both pay items are in the Contract, a Portable Changeable Message Sign used as a Portable Arrow Board will be paid for at the Contract price for a Portable Arrow Board.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
641.10 Traffic Control	Lump Sum
641.15 Portable Changeable Message Sign	Each
641.16 Portable Arrow Board	Each
641.17 Portable Changeable Message Sign Rental	Day
641.18 Portable Arrow Board Rental	Day

SECTION 643

THIS SECTION RESERVED

SECTION 646 - RETROREFLECTIVE PAVEMENT MARKINGS

646.01 DESCRIPTION. This work shall consist of furnishing and placing retroreflective markings, including temporary markings, and necessary signing on roadway pavement and other surfaces.

Markings shall exhibit adequate intensity to demark the roadway in both daylight and under vehicle headlights at night. Markings shall have adequate contrast to distinguish them from the background material color unless otherwise specified. Minimum retroreflectivity shall be provided as specified in the Plans.

Marking operations shall be conducted in a manner that minimizes traffic disruptions. Adequate safety measures shall be provided for both the construction workers and the traveling public.

Details not shown on the Plans shall be in conformity with the MUTCD.

646.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Polyurea Pavement Markings.....	708.08(a)
Low VOC Traffic Paint.....	708.08(b)
Epoxy Paint.....	708.08(c)
Waterborne Traffic Paint.....	708.08(d)
Methyl-methacrylate Paint.....	708.08(e)
Glass Beads.....	708.09
Thermoplastic Pavement Markings.....	708.10
Raised Pavement Markers.....	708.11
Pavement Marking Tape, Type I.....	708.12(a)
Pavement Marking Tape, Type II.....	708.12(b)
Pavement Marking Mask.....	708.12(c)
Preformed Traffic Markings and Symbols.....	708.13
Line Striping Targets.....	708.14

Pavement marking materials furnished shall be the ones shown on the Plans, or listed in these specifications as being acceptable for the project. The Contractor may submit alternate materials for approval in accordance with Subsection 646.11.



646.03 CLASSIFICATION. Retroreflective pavement markings are hereby classified as Paint Pavement Markings, Durable Pavement Markings, Temporary Pavement Markings, and Other Related Markings.

646.04 APPLICATION OF MARKINGS, GENERAL.

- (a) Placement of Markings. The final pavement markings shall be placed the same day as the wearing course of pavement.

Roadway surfaces shall be clean and dry at the time of application of pavement markings. The Engineer will inspect the pavement to determine if conditions are suitable for the placement of markings. The Engineer will check the pavement for cleanliness, moisture content, and temperature; and will check ambient air conditions. The Engineer will make the final determination as to the suitability of project conditions for the application of pavement markings. Where required, the Contractor shall clean the surface to be marked to the satisfaction of the Engineer so as to provide for an acceptable bond between the marking and the pavement or surface.

Pavement markings shall be applied only during daylight hours, and in accordance with the manufacturer's recommendations. Weather conditions must be sufficient to allow the placement and curing of the pavement marking material without violating the manufacturer's requirements.

All markings shall be applied in a neat and professional manner. The lines shall be sharp and clear with no feathered edging or fogging, and precautions shall be taken to prevent tracking by tires of the marking equipment. Adequate quantities of the material shall be applied to assure constant thickness of marking material. Glass beads shall be delivered at a velocity that is at least 60% of ground speed for the application device. Markings shall be applied parallel to the roadway centerline or as shown on the Plans with no unsightly deviations.

After application, markings shall be protected from crossing vehicles for a time at least equivalent to the drying time of the marking material used. Markings shall be protected from the moment of application until they are sufficiently dry to bear traffic without damage to the marking, tracking, or adhering to vehicle tires.

Any pavement marking materials spilled or tracked on roadway surfaces shall be removed by the Contractor to the satisfaction of the Engineer and at no additional cost to the State. The method of removal shall be such that it is not injurious to the roadway or other surface and is acceptable to the Engineer.

Any pavement marking that is applied on hot pavement and discolors shall be reapplied, at the Engineer's discretion. Payment for each reapplication will be at the Contract unit price for the reapplied item.

All interim pavement markings, including line striping targets when used, shall be applied so that at the end of each working day all centerlines, island markings, gore markings, lane lines, special markings, etc. are in place on all paved surfaces where traffic will be maintained. During paving and cold planing, work shall be scheduled so that the pavement markings are complete immediately after the paving and cold planing operations cease for the day. All required markings shall be completely placed before dusk.

Unless otherwise directed by the Engineer, edgelines shall be applied within three calendar days of the placement of any course of pavement. The Engineer may require edgelines to be applied within a shorter time frame if traffic volume and the safety of the traveling public appear to require an earlier application.

When line striping targets (LSTs) are not shown on the Plans, but are used as a short term substitute for other temporary pavement markings, they shall be placed as directed by the Engineer and will be paid for as the equivalent quantity of temporary pavement marking for which the LSTs are substituted. However, if it becomes necessary to replace those temporary LSTs with either more LSTs or the actual temporary pavement markings designated for that particular location, no further payment for the temporary pavement markings at that particular location will be made.

Failure on the part of the Contractor to comply with the provisions of this part of the specifications may result in all progress payments being withheld until the required work is performed to the satisfaction of the Engineer.

- (b) Equipment, General. The pavement marking equipment shall meet the approval of the Engineer and shall be maintained in working condition at all times. It shall be of standard commercial manufacture of the type capable of satisfactorily applying the designated material at required application temperatures, rates, and manufacturer's recommended application practices. For long line markings, each machine shall be capable of applying two separate stripes, either solid or dash, at the same time. Each applicator shall be equipped with satisfactory cutoffs that will apply broken, dashed, or dotted lines automatically. Each applicator shall have a mechanical bead dispenser that will operate simultaneously with the applicator and distribute the beads in a uniform pattern at the rate specified over the entire surface area of the marking. The bead placement device shall maximize bead embedment in the marking material. Each applicator shall also be equipped with suitable line guides.

Equipment for application shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. Equipment shall include adequate process controls to regulate the application of marking materials and maintain required temperatures, pressures, and delivery speed of components in the pavement marking.

The pavement marking equipment shall be operated in accordance with recommendations of the equipment manufacturer, unless otherwise directed by the Engineer. Operating speeds shall be such as to provide uniformity and the specified wet or dry film thicknesses.

Pavement marking vehicles shall operate in the lane for traffic moving in the same direction; they shall not encroach into the lane for opposing traffic flow. Exceptions to this requirement shall be approved in writing by the Engineer.

The application equipment shall be so constructed as to ensure continuous uniformity in the dimensions of stripes. The applicator shall provide a means for cleanly cutting off stripe ends squarely and shall provide a method of applying dashed and dotted lines. The equipment shall be capable of applying varying widths of traffic markings.

Equipment to be used for determining temperature, moisture, and material thickness including, but not limited to, a thermometer and a micrometer are specified in Subsection 631.06.

(c) Weather Limitations.

- (1) At the time of application of painted markings, the temperature of the surface to be painted shall be a minimum of 10 °C (50 °F) and the ambient air temperature shall be 10 °C (50 °F) and rising. Ambient hygrometric conditions required for drying within a twenty minute period shall exist or painting shall be suspended.
- (2) At the time of application of durable pavement markings, the pavement surface temperature shall be the greater of: a minimum of 10 °C (50 °F) and the ambient air temperature shall be a minimum of 10 °C (50 °F) and rising or the manufacturer's specified application temperatures.
- (3) If weather does not permit the application of durable markings prior to October 15th, paint will be applied in accordance with this Section and Section 708.
- (4) When it is in the public interest, the Engineer may authorize the application of pavement markings under conditions that vary from these limitations or the manufacturer's published recommendations.

(d) Layout and Control. The Contractor is responsible for the layout of all markings. The pattern of painted, durable, or temporary markings shall be as follows, unless otherwise shown in the Contract Documents or directed by the Engineer:

- (1) Centerline Markings. Centerline markings shall be positioned at the geometric center of the roads. Solid (barrier) lines and dash lines shall start and end at points shown on the Plans or as directed by the Engineer. A dash line shall consist of 3 m  $\pm$  300 mm (10 foot  $\pm$  12 inch) line segments, and 9 m  $\pm$  300 mm (30 foot  $\pm$  12 inch) spaces. The spacing between a double barrier line and between a barrier line and a dash line shall be 100  $\pm$  5 mm (4  $\pm$  1/4 inch). The width of the lines shall be as shown on the Plans,  $\pm$  5 mm ( $\pm$  1/4 inch).

Raised pavement markers will not be permitted for solid (barrier) lines. For dashed lines, four raised pavement markers on 1 m (3 foot) centers shall be used for the 3 m (10 foot) line segment. The 9 m (30 foot) space shall remain a space.

- (2) Edgeline Markings. Edgeline markings shall be applied along both edges of the road, as shown on the Plans or as directed by the Engineer. Edgelines shall be discontinued through intersections of paved public side roads, unless otherwise shown on the Plans. The width of edgelines shall be as shown on the Plans,  $\pm$  5 mm (1/4 inch).

On four-lane roadways, raised pavement markers shall not be used on the right-most lane. Raised pavement markers on the drivers' left side shall be placed on 1.5 m (5 foot) centers.

- (3) Dotted Line. Dotted lines shall be positioned as shown on the Plans or as directed by the Engineer. A dotted line shall consist of 600  $\pm$  50 mm (24  $\pm$  2 inch) line segments, and 1200  $\pm$  50 mm (48  $\pm$  2 inch) spaces. The width of the lines shall be as shown on the Plans,  $\pm$  5 mm ( $\pm$  1/4 inch).

Raised pavement markers shall not be used for dotted lines.

- (4) Control. The Contractor shall provide the necessary horizontal and longitudinal control to keep all longitudinal lines within 50 mm (2 inches) of their designated locations.

In addition, on tangent, the Contractor shall not allow longitudinal lines to vary from either side of a straight line by more than 25 mm (1 inch) in a distance of 30 m (100 feet).

646.05 ACCOMMODATION AND PROTECTION OF TRAFFIC. The Contractor shall provide adequate warning signs and traffic control measures for the accommodation and protection of traffic, as shown on the Plans or as directed by the Engineer. Placement of pavement markings may be suspended at the discretion of the Engineer during peak traffic hours, or at any time, when in the Engineer's judgment, traffic is being unduly hampered, delayed by the work or when traffic interferes with the quality of work.

All equipment and devices necessary for the application of pavement markings and protection thereof, and for the protection of the traveling public shall be as usually required for work of this type, as shown on the Plans or as directed by the Engineer, and shall be furnished by the Contractor.

646.06 PAINT PAVEMENT MARKINGS. Retroflective paint pavement markings shall be applied by a method in which the liquid paint is applied to the road surface and the glass beads are immediately applied on the paint and firmly embedded therein. The application procedure shall provide a retroflective marking, with a night visibility satisfactory to the Engineer. The material shall have a dry film thickness of  $380 \pm 25 \mu\text{m}$  ( $15 \pm 1$  mil) for paint, unless otherwise specified, and shall be applied in a smooth uniform coat, free from thin places or films of excessive thickness.

Liquid tanks on paint application equipment shall be equipped with mechanical agitators. Beads shall be conditioned to provide a smooth uniform rate of release. All materials shall be maintained in the condition recommended by the marking manufacturer prior to and at the time of marking.

Paint shall conform to the requirements of Subsection 708.08 (b) or 708.08 (d). Application shall be in accordance with the manufacturer's requirements.

The paint for permanent markings shall be applied at a rate to create a uniform wet film thickness of 22 mils with an allowable range of +/-2 mils. The application rate shall take into account the surface roughness of the pavement to be marked. Minimum application rates are 70 square feet per gallon (1.9 square meters per liter) with glass beads applied at a rate of 960 grams per liter (8.0 lb per gallon) of paint.

Only painted pavement markings shall be used on portland cement concrete pavement surfaces.

646.07 DURABLE PAVEMENT MARKINGS. Durable pavement markings shall be used at those locations shown on the Plans or directed by the Engineer. Durable pavement markings are classified as pavement marking tape, epoxy paint, thermoplastic markings, polyurea paint, and methyl-methacrylate. Unless otherwise indicated in the Contract, the Contractor may choose any of the following as being acceptable for durable pavement markings:

- (a) Pavement Marking Tape, Type I. Type I tape for pavement markings is classified as non-removable. Type I tape shall conform to the requirements of Subsection 708.12(a).

Type I tapes, when used as a final durable marking, shall be applied only by being inlaid in the bituminous pavement during the rolling operation in accordance with the manufacturer's requirements.

- (b) Epoxy Paint. Epoxy paint for pavement markings shall conform to the requirements of Subsection 708.08(c). Application shall be in accordance with the manufacturer's requirements. Mixing of the epoxy reagents shall be complete prior to the placement of the marking. Failure to set to a hard condition shall be grounds for rejection. Glass beads shall be AASHTO M247 Type I incorporated at 30% mass of the combined material, unless otherwise specified

- (c) Thermoplastic. Thermoplastic pavement markings shall conform to the following requirements and shall meet the requirements of Subsection 708.10.

The thermoplastic pavement marking compound shall be extruded onto the pavement surface in a molten state. The temperature of the material shall not exceed the manufacturer's recommended heating temperature or rate of temperature increase. The surface shall be properly prepared for receipt of the marking material, including surface roughness, cleanliness, and moisture levels. The surface shall be primed when the manufacturer's recommendations require priming.

Following an application of glass beads to the marking surface, and upon cooling to normal pavement temperatures, the resultant marking shall be an adherent retroreflective stripe of the specified thickness and width that is capable of resisting deformation by traffic.

- (1) Thermoplastic Application Equipment. Thermoplastic application equipment shall be approved by the Engineer prior to the start of work.

Thermoplastic material shall be applied to the pavement surface by the extrusion method, wherein the bottom of the extrusion shoe is the pavement and the top and other three sides are contained by, or are part of, suitable equipment for maintaining the temperature and controlling the flow of material. The fourth side contains the extrusion opening.

The ribbon extrusion method will not be permitted.

The equipment used for the placement of thermoplastic pavement markings shall be of two general types:

- a. Mobile Applicator Equipment. The mobile applicator shall be defined as truck mounted equipment designed to apply thermoplastic by the extrusion method. The unit shall be equipped to apply the thermoplastic material at temperatures exceeding 205 °C (400 °F), and at the widths and thicknesses specified herein. The mobile unit shall be capable of operating continuously and/or installing a minimum of 6.1 km (3.8 miles) of longitudinal markings in an eight-hour day.



The mobile unit shall be equipped with extrusion shoes and shall be capable of simultaneously marking edgeline and/or two centerline stripes. The extrusion shoes shall be closed, heat jacketed or suitably insulated units; shall hold the molten thermoplastic at a temperature from 205 to 225 °C (400 to 435 °F); and shall be capable of extruding a line from 100 to 200 mm (4 to 8 inches) wide, between 2.4 and 2.5 mm (96 and 100 mils) thick, and of generally uniform cross-section. Material temperature gauges shall be affixed, adjacent to or incorporated in the extrusion shoe in such a manner as to be visible and capable of monitoring the composition temperature throughout the marking operation.

The mobile unit shall be equipped with an electronic and programmable line pattern control system, or mechanical system, so as to be capable of applying dashed, dotted, or solid lines in any sequence and through any extrusion shoe in any cycle length.

- b. Portable Applicator Equipment. The portable applicator shall be defined as hand operated equipment specifically designed for placing thermoplastic installations such as crosswalks, stop bars, legends, arrows, and short lengths of lane, edge, and centerlines. The portable applicator shall be capable of applying thermoplastic markings by the extrusion method. It is intended that the portable applicator will be loaded with hot thermoplastic composition from the melting kettle(s) or that the material will be melted by an integral "melting stack" when so equipped. The portable applicator shall be equipped with all the necessary components, including a material storage reservoir, bead dispenser, extrusion shoe and heating accessories, so as to be capable of holding the molten thermoplastic at a temperature from 205 to 225 °C (400 to 435 °F), and of extruding a line from 100 to 200 mm (4 to 8 inches) wide in 50 mm (2 inch) increments, between 2 and 2.5 mm (80 and 100 mils) thick, and of generally uniform cross-section. Material temperature gauges shall be affixed, adjacent to or incorporated in the extrusion shoe in such a manner as to be visible and capable of monitoring the composition temperature throughout the marking operation. If a machine, as manufactured, cannot be equipped with gauges at the extrusion shoe, the Engineer may approve an alternate method of monitoring the composition temperature at the point of deposition.

(2) Application Requirements.

- a. Primer. Primer shall be used under such conditions, at such rates and thicknesses and of a type as is recommended by the manufacturer of the thermoplastic material being applied. Bituminous concrete primer shall be applied to pavements older than two years at the application rates and procedures recommended by the manufacturer of the thermoplastic material.
- b. Thermoplastic Composition. Thermoplastic composition shall conform to the requirements of Subsection 708.10.
- c. Application Temperature. Thermoplastic composition shall be applied at a temperature range between 205 and 225 °C (400 and 435 °F).
- d. Extruded Markings. All extruded markings shall be applied at the specified width and at a thickness between 2.4 and 2.5 mm (96 and 100 mils) exclusive of any drop on glass beads.
- e. Beads.
  1. Glass beads meeting the requirements of AASHTO M247 Type I incorporated into the thermoplastic composition at a rate of between 28 and 30 percent by mass (weight) of the combined material.
  2. Reflective glass spheres (for “drop on”) shall be placed concurrently with application of the thermoplastic. The reflective glass spheres shall be dropped onto the molten thermoplastic marking at the rate of 245 g/m<sup>2</sup> [7 ounces (avoir) per square yard] of composition. The glass spheres shall conform to the requirements of AASHTO M247 Type I.

- f. Gaps and Overlaps. When applying durable diagonal pavement markings that are to be enclosed within durable long line borders, the Contractor shall apply the diagonals in such a manner as to allow a maximum of a single overlap and no gaps between the diagonals and the long lines.

Where possible and where applicable, a 50 mm (2 inch) gap should be maintained between thermoplastic pavement markings and parallel joints in bituminous concrete pavement. This requirement is secondary to the alignment controls specified in Subsection 646.04(d).

- (d) Polyurea Paint. Approved polyurea marking materials shall be one of the markings listed on the Approved Products List on file with the Agency's Materials and Research Section under Subsection 708.08(a). Glass beads shall be AASHTO M247 Type I incorporated at 30% mass of the combined material, unless otherwise specified.
- (e) Methyl-methacrylate Paint. Approved Methyl-methacrylate Paint shall be one of the Methyl-methacrylate Paints listed on the Approved Products List on file with the Agency's Materials and Research Section under Subsection 708.08(e). Glass beads shall be AASHTO M247 Type I incorporated at 30% mass of the combined material, unless otherwise specified.

646.08 TEMPORARY PAVEMENT MARKINGS. Temporary pavement markings are classified as Type II tape (removable), Pavement Marking Mask, Type II raised pavement markers, traffic paint with glass beads, and line striping targets. Unless otherwise indicated in the Contract, the Contractor may choose any of the above as being acceptable for temporary pavement markings.

- (a) Pavement Marking Tape, Type II. Type II tape for pavement markings is classified as temporary. Type II tape shall conform to the requirements of Subsection 708.12 (b), and shall be installed in accordance with the manufacturer's requirements.

- (b) Pavement Marking Mask. Black or other compatible pavement color Pavement Marking Mask is classified as removable. It shall conform to the requirements of Subsection 708.12 (c), and shall be installed in accordance with the manufacturer's requirements.
- (c) Raised Pavement Markers, Type II. Type II raised pavement markers are intended to be temporary markers, usually placed and removed during the period of construction activity.

Type II raised pavement markers, of the color shown on the Plans or directed by the Engineer, shall be installed at the locations shown on the Plans or directed by the Engineer. Unless otherwise shown on the Plans or directed by the Engineer, Type II raised pavement markers shall be installed in accordance with the requirements of the MUTCD.

- (d) Line Striping Targets. Line striping targets are intended to be substitutes for planned pavement markings on the wearing course of pavement, and shall be used only in conjunction with "Do Not Pass" signs for not longer than 14 calendar days.

Line striping targets of the color shown on the Plans or directed by the Engineer shall be installed as described below or as directed by the Engineer.

Line striping targets in conjunction with "Do Not Pass" signs shall be used on wearing courses of pavement prior to applying durable markings. Durable markings shall be placed within two weeks of the date the segment of wearing course pavement is placed. Line striping targets shall be placed at 12 m (40 foot) intervals on tangents and curves with a radius of 235 m (771 feet) or greater and at 6 m (20 foot) intervals on curves with a radius less than 235 m (771 feet), or as determined by the Engineer.

"Do Not Pass" signs shall be erected prior to traffic traveling on the wearing course of pavement. "Do Not Pass" signs shall be erected on each side of the road 300 m (985 feet) into the project limits and subsequent signs placed at 800 m (2625 foot) intervals. Additional signs shall be utilized 300 m (985 feet) from significant side roads.

“Do Not Pass” signs shall be 610 by 760 mm (24 × 30 inch) black text on orange Type III retroreflective sheeting as shown on the Plans and shall be mounted as shown on the Plans. The signs shall be turned away from traffic immediately upon placement of the durable markings.

- (e) Paint. Temporary paint applied on the base or intermediate courses of pavement shall have a thickness of  $200 \pm 25 \mu\text{m}$  ( $8 \pm 1$  mil). Beads shall be applied at a rate of 360 g/L (3 pounds per gallon) of paint.

All paint used for temporary markings shall be held to the same alignment and horizontal control standards as specified in Subsection 646.04.

Temporary markings that remain in place for fewer than seven calendar days shall be Type II tape (removable) or Type II raised pavement markers. Paint will not be permitted for use as a temporary marking which remains in place for fewer than seven calendar days on the wearing course of pavement.

#### 646.09 OTHER RELATED MARKINGS.

- (a) Pavement Marking Recess. Recessed pavement markings shall be installed as specified for permanent markings. The recess shall be a uniform depth across the width of the marking. The recess shall be controlled such that the depth provided is 125% of the marking material thickness. The recess shall be clean and dry at the time of marking placement.
- (b) Raised Pavement Markers, Type I. Type I raised pavement markers are intended to be permanently installed in the pavement surface and are manufactured of a material which will resist destruction by snow plowing equipment.

Type I raised pavement markers shall meet the requirements as specified in Subsection 708.11 and shall be permanently installed in the wearing course of pavement in accordance with the manufacturer’s recommendations.

Type I raised pavement markers of the color shown on the Plans or directed by the Engineer shall be installed at the locations shown the Plans or directed by the Engineer. Unless otherwise shown on the Plans or directed by the Engineer, Type I raised pavement markers shall be installed in accordance with the requirements of the MUTCD.

- (c) Painted Curbs and Islands. Where painted curb or painted island is called for, the existing curb or island shall be blast cleaned or wire brushed to remove scale, dirt, grass, etc. to the satisfaction of the Engineer, prior to painting. This cleaning work will not be paid for directly, but will be considered incidental to the Contract item Painted Curb or Painted Island.

Paint shall be applied at a rate of 2.5 to 2.8 m<sup>2</sup>/L (100 to 115 square feet per gallon) with glass beads applied at a rate of 720 g/L (6 pounds per gallon). All paint shall be applied within the manufacturer's allowable application temperatures.

Retroreflective paint shall be applied by a method in which the liquid material is applied to the curb or island surface and the glass beads are immediately applied to the material and firmly embedded therein, and which shall provide a retroreflective marking, with a night visibility satisfactory to the Engineer. The material shall have a minimum wet film thickness of 380 ± 25 µm (15 ± 1 mil), unless otherwise specified, and shall be applied in a smooth uniform coat, free from thin places or films of excessive thickness.

Beads shall be applied uniformly over the entire painted surface area at the specified rate.

646.10 SUBSTITUTION OF MARKING MATERIALS. If the durable markings can not be placed under suitable environmental conditions, paint shall be applied at the current standards as specified in Subsection 646.06 at no cost to the Agency. Where it can be determined that through no fault of the Contractor the durable markings cannot be applied under suitable environmental conditions, paint may be applied for durable marking of the types indicated on the Plans where appropriate and as directed by the Engineer.

Regardless of the circumstance under which paint is applied after an unsuitable environmental condition determination, durable markings of the types indicated on the Plans shall be applied as soon as suitable environmental conditions permit during the following Spring. These durable markings shall be measured and paid for in accordance with Subsections 646.13 and 646.14.

646.11 ALTERNATE MARKING MATERIALS. If the Contractor wishes to use pavement markings or markers that are not specified in this Section, the Contractor shall submit samples, technical data, installation instructions and, if applicable, removal instructions to the Engineer for approval at least 30 calendar days before the date the markings or markers are to be placed. The Engineer, after consultation with the Materials and Research Engineer, will approve or disapprove the use of the submitted products within the 30 calendar day period. The Contractor should be prepared to place approved markings on the proper date, even if the submittal is disapproved.

646.12 REMOVAL OF EXISTING PAVEMENT MARKINGS. Existing markings shall be obliterated in such a manner and by such means that a minimum of pavement scars are left and all of the existing marking is removed; i.e., grinding a square or rectangle on the pavement to remove a letter or arrow or grinding a large rectangle to remove a word so that the outline of the letter, symbol, or word is not ground into the pavement and therefore still legible even though the marking has been removed. Painting over existing markings is not an acceptable method of removal. The work shall be completed to the satisfaction of the Engineer. Masking of lines in intermediate duration activities shall be completed according to the Plans or as directed by the Engineer.

646.13 METHOD OF MEASUREMENT. The quantity of Pavement Marking edgeline(s) and centerline(s) of the type(s) and size(s) specified to be measured for payment will be the number of meters (linear feet) applied in the complete and accepted work, as measured along the centerline of the pavement stripe. The number of meters (linear feet) of open spaces in a dashed or dotted line will not be measured for payment.

The quantity of Paint Pavement Marking(s) of the type(s) and size(s) specified per Subsection 646.10 through no fault of the Contractor and applied on the project to be measured for payment will be the quantity determined per the measure for the Durable Pavement Marking specified, multiplied by a factor of 1.5 to determine the accepted quantity for payment.

The quantity of Stop Bar of the type specified to be measured for payment will be the number of meters (linear feet) applied in the complete and accepted work, as measured along the centerline of the pavement stripe.



The quantity of Letter or Symbol of the type specified to be measured for payment will be the number of each unit applied in the complete and accepted work. A unit will consist of one letter or one symbol. Example: "SCHOOL" would be measured as six units, a handicapped symbol would be measured as one unit.

The quantity of Crosswalk Marking of the type specified to be measured for payment will be the number of meters (linear feet) applied from curb to curb in the complete and accepted work, as measured along the center of the crosswalk.

The quantity of Railroad Crossing Symbol of the type specified to be measured for payment will be the number of each unit applied in the complete and accepted work. A unit will consist of three "stop bars," two "R's," and one "X" for one traffic lane in one direction of travel.

The quantity of Raised Pavement Markers, Type II to be measured for payment will be the number of individual markers installed in each phase of the traffic control plan and removed when no longer needed.

The quantity of Line Striping Targets to be measured for payment will be the number of individual targets installed on the pavement and removed when no longer needed.

The quantity of Raised Pavement Markers, Type I to be measured for payment will be the number of individual markers installed on/in the pavement in the complete and accepted work.

The quantity of Painted Curb to be measured for payment will be the number of meters (linear feet) applied in the complete and accepted work, as measured along the centerline of the pavement stripe.

The quantity of Painted Island to be measured for payment will be the number of square meters (square feet) of the top of an island painted in the complete and accepted work.

The quantity of Removal of Existing Pavement Markings to be measured for payment will be the number of square meters (square feet) of markings removed or total area in square meters (square feet) of symbol or letter removed in the complete and accepted work, as determined by the Engineer.

The quantity of Pavement Marking Mask to be measured for payment will be the number of square meters (square feet) of existing marking masked in the complete and accepted work.

646.14 BASIS OF PAYMENT. The accepted quantity of Pavement Marking edgeline(s) and centerline(s) of the type(s) and size(s) specified will be paid for at the Contract unit price(s) per meter (linear foot).

The accepted quantity of Paint Pavement Markings of the type(s) and size(s) specified per Subsection 646.10 and measured for payment will be paid for at the corresponding Contract unit price(s) for Temporary Pavement Marking(s).

The accepted quantity of Stop Bar of the type specified will be paid for at the Contract unit price per meter (linear foot).

The accepted quantity of Letter or Symbol of the type specified will be paid for at the Contract unit price per each unit.

The accepted quantity of Crosswalk Marking of the type specified will be paid for at the Contract unit price per meter (linear foot).

The accepted quantity of Railroad Crossing Symbol of the type specified will be paid for at the Contract unit price per each unit.

The accepted quantity of Raised Pavement Markers, Type I will be paid for at the Contract unit price per each unit.

The accepted quantity of Painted Curb will be paid for at the Contract unit price per meter (linear foot).

The accepted quantity of Painted Island will be paid for at the Contract unit price per square meter (square foot).

Payment will be full compensation for furnishing, transporting, handling, assembling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The Contract unit price for recessed Pavement Marking items will also include all labor, equipment, tools, and incidentals necessary for the placement of the recess and any necessary cleaning, drying, or conditioning of the recess prior to placement of the marking.

The Contract unit price for Pavement Marking items that are used as temporary pavement markings (tape, raised pavement markers, paint, and line striping targets) as specified in Subsection 646.08 will also include all costs of removal of those temporary markings, if removal is required by construction procedures, shown on the Plans or directed by the Engineer.

The accepted quantity of Raised Pavement Markers, Type II will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, transporting, handling, and installing the markers as required for each phase of the traffic control plan; for maintaining the installed units during the phase and removing the markers, if necessary, when the phase has been completed; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Adjusting the markers as required by the Engineer during each phase of the traffic control plan, including replacing or resetting improperly placed or poorly oriented markers, will be considered incidental to the Contract item Raised Pavement Markers, Type II.

The accepted quantity of Line Striping Targets will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, transporting, handling, installing, removing, and disposing of the targets and the "Do Not Pass" signs, posts, and sleeves (if used); and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. If line striping targets remain in place on the roadway for longer than 14 calendar days, no payment will be made for the Contract item Line Striping Targets.

The accepted quantity of Removal of Existing Pavement Markings will be paid for at the Contract unit price per square meter (square foot). Payment will be full compensation for removing the markings and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. No payment will be made for removal of temporary paint markings installed and removed under the Contract.

The accepted quantity of Pavement Marking Mask will be paid for at the Contract unit price per square meter (square foot). Payment will be full compensation for obliterating existing markings with a masking material, for removing the masking material when it is no longer required as directed by the Engineer, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

"Do Not Pass" signs will not be paid for directly, but will be considered incidental to the Contract item Line Striping Targets.

The Contractor is responsible for supplying necessary materials and equipment recommended by the manufacturer to determine the surface moisture condition of the pavement. The costs for supplying this material and equipment are paid for under the appropriate Contract item specified in Section 631.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
(a) <u>Paint Pavement Markings.</u>	
646.20 100 mm (4 inch) White Line	Meter (Linear Foot)
646.21 100 mm (4 inch) Yellow Line	Meter (Linear Foot)
646.214 150 mm (6 inch) White Line	Meter (Linear Foot)
646.215 150 mm (6 inch) Yellow Line	Meter (Linear Foot)
646.22 200 mm (8 inch) White Line	Meter (Linear Foot)
646.23 200 mm (8 inch) Yellow Line	Meter (Linear Foot)
646.24 300 mm (12 inch) White Line	Meter (Linear Foot)
646.25 300 mm (12 inch) Yellow Line	Meter (Linear Foot)
646.26 600 mm (24 inch) Stop Bar	Meter (Linear Foot)
646.30 Letter or Symbol	Each
646.31 Crosswalk Marking	Meter (Linear Foot)
646.32 Railroad Crossing Symbol	Each
(b) <u>Durable Pavement Markings.</u>	
646.400 to 646.409 Durable 100 mm (4 inch) White Line	Meter (Linear Foot)
646.410 to 646.419 Durable 100 mm (4 inch) Yellow Line	Meter (Linear Foot)
646.420 to 646.429 Durable 150 mm (6 inch) White Line	Meter (Linear Foot)
646.430 to 646.439 Durable 150 mm (6 inch) Yellow Line	Meter (Linear Foot)
646.440 to 646.449 Durable 200 mm (8 inch) White Line	Meter (Linear Foot)
646.450 to 646.459 Durable 200 mm (8 inch) Yellow Line	Meter (Linear Foot)
646.460 to 646.469 Durable 300 mm (12 inch) White Line	Meter (Linear Foot)
646.470 to 646.479 Durable 300 mm (12 inch) Yellow Line	Meter (Linear Foot)
646.480 to 649.489 Durable 600 mm (24 inch) Stop Bar	Meter (Linear Foot)
646.490 to 646.499 Durable Letter or Symbol	Each
646.500 to 649.509 Durable Crosswalk Marking	Meter (Linear Foot)
646.510 to 646.519 Durable Railroad Crossing Symbol	Each

(c)	<u>Temporary Pavement Markings.</u>	
	646.600 to 646.605 Temporary 100 mm (4 inch) White Line	Meter (Linear Foot)
	646.610 to 646.615 Temporary 100 mm (4 inch) Yellow Line	Meter (Linear Foot)
	646.620 to 646.625 Temporary 150 mm (6 inch) White Line	Meter (Linear Foot)
	646.630 to 646.635 Temporary 150 mm (6 inch) Yellow Line	Meter (Linear Foot)
	646.640 to 646.645 Temporary 200 mm (8 inch) White Line	Meter (Linear Foot)
	646.650 to 646.655 Temporary 200 mm (8 inch) Yellow Line	Meter (Linear Foot)
	646.660 to 646.665 Temporary 300 mm (12 inch) White Line	Meter (Linear Foot)
	646.670 to 646.675 Temporary 300 mm (12 inch) Yellow Line	Meter (Linear Foot)
	646.680 to 646.685 Temporary 600 mm (24 inch) Stop Bar	Meter (Linear Foot)
	646.690 to 646.695 Temporary Letter or Symbol	Each
	646.700 to 646.705 Temporary Crosswalk Marking	Meter (Linear Foot)
	646.710 to 646.715 Temporary Railroad Crossing Symbol	Each
	646.75 Raised Pavement Markers, Type II	Each
	646.76 Line Striping Targets	Each
(d)	<u>Other Related Marking Items.</u>	
	646.80 Raised Pavement Markers, Type I	Each
	646.81 Painted Curb	Meter (Linear Foot)
	646.82 Painted Island	Square Meter (Square Foot)
(e)	<u>Marking Removal.</u>	
	646.85 Removal of Existing Pavement Markings	Square Meter (Square Foot)
	646.86 Pavement Marking Mask	Square Meter (Square Foot)

SECTION 649 - GEOTEXTILE FABRIC

649.01 DESCRIPTION. This work shall consist of furnishing and placing geotextiles in underdrain trenches, under embankments, for embankment reinforcement, under riprap and stone fill, behind retaining structures, over roadbed subgrades, and beneath pavement overlays.

649.02 MATERIALS. Geotextile terms are defined in Section 720. Materials shall conform to the applicable requirements of Section 720 and the following:

- (a) Where sewn seams are used, the Contractor shall furnish the manufacturer's wide strip tensile test results as part of the certification. The results must verify that the seam meets or exceeds the specified average minimum roll values for the grab tensile strength of the geotextiles, or wide strip tensile strength for reinforcement applications.
- (b) Where field seams are made, the Contractor shall provide the Engineer with a field-stitched seam test sample in accordance with ASTM D 1683. The Engineer's approval will be required prior to the Contractor beginning production field stitching/seaming.
- (c) Where woven wire reinforcement is used, the woven wire shall be 14 gauge minimum with a 150 mm (6 inch) maximum mesh opening.

649.03 GENERAL. The rolls of geotextile shall be protected against damage and deterioration until incorporated into the project. The geotextile shall be dry at the time of installation. The geotextile shall be rejected if, at the time of installation, it has defects, deterioration, or damage as determined by the Engineer.

649.04 INSTALLATION.

- (a) General. The surface receiving the geotextile shall be prepared to a smooth condition free of obstructions, depressions and debris, unless otherwise directed by the Engineer. Where angular aggregate or sharp objects will be in contact with the geotextile, increased geotextile strength properties will be required as specified in Section 720. The geotextile shall not be dragged on the ground or mishandled in any way. The geotextile shall be placed loosely and without wrinkles so that placement of the overlying material will not tear the geotextile. The geotextile shall be lapped or sewn as specified at the ends and sides of adjoining sheets. In addition to the above general requirements, the following specific requirements shall be followed for the specified application:
- (1) Geotextile Placement on Slopes. The geotextile sheets shall be placed with the machine direction oriented perpendicular to the slope. When the geotextile is placed on slopes steeper than 1:6 (vertical:horizontal), the upper sheets shall lap over the top of the lower sheets. The laps shall be securely anchored to the ground surface with pins or stakes as necessary to prevent slippage and tearing of the geotextile. As specified by the geotextile manufacturer or as directed by the Engineer, placement of fill material on the geotextile shall start at the toe of the slope and proceed upwards.
  - (2) Geotextile Placement for Stream Bank Protection. Where geotextiles are placed under water, or in an area where water will flow, the geotextile shall be placed with its machine direction parallel to the direction of water flow. Successive geotextile sheets shall be overlapped in such a manner that the upstream sheet is placed over the top of the downstream sheet. The geotextile shall be adequately secured to prevent slippage. As the geotextile is placed under water, the backfill material shall be placed on it to the required thickness. The geotextile placement shall not progress more than 15 m (50 feet) ahead of the backfill placement.
  - (3) Underdrains. When a geotextile is specified to line an underdrain trench, the geotextile shall be placed to conform loosely to the shape of the trench.

- (4) Geotextiles Under Stone Fill. Geotextiles under riprap or stone fill shall be constructed in accordance with the details shown on the Plans and the following requirements. The Contractor shall demonstrate to the satisfaction of the Engineer that the combination of the stone fill drop height and the thickness of any sand cushion, when specified or required, are adequate so as not to puncture or damage the geotextile when placing the riprap or stone fill. Where a sand cushion is used, it shall be a minimum of 150 mm (6 inches) thick, unless otherwise directed by the Engineer. In addition, the following limits apply:

Type of Stone Fill	Maximum Drop Height	
	Onto Geotextile	Onto a Sand Cushion Blanket
Type I	900 mm (36 inches)	900 mm (36 inches)
Type II, III, IV,0 and Riprap		300 mm (12 inches)

After placement of the stone fill or riprap, all voids in the stone face that allow the geotextile to be visible shall be satisfactorily backfilled so that the geotextile is completely covered.

- (5) Roadbed Subgrade and Railroad Ballast Separation. The subgrade shall be prepared in accordance with Section 203. Construction vehicles shall be limited in size and mass (weight) such that rutting of the initial lift placed above the geotextile is no greater than 75 mm (3 inches) deep. Ruts shall not be graded off but shall be filled with material specified by the Engineer such that a minimum 200 mm (8 inches) of cover is kept over the geotextile. Turning of vehicles on the first lift of cover material shall not be permitted. The Contractor shall not use vibratory rollers on the first lift if pumping or distortion of the subgrade occurs, as determined by the Engineer.



- (6) Silt Fence. The geotextile, and when required woven wire reinforcement, shall be attached on the up-slope side of posts in accordance with the manufacturer's recommendation or as directed by the Engineer. The geotextile at the bottom of the fence shall be buried in a trench a minimum of 150 mm (6 inches) below the ground surface. Where the geotextile elongation is 50 percent as measured in accordance with ASTM D 4632, the post spacing shall not exceed 1.2 m (4 feet); and where the elongation is less than 50 percent, the post spacing shall not exceed 2 m (6 feet).

Either wood or steel posts shall be used. The posts shall have a minimum length of 910 mm (3 feet) and shall be embedded a minimum of 405 mm (16 inches) below the ground surface. The spacing of the posts shall be as shown in the Plans, or as determined by the silt fence manufacturer or the Engineer.

Wood posts shall have minimum dimensions of 25mm by 25 mm (1 inch × 1 inch) and shall be free of defects such as knots, splits, or gouges. Steel posts shall consist of either No. 22 (No. 7) size reinforcing steel or larger, or shall consist of ASTM A 120 steel pipe with a minimum diameter of 20 mm (3/4 inch).

Sediment deposits that accumulate behind the fence shall be removed when the deposit reaches 50 percent of the height of the silt fence above the ground surface.

The Contractor shall repair or replace damaged silt fence as ordered by the Engineer. The silt fence shall be completely removed prior to acceptance of the project, unless otherwise directed by the Engineer.

- (7) Filter Curtain. When used to contain sediments or pollutants from a work area that is adjacent to or under water, the fabric shall be installed to completely enclose the portion of the work area that will be under water. The Contractor shall design and construct the curtain to deflect and withstand any existing current or wave action, to be anchored continuously along the bottom, to be effective at any anticipated water level, and to prevent the escape of all sediments or pollutants into the main stream or body of water.

The Contractor shall repair or replace damaged or otherwise ineffective filter curtains as ordered by the Engineer. The Contractor shall remove material accumulated behind the filter curtain as directed by the Engineer.

The Contractor shall remove the filter curtain and all supporting and anchoring material prior to acceptance of the project, unless otherwise directed by the Engineer.

The design, construction, and maintenance plan for the filter curtain installation shall be acceptable to the Engineer before installation of the curtain begins.

- (b) Protection of Geotextile. The Contractor shall not permit traffic or construction equipment to travel directly on the geotextile. The geotextile shall be protected at all times during construction from contamination by surface runoff and construction activities. The geotextile shall be covered with the specified cover material as soon as possible; uncovered conditions shall not exceed seven days. Specified cover material shall be placed on the geotextile in such a manner that the geotextile is not torn, punctured, or shifted. The minimum cover layer shall be 200 mm (8 inches) thick or twice the maximum aggregate size, whichever is thicker, before construction equipment is allowed over the area of the geotextile. The Contractor shall not permit end-dumping of aggregates from trucks directly on the geotextile.
- (c) Repair of Geotextile. All geotextile that is torn, punctured, or contaminated during construction shall be repaired or replaced by the Contractor. The repair shall consist of a patch of the same type of geotextile placed over the affected area. The patch shall overlap the existing geotextile a minimum of 900 mm (36 inches) from the edge of any part of the rupture. Where geotextile seams are required to be sewn, all damaged sheets shall be repaired by sewing, unless otherwise shown in the Contract Documents or as directed by the Engineer.

- (d) Overlaps. The minimum overlap requirements for geotextiles are as follows:

<u>Minimum Overlap Requirements</u>	
Underdrain Trench	300 mm (12 inches)
Under Type I and II Stone Fill	600 mm (24 inches)
Under Riprap and Type III and IV Stone Fill	900 mm (36 inches)
Roadbed Subgrade Stabilization	900 mm (36 inches)
Under Railroad Ballast	900 mm (36 inches)

In the event the Engineer determines that the specified overlap is not sufficient, the overlap shall be increased to provide adequate coverage or the geotextile shall be sewn together in the field. If field sewn, the requirements in part (e) below shall apply.

- (e) Field Seams. Field seams shall be sewn with polymeric thread, consisting of polypropylene, polyester, or Kevlar and shall be as resistant to deterioration as the geotextile being sewn. The thread shall be of a contrasting color with the geotextile being sewn, and the seams shall be made such that the stitches are exposed for inspection when the geotextile is placed.
- (1) Stitching Equipment. The stitching equipment shall be such that it will provide an acceptable lock-type stitch, as recommended by the geotextile manufacturer and approved by the Engineer.
  - (2) Stitch Requirements. Two rows of lock-type stitching shall be used to make the seam. The two rows of stitching shall be 13 mm (1/2 inch) apart with a tolerance of  $\pm 6$  mm ( $\pm 1/4$  inch) and shall not cross, except for restitching.

- (3) Minimum Seam Allowance. The minimum required seam allowances, i.e., the minimum distances from the geotextile edge to the stitchline nearest to that edge, are as follows:

Seam Type (See Plans)	Minimum Seam Allowance
Flat or Prayer Seam, Type SSa-1	40 mm (1 1/2 inches)
“J” Seam, Type SSa-1	125 mm (1 inch)
Butterfly-Folded Seam, Type SSd-1	25 mm (1 inch)

- (4) Seam Type. The Contractor shall obtain the geotextile manufacturer’s recommendation for the type of seam and stitch to be used. If the Contractor does not provide the foregoing technical information, then the Contractor shall use a “J” seam with two passes of a lock-type stitch which places at least three stitches per 25 mm (1 inch) of sewn seam. This seam will be tested as required by these Specifications. The prayer seam (flat) may be used for repair of damaged in-place geotextile.

649.05 METHOD OF MEASUREMENT. The quantity of Geotextile of the type specified to be measured for payment will be the number of square meters (square yards) placed in the complete and accepted work. Slope measurements will be used in computing the area. Measurement will not be made for material used for repairs, seams, or overlaps. Measurement will not be made for material used to replace an installation of fabric that has become damaged, destroyed, lost, washed away, or otherwise ineffective unless authorized by the Engineer.

649.06 BASIS OF PAYMENT. The accepted quantity of Geotextile of the type specified will be paid for at the Contract unit price per square meter (square yard). Payment will be full compensation for furnishing, transporting, storing, handling, placing, repairing, and removing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Unless otherwise specified in the Contract, payment for the maintenance of Geotextile of the type specified will not be paid for directly, but will be considered incidental to the specific Contract item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
649.11 Geotextile For Roadbed Separator	Square Meter (Square Yard)
649.21 Geotextile Under Railroad Ballast	Square Meter (Square Yard)
649.31 Geotextile Under Stone Fill	Square Meter (Square Yard)
649.41 Geotextile For Underdrain Trench Lining	Square Meter
649.51 Geotextile For Silt Fence	Square Meter (Square Yard)
649.515 Geotextile for Silt Fence, Woven Wire Reinforced	Square Meter (Square Yard)
649.61 Geotextile For Filter Curtain	Square Meter (Square Yard)

SECTION 651 - TURF ESTABLISHMENT

651.01 DESCRIPTION. This work shall consist of the preparation of the area and the application of topsoil, grubbing material, sod, seed, soil amendments, and mulch.

651.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Topsoil.....	755.02
Sod.....	755.03
Seed.....	755.04
Compost.....	755.05
Fertilizer.....	755.06
Agricultural Limestone.....	755.08
Liquid Lime.....	755.09
Hay Mulch.....	755.10(a)
Fiber Mulch.....	755.10(d)
Hydraulic Matrix.....	755.10(e)
Tackifier.....	755.10(f)
Straw Mulch.....	755.10(g)
Temporary Erosion Matting.....	755.11(a)
Permant Erosion Matting.....	755.11(b)

Stakes for holding sod shall be rounded or square wooden stakes at least 200 mm (8 inches) long, having a cross-sectional area of approximately 650 mm<sup>2</sup> (1 in<sup>2</sup>). Stakes of other materials or designs may be used when authorized by the Engineer.

Grubbing Material for use on stone fill along streams shall consist of grubbed or stripped earth material containing roots of native stream bank vegetation. Material for use on rock fill slopes shall consist of grubbed or stripped earth material containing roots (not necessarily from native stream bank vegetation) which will promote the growth of vegetation.

Grubbing Material shall not contain any invasive plant material found on the Invasive Species List on file with the Vermont Agency of Agriculture.

651.03 SEASONAL LIMITATIONS. Turf establishment shall occur from May 1st to September 15th unless otherwise authorized under applicable permits and directed by the Engineer. If turf has not been established before October 15th due to the Contractor's neglect, additional stabilization measures as approved by the Engineer shall be implemented at the Contractor's expense.

651.04 GENERAL. The Contractor shall place turf establishment items on all cuts and fills within 48 hours of obtaining final grade, unless otherwise directed by the Engineer.

The Contractor shall be responsible for a vigorous growth of grass until final acceptance of the project. All seeded or sodded areas shall be watered sufficiently to promote continuous growth.

651.05 PREPARATION OF AREA. In areas to be topsoiled and/or sodded, allowance shall be made for the depth of topsoil and/or thickness of sod if not accounted for on the Plans. All breaks in grade shall be well rounded. The surface shall be thoroughly raked, dragged, or otherwise mechanically smoothed. All stones, lumps, roots, or other objectionable materials shall be removed. The soil shall be loosened to a depth of approximately 50 mm (2 inches).

If shown on the Plans or if in the opinion of the Engineer, the area to be seeded or sodded is of such a composition that it is unsuitable for vegetation, it shall be covered with 50 mm (2 inches) of topsoil.

Also, if shown on the Plans or determined necessary by the Engineer to reduce compaction and erosion potential and to increase drainage, nutrient exchange capacity, and moisture retention as well as the speed and total % germination of seed and knitting of roots for sodded areas, compost shall be incorporated into the topsoil such that it comprises 25% of the total prepared soil.

Fertilizer and Agricultural Limestone shall be spread over the area to be sodded. If specified in the Contract Documents or deemed necessary by the Engineer, the Contractor shall conduct a soil test to determine the type and quantity of fertilizer and limestone to be used.

651.06 TOPSOIL. Topsoil shall be obtained from a source shown on the Plans or otherwise approved by the Engineer. Spreading shall not be done when ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work, as determined by the Engineer.

The topsoil shall be spread evenly to a depth of approximately 50 mm (2 inches) or to the depth as shown on the Plans. Topsoil shall be lightly compacted as heavy compaction will reduce the potential for seed-soil contact and germination success.

All large stones and other unsuitable material shall be removed from the area.

Topsoil stockpile areas shall be graded, seeded, and left in a neat and presentable condition. Areas shall be properly drained and all excess or unsuitable materials removed and disposed. This work shall be done to the satisfaction of the Engineer and shall comply with all relevant permits.

Any topsoil stockpiled for more than one year shall be laboratory tested by the Contractor to determine which amendments may need to be incorporated to aid in the establishment of vegetation.

651.07 GRUBBING MATERIAL. Grubbing material shall be placed as shown on the Plans or as directed by the Engineer. Spreading shall not be done when grubbing material is frozen, excessively wet, or otherwise in a condition detrimental to the work, as determined by the Engineer.

The grubbing material shall be spread evenly to a depth of approximately 300 mm (12 inches) or to the depth shown on the Plans. All large stones and other unsuitable material shall be removed from the area.

Grubbing material stockpile areas shall be graded, seeded, and left in a neat and presentable condition. Areas shall be properly drained and all excess or unsuitable materials removed and disposed. This work shall be done to the satisfaction of the Engineer and shall comply with all relevant permits.

Any grubbing material stockpiled for more than one year shall be laboratory tested by the Contractor to determine which amendments may need to be incorporated to aid in the establishment of vegetation.

651.08 SEEDING.

- (a) Seed, Limestone and Fertilizer. Seed, limestone, and fertilizer shall be spread uniformly at the rate specified and at the locations shown on the Plans.

Seeding shall not be done when ground is frozen, excessively wet, or otherwise untillable. Seed, limestone, and fertilizer may be applied using a hydraulic application machine (i.e. hydroseeder) or by hand.

Hydroseeding shall consist of mixing and applying seed, lime, commercial fertilizer, stabilizing emulsion, and other materials with water, as specified in the approved Erosion Prevention and Sediment Control Plan.

The quantity of water shall be as needed for application, except that when stabilizing emulsion is specified, the ratio of total water to total stabilizing emulsion in the mixture shall be as recommended by the manufacturer of the emulsion. Mixing of materials for application with hydro-seeding equipment shall be performed in a tank with a built-in continuous agitation system of sufficient operating capacity to produce a homogeneous mixture and a discharge system which will apply the mixture at a continuous and uniform rate. A dispersing agent may be added to the mixture provided the Contractor furnishes evidence that the additive is not harmful. Any material considered harmful, as determined by the Engineer, shall not be used.

When seeding is done by the hydraulic method, liquid lime may be substituted for agricultural limestone at a rate of 4.2 liters (1.1 gallons) of liquid lime to 227 kilograms (500 pounds) of agricultural limestone or at such other rate as recommended by the manufacturer and approved by the Engineer.

Any mixture containing stabilizing emulsion shall not be applied during rainy weather or when soil temperatures are below 5°C (40°F). Pedestrians or equipment shall not be permitted to enter areas where mixtures containing stabilizing emulsion have been applied until vigorous vegetation is established.

Seed sown by hand shall be incorporated into the top ¼ inch of soil by hand raking or other method approved by the Engineer.

Mulching shall occur the same day as the seeding operation.



- (b) Mulch. Mulch shall be applied to disturbed areas that have been seeded and require temporary protection until permanent vegetation is established or disturbed areas that must be re-disturbed following an extended period of inactivity.

1. Hay Mulch. Hay mulch shall be applied uniformly, by hand or mechanical blower, over the area at a minimum rate of 4.5 metric tons per hectare (2 tons per acre) or as ordered by the Engineer. Hay mulch shall be anchored by mechanical methods or by applying a tackifier, unless otherwise directed by the Engineer.

Erosion matting in the form of a biodegradable mesh netting may be applied to reinforce the mulch until turf is established.

Tackifier may be applied in a liquid or dry powder form using the methods and rates recommended by the manufacturer based on longevity and ability to hold fibers in place. To allow tackifier time to cure and bond the hay fibers together and to the soil surface, hay mulch with tackifier shall not be applied during or immediately before rainfall.

2. Hydraulic Mulch. Hydraulic mulch consists of applying a fiber mulch or hydraulic matrix with hydro-mulching equipment.

Fiber mulch shall be mixed in a hydraulic application machine and applied as a liquid slurry in accordance with the manufacturer's specified procedures. Fiber mulch shall be applied from multiple directions and angles to insure complete and proper coverage and only when rainfall is not predicted for at least 12 hours. The resulting coverage must be at least 3 mm (1/8 inch) thick over the entire area.

Hydraulic matrix shall be hydraulically applied to the soil as a viscous mixture, creating a continuous three-dimensional blanket that adheres to the soil surface. Upon drying, the matrix shall form a high-strength, porous, and erosion-resistant mat that shall not inhibit the germination and growth of plants in and beneath the layer. The matrix shall retain its form despite re-wetting. Pedestrians or equipment shall not be permitted to enter areas where mixtures containing stabilizing emulsion have been applied until vigorous vegetation is established.

3. Straw Mulch. Straw mulch shall be applied at the locations and rate indicated in the Plans.

All seeded areas shall be inspected for turf establishment within 14 days of application. Areas not showing signs of sufficient growth shall have seed, limestone, fertilizer, and mulch reapplied at the Contractor's expense.

#### 651.09 SODDING.

- (a) Cutting and Transporting. Before cutting sod, the area from which it is to be removed shall be mowed to a height of approximately 50 mm (2 inches) and cleared of excess grass clippings and other foreign material.

The sod shall be cut with an approved sod cutter into strips of uniform width having a minimum dimension of 300 mm (12 inches) in width and 450 mm (18 inches) in length and uniform thickness of approximately 50 mm (2 inches), unless otherwise directed by the Engineer. The sod shall contain the majority of the feeding roots of the grasses.

The sod shall be transported in an unbroken condition to the area to be sodded. Unless otherwise directed by the Engineer, the sod shall be placed in its final position within 48 hours after cutting. When conditions require the sod to be stored, it shall be placed in stacks or piles, grass to grass and roots to roots for not more than five days and shall be protected against drying from sun and wind.

- (b) Placing. The sod shall be moist when placed on the prepared surface with the edges in close contact and alternate courses staggered. Any gaps shall be filled with sod plugs or topsoil.

Sod shall be staked (600 mm (2 foot) intervals) on grades greater than 1V:4H and in drainage ditches, unless otherwise directed by the Engineer. In ditches, the sod shall be placed with the longer dimension perpendicular to the flow of water. On slopes, starting at the bottom of the slope, the sod shall be placed with the longer dimension approximately parallel to the bottom of the slope.

The stakes shall be driven center to center in each direction and driven through the sod perpendicular to the surface so that the tops of stakes are flush with the top of the sod.

After installation, sod shall be lightly watered and rolled in order to form tight contact between the sod and the soil grubbings. Sod shall be thoroughly watered within an hour of placing. If any sections of sod turn brown or curl up, these areas are to be carefully cut out and new sod applied and watered, to create a uniform mat and appearance.

651.10 THIS SUBSECTION RESERVED

651.11 CARE DURING CONSTRUCTION. The Contractor shall be responsible for protecting and caring for sodded, seeded, and mulched areas until acceptance of the work. The Contractor shall repair and replace all areas where seed has failed to germinate or sod has failed to grow and any areas damaged by pedestrian or vehicular traffic or other causes at no cost to the Agency, except for conditions covered in Subsection 107.18.

651.12 METHOD OF MEASUREMENT. The quantities of Seed, of the type specified, and Fertilizer to be measured for payment will be the number of kilograms (pounds) for the specified item used in the complete and accepted work, as determined from load tickets furnished to the Engineer. With written permission of the Engineer, the mass (weight) of small quantities may be determined by alternate methods. The Engineer will verify and document such mass (weight) determination.

The quantities of Agricultural Limestone, Hay Mulch, and Straw Mulch to be measured for payment will be the number of metric tons (tons) for the specified item used in the complete and accepted work, as determined from load tickets furnished to the Engineer. When seeding is done by the hydraulic method, liquid lime will be measured for payment in equivalent units of Agricultural Limestone. With written permission of the Engineer, the mass (weight) of small quantities of mulch may be determined by alternate methods. The Engineer will verify and document such mass (weight) determination.

The quantity of Hydraulic Mulch to be measured for payment will be the number of Liters (Gallons) used in the complete and accepted work.

The quantity of Sodding to be measured for payment will be the number of square meters (square yards) of sod used in the complete and accepted work, as determined by using slope measurements.

The quantity of Topsoil to be measured for payment will be the number of cubic meters (cubic yards) including any compost added, used in the complete and accepted work, as measured in its final position using slope measurements for determining area.

The quantity of Grubbing Material to be measured for payment will be the number of square meters (square yards) of grubbing material used in the complete and accepted work, as measured in its final position using slope measurements for determining area.

651.13 BASIS OF PAYMENT. The accepted quantities of Seed, of the type specified, and Fertilizer will be paid for at the Contract unit price per kilogram (pound) for the item specified.

The accepted quantities of Agricultural Limestone, Hay Mulch, and Straw Mulch will be paid for at the Contract unit price per metric ton (ton) for the item specified. Netting and Tackifier shall not be considered for payment and will be considered incidental to the Hay Mulch item.

The accepted quantity of Hydraulic Mulch will be paid for at the Contract unit price per liter (gallon). When hydraulic mulch is not in the Contract hydraulic mulch may be substituted for hay mulch at a rate of 1 unit of hydraulic mulch to 3.1 units of hay mulch or at such other rate as recommended by the manufacturer and approved by the Engineer.

The accepted quantity of Sodding will be paid for at the Contract unit price per square meter (square yard).

The accepted quantity of Topsoil will be paid for at the Contract unit price per cubic meter (cubic yard). Compost will not be paid for separately but will be considered incidental to the Topsoil item.

The accepted quantity of Grubbing Material will be paid for at the Contract unit price per square meter (square yard).

Payment for these items will be full compensation for testing, furnishing, transporting, handling, and placing the material specified, including tackifier when used, and for furnishing all labor, tools, equipment, maintenance, water necessary to promote growth, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
651.15 Seed	Kilogram (Pound)
651.16 Wildflower Seed	Kilogram (Pound)
651.17 Seed, Winter Rye	Kilogram (Pound)
651.18 Fertilizer	Kilogram (Pound)
651.20 Agricultural Limestone	Metric Ton (Ton)
651.25 Hay Mulch	Metric Ton (Ton)
651.28 Hydraulic Mulch	Liter (Gallon)
651.29 Straw Mulch	Metric Ton (Ton)
651.30 Sodding	Square Meter (Square Yard)
651.35 Topsoil	Cubic Meter (Cubic Yard)
651.40 Grubbing Material	Square Meter (Square Yard)

SECTION 653 – EROSION PREVENTION AND SEDIMENT  
CONTROL MEASURES

653.01 DESCRIPTION. This work shall consist of furnishing, installing, maintaining, removing, and disposing of erosion prevention and sediment control measures in accordance with these Specifications.

653.02 MATERIALS.

Aggregate for Erosion Prevention and Sediment Control .....	704.17
Vehicle Tracking Pad .....	704.17(a)
Stone Check Dam, Type I .....	704.17(b)
Stone Check Dam, Type II .....	704.17(c)
Inlet Protection Device, Type I.....	704.17(d)
Geotextile Under Stone Fill.....	720.02(a)(2)
Prefabricated Check Dam.....	720.05
Inlet Protection Device, Type II .....	720.06
Filter Bag.....	720.07
Topsoil.....	755.02
Seed .....	755.04
Fertilizer .....	755.06
Agricultural Limestone.....	755.08
Liquid Lime.....	755.09
Hay Mulch.....	755.10(a)
Wood Chip Mulch .....	755.10(b)
Fiber Mulch .....	755.10(d)
Hydraulic Matrix .....	755.10(e)
Tackifier .....	755.10(f)
Temporary Erosion Matting .....	755.11(a)
Permanent Erosion Matting .....	755.11(b)
Erosion Logs.....	755.17
Live Fascines.....	755.18
Live Stakes .....	755.19
Brush Layering .....	755.20

Barrier Fence shall be fluorescent yellow or orange, ultraviolet stabilized, high density polyethylene mesh or grid that will not sag, corrode, rot, or conduct electricity.

Project Demarcation Fence shall be non-adhesive, ultraviolet stabilized, fluorescent yellow or orange vinyl-coated polyester mesh or polyethylene plastic tape that will not sag or tear over time due to natural weather conditions.

653.03 TEMPORARY SOIL STABILIZATION. Temporary soil stabilization methods may include seed, mulch, soil binder, or other methods as approved by the Engineer.

Temporary soil stabilization methods shall be applied to exposed earth within 48 hours of earth disturbance. If vegetation is not established within 21 days seed, mulch, and additional stabilization measures required by the Contract Documents or the Engineer shall be applied at the Contractor's expense.

If vegetation is not established by October 15th, temporary stabilization shall be applied in accordance with the Contract Documents as ordered by the Engineer.

- (a) Seed. Seed materials and placement for establishing a temporary vegetative cover on disturbed soil shall be in accordance with Section 651.
- (b) Mulch. Mulch materials and placement for establishing a temporary cover on disturbed soil shall be in accordance with Section 651.
  - (1) Wood Chip Mulch. Wood Chip Mulch consists of applying material generated during tree cutting and clearing operations.

Wood Chip Mulch shall be applied evenly over the disturbed areas to a depth of 25 mm (1 inch).

The Contractor will not be compensated for using wood chip mulch as it is a product of other operations.

- (c) Tackifier. Tackifier shall be applied as an ingredient of a dry-applied practice or of a hydraulically-applied practice. Hydraulically applied tackifiers can be used as a stand-alone application of liquid that forms a crust on the soil surface by binding soil particles together; as a tackifying agent over straw or hay mulch as an alternative to crimping; or in combination with hydraulic mulches to create a hydraulic matrix.

Application frequency, rate, and method shall be in accordance with the manufacturer's recommendations based on longevity requirements. Tackifier shall not be applied to saturated soils, frozen soils, areas with standing water, under freezing or rainy conditions, or when the temperature is below 4°C (40° F). The area shall be allowed to cure as recommended by the manufacturer.

Any temporary soil stabilization efforts that are not effectively preventing erosion shall be reapplied or another practice implemented as directed by the Engineer.

653.04 HAY BALES. The Contractor shall install and anchor hay bales as shown in the Contract Documents. Hay bales shall be at least 900 mm (3 feet) in length.

653.05 EROSION MATTING. Temporary erosion matting shall be used to anchor loose mulch and provide temporary erosion control while vegetation is established in those areas where vegetation will provide permanent erosion protection.

Permanent erosion matting shall be used where vegetation will not sustain expected flow conditions or provide sufficient long-term erosion protection. Permanent erosion matting shall provide sufficient thickness and void space to permit soil filling and/or retention to allow for the development of vegetation.

The ground surface shall be shaped to the lines and grades shown on the Plans and shall have a smooth surface free of depressions and eroded areas that would allow water to collect or flow under the matting. The surface shall be cleared of stones, sticks, and other objectionable material that would prevent the matting from maintaining close contact with the ground. Placement of topsoil, fertilizer, seed, and mulch, when required, shall be completed prior to placement of the matting.

After the soil has been properly shaped, fertilized, and seeded the matting shall be placed parallel to the flow of water in channels or vertically on slopes and in direct contact with the soil surface. The Contractor shall not stretch or allow material to bridge over surface inconsistencies. Erosion matting and ground fasteners shall be installed as recommended by the manufacturer for the particular application.

No vehicular traffic of any kind will be permitted over the matting during or after placement. Any torn or damaged material shall be replaced at the Contractor's expense.

The Contractor shall maintain the matted areas until vegetation is established and has been accepted.

653.06 TEMPORARY CHECK DAMS. Temporary check dams shall be constructed and/or installed in the stormwater flow path with the primary purpose of reducing flow velocity and the secondary purpose of allowing sediment to settle out.



- (a) Temporary Stone Check Dam, Type I. Temporary Stone Check Dam, Type I shall be designed for placement in a channel. Temporary Stone Check Dam, Type I structures shall be placed on geotextile and shall have a typical height of 600 mm (24 inches). They may vary in height, width, and length depending on site specific conditions. The center shall be at least 150 mm (6 inches) lower than the outside edges and the outside edges shall be a minimum of 150 mm (6 inches) lower than the adjoining banks. The specified configuration will form a spillway or weir at the center for overflow and will prevent water from overflowing onto the roadway or from eroding the banks.
- (b) Temporary Stone Check Dam, Type II. Temporary Stone Check Dam, Type II shall be designed for placement along a curb. Temporary Stone Check Dam, Type II structures shall vary in height, width, and length depending on site specific conditions. They shall have a minimum height of 100 mm (4 inches), a minimum width of 150 mm (6 inches) and shall extend 300 mm (1 foot) in a direction perpendicular to the curb and 600 mm (2 feet) up gradient of the curb at an angle ranging from 30 – 60 degrees from the curb face.
- (c) Prefabricated Check Dams. Prefabricated check dams shall be installed in accordance with the Contract Documents and the manufacturer's recommendations.

The Contractor shall remove accumulated sediment in accordance with the Contract Documents or as directed by the Engineer, but generally when it reaches half the height of the structure.

653.10 VEHICLE TRACKING PAD. A vehicle tracking pad shall be constructed at each access point between the construction area and all public or private roads. The Contractor shall maintain any existing drainage.

Aggregate for vehicle tracking pad shall be placed on geotextile fabric to reduce the migration of fines through the aggregate.

Vehicle tracking pads shall have a minimum 16 meter (50 foot) length, 3.6 meter (12 foot) width and 200 mm (8 inch) thickness.

Vehicle tracking pads shall be maintained to prevent the aggregate from becoming clogged and resulting in tracking of sediment onto public rights-of-ways. Additional aggregate may be added on top of the existing aggregate only to a point which allows a smooth transition between the road surface and construction area.

When a vehicle tracking pad alone is not capable of preventing tracking of sediment onto the road surface, the Contractor shall take additional steps to remove sediment before vehicles leave the construction area.

653.11 INLET PROTECTION DEVICE. Inlet Protection Devices shall be constructed and installed such that flow is directed through the device and into the inlet.

- (a) Inlet Protection Device, Type I. Inlet Protection Device, Type I shall be manufactured in the field as detailed in the Contract Documents. All materials used to construct field manufactured inlet protection devices shall conform to the appropriate Agency material specification or be approved by the Engineer.
- (b) Inlet Protection Device, Type II. Inlet Protection Device, Type II shall be pre-fabricated units specifically designed to eliminate sediment from entering a catch basin or drainage inlet. Inlet Protection Device, Type II shall be installed in accordance with the Contract Documents and manufacturer's recommendations.

The Contractor shall remove accumulated sediment from inlet protection devices in accordance with the Contract Documents or as directed by the Engineer.

653.12 FILTER BAG. A filter bag is a device that may be used during dewatering pumping operations. The filter bag shall retain silt, sand, and fines while allowing filtered water to pass through.

Where possible, a filter bag shall be placed a minimum of 50 feet from any waters of the State and on a gradual slope in order that incoming water flows downhill through the bag. To increase the efficiency of filtration the filter bag shall be placed on a coarse aggregate or hay bale bed, unless otherwise directed by the Engineer or specified in the Contract Documents.

The neck of the filter bag shall be strapped tightly to the discharge hose. A filter bag is full when it no longer can efficiently filter sediment or allow water to pass at a reasonable rate. Use of excessive flow rate or overfilling a filter bag with sediment will cause rupture of the bag or failure of the hose attachments.

A filter bag shall be disposed of at an approved location as directed by the Engineer.

653.13 BARRIER FENCE. Barrier Fence shall be installed to enclose archaeologically sensitive areas, existing wetlands or other sensitive resources, for tree protection zones, or as detailed on the Contract Documents as a means for restricting construction activities in these areas and preventing the Contractor and project personnel from entering these areas.

Barrier Fence shall be installed on w-shape steel posts. The fence shall have a minimum height of 1.25 meters (4 feet). The posts shall be embedded a minimum of 600 mm (2 feet) into the ground, shall extend above the fabric, and shall be installed at a 1.5 meter (5 foot) spacing.

The Contractor shall select, inspect, and maintain Barrier Fence in accordance with the Contract Documents or as directed by the Engineer.

653.14 PROJECT DEMARCATION FENCE. Project Demarcation Fence shall be installed as shown on the Contract Documents as a visible barrier beyond which there shall be no construction activity by the Contractor or project personnel.

Project Demarcation Fence shall be installed on hardwood stakes and shall have a minimum width of 75 mm (3 inches). The stakes shall be 25 mm x 25 mm x 1220 mm (1 inch x 1 inch x 4 feet), shall be embedded 300 mm (1 foot) into the ground, shall extend above the fabric, and shall be installed at a 3 meter (10 foot) spacing.

The Contractor shall select, inspect, and maintain Project Demarcation Fence in accordance with the Contract Documents or as directed by the Engineer.

653.15 BIOTECHNICAL SLOPE PROTECTION. Biotechnical slope protection measures shall consist of both structural or mechanical and vegetative elements working together to stabilize a site specific condition. The measures shall be installed to stabilize slopes by slowing water movement down slope, increasing infiltration, trapping sediment, and increasing soil stability with root systems.

- (a) Erosion Logs. Erosion logs shall be installed along the toe, top, face, and at grade breaks of exposed and erodible slopes and along stream banks as a base for plantings. Erosion logs may also be used as check dams in unlined ditches and for drain inlet protection where approved.

Erosion logs shall be secured adequately to prevent displacement as a result of normal rain events and such that flow is not allowed under the log. Multiple logs shall be overlapped instead of abutting end to end. Rows shall be spaced as shown on the Contract Documents.

- (b) Live Fascines. Live fascines shall be installed on sloping areas such as roadway cuts and fills, slumped areas, and streambanks subject to erosion, seepage, or weathering. Slopes must be 1:1 or flatter.

Live fascines shall be made by forming bundles 2.5 to 4.5 meters (8 to 15 feet) long, 100 mm (4 inches) minimum in diameter, from stems no more than 25 mm (1 inch) in diameter.

Fascines shall be placed in a shallow trench and covered with soil in order that 10% of the fascine is left exposed. Fascines shall be anchored with stakes spaced 600 mm (2 feet) apart. Fascines shall be overlapped a minimum of 300 mm (1 foot) at the tapered ends. Rows shall be spaced as shown on the Contract Documents.

- (c) Live Stakes. Live stakes shall be installed for repair of small earth slips and slumps and for stabilizing raw streambanks.

Live stakes shall be 25 to 50 mm (1 to 2 inches) in diameter and 600 mm to 1.8 m (2 to 6 feet) long, depending on site application. If placed in stone fill, at least half the length of the stake shall be inserted into the soil below the stone. A minimum 50 to 100 mm (2 to 4 inches) of the stake and two live buds shall be left exposed.

Live stakes shall be installed using methods described in the Contract Documents and approved by the Engineer.

- (d) Brush Layering. Brush layering shall be installed to stabilize slope areas above the flow line of streambanks and cut and fill slopes up to 1:2 (vertical: horizontal) in steepness and 6 meters (20 feet) in height.

Brush layer cuttings shall be from dormant plants and shall be 12 to 50 mm (½ to 2 inches) in diameter. The cuttings shall be long enough to contact the back of the bench on which they are placed with the growing tips protruding out of the slope face.

Benches shall be 600 to 900 mm (2 to 3 feet) deep with the surface angled so the front edge is slightly higher than the back. Cuttings shall be placed on the bench in a crisscross or overlapping configuration in layers 75 to 100 mm (3 to 4 inches) thick. Backfill shall be placed on top of the cuttings and tamped in 150 mm (6 inch) lifts.

Areas between biotechnical slope protection measures shall be stabilized with seed in accordance with Section 651 or as approved by the Engineer.

653.16 METHOD OF MEASUREMENT. The quantity of Tackifier to be measured for payment will be the number of liters (gallons) used in the complete and accepted work. When used with mulch, Tackifier shall not be considered for payment and will be considered incidental to the item Hay Mulch.

The quantity of Hay Bales to be measured for payment will be the number of hay bales used in the complete and accepted work.

The quantity of Temporary and Permanent Erosion Matting to be measured for payment will be the number of square meters (square yards) used in the complete and accepted work, as measured in its final position using slope measurements for determining area.

The quantity of Temporary Stone Check Dam of the Type specified to be measured for payment will be the number of cubic meters (cubic yards) of the stone specified used in the complete and accepted work.

The quantity of Prefabricated Check Dam to be measured for payment will be on a per unit basis for each Prefabricated Check Dam used in the complete and accepted work.

The quantity of Vehicle Tracking Pad to be measured for payment will be the number of cubic meters (cubic yards) of stone specified used in the complete and accepted work.

The quantity of Inlet Protection Device of the Type specified to be measured for payment will be on a per unit basis for each Inlet Protection Device used in the complete and accepted work.

The quantity of Filter Bag to be measured for payment will be on a per unit basis for each Filter Bag used in the complete and accepted work.

The quantity of Barrier Fence and Project Demarcation Fence to be measured for payment will be the number of meters (linear feet) used in the complete and accepted work.

The quantity of Erosion Log, Live Fascine, and Brush Layering to be measured for payment will be the number of meters (linear feet) used in the complete and accepted work.

The quantity of Live Stake to be measured for payment will be on a per unit basis for each Live Stake used in the complete and accepted work.

653.17 BASIS OF PAYMENT. The accepted quantities of erosion prevention and sediment control measures will be paid for at the Contract unit price specified for each item. Payment shall be full compensation for furnishing, transporting, handling, placing, and removing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Geotextile, culvert, or any other items necessary to complete the work shall be considered incidental to the appropriate Contract item.

Unless otherwise specified in the Contract, payment for the maintenance of erosion prevention and sediment control measures will be incidental to the specific Contract item.

<u>Pay Item</u>	<u>Pay Unit</u>
653.10 Tackifier	Liter (Gallon)
653.15 Hay Bales	Each
653.20 Temporary Erosion Matting	Square Meter (Square Yard)
653.21 Permanent Erosion Matting	Square Meter (Square Yard)
653.25 Temporary Stone Check Dam, Type I	Cubic Meter (Cubic Yard)
653.26 Temporary Stone Check Dam, Type II	Cubic Meter (Cubic Yard)
653.30 Prefabricated Check Dam	Each
653.35 Vehicle Tracking Pad	Cubic Meter (Cubic Yard)
653.40 Inlet Protection Device, Type I	Each
653.41 Inlet Protection Device, Type II	Each
653.45 Filter Bag	Each
653.50 Barrier Fence	Meter (Linear Foot)
653.55 Project Demarcation Fence	Meter (Linear Foot)
653.60 Erosion Log	Meter (Linear Foot)
653.65 Live Fascine	Meter (Linear Foot)
653.70 Live Stake	Each
653.75 Brush Layering	Meter (Linear Foot)

SECTION 656 - PLANTING TREES, SHRUBS, AND VINES

656.01 DESCRIPTION. This work shall consist of furnishing, transporting, planting, and transplanting various size trees, shrubs, vines, perennials, and ground cover plants.

656.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Barrier Fence .....	727.03
Water .....	745.01
Landscape Backfill .....	755.01
Topsoil.....	755.02
Compost .....	755.05
Fertilizer .....	755.06
Mycorrhizal Fungi Product.....	755.07
Wood Chip Mulch .....	755.10(b)
Bark Mulch.....	755.10(c)
Plant Materials.....	755.12
Antidesiccant.....	755.13
Wire Rodent Guards .....	755.14
Tree Watering Bags.....	755.16

When weed separator fabrics are required, the separator fabric used shall be one of the separator fabrics and the necessary associated materials on the Approved Products List on file and maintained by the Agency’s Materials and Research Section.

656.03 PLANTING SEASON. For best results, the initial planting should be accomplished between April 1st and June 30th. Fall planting will only be allowed between August 15th and October 15th unless otherwise shown on the Plans or directed by the Engineer. Fall planting for deciduous trees is not allowed.

No planting shall be done in frozen ground, when snow covers the ground, or when the soil or weather is determined to be unsatisfactory for planting.

656.04 INSPECTION AND DELIVERY. Plants transported in open vehicles shall be covered by tarpaulins or other suitable covers securely tied to the body of the vehicle. Closed vehicles shall be adequately ventilated to prevent overheating of the plants.

The Engineer will make a preliminary inspection of all plants at the time of delivery on the project. Trees with multiple leaders will be rejected unless otherwise specified in the Contract. Trees with damaged or crooked leaders, bark abrasions, sun scald, disfiguring knots, insect damage, or cuts of limbs over 20 mm ( $\frac{3}{4}$  inch) in diameter that are not completely closed will be rejected. Container grown plants that have stem girdling roots will be rejected. Balled and burlapped trees and shrubs with excessive soil on top of the root flare and an otherwise minimal root ball will be rejected.

Substitutions of plant materials will not be permitted unless authorized in writing by the Engineer. Plant substitutions shall be either the nearest available size of that variety or a similar variety with comparable form and function.

A more thorough inspection will be performed just prior to planting. Only those plants that have received this inspection and have been approved for planting shall be planted.

656.05 PROTECTION AND TEMPORARY STORAGE. The Contractor shall keep all plant material moist and protected from drying out. Temporary storage shall be limited to 45 days from the time of delivery. Plants shall be protected when in transit, in temporary storage, or on the project site awaiting planting.

The Contractor shall exercise the utmost care in loading, unloading, and handling of plants to prevent injuries to the branches or to the roots of the plants. The solidity of balled and burlapped plants shall be carefully preserved.

Plants delivered but not scheduled for immediate planting shall be protected as follows:

- (a) Bare root materials that are not planted immediately upon receipt shall have the bundles opened, the plants separated and heeled-in in moist soil so as to leave no air spaces and shall be properly maintained until planted.
- (b) Balled and burlapped plants which are not scheduled for planting within 48 hours shall be kept in a moist condition and protected adequately by covering the earth balls with topsoil, wood chips, or other suitable material until removed for planting.

Failure to manage the storage of plant material as specified herein may be cause for rejection.



656.06 LAYOUT. Plant material locations and bed outlines shall be staked by the Contractor and approved by the Engineer.

656.07 EXCAVATION. Prior to excavating for plant pits and beds, the area shall conform to the lines and grades shown on the Plans. All sod, weeds, roots, and other objectionable material unsuitable for backfill shall be removed from the site and disposed of by the Contractor in a manner satisfactory to the Engineer.

The size of plant pits shall bear the following relation to the root spread (or diameter of balls) of the plants to be planted in them: The pit diameters shall be three times the root spread diameter. The pit depth shall be the distance from root flare to bottom of root ball. The pits shall be only deep enough to expose the root flare.

Pits for vines and perennials shall be approximately 450 mm (18 inches) in diameter by 300 mm (12 inches) deep.

Bare root, non-containerized seedlings or transplants may be planted in the existing soil. Plant holes shall be deep enough to allow room for the full depth of the root without doubling or folding and wide enough to allow room for its normal spread.

656.08 SETTING PLANTS.

The Contractor shall determine the depth of the main order roots in the rootball before placing the plant in the planting pit by loosening the twine and burlap from the stem and the top one half of the ball. Excess soil on top of the root ball above the root flare or main order roots shall be carefully removed. The depth of the pit shall be adjusted accordingly in order that the main order roots are at or slightly above finish grade. The Contractor shall avoid planting the plant too deep.

All plants shall be moved with the root ball intact, using mechanical methods if needed. If the root ball has been badly cracked or broken, the plant shall be rejected for use.

Plants must be set plumb on all terrain. Soil must be firmly compacted around the roots, leaving no air pockets; a 75 mm (3 inch) diameter and continuous rim for shrubs and 100 mm (4 inch) for trees located at the drip edge of each plant shall form a saucer to retain water.

- (a) Bare Root Plants (BR). Bare root plants shall be placed in the center of the plant pit and the roots properly spread out in a natural position. All broken or damaged roots shall be cleanly cut back to sound root growth.

Landscape Backfill shall be carefully worked around and over the roots and be thoroughly and properly tamped. Thorough watering shall accompany backfill around bare root plants.

- (b) Balled and Burlapped Plants (B & B). Balled and burlapped plants shall be carefully placed in prepared pits on the required depth of tamped Landscape Backfill so as to rest in a firm, upright position. Plants shall be handled and moved only by the ball. They shall be planted as follows:

- (1) Plants Balled in Synthetic Material. Once positioned in the pit, the synthetic covering shall be totally removed. Previously treated burlap shall also be removed.
- (2) Plants Balled in Hemp Burlap/Wire Baskets. Once positioned in the pit, all ropes and burlap shall be cut and removed from around the root ball and the stem of the plant. If the plant is balled in a wire basket, once the plant is positioned in the pit, the wire basket shall be cut and the top 2/3 of the basket removed.

Landscape Backfill shall be filled in around the plant ball to 50 percent of the depth of the ball and then tamped. The remainder shall then be placed and tamped.

- (c) Containerized Plants. Containerized plants including seedlings, ground covers and vines, perennials, and tubelings shall be planted in accordance with the “American Standard for Nursery Stock” (ANSI Z-60.1 latest edition) published by the American Association of Nurserymen (AAN).
- (d) Transplanted Plants. Transplanted plants shall be set in accordance with the requirements of either part (a) or (b) of this Subsection, as appropriate.
- (e) Fertilizer and Mycorrhizal Fungi. The use of fertilizer and mycorrhizal fungi shall be as specified in the Contract Documents or as directed by the Engineer. Fertilizer shall be a slow release variety, cultivated into the top 50 mm (2 inches) of the plant pit area or shrub bed within five days after planting. No fertilizer shall be applied to seedlings or during a fall planting. Mycorrhizal fungi shall be applied in accordance with the manufacturer’s specifications.

The rates of fertilizer application shall be approximately as follows:

Trees:	40 g/mm (32 ounces/inch) of caliper
Shrubs and Evergreens:	400 g/m (4 ounces/foot) of height or spread
Vines:	50 g/vine (2 ounces/vine)

- (f) Watering. All plant material shall be watered thoroughly at planting. Unless otherwise specified, the minimum interval for watering during the establishment period shall be twice weekly. At each watering, the soil around the plant shall be thoroughly saturated. The time interval between waterings may be increased or decreased by the Engineer to maintain adequate moisture levels. Trees shall receive a minimum of 40 L (10 gallons) at each watering, shrubs a minimum of 20 L (5 gallons) and vines and plants a minimum of 10 L (3 gallons). Natural rainfall of 25 mm (1 inch) per week shall be equivalent to the amount of water specified above.

Tree watering bags may be utilized as approved by the Engineer. The installation and maintenance of the bags shall be in accordance with the manufacturer's recommendations. The bags shall be removed by the Contractor after final inspection. Replacement of watering bags during the establishment period shall be the responsibility of the Contractor.

The Contractor shall provide to the Engineer a weekly log to account for the frequency and amount of watering during the establishment period. When natural rainfall occurs the amount shall be noted in the log as measured on site or noted by the U.S. Weather Service.

- (g) Guys and Stakes. Trees shall be guyed and staked as shown on the Plans as soon as planting is completed.

Support posts may be required instead of guys and stakes when ordered by the Engineer.

Stakes, support posts, and deadmen shall be sound new hardwood, treated softwood, or redwood that is free of knots, knot holes, and other defects.

Guys shall prevent lateral deflection of the supported plant. The type of guy shall be approved by the Engineer prior to installation. Guys and stakes shall be removed prior to final acceptance.

The Contractor shall provide rubber or soft plastic hose of a green color to provide protection for guyed trees from the wire. This hose shall be a minimum of 13 mm (1/2 inch) in diameter and long enough to provide full protection. The hose shall be of the same material and the same color for all guyed trees. Guyed trees shall have a minimum of three guys per tree, unless otherwise shown on the Plans or directed by the Engineer.

- (h) Antidesiccant Spray. When the Plans indicate the use of antidesiccant spray, it shall be applied in accordance with the manufacturer's recommendations. A second spraying shall be applied prior to winter or as directed by the Engineer.
- (i) Pruning. All broken, injured, or damaged branches shall be pruned before or immediately after planting in such a manner as to preserve the natural character of each plant. All pruning shall be performed by experienced personnel with proper equipment and in keeping with accepted horticultural practice.
- (j) Mulching. Bark mulch material shall be applied as detailed in the Contract. Wood chip mulch shall not be used. The same type of material shall be used in all areas to provide visual uniformity.
- (k) Wire Rodent Guards. Wire rodent guards may be used at the Contractor's option. If used, wire rodent guards shall be removed prior to final acceptance.
- (l) Weed Separator Fabric. Weed separator fabric shall be installed on the prepared top surface of the planting bed during the planting procedure as shown on the Plans. The fabric shall extend to the edges of the plant pit and shall be closely fitted around the trunks or stems of the plants, unless otherwise shown on the Plans or directed by the Engineer. Small plants may be inserted through the fabric by making cuts of sufficient size in the fabric to allow planting. Fabric patches may be required over the cuts to ensure coverage.

The fabric shall be covered with a minimum of 100 mm (4 inches) of bark mulch, unless otherwise shown on the Plans or directed by the Engineer.

- (m) Restoration and Maintenance. The Contractor shall restore all seeded and grassed areas outside the planting areas that were disturbed by the planting operations at no cost to the State.

All debris, excess excavation, and other objectionable material shall be removed and disposed of as directed by the Engineer.

The Contractor shall actively maintain the plants immediately after planting. Plants shall be pruned and/or cultivated, as appropriate. All mulched areas shall be kept weeded, neat, and maintained to the original layout lines. Stakes, support posts, and deadmen shall be restored or replaced as necessary and guys adjusted as necessary. Weed separator fabric and tree wrappings shall be restored or replaced as necessary and basins and saucers shall be repaired to hold water.

If the Contractor feels that spraying of the plant materials and mulched areas is necessary to prevent damage from insects or plant diseases, the material, application rate, number of applications and any other data pertinent to the spraying shall be submitted to the Engineer for approval. The submittal shall also include a letter from the Vermont Department of Agriculture approving the spraying.

- (n) Establishment Period. The Contractor shall properly maintain all planted trees, shrubs, vines, plants, and ground cover until final planting by necessary watering, weeding, fertilizing, spraying with approved insecticides or fungicides, providing protection from rodents and other work necessary to keep plants in living healthy condition. Any plants damaged, dried out, or otherwise in poor condition shall be replaced in kind with healthy stock at the Contractor's expense.

Approximately four to six months following the first planting, the Engineer and Contractor shall inspect the planted material and any dead, dying, or damaged material shall be replaced by the Contractor. This second planting shall be completed within 30 days after inspection or as directed by the Engineer.

The planted material shall be inspected again by the Engineer and Contractor approximately four to six months following the second planting and any dead, dying, or damaged material found at the time shall be replaced by the Contractor. This final planting shall be completed within 30 days of the inspection.

The initial, second, and final plantings shall be in accordance with Subsection 656.03.

656.09 TRANSPLANTING. Transplanting shall be done in accordance with Subsection 656.08 or as ordered by the Engineer.

Transplanted plant materials shall be maintained during establishment in accordance with Subsection 656.08, except that on projects where only transplanting of existing plant materials is performed, the establishment period shall end on the Contract Acceptance Date.

656.10 TREE PROTECTION. The purpose of this item is to prevent damage to branches, stems, and root systems of existing individual trees to remain and to ensure their survival. Provisions under this item include steps to minimize soil and root disturbance and to construct protection measures for trees close to construction areas. The Contractor shall install barrier fence to the drip line of existing trees or shrubs marked either "Save" or "Protect" or shown with a Tree Protection Zone (TPZ) on the Plans prior to any earth disturbance; barrier fence shall not be removed until the final project inspection. There will be no activity within the TPZ or the drip line of the tree except watering or installation of erosion prevention or sediment control measures where required. Tree protection methods and schedule of work shall be approved by the Engineer.

The following protection procedure shall apply when excavation is to be performed near trees or shrubs labeled "Save" or "Protect" or shown with a TPZ on the Plans:

1. Care shall be taken to avoid breaking tree limbs and branches with construction equipment. Prior to construction, tree limbs of trees identified for protection and any other trees identified by the Engineer shall be pruned by a qualified tree service.
2. Roots encountered during excavation work in the vicinity of a TPZ area, shall be cleanly cut with no tearing of roots. Exposed tree roots shall be protected by a double layer of dampened burlap at all times until they can be covered with soil, at which time the dampened burlap shall be removed. Following excavation and during the construction season, water shall be provided to impacted trees at a minimum of 10 liters (2.5 gallons) per week, per 25 mm (1 inch) caliper or as directed by the Engineer. The Contractor shall provide a log to document watering and natural rainfall to the Engineer.

If a tree is damaged due to the Contractor's negligence and determined to be non-repairable by the Engineer, the Contractor shall replace it at no additional cost to the Agency with a tree of equal value, or two or more trees with a total value equal to that of the damaged tree, using the trunk formula method of appraisal established by the International Society of Arboriculture.

656.11 METHOD OF MEASUREMENT. The quantity of Seedlings, Trees, Shrubs, Ground Covers and Vines, Perennials, and Tubelings to be measured for payment will be the number of each of the specified types and sizes furnished and planted or transplanted in the complete and accepted work, with the exception of Transplanting Groundcover, which will be measured by the square meter (square yard). Only living plants in healthy condition at the time of final inspection will be accepted.

The quantity of Landscape Watering to be measured for payment will be the number of cubic meters (1000 gallons) of water used in the complete and accepted work. The Contractor shall provide a written log meeting the approval of the Engineer for measuring the quantity of water applied.

The quantity of Landscape Backfill, Truck Measurement to be measured for payment will be the number of cubic meters (cubic yards) used in the complete and accepted work, as determined by vehicle loads using three-dimensional measurement. All loads designated shall be leveled at the point of delivery when directed by the Engineer. A load ticket shall be furnished to the Engineer with each load delivered to the job site.

The quantity of Tree Protection to be measured for payment will be on a lump sum basis in the complete and accepted work.

656.12 BASIS OF PAYMENT. The accepted quantity of Seedlings, Trees, Shrubs, Ground Covers and Vines, Perennials, and Tubelings will be paid for at the Contract unit price each for the specified types and sizes and kinds for planting or transplanting, with the exception of Transplanting Groundcover, which will be paid for at the Contract unit price per square meter (square yard). All Seedlings, Trees, Shrubs, Ground Covers and Vines, Perennials, and Tubelings that have died, failed to grow, or otherwise have proven unsatisfactory to the Engineer during the establishment period shall be replaced with healthy stock of the same type or approved substitute at the Contractor's expense.

Payment will be made as follows:

- (a) 80 percent of the Contract unit price after the first planting;
- (b) 10 percent of the Contract unit price after the second planting;
- (c) 5 percent of the Contract unit price after the final planting; and
- (d) The remaining percentage of the Contract unit price after the Acceptance Date.

Payment for these items will be full compensation for testing, furnishing, transporting, handling, and placing plants, fertilizer, mycorrhizal fungi, mulch, and all incidental materials; for excavation, pruning, guying and staking, mulching, wire rodent guards, water basin formation, cleanup, and plant maintenance establishment work and care including replacement; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Weed separator fabric, water bags, or any other item necessary to complete the work will be considered incidental to the appropriate Contract items.

The accepted quantity of Landscape Watering will be paid for at the Contract unit price per cubic meter (1000 gallons). When the Landscape Watering item is not specified as a separate pay item in the Contract, water applied during the plant establishment period will not be paid for directly, but will be considered incidental to the other Section 656 items in the Contract. Water bags, when specified in the Contract, will not be paid for directly but will be considered incidental to Landscape Watering.

The accepted quantity of Landscape Backfill, Truck Measurement will be paid for at the Contract unit price per cubic meter (cubic yard). Payment will be full compensation for furnishing, mixing, testing, transporting, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Tree Protection will be paid for at the Contract lump sum price. Payment will be compensation for all tree protection measures including barrier fence, branch and root pruning, watering, and all incidentals necessary to complete the work.

Partial payments will be made as follows:

- (a) The first payment of 25 percent of the lump sum price will be paid upon installation of all required barrier fence;



- (b) The second payment of 50 percent of the lump sum price will be paid upon completion of 50 percent of the work under the Contract;
- (c) The third payment of 25 percent of the lump sum price will be paid upon removal of all barrier fence.

The project will not be accepted until the replacement of all dead, dying, or poorly growing material has been completed to the satisfaction of the Engineer.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
656.15 Evergreen Seedlings	Each
656.16 Deciduous Seedlings	Each
656.20 Evergreen Trees	Each
656.25 Evergreen Shrubs	Each
656.30 Deciduous Trees	Each
656.35 Deciduous Shrubs	Each
656.40 Ground Covers and Vines	Each
656.41 Perennials	Each
656.42 Tubelings	Each
656.45 Transplanting Trees	Each
656.50 Transplanting Shrubs	Each
656.55 Transplanting Groundcover	Square Meter (Square Yard)
656.65 Landscape Watering	Cubic Meter (Thousand Gallons)
656.80 Landscape Backfill, Truck Measurement	Cubic Meter (Cubic Yard)
656.85 Tree Protection	Lump Sum

#### SECTION 675 - TRAFFIC SIGNS

675.01 DESCRIPTION. This work shall consist of furnishing and installing traffic signs, removing existing signs, installing salvaged signs, and overlaying existing signs.

675.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Paint for Traffic Signs .....	708.06
Bar Reinforcement.....	713.01
Sign Posts .....	750.01
Extruded Aluminum Panels.....	750.02
Flat Sheet Aluminum.....	750.03
High Density Overlaid Plywood.....	750.06
Acrylic Plastic Reflectors .....	750.07
Retroreflective Sheeting .....	750.08
Demountable Characters .....	750.09
Plastic Lettering Film .....	750.10
Extruded Aluminum Molding .....	750.11
Assembly Hardware .....	750.12

All traffic signs shall conform to the requirements of the Contract and the latest edition of the MUTCD.

If the Contract does not specify a particular type of sign material, the Contractor may furnish any one of the following materials:

- (a) Type A sign with an area  $2 \text{ m}^2$  ( $20 \text{ ft}^2$ ) or less:
  - (1) Flat sheet aluminum.
  - (2) Extruded aluminum panels (if attached to a Type B sign).
- (b) Type B sign with an area greater than  $2 \text{ m}^2$  ( $20 \text{ ft}^2$ ):
  - (1) Extruded aluminum panels.
  - (2) High density overlaid plywood.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

All new signs installed shall be marked on the back with the following information:

<u>Examples</u>	
(State) or (Town)	VAOT Swanton
Month and Year of Sign Fabrication	01/00 09/85
Route Where Sign Installed	US 5 TH 13

The letters and numbers of the text shall be 25 mm (1 inch) high.

Either stick-on letters and numbers or silk-screened letters and numbers will be allowed as long as they are applied in such a way that they remain intact during the life of the sign. If stick-on letters and numbers are used, all letters and numbers to be placed on a sign shall come from the same stick-on sheet. Individual stick-on letters or numbers will not be allowed.

**675.03 EXTRUDED ALUMINUM PANELS.** Extruded aluminum panels shall be of the butting type, 300 mm (12 inches) wide and of the lengths shown on the Plans. The moment of inertia of a panel shall not be less than  $318\,500\text{ mm}^4$  ( $0.765\text{ inch}^4$ ), and shall be designed to carry a wind load of 1.44 kPa (30 psf).

All signs fabricated from extruded aluminum panels shall have extruded aluminum molding on the two vertical sides. The color shall be the same as the parent sign.

Fabrication, including punching or drilling holes and cutting to length, shall be completed prior to metal degreasing, treating, and application of the background material. Cut edges shall be true and smooth and free from burrs. Flame cutting will not be permitted. Bolt holes may be drilled to finished size or punched to finished size provided the diameter of the punched hole is at least twice the thickness of the metal being punched. The surface of all panels shall be flat and free of defects. The panels shall be fabricated for horizontal mounting. Each panel shall extend the full width of a sign and shall be bolted at least every 600 mm (24 inches) to each adjacent panel.

If a Type A sign is attached to or part of a Type B sign, it shall be fabricated from extruded aluminum panels.

675.04 FLAT SHEET ALUMINUM. Fabrication of the flat aluminum sheets, including cutting to size, bending, and punching or drilling holes and the welding of reinforcing or stiffening members, if any are required, shall be completed prior to degreasing, etching, or treating, and application of the background material. Material may be sheared, blanked, sawed, or milled. Cut edges shall be true and smooth and free from burrs. No flame cutting will be permitted. The surface of all sign faces shall be flat and free of buckles, warp, dents, burrs, or other defects.

675.05 HIGH DENSITY OVERLAID PLYWOOD. Fabrication of plywood sign blanks, including drilling holes and cutting to size, shall be completed prior to the application of retroreflective sheeting. Plywood sign blanks shall be cut to shape and size using a saw blade that does not tear the plywood grain. Holes shall be 11 mm (7/16 inch) in diameter, clean cut, and uniform. When cut to size and shape, the sign blanks shall be free of warping, open checks, open splits, open joints, open cracks, loose knots, and other defects. The surfaces of all sign blanks shall be flat.

All edges and holes shall be thoroughly sealed with exterior aluminum paint meeting the approval of the Engineer. The paint shall contain at least 30 percent solids (aluminum powder) by volume. After sealing, the edges and interior of the holes shall be painted with one coat of enamel primer followed by one coat of exterior black sign enamel. After a sign has been installed, the edges shall be resealed and repainted if ordered by the Engineer.

The color of the plywood used for the sign base material may be either natural or black. When of natural color, the edges and back of the sign blank shall be painted with one coat of enamel primer followed by one coat of exterior black sign enamel. Before applying the first coat, the surface shall be cleaned with an approved solvent, abraded lightly with fine sandpaper or steel wool and wiped clean.

675.06 THIS SUBSECTION RESERVED

675.07 THIS SUBSECTION RESERVED

675.08 THIS SUBSECTION RESERVED

675.09 APPLICATION OF RETROREFLECTIVE SHEETING. Retroreflective sheeting shall be of the color shown on the Plans. The face of a sign shall be completely covered by the retroreflective sheeting when used as a background. All panels of a multi-panel sign shall be of uniform background color and brilliance both day and night.

Before application of the retroreflective sheeting, the sign face shall be cleaned, degreased, coated, treated, and etched or abraded in accordance with standard commercial processes for the sign base material involved. The faces shall be dried by use of a forced hot-air drier and shall not be handled except by device or clean canvas gloves between all cleaning operations and application of the retroreflective sheeting. There shall be no opportunity for the sign faces to come in contact with greases, oils, or other contaminants prior to the application of the retroreflective sheeting.

Retroreflective sheeting shall be applied to the face of an extruded aluminum panel by a squeeze roller applicator. Retroreflective sheeting shall be applied to flat sheet aluminum, embossed letter frames, and high density overlaid plywood by vacuum heat applicator at 95 °C (200 °F), or by squeeze roller applicator. After aging 48 hours at 20 °C (68 °F), adhesion of the retroreflective sheeting to the sign surface shall be strong enough to resist stripping when tested with a stiff putty knife.

Retroreflective sheeting having a solvent or heat-activated adhesive shall be completely covered with a clear coating. Retroreflective sheeting with a pressure sensitive adhesive shall be edge sealed with a clear coating. When plastic lettering film or retroreflective sheeting or lettering paint is used for the sign text, the clear coating shall be applied only after the entire text is in place on the retroreflective sheeting.

675.10 TRANSPORTATION AND HANDLING. Sign materials and finished signs shall be handled at all times so as to prevent damage or disfigurement. Damaged signs shall be rejected.

675.11 ERECTION OF SIGN POSTS AND FOUNDATIONS. Signs shall be installed at the locations shown on the Plans or directed by the Engineer. In erecting the sign posts, the materials, methods, and installation procedures shown on the Plans shall be followed, unless otherwise directed by the Engineer.

When a post is set in a concrete footing, the post shall be placed in position and plumbed and braced before the footing is constructed. The type of footing, materials used, and method of construction shall be as shown on the Plans. Care shall be taken during construction of the footing to preserve the setting of the post. When aluminum posts are used, the area to be in contact with concrete shall be treated with one coat of an approved sealer paint. The sealer shall be allowed to dry thoroughly before installing the post.

When a breakaway-type galvanized steel post on a concrete footing is to be used, the post stub section, with or without the upper post section attached, shall be set carefully in the foundation hole and held in place by an approved form or template before the concrete for the footing is placed. The stub post sections shall be so positioned that the projection above finished grade is as shown on the Plans. The shear plates shall be so positioned that when the upper post section is attached, using shims as required, the upper post section shall be vertical and properly oriented with the roadway. The upper post section shall be attached to the stub post section by bolts using procedures as shown on the Plans. With all supporting form work removed from the posts, the bolts shall be tightened as shown on the Plans. Springing or raking of posts to secure proper alignment will not be permitted.

The forms and templates supporting the posts shall not be removed, and a sign shall not be mounted on the posts, until the concrete has cured.

Sign posts shall be installed so that the sign face is oriented as shown on the Plans.

When two or more posts are used to support a single sign, the flanges to which the sign will be fastened shall be in the same plane and the tops of the posts shall be at the same elevation.

When a post does not require a concrete footing, it may either be driven or placed in a hole carefully dug to the depth shown on the Plans. The post shall be plumbed and set so that the sign will face in the proper direction. The hole shall be backfilled with suitable material approved by the Engineer. The backfill shall be placed in layers of not more than 150 mm (6 inches) and thoroughly compacted by the use of an air or mechanical tamper. Care shall be taken in placing and tamping the backfill to preserve the setting of the post.

675.12 MOUNTING OF SIGNS. After the post or posts required for a sign have been erected, the sign shall be mounted as shown on the Plans. A sign shall be mounted tightly to the post or posts, or to the horizontal supporting members if shown on the Plans.

Horizontal and vertical supporting members required to hold together the separate panels forming a multi-panel sign and to attach the sign to the posts, shall be either standard steel or aluminum structural shapes meeting the same requirements as for sign posts and shall conform to the designs shown on the Plans. After a multi-panel sign is mounted, the individual panels shall be joined together as shown on the Plans to ensure a smooth, flat sign face free of deflection.

675.13 REMOVING SIGNS. The Contractor shall remove and salvage signs, posts, and overhead supports and remove foundations and posts, if any, as shown on the Plans or indicated in the Contract. All salvaged signs shall be carefully separated from the posts and/or frames on which they are mounted.

Unless otherwise specified, the signs, supports, mounting frames, and posts shall remain the property of the Agency and shall be carefully removed, separated, transported, and stockpiled at locations specified in the Contract or as ordered by the Engineer. All salvaged mounting hardware shall be placed in separate covered pails and labeled as to contents with a permanent label.

Foundations shall be removed to a depth of at least 300 mm (12 inches) below the ground surface and the unsuitable material disposed of as directed by the Engineer. The resulting holes and post holes from which posts are removed shall be backfilled with suitable material and the area restored to a condition similar to that of the adjacent area.

675.14 ERECTING SALVAGED SIGNS. The specified salvaged signs shall be transported from their stockpiled location and erected on posts at the locations shown on the Plans. The same care in handling, transporting, and erecting new signs shall be exercised for salvaged signs. Attaching devices shall be repositioned or new ones furnished as necessary. Any new material required shall be furnished by the Contractor. Material and erection requirements shall be in accordance with the applicable requirements of this Section.

After erection, the signs shall be washed to remove dirt, grease, and other foreign material to the satisfaction of the Engineer.

675.15 SETTING SALVAGED POSTS. When specified, salvaged sign posts of the type required shall be transported from the stockpiled location and erected on new foundations or placed in holes at the locations shown on the Plans.

The same care in transporting and erecting the new posts shall be exercised for salvaged posts.

The fastening devices, including bolts, nuts, and washers, shall be furnished as necessary for the erection of the posts.

Material and erection requirements shall be in accordance with the applicable requirements of this Section.

675.16 MODIFYING SIGN POSTS. The Contractor shall modify the existing sign posts as shown on the Plans. Posts shall be removed and re-erected where applicable.

675.17 METHOD OF MEASUREMENT. The quantity of Traffic Sign to be measured for payment will be the number of square meters (square feet) of the type specified, installed in the complete and accepted work.

The quantity of Flanged Channel Sign Post to be measured for payment will be the actual measured meters (linear feet) from the tops of the posts to the bottom of the posts, installed in the complete and accepted work. No added measurement will be made for required anchors, sleeves, and overlaps.

The quantity of Square Tube Sign Post and Anchor to be measured for payment will be the actual measured meters (linear feet) from the tops of the posts to the bottom of the anchors, installed in the complete and accepted work. No added measurement will be made for required sleeves and overlaps.

The quantity of other traffic Sign Posts to be measured for payment will be the number of kilograms (pounds) of each type of post installed in the complete and accepted work, as determined by the lengths and the standard mass per meter (weight per linear foot) of the specified material.

The quantity of Foundations, Erecting Salvaged Signs, Setting Salvaged Posts, and Modifying Sign Posts to be measured for payment will be the number of each installed in the complete and accepted work.

The quantity for Removing Signs to be measured for payment will be the number of signs removed in the complete and accepted work.

675.18 BASIS OF PAYMENT. The accepted quantities of the specified Contract items will be paid for at their respective Contract unit prices.

When shown on the Plans, the use of tee-bar auxiliary sign mounting will be considered incidental to the Contract item Traffic Signs.

The concrete, galvanized steel post stub section required for breakaway posts, reinforcing steel, or anchor bolts required for the various types of foundations will not be paid for separately but shall be considered incidental to the Contract unit price of the specified type of foundation.

Removal of sign posts and foundations will be considered incidental to the Contract item Removing Signs.



The cost of attachment hardware, including vandal proof hardware when required, will be considered included in the Contract item for the particular sign being used.

Payment will be full compensation for furnishing and erecting, fabricating, transporting, handling, applying, and installing the materials specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation and backfill will not be paid for separately, but will be considered incidental to the Contract unit prices for other items in the Contract.

Signs having an area of 2 m<sup>2</sup> (20 square feet) or less will be paid for as Type A signs without regard for any limitations placed on the choice of the basic panel material by the existence of a parent sign.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
675.20 Traffic Sign, Type A	Square Meter (Square Foot)
675.21 Traffic Sign, Type B	Square Meter (Square Foot)
675.301 Flanged Channel Sign Post	Meter (Linear Foot)
675.31 W-Shape Steel Sign Post	Kilogram (Pound)
675.32 Tubular Aluminum Sign Post	Kilogram (Pound)
675.33 Tubular Steel Sign Post	Kilogram (Pound)
675.341 Square Tube Sign Post and Anchor	Meter (Linear Foot)
675.40 Foundation for W-Shape Steel Post, Each 450 mm (18 inch) Diameter	
675.41 Foundation for W-Shape Steel Post, Each 600 mm (24 inch) Diameter	
675.42 Foundation for W-Shape Steel Post, Each 750 mm (30 inch) Diameter	
675.43 Foundation for Tubular Steel Post	Each
675.50 Removing Signs	Each
675.60 Erecting Salvaged Signs	Each
675.61 Setting Salvaged Posts	Each
675.70 Modifying Sign Posts	Each

#### SECTION 676 - DELINEATORS

676.01 DESCRIPTION. This work shall consist of removing or furnishing and installing reflector units or delineators consisting of new or salvaged posts, reflectors, and plaques.

676.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Delineator Posts.....	751.01
Retroreflective Sheeting .....	751.03
Back Plates and Housing.....	751.04
Plaques .....	751.05
Assembly Hardware .....	751.06

676.03 INSTALLATION. Delineator posts shall be set to the heights and at the locations shown on the Plans. They shall be set vertically facing the direction shown on the Plans or as directed by the Engineer.

Posts set in the ground shall be driven either by hand or by mechanical devices using a suitable driving cap and shall be set in the ground to the satisfaction of the Engineer. Hand tamping will be permitted. Posts set on the roadway surface shall have the base securely fastened to the surface. Delineators to be attached to bridge rail shall be consistent with the design shown on the Plans and securely fastened to the railing as shown on the Plans or as directed by the Engineer. Delineator assemblies and plaques, when required, shall be attached after the posts are set.

The replacement of reflector units on existing posts or guardrail that are to remain shall be as shown on the Plans or as directed by the Engineer.

676.04 METHOD OF MEASUREMENT. The quantity of Delineators or Reflector Units to be measured for payment will be the number removed or installed in the complete and accepted work.

676.05 BASIS OF PAYMENT. The accepted quantity of Delineators or Reflector Units will be paid for at the Contract unit price each. Payment will be full compensation for removing or furnishing, fabricating, transporting, handling, and installing the materials specified, including plaques when required, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
676.10 Delineator with Steel Post	Each
676.12 Removal of Existing Delineator	Each
676.15 Remove and Replace Reflector Unit	Each
676.20 Delineator with Flexible Post	Each

SECTION 677 - OVERHEAD TRAFFIC SIGN SUPPORTS

677.01 DESCRIPTION. This work shall consist of furnishing and installing overhead traffic sign supports, including the concrete footings.

677.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type IV .....	707.03
Caulking Compound.....	707.13
Bar Reinforcement.....	713.01
Anchor Bolts.....	714.09
Prefomed Fabric Bearing Pads .....	731.01
Grounding Electrodes.....	753.05

The sign support shall be of the materials shown on the Plans.

The sign support design may be a cantilever structure or a multi-support structure (tubular beam, tri-chord, or box truss).

Overhead traffic sign support structures, components, and hardware furnished under this Section shall be covered by a Type D Certification. All design details, quality of work, procedure, materials, etc., shall be in accordance with the latest edition of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

All welding shall be performed in accordance with the provisions of Section 506.

677.03 GENERAL. The overhead traffic sign supports shall be constructed in accordance with the details shown on the Plans.

Prior to installation, the Contractor shall submit Fabrication Drawings in accordance with Section 105, which shall include a complete list of materials.

Concrete footings shall be backfilled by placing and compacting uniform layers of approved material not exceeding 150 mm (6 inches) in depth.

Where aluminum alloys come in contact with other materials, the contacting surfaces shall be separated with a fabric pad 3.2 mm (1/8 inch) in thickness or cleaned and thoroughly coated with an aluminum impregnated caulking compound.

The space between the top of the concrete footing and metal base of the support shall be filled with Mortar, Type IV.

677.04 GROUNDING. All posts used in overhead sign supports shall be grounded. The grounding shall be accomplished by means of a soft drawn, bare copper wire with a cross-sectional area of 13.30 mm<sup>2</sup> (No. 6 AWG) run between the post or pole base and the grounding electrode(s). The grounding electrode conductor shall be attached to the grounding electrode by an exothermic welding process.

After erection of the structure, the Contractor shall demonstrate, by tests, that the resistance of the entire specified grounding system is not more than 25 ohms.

If lights are to be installed on the overhead sign supports, the lighting work shall be performed in accordance with the applicable requirements of Section 679.

677.05 METHOD OF MEASUREMENT. The quantity of Overhead Traffic Sign Support, of the type specified, to be measured for payment will be the number of each installed in the complete and accepted work.

The quantity of Remove and Reset Overhead Traffic Sign Support to be measured for payment will be the number of each removed and reset in the complete and accepted work.

677.06 BASIS OF PAYMENT. The accepted quantity of Overhead Traffic Sign Support, of the type specified, will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, transporting, handling, and installing the materials specified, including the concrete footings, excavation, and backfilling and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Remove and Reset Overhead Traffic Sign Support will be paid for at the Contract unit price for each. Payment will be full compensation for removing the existing sign support, including all excavation, removal of the existing base as required, furnishing, placing, and compacting all necessary backfill, all necessary disconnections and modifications to existing wiring, construction of a new base as required, grading all areas disturbed by the work, turf establishment in those areas if turf establishment is not otherwise included in the Contract and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
677.12 Overhead Traffic Sign Support, Cantilever	Each
677.13 Overhead Traffic Sign Support, Multi-Support	Each
677.22 Overhead Traffic Sign Support, Cantilever with Lighting	Each
677.23 Overhead Traffic Sign Support, Multi-Support with Lighting	Each
677.25 Remove and Reset Overhead Traffic Sign Support	Each

#### SECTION 678 - TRAFFIC CONTROL SIGNALS

678.01 DESCRIPTION. This work shall consist of furnishing and installing a traffic control system.

All electrical work performed under the Contract and all materials installed shall be subject to inspection and approval of the State or Municipal Electrical Inspector, whichever position is applicable. As a minimum, all work must meet the requirements of the National Electrical Code.

678.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type IV .....	707.03
Paint for Traffic Control Signals .....	708.07
Electrical Conduit Sleeve .....	710.06
Anchor Bolts.....	714.09
Preformed Fabric Bearing Pads.....	731.01
Pedestal Posts .....	752.01
Strain Poles.....	752.02
Traffic Signal Poles with Mast Arms or Bracket Arms..	752.03
Span Wire.....	752.04
Traffic Signal Heads.....	752.05
Traffic Signal Controllers.....	752.06
Flashing Beacons.....	752.07
Electrical Conduit.....	752.08
Traffic Signal Conductor Cable.....	752.09
Detectors.....	752.10
Vehicle Detector Slot Sealant.....	752.11
Junction Box.....	752.12
Accessible Pedestrian Signals .....	752.13
Pedestrian Pushbutton Assemblies .....	752.14
Grounding Electrodes.....	753.05

Prior to ordering any traffic control components of the signal system, the Contractor shall submit Fabrication Drawings in accordance with Section 105. The submittal shall contain, as a minimum, the following information:

- (a) Traffic Signal Controller. Type of controller, manufacturer, model, number of phases and functions, and assurance of conformance to NEMA standards. Bench testing (minimum of seven calendar days) will be required. Copies of the test results shall be submitted as discussed in Subsection 752.06. The test results shall contain the begin and end time and date of the test, all controller and time-based coordinator settings used, equipment serial numbers, signature of the person performing the test, and signature of a witness who shall be either a registered electrical engineer or a licensed master electrician. The bench test report shall be approved by the Agency prior to the shipping of the controller(s).

- (b) Traffic Signal and Pedestrian Heads. Size, manufacturer, model, lamp wattage, wiring, housing (material and color), visors, and back plates, if required. The signal heads shall conform to the requirements of ITE standards.
- (c) Controller Cabinet. Size, manufacturer, model, accessories, materials, and finish.
- (d) Auxiliary Equipment. Flasher(s), vehicle detector(s), conflict monitor or malfunction management unit, pedestrian audio unit(s), accessible pedestrian signals, manufacturer, model, functions, and assurance of conformance to NEMA standards, where applicable.
- (e) Strain Poles, Cantilevers, and Pedestal Posts.
  - (1) Dimensions for pole/post height, span wire attachment height, pole/post diameter (top and bottom), pole gauge, handhole (size and location), baseplate, bolt circle, and anchor bolt size.
  - (2) Material specifications for each component.
  - (3) Welding information for all welded connections.
  - (4) Special features as shown on the Plans, such as finish or color.
  - (5) Pole/baseplate stamping detail.

In the above, all information supplied shall match or be equivalent to the details shown on the Plans. If equivalent, the Contractor may be asked to supply proof of equivalency. Copies of catalogue sheets are acceptable if all the appropriate information is included.

Submitted Fabrication Drawings shall indicate by either text in the transmittal letter or by text and signature on the Fabrication Drawings, that the Contractor has reviewed the Fabrication Drawings and that the Fabrication Drawings are in conformance with the Contractor's proposed installation procedures.

Strain pole styles other than that shown on the Plans will be permitted. The poles must be able to carry the design loads with a maximum dead load (span wire and signal head) deflection of 150 mm (6 inches). Bending stress ( $f_b$ ) is limited to 66 percent of the minimum yield stress ( $f_y$ ). All design details, quality of work, procedures, materials, etc., shall be in accordance with the latest edition of the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

Schedule 80 conduit shall be used for all applications.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

Steel bar reinforcement shall conform to the requirements of Section 507.

Pull box frames and covers shall be steel plate and conform to the requirements of ASTM A 36/A 36M. A Type D Certification shall be furnished for the steel frames and covers in accordance with Subsection 700.02. Where the cover is exposed to vehicle or pedestrian traffic, it shall have an approved nonskid surface such as diamond plate. Frames and covers shall be galvanized in accordance with AASHTO M 111M/M 111. Pull boxes shall be designed and constructed to support at least an AASHTO M-18 (H 20) loading.

#### 678.03 EXCAVATION AND BACKFILL.

- (a) General. Unless otherwise shown in the Contract Documents, the Contractor shall perform all excavation, backfilling, and resurfacing work, including removal and replacement of curbs, sidewalks, paved surfaces, and any other materials necessary to complete the work in accordance with the Contract Documents or as directed by the Engineer.

In making excavations in paved surfaces, cuts shall be made with a concrete saw to a minimum depth of 50 mm (2 inches) along the neat lines of the area to be removed.

All landscaping and underground utility systems that have been disturbed by the construction shall be restored to their original condition at the Contractor's expense upon completion of the work.

- (b) Excavation. Excavation shall be at the locations and to the dimensions shown on the Plans.



- (c) Backfill. Backfill of suitable material shall be placed and compacted in layers not exceeding 150 mm (6 inches). The bottom of pull boxes shall be filled with granular materials approved by the Engineer to within 150 mm (6 inches) of the bottom of conduit.

678.04 ERECTION OF POSTS AND POLES. All posts and poles shall be erected on concrete bases at the locations shown on the Plans.

In the erection of posts and poles, leveling nuts shall be provided for installation between the bases and the concrete foundation to aid in plumbing.

The space between the top of the concrete footing and metal base of the support shall be filled with Type IV mortar.

Where aluminum alloys come in contact with other materials, the contacting surfaces shall be separated with a fabric pad 3.2 mm (1/8 inch) in thickness or cleaned and thoroughly coated with an aluminum impregnated caulking compound.

678.05 PLACING OF CONDUIT, PULL BOXES, AND JUNCTION BOXES. Unless otherwise specified, the conduit for the cable shall be placed not less than 600 mm (24 inches) below the top of curb in the sidewalk areas and not less than 1 m (36 inches) below the finished grade of pavement when passing under roadways. Conduit shall be pitched or graded at not less than 1:400 (vertical:horizontal) and provision shall be made for draining moisture away from pull boxes as directed by the Engineer.

Red plastic marking tape 150 mm (6 inches) wide shall be placed in the excavated trench 150 to 300 mm (6 to 12 inches) below the finished grade for all conduit and sleeve runs except those jacked under the roadway.

High density polyethylene (HDPE) plastic pipe conduit shall be used only for underground installations.

A minimum of 600 mm (24 inches) of cover shall be required over conduit at all times during construction.

Unless otherwise specified, the conduit shall be laid in a straight line with no bends except preformed bends and at the entrance to a pull box or a concrete base.

All joints for PVC or HDPE conduit shall be made with a tapering tool and not an edging tool.

For metal conduit, all couplings shall be tightened until the ends of the conduit are together and provide a good electrical connection. Any cutting of the conduit shall be made squarely so that the resulting ends will butt together over their full area. The ends of conduits shall be reamed and have threaded connections. Slip joints or running threads shall not be used for couplings. The exposed ends for all types of conduits shall be capped with standard conduit caps until wiring starts, at which time they shall be replaced with approved bushings.

Where factory conduit bends are not being used, the conduit shall be bent using the longest radius possible but not less than six times the inside diameter of the conduit and in a manner that will not crimp or flatten the conduit.

No more than three 90-degree bends or equivalent (270 degrees total) shall be used on a continuous conduit line. If more than 270 degrees in total bends are necessary, then a pull box or junction box shall be installed. Either elbows or sweeps may be used for entering concrete bases, but elbows shall be used at the base of a service pole on the street quarter of the pole.

One approved expansion fitting shall be used for each conduit run on a bridge structure at every expansion joint of the bridge. Expansion couplings shall also be used on the power service pole and all conduits entering or leaving the meter or disconnects on a power drop stanchion.

After the conduit lines are completed, the Contractor shall, in the presence of the Engineer, check the installation by pushing a one diameter long mandrel having a diameter of 5 mm (1/4 inch) less than the diameter of the conduit through the length of conduit. Any obstructions, including stone and dirt, shall be removed. Damaged conduit shall be removed and replaced at the Contractor's expense. When conductor cable is not being placed in conduit under the Contract, a pull cord with a 2.2 kN (5 kips) minimum pull strength shall be installed in all conduits. The pull cord shall terminate beyond the end of the conduit in each pull box or just under the cap at concrete bases for poles.

Pull Boxes and Junction Boxes shall be placed at locations shown on the Plans or as directed by the Engineer.

#### 678.06 INSTALLATION OF ELECTRICAL CONDUIT SLEEVES.

Electrical Conduit Sleeves shall be installed at the locations shown on the Plans or as directed by the Engineer.

Unless otherwise specified, electrical conduit sleeves placed under roadways or drives shall have a minimum cover depth of 1 m (3 feet) measured from the finished roadway surface. Sleeves shall be pitched or graded at not less than 1:400 (vertical:horizontal) and provision shall be made for draining moisture away from the sleeve location or as directed by the Engineer.

Unless otherwise specified, the Contractor shall install electrical conduit sleeves in a straight line with no bends. The installed sleeve shall terminate a minimum of 1.2 m (4 feet) outside the face of curb or edge of shoulder of the roadway or drive that the sleeve crosses. Electrical Conduit Sleeves may be placed by an open cut or may be directionally bored under roadways or drives.

When conduit is not being placed in a sleeve, prior to backfilling around the sleeve, the Contractor shall install a suitable pull cord with a 2.2 kN (5 kips) minimum pull strength in the sleeve and seal the ends prior to backfilling the sleeve.

678.07 DETECTORS AND CONTROLLERS. Detectors and controllers shall be installed at the locations shown on the Plans and in accordance with directions furnished by the manufacturer. The type of mounting of the controller cabinet shall be as shown on the Plans. Controller cabinets shall be provided with locks as shown on the Plans. Two keys shall be furnished with each lock. All pedestrian activated push buttons shall have an advisory sign attached as shown on the Plans. At locations where Accessible Pedestrian Signals (APS) are installed, the push buttons shall include audible locator tones, raised arrows and vibro-tactile features that comply with the latest editions of the MUTCD and ADA standards as specified in Subsection 752.14.

When applying vehicle detector slot sealant to the slot, it shall be by a pressurized system such as a manual or mechanical caulking gun or in a manner approved by the manufacturer. The loop wires shall be held in place during sealing by nonmetallic strips or tabs approximately 50 mm (2 inches) long located about every 600 mm (24 inches) along the slot.

678.08 ELECTRIC POWER SERVICE. Prior to submitting a proposal, the Contractor shall obtain from the utility company the location of the power source, the amount of power to be supplied, an understanding of the termination of the power company's services and the requirements of the power company for connection of the electrical facilities to be constructed under the Contract.

The Contractor shall furnish and install a service riser at the power control center, a fully enclosed and watertight cabinet with a meter socket, appropriate sized and number of disconnect equipment, and circuit breakers to meet load and/or equipment manufacturer's requirements. All State and local codes shall be adhered to.

Luminaires installed on strain poles shall utilize the same power source as the traffic signal but with a separate disconnect breaker and meter

678.09 WIRING. All wiring shall be performed in accordance with the National Electrical Code. Splices shall be made only at pull boxes, junction boxes, or pole bases. All splices shall be electrically and mechanically secure and shall be insulated for 600 V. The completed splice shall be watertight and shall test electrically equal to or greater than the cable. All splices shall be soldered, using rosin core solder, and then be fully sealed by the application of dual wall heat-shrinkable tubing.

Unless otherwise shown on the Plans, a minimum of 1 m (3 feet) of slack shall be left in each cable in each box or base.

Where shown on the Plans, wired conduit may be either pre-wired before the conduit is installed or the wire may be installed after the conduit is installed. The Contract item Wired Conduit includes both the conduit and the wires contained within the conduit; however, the wires and the conduit shall not be attached to each other and the wires shall be readily pulled from the conduit for replacement without excessive effort.

Except when otherwise shown on the Plans, the minimum size for an installed conduit shall be 50 mm (2 inch) DN inside diameter conduit or shall match the size of the existing conduit to which it attaches, provided that in either case the installed conduit shall be of sufficient inside diameter to contain wiring of a size such that the voltage drop in the secondary circuit(s) will not exceed 3 percent; shall be of sufficient inside diameter that the combined cross-sectional area of the wiring shall not exceed the percentage of conduit fill specified in the National Electrical Code; and shall, in accordance with the other requirements of this Subsection, contain the wires necessary to make the completed system or subsystem function.

Where electrical wiring is shown on the Plans, the Contractor shall remove the existing wiring, if such exists, from the existing conduit, strain pole, streetlight pole or bracket arm and shall install new wiring meeting all code and specification requirements. The wiring shall be of a size such that the voltage drop in the secondary circuit(s) will not exceed 3 percent and the wiring will contain only the number of conductors necessary to make the completed system or subsystem function.

The minimum wire sizes for circuits shall conform to the following requirements:

Service	Area in mm <sup>2</sup>	AWG
From supply to Disconnect	13.30	No. 6
Ground	13.30	No. 6
Disconnect to Controller or Flasher	8.37	No. 6
Controller to Signals or Beacons	3.31	No. 12
Controller to Pavement Units	2.08	No. 14
Controller to Push Buttons	2.08	No. 14
Interconnect Figure "8"		
[1 km (1/2 mile) or less]	2.08 (solid)	No. 14 (solid)
[1 to 2 km (1/2 to 1 mile)]	3.31 (solid)	No. 12 (solid)

There shall be a neutral wire for every eight or fewer ungrounded conductors.

Plastic cable rings shall not be permitted for supporting electrical cable from a span wire.

Stranded wire shall be used for all unsupported and span wire supported wiring.

The Contractor shall furnish and install sufficient cable and wire to operate the system properly as shown on the Plans and as specified and shall provide at least two spare conductors in all signal and interconnect cable runs, including fire and railroad preemption cables.

The Contractor shall wire the system in accordance with the following color-coding system where practicable:

Wire Color	Application
Red	Red, Main Street
Orange	Yellow, Main Street
Green*	Green, Main Street
Red with tracer	Red, Side Street
Orange with tracer	Yellow, Side Street
Green with tracer*	Green, Side Street
White	Common ground for all signals and exposed metal parts
Blue	All Steady Burning Arrows
Blue with tracer	Intermittent Arrows
Remaining	Pavement units, push buttons, and spare

\* Green wires shall be tagged "NOT GROUNDED WIRES"

**678.10 GROUNDING AND TESTING.** Each metal pedestal post, strain pole and signal pole, and the common grounding electrode connector of the signal system shall be grounded to the power source and shall be effectively grounded by connection to a grounding electrode driven at each post or pole location. The grounding shall be accomplished by means of a soft drawn, bare, copper wire with a cross-sectional area of 13.30 mm<sup>2</sup> (No. 6 AWG) run between the post or pole base and the grounding electrode or electrodes. The grounding electrode conductor shall be attached to the grounding electrode by an exothermic welding process.

The "white wire" shall be used for the neutral ground connections and shall be continuously connected to ground.

All exposed metal parts, including service pipe and control box housing shall be connected to ground. On all controllers employing the solid common ground, there shall be installed a visible jumper between the service neutral and the signal common ground. The signal common ground bar shall be jumpered to the bonded grounding electrode.

Upon completion of each signal or beacon system, the Contractor shall demonstrate by tests that all circuits are continuous and free from short circuits; that all circuits are free from unspecified grounds; and that the resistance to ground of non-grounded conductors is at least 100 M $\Omega$  for new construction or 5 M $\Omega$  for existing wiring at 16 °C (60 °F) when the test is conducted using 500 V DC. The resistances in the entire specified grounding systems shall not be more than 25  $\Omega$ .

If luminaires are to be installed on strain poles, the lighting work shall be performed in accordance with the applicable requirements of Section 679.

All new traffic and pedestrian signal heads that have been installed but not placed in either flashing or full operation shall be covered. Existing signal heads which are placed out of service in order to perform work on the signal system shall also be covered, except when such work can be completed in a relatively short period of time (several hours) and traffic control has been provided for.

The signal covers shall consist of a one-piece plastic bag having a minimum thickness of 100  $\mu\text{m}$  (4 mils). The bag shall be black or dark brown in color and shall be opaque. The cover shall slip over the entire signal head and shall be securely tied at the opening to secure the cover. An intermediate tie of the same material shall be drawn around the center of the cover to prevent excess flapping in the wind.

A drain hole shall be made at the bottom of the bag to allow the escape of moisture. No tape or adhesive will be allowed to be attached to any surface of the signal housing or lenses. All covers shall be placed in a neat professional manner. Any cover that is torn or missing shall be immediately replaced. Payment for the covers, their placement and removal, and all incidentals for completion of the work will be considered incidental to the installation of the traffic signal.

678.11 INSTALLATION AND COMPLETION. The signals and equipment shall be properly installed, and operating sequences set as shown on the Plans by a competent factory-trained representative of the manufacturer or by workers under the manufacturer's supervision.

All span wire mounted signals shall have disconnect hangers. All fixed mounted signals shall have terminal components.

Traffic signals installed at locations that were previously unsignalized shall be operated in the flash mode for a minimum of 48 hours prior to being put into full operation. Full operation for new installations or switch over for replacement signals shall not be initiated except in the presence of the Roadway, Traffic, and Safety Engineer or a designated representative.

The traffic signals shall not operate without the pavement markings and signal related signing in place.

All work shall conform to the requirements of the National Electrical Code.

After the signal or beacon system has been completely installed, any fixtures with damaged factory applied paint shall be corrected by applying one coat of enamel meeting the requirements of VT 6.01 (Flat Black Enamel) or VT 6.02 (Yellow Enamel) applied to the complete sectional area that is damaged after being lightly sanded to remove gloss. The visors (hoods) and the entire surface of louvers, fins, and the front surface of back plates shall have a dull black finish.

The Contractor shall submit in duplicate to the Engineer the wiring diagrams, signal sequence chart, signal terminal connection diagram, service manual, programming manual (if applicable), and parts list for each signal controller. The foregoing and manufacturer's warranties and guarantees furnished for materials used in the work shall be delivered to the Engineer prior to acceptance of the work. The warranties shall be the manufacturer's customary trade warranties.

There will be a minimum 30-day test control period to adjust and establish timing sequences for the installation. If, during the last 14 days of the control period, the system does not operate correctly, the test period will be extended until the system operates correctly for 14 calendar days.

The Contractor shall correct all deficiencies found in the traffic control signal system as a result of the test control period, and shall repair or replace defective equipment at no additional cost to the Agency. The traffic control system shall not be accepted until successful completion of the test control period.

The Contractor shall make every reasonable effort to have the installation complete and operating, including the test control period, prior to the date specified in the Contract. However, if all other work under the Contract has been completed, any portion of the test control period which extends beyond the completion date may not be considered time charged for liquidated damages.



For new traffic signals or flashing beacons, the Contractor shall be responsible for all utility costs until acceptance of the signal or beacon system. For upgrading of existing signals or beacons, the State or Municipality, whichever is applicable, shall continue to pay for normal monthly power usage while the Contractor shall be responsible for all other utility costs.

When the installation of a telephone line in a traffic signal controller cabinet is included in the Contract, the Contractor shall initiate the installation by the telephone company by contacting the Business Manager for the Agency's Operations Division. The billing for the telephone service will be set up in the name of the Agency's Maintenance District within which the traffic signal controller is located. The Contractor shall reimburse the District for all costs incurred for the installation and for the monthly fees until acceptance of the traffic signal installation. The Contractor shall reimburse the District within 14 days of receiving a copy of the bill. The Final Estimate will not be paid until the Agency's District Transportation Administrator (DTA) certifies that all reimbursements have been received.

The required 30-day test control period for the signal installation shall not begin until all construction of the signal installation is complete and the Engineer has received notice from the responsible Agency parties that all paperwork, including Fabrication Drawings, materials certifications, bench test reports, etc., related to the signal equipment and installation have been completed to the satisfaction of the responsible parties. Once the 30 day test period has been completed, and the project has been declared substantially complete by the Engineer, the Engineer will send a memorandum or an e-mail to the Roadway, Traffic, and Safety Engineer, with a copy to the Traffic Signal Maintenance Technician and the appropriate Agency DTA stating that the above criteria have been met and that the Agency is now responsible for the maintenance of the traffic signal system. The name of the power company and the account number on the power bill shall be included for the DTA's records. If a memorandum is sent, a telephone call will also be made by the Engineer to ensure the transfer of responsibility.

For projects where several signal systems are coordinated, all the individual signal systems must have successfully completed the 30-day test control period before the signal systems can be accepted.

The Contractor shall notify the Engineer and/or the town or city engineer at least 48 hours prior to turning off existing traffic control signals at any location, or when the Contractor is ready to install the traffic control signal system. Notice is required so that a representative may be provided to observe the installation of the equipment in preparation for maintenance and repair of the system and to have a uniformed traffic officer present to maintain traffic.

Removal of existing or reuse of salvaged equipment:

- (a) Unwanted equipment must be disposed of by the Contractor. Removal of equipment shall include removal of concrete bases and backfill of the holes, where applicable. Any equipment that is damaged or lost by the Contractor during removal shall be repaired or replaced to the satisfaction of the Engineer, at the Contractor's expense.
- (b) All salvaged and reused equipment shall be thoroughly cleaned and painted as required, before reuse.
- (c) All reused traffic signal, flashing beacon, or street lighting lenses and reflectors shall be cleaned and all lamps shall be replaced using lamps conforming to the applicable requirements of Subsection 752.05.

678.12 TEMPORARY TRAFFIC CONTROL SIGNALS AND FLASHING BEACONS.

- (a) General. Temporary traffic control signals and temporary flashing beacons shall be installed by the Contractor at the locations shown on the Plans or directed by the Engineer.

The temporary traffic control signal system or temporary flashing beacon system installed at the designated location shall include all necessary existing or Contractor provided materials and equipment shown on the Plans, including, but not limited to, controllers, flashers, wiring, conduit, strain poles, associated signs, sign posts, pavement markings, electrical service, vehicle detectors, span wires, interconnect cables, signal heads, warning beacons, and lights. In the case of temporary signals at a temporary bridge location, the signal system shall include all the signals and associated signage to be installed at all approaches to the temporary bridge.

- (b) Materials. The traffic signal, flashing beacon, and lighting equipment provided shall conform to the requirements of the latest edition of the MUTCD and NEMA, but are not required to be new. Fabrication Drawings and certification will not be required for the temporary signal, flashing beacon, and lighting materials and equipment.

Materials shall conform to the applicable requirements of Sections 678 and 679.

All associated signing shall conform to the MUTCD and Section 675, except that the materials are not required to be new.

Pavement marking shall conform to the MUTCD and Section 646.

- (c) Installation. The components of the temporary traffic signal and flashing beacon systems shall be installed in accordance with the applicable requirements of Sections 646, 675, 677, 678, and 679, with the following modifications:

Concrete bases will not be required for temporary traffic signal installations.

The Contractor shall correct all deficiencies found in the traffic control signal system and shall repair or replace defective equipment at no cost to the State.

During installation of the temporary traffic signal system or flashing beacons for advanced warning signs, no conduit shall be placed under the existing roadway.

The entire signal system including signs, warning beacons, poles, lights, detectors, and other required materials shall be in place and operating correctly prior to the start of the part of the project requiring its operation. Removal of the temporary signal system in its entirety and restoration of the disturbed areas shall constitute completion of the Contract item.

The Contractor shall be responsible for all permits and costs associated with providing electrical power for the traffic signal and warning beacon operation.

The Contractor shall notify the Engineer and/or the town or city officials at least 48 hours prior to turning off the existing traffic control signals, and/or installing temporary signals.

Pavement marking shall meet the requirements for temporary pavement markings, unless otherwise shown on the Plans.

- (d) Detectors. Unless shown on the Plans, detectors for temporary traffic signal activation may be of the type and manufacture chosen by the Contractor. However, the furnished detector must function properly and provide the actuation required for the specific installed site. If, in the opinion of the Engineer, the furnished detector either does not function properly or does not perform the required actuation, the Contractor shall replace the detector within 24 hours of receiving notice to do so from the Engineer. The costs of replacement shall be solely at the Contractor's expense.

Unless otherwise shown on the Plans, detectors designed to be installed in the roadway shall be cut and sealed in the pavement in the same manner as permanently installed detectors.

If temporary loop detectors are installed in a gravel roadway, they shall be placed in Schedule 80 PVC or HDPE conduit and buried at least 100 mm (4 inches) below the travel surface. Other detectors installed in gravel roadways shall be installed in accordance with the manufacturer's recommendations.

678.13 METHOD OF MEASUREMENT. The quantity of Traffic Control Signal System, Intersection to be measured for payment will be the number of each signal system installed in the complete and accepted work.

The quantity of Flashing Beacon, Ground Mounted or Flashing Beacon, Aerial Mounted to be measured for payment will be the number of each beacon system installed in the complete and accepted work.

The quantity of Interconnecting Cable to be measured for payment will be the number of meters (linear feet) of the interconnected system installed in the complete and accepted work, as measured between controller units along the alignment shown on the Plans. No allowance will be made for sag between poles or for loops created in making connections.

The quantity of Electrical Conduit and Wired Conduit to be measured for payment will be the number of meters (linear feet) of the specified conduit installed as required by the system being constructed in the complete and accepted work. The measurement will include sweeps into, and out of, bases, pull boxes, and junction boxes.

The quantity of Vehicle Loop Detector to be measured for payment will be the number of meters (linear feet) of pavement cut and sealed, measured from the curb, containing the loop and lead-in wires, in the complete and accepted work.

The quantity of Electrical Wiring to be measured for payment will be the number of meters (linear feet) of specified wiring installed in the complete and accepted work, as measured between connection points along the installed alignment. No allowance will be made for sags or loops for making connections, but including the wiring installed in sweeps into, and out of, bases, pull boxes, and junction boxes.

The quantity of Pull Box, of the type specified, and Junction Box to be measured for payment will be the number of each box installed in the complete and accepted work.

The quantity of Electrical Conduit Sleeve to be measured for payment will be the number of meters (linear feet) of the specified sleeve installed in the complete and accepted work.

The quantity of Temporary Traffic Signal System, Temporary Flashing Beacon, or Temporary Detector to be measured for payment will be the number of each system installed in the complete and accepted work, maintained during construction, and then removed from the project when the Engineer determined it was no longer required.

678.14 BASIS OF PAYMENT. The accepted quantity of Traffic Control Signal System, Intersection will be paid for at the Contract unit price per each at each designated intersection. Payment will include strain poles, signal heads, controller and cabinet, all wiring not included in the Contract items Wired Conduit and Electrical Wiring, and all other materials necessary for a fully operational Traffic Control Signal System not otherwise paid for under other Contract items in this Section. The Contractor shall be responsible for all maintenance costs for new or existing signal(s) and beacons until project acceptance. This period shall include any winter shut downs during the Contract period. Replacement of poles and cabinet/controllers will not be considered maintenance costs unless the loss is due to the Contractor's negligence. At the discretion of the Engineer, the Contractor may be required to replace poles and cabinet/controllers that are lost or damaged due to an accident. If required, such work will be considered Extra Work under Subsection 109.06 and additional payment will be allowed. Any equipment that is defective or damaged prior to the beginning of the Contract shall be maintained in at least as good condition, until it is replaced as part of the Contract.

The accepted quantity of Flashing Beacon, Ground Mounted will be paid for at the Contract unit price per each at each designated location. Payment will include beacon head(s), flasher and cabinet, all wiring not included in the Contract items Wired Conduit and Electrical Wiring, power source, and all other materials necessary for a fully operational Flashing Beacon not otherwise paid for under other Contract items in this Section. Sign post(s) and panel(s) will be paid for under their own Contract items.

The accepted quantity of Flashing Beacon, Aerial Mounted will be paid for at the Contract unit price per each at each designated location. Payment will include strain poles, span wire, attachment hardware, beacon heads, and all other materials necessary for a fully operational flashing beacon system not otherwise paid for under other Contract items in this Section. Sign post(s) and panel(s) will be paid for under their own Contract items.

Payment for Traffic Control Signal System, Intersection; Flashing Beacon, Ground Mounted; and Flashing Beacon, Aerial Mounted will be made as follows:

- (a) When applicable, 10 percent of the Contract unit price will be paid for the installation of strain poles.
- (b) Upon installation of a functioning system as indicated by a successful continuous 24-hour operation test period, an additional 10 percent of the Contract unit price will be paid. When the installation does not include strain poles, 20 percent of the Contract unit price will be paid upon successful completion of a continuous 24-hour operation test.
- (c) Thirty percent of the Contract unit price will be paid upon receipt by the Engineer of notice from all responsible Agency parties that all paperwork related to the signal or beacon installation has been completed to the satisfaction of the Agency.
- (d) The remainder, less 20 percent of the Contract unit price, will be paid after successful completion of the 30-day test control period.
- (e) The final 20 percent of the Contract unit price will be paid upon acceptance of the project.

- (f) The Contractor will not be paid more than 50 percent of the Contract unit price for the traffic signal or flashing beacon installation, whether directly or through stockpile or any other means until the Engineer has been notified that all signal related paperwork has been completed to the satisfaction of the Agency.

The accepted quantities of Interconnecting Cable, Electrical Conduit, and Vehicle Loop Detector will be paid for at the Contract unit price per meter (linear foot). Payment for Electrical Conduit will include installed electrical conduit only.

The accepted quantity of Wired Conduit will be paid for at the Contract unit price per meter (linear foot). Payment will include both the installed conduit and the wiring inside the conduit.

The accepted quantity of Electrical Wiring will be paid for at the Contract unit price per meter (linear foot). Payment will include removing any existing wiring in an existing conduit, strain pole, streetlight pole, or bracket arm; installing new updated wiring including necessary connections; fusing in that existing enclosed location, and providing all the required number of conductors (including grounds, neutrals, and the designated number of spares). No adjustment of the Contract price will be made if a lesser or greater number of conductors becomes necessary to complete the work.

Unless otherwise shown on the Plans, Wired Conduit and Electrical Wiring will not occur in the same location as Electrical Conduit. Furthermore, Electrical Wiring will only occur inside existing and previously installed conduits, strain poles, streetlight poles, or bracket arms.

The accepted quantities of Pull Box, of the type specified, and Junction Box will be paid for at the Contract unit price per each.

The accepted quantity of Electrical Conduit Sleeve will be paid for at the Contract unit price per meter (linear foot). The cost of excavation and backfill will not be included in the costs of the sleeve. When the sleeve is installed for use with one or more conduits, the costs of excavation and backfill will be considered included in the Contract unit price for the conduit(s) installed within the sleeve. When the sleeve is installed without conduit, the pay limits and the excavation and backfill will be paid in the same manner as specified for culverts in Subsection 601.10.

Payment for the above Contract unit prices will be full compensation for furnishing, transporting, handling, and installing the materials and equipment specified, including excavation, backfill, concrete, hanger hardware for pole mounting of cable, pole identification, cutting and resealing the pavement, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Disconnecting existing loop or other detectors will be considered incidental to other Contract items.

The accepted quantity of Temporary Traffic Signal System will be paid for at the Contract unit price per each. Payment will include the installation and removal of strain poles, signal heads, controller and cabinet, luminaires, signs, sign posts, flashing beacons, pavement markings, wiring, conduit, and all other materials necessary for a fully operational Temporary Traffic Signal System complete in place.

When a Temporary Flashing Beacon system is installed on a project that also requires the installation of a temporary traffic signal, the Temporary Flashing Beacon will not be paid for directly, but will be considered incidental to the Contract item Temporary Traffic Signal System.

The accepted quantity of Temporary Flashing Beacon will be paid for at the Contract unit price per each. Payment will include the installation and removal of poles, span wires, signs, sign posts, beacon heads, flasher units and cabinets, conduit, wiring, attachment hardware, and all other materials necessary for a fully operational Temporary Flashing Beacon system complete in place.

The accepted quantity of Temporary Detector will be paid for at the Contract unit price per each. Payment will include the detector and all necessary installation hardware and materials. A detector consists of the "black box" container or the loop and leads within the paved area of the roadway (on unpaved highways, the graveled surface). Wiring from the controller to the detector, including connection to the detector, is included in the Contract item Temporary Traffic Signal System.

Payment of the above Contract unit prices will be full compensation for furnishing, transporting, handling, and installing the materials and equipment specified, including excavation, backfill, hanger hardware for cable and signals, span wires, poles, cutting and resealing pavement, providing electrical service and power, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work, to maintain the system while it is required, and then to completely remove it from the project and properly dispose of it when so directed by the Engineer.



All components, materials, and equipment furnished by the Contractor shall remain the property of the Contractor and shall be properly removed from the project and disposed of by the Contractor when the temporary system is removed. Existing components and materials that were utilized for the temporary system shall be disposed of as shown in the Contract Documents.

Payment for Temporary Traffic Signal System and Temporary Flashing Beacon will be made as follows:

- (a) When the entire system has been installed at a site (including signing and pavement markings) and working for 24 hours to the satisfaction of the Engineer, 50 percent of the Contract unit price for each will be paid.
- (b) When 60 percent of the working days between the date of installation and the original completion date have elapsed, an additional 30 percent of the Contract unit price for each will be paid.
- (c) Upon complete removal of the system from the site and restoration of disturbed areas, the remaining 20 percent of the Contract unit price will be paid.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
678.15 Traffic Control Signal System, Intersection	Each
678.16 Flashing Beacon, Ground Mounted	Each
678.17 Flashing Beacon, Aerial Mounted	Each
678.20 Interconnecting Cable	Meter (Linear Foot)
678.21 Electrical Conduit	Meter (Linear Foot)
678.22 Vehicle Loop Detector	Meter (Linear Foot)
678.23 Wired Conduit	Meter (Linear Foot)
678.24 Electrical Wiring	Meter (Linear Foot)
678.25 Pull Box, Standard	Each
678.26 Junction Box	Each
678.27 Pull Box, Double	Each
678.30 Electrical Conduit Sleeve	Meter (Linear Foot)
678.40 Temporary Traffic Signal System	Each
678.41 Temporary Flashing Beacon	Each
678.42 Temporary Detector	Each

SECTION 679 - STREET LIGHTING

679.01 DESCRIPTION. This work shall consist of furnishing and installing a street lighting system.

All electrical work performed under the Contract and all materials installed shall be subject to inspection and approval of the State or Municipal Electrical Inspector, whichever is applicable. All work must meet the requirements of the National Electrical Code.

679.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type IV .....	707.03
Bar Reinforcement.....	713.01
Anchor Bolts.....	714.09
Preformed Fabric Bearing Pad .....	731.01
Electrical Conduit.....	752.08
Aluminum Poles .....	753.01(b)
Steel Poles .....	753.01(c)
Luminaires.....	753.02
Photoelectric Control Devices .....	753.03
Highway Illumination Conductor Cable.....	753.04
Grounding Electrodes.....	753.05

All welding shall be performed in accordance with the provisions of Subsection 506.10. Unless otherwise specified, AWS ER 4043 electrode wire shall be used with Alloy 6063-T6, and AWS ER 5356 electrode wire shall be used with Alloys 6005-T5 and 6061-T6 when welding aluminum.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

Prior to ordering the items, the Contractor shall submit Fabrication Drawings in accordance with Section 105. The submittal shall contain at a minimum the following information:

- (a) Luminaires.
  - (1) Fixture.
    - a. Voltage rating.
    - b. Wattage and lamp type.

- c. Ballast type.
  - d. Photo cell.
  - e. Any other features shown on the Plans, such as finish, special wire access, etc.
- (2) Photometric Data.
- a. IES Distribution type.
  - b. Utilization curve.
  - c. Iso-lux curves.
  - d. Mounting height factor.
  - e. Maintenance factor.
- (b) Poles.
- (1) Dimensions for pole height, mounting height, pole diameter (top and bottom), arm length and diameter(s), handhole (size and location), baseplate, bolt circle, and anchor bolt size.
  - (2) Material specifications for each component.
  - (3) Anchor bolts, nuts, and washers. (See Subsection 714.09.)
  - (4) If frangible bases are shown on the Plans, the submittal shall include type (transformer base, breakaway coupling, or other approved type) and literature to indicate that the base meets the AASHTO standards.
  - (5) Types of connections and welding information for pole to baseplate, pole to arm and arm components if a truss arm is used. (See Subsection 506.10.)
  - (6) The welding process and procedures and the materials used to make the two continuous circumferential welds, one attaching the top of the shoe base (anchor base) to the pole shaft and the other attaching the bottom of the pole shaft to the inside of the shoe base.

- (7) Special features as shown on the Plans, such as finish or color.
- (c) Wiring. Conductor material, insulation type, voltage rating and temperature rating shall conform to the National Electrical Code for use and size and shall be color-coded.
- (d) Welding Information. For all welded connections in all of the above, the information supplied shall match or be equivalent to the details shown on the Plans. If equivalent, the Contractor may be asked to supply proof of equivalency. Copies of catalogue sheets are acceptable if all the appropriate information is included.

All design details, quality of work, procedures, materials, etc. shall conform to AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, most current section for Aluminum Design.

Pull box frames and covers shall be of steel plate and conform to the requirements of ASTM A 36/A 36M. A Type D Certification shall be furnished in accordance with Subsection 700.02 for the steel frames and covers provided. Where the cover is exposed to vehicle or pedestrian traffic, it shall have an approved nonskid surface such as diamond plate. Frames and covers shall be galvanized in accordance with AASHTO M 111M/M 111. Pull boxes shall be constructed to support an AASHTO M-18 (H 20) loading.

#### 679.03 EXCAVATION AND BACKFILL.

- (a) General. Unless otherwise shown in the Contract Documents, the Contractor shall perform all excavation, backfilling, and resurfacing work, including removal and replacement of curbs, sidewalks, paved surfaces, and any other materials necessary to complete the work, in accordance with the Contract Documents or as directed by the Engineer.

In making excavations in paved surfaces, cuts shall be made with a concrete saw to a minimum depth of 50 mm (2 inches) along the neat lines of the area to be removed.

All landscaping and underground utility systems that have been disturbed by the construction shall be restored to their original condition upon completion of the work, at the Contractor's expense.

- (b) Excavation. Excavation shall be at the locations and to the dimensions shown on the Plans.
- (c) Backfill. Backfill of suitable material shall be placed and compacted in layers not exceeding 150 mm (6 inches). The bottom of pull boxes shall be filled with granular materials approved by the Engineer to within 150 mm (6 inches) of the bottom of conduit.

679.04 PLACING OF CONDUIT, PULL BOXES, AND JUNCTION BOXES. Unless otherwise specified, the conduit for the cable shall be placed not less than 600 mm (24 inches) below the top of curb in the sidewalk areas and not less than 1 m (3 feet) below the finished grade of pavement when passing under roadways. Conduit shall be pitched or graded at not less than 1:400 (vertical:horizontal) and provision shall be made for draining moisture away from pull boxes as directed by the Engineer.

Red plastic marking tape of 150 mm (6 inch) width shall be placed in the excavated trench 150 to 300 mm (6 to 12 inches) below the finished grade for all conduit and sleeve runs except those jacked under the roadway.

HDPE conduit shall be used for underground installations only.

A minimum of 600 mm (24 inches) of cover shall be required over conduit at all times during construction.

Unless otherwise specified, the conduit shall be laid in a straight line with no bends except preformed bends or bends at the entrance to a pull box or a concrete base.

All joints for PVC or HDPE conduit shall be made with a tapering tool and not an edging tool.

For metal conduit, all couplings shall be tightened until the ends of the conduit are together and provide a good electrical connection. Any cutting of the conduit shall be made squarely so that the resulting ends will butt together over their full area. The ends of conduits shall be reamed and have threaded connections. Slip joints or running threads shall not be used for couplings. The exposed ends for all types of conduits shall be capped with standard conduit caps until wiring starts, at which time they shall be replaced with approved bushings.

Where factory conduit bends are not being used, the conduit shall be bent using the longest radius possible but not less than six times the inside diameter of the conduit, and in a manner that will not crimp or flatten the conduit.

No more than three 90 degree bends or equivalent (270 degrees total) shall be used on a continuous conduit line. If more than 270 degrees in total bends are necessary, then a pull box or junction box shall be installed. Either elbows or sweeps may be used for entering concrete bases, but elbows shall be used at the base of a service pole on the street quarter of the pole.

One approved expansion fitting shall be used for each conduit run on a bridge structure at every expansion joint of the bridge. Expansion couplings shall also be used on the power service pole and all conduits entering or leaving the meter or disconnects on a power drop stanchion.

After the conduit lines are completed, the Contractor shall, in the presence of the Engineer, check the installation by pushing a one-diameter long mandrel having a diameter of 5 mm (1/4 inch) less than the diameter of the conduit through the length of conduit. Any obstructions, including stone and dirt, shall be removed. Damaged conduit shall be removed and replaced at the Contractor's expense. When conductor cable is not being placed in conduit under the Contract, a pull cord with a 2.2 kN (5 kip) minimum pull strength shall be installed in all conduits. The pull cord shall terminate beyond the end of the conduit in each pull box or just under the cap at concrete bases for poles.

Pull boxes and junction boxes shall be placed at the locations shown on the Plans or as directed by the Engineer.

679.05 ERECTION OF LIGHT STANDARDS. The light standards shall be erected on concrete bases at the locations shown on the Plans.

If a pole that does not have a breakaway feature needs leveling or plumbing when being erected, metal shims shall not be used. Leveling or plumbing shall be accomplished by the use of leveling nuts installed on the anchor bolts between the pole base and the concrete foundation.

If a pole that has a transformer base needs leveling or plumbing when being erected, metal shims shall be used between the transformer base and the concrete foundation. Leveling nuts shall not be installed on the anchor bolts.

The space between the top of the concrete footing and metal base of the support shall be filled with Mortar, Type IV.

The length of bracket arms and mounting height shall be as shown on the Plans. The bracket arm shall be mounted perpendicular to the centerline of roadway, unless otherwise specified.

Where aluminum alloys come in contact with other materials, the contacting surfaces shall be separated with a fabric pad 3.2 mm (1/8 inch) in thickness or cleaned and thoroughly coated with an aluminum impregnated caulking compound.

Luminaires shall be installed simultaneously with the erection of light standards when aluminum or steel poles are used. Failure to do so may result in damage to the pole due to vibrations that can occur.

Where street lighting is to be installed on existing wood poles, the bracket arms shall be equipped with devices suitable for attachment to wood poles.

679.06 ELECTRIC POWER SERVICE. It shall be the responsibility of the Contractor, prior to submitting a proposal, to have obtained from the utility company, the location of the power source; the amount of power to be supplied; an understanding of the termination of the power company's services; and the requirements of the company for connection of the electrical facilities to be constructed under the Contract.

The Contractor shall furnish and install a service riser at the power control center; a totally enclosed and watertight cabinet with a meter socket; appropriate sized and number of disconnect equipment and circuit breakers to meet load and/or equipment manufacturers' requirements. All State and local codes shall be adhered to.

679.07 WIRING. All wiring shall be done in accordance with the National Electrical Code. Splices shall be made only at pull boxes, junction boxes or pole bases. All splices shall be electrically and mechanically secure and shall be insulated for 600 V. The completed splice shall be watertight and shall test electrically equal to or greater than the cable.

Unless otherwise shown on the Plans, a multiple system of distribution shall be used and the wire sizes shall be such that the voltage drop in the secondary circuit(s) does not exceed 3 percent. Fuses in each light pole base shall be rated three times the maximum current for high intensity discharge ballasts.

Wire connections in the base of each light pole shall be made with a watertight wye or in-line plug-in type connector of a type that will disconnect upon impact to eliminate the shock hazard in a "knock-down"

situation and eliminate damage to the rest of the underground wiring. There shall also be enough slack cable to permit working on the wye-connector outside the pole hand hole.

679.08 GROUNDING AND TESTING. Each metal light standard and the continuous grounded conductor of the distribution circuit shall be effectively grounded at the power source and at each metal light standard with a soft drawn, bare, copper wire with a cross-sectional area of 13.30 mm<sup>2</sup> (No. 6 AWG) run between light standard, power source and grounding electrode(s) at each concrete base location. The grounding electrode conductor shall be attached to the grounding electrode by an exothermic welding process. The neutral wire shall be grounded at the power source. On bridges, the light standards and conduits, if metallic, shall be electrically connected in an approved manner. For bridges that are less than 150 m (500 feet) in length, one end of the conduit, if metallic, shall be connected to a ground electrode and for bridges that are greater than 150 m (500 feet) in length, the conduit shall be grounded in the same manner at both ends.

Upon completion of the system, the Contractor shall demonstrate by tests that all circuits are continuous and free from short circuits; that all circuits are free from unspecified grounds; and that the resistance to ground of non-grounded conductors is at least 100 MΩ for new construction or 5 MΩ for existing wiring at 16 °C (60 °F) when the test is conducted using 500 V DC. The resistances in the entire specified grounding systems shall be not more than 25 Ω.

Voltage readings shall be made at each circuit breaker and distribution transformer with load and without load, and on each side of each circuit breaker and at the end of each circuit with load. Except for no load readings, nighttime and daytime readings shall be taken with the lighting system in normal operation.

Current readings shall be made on the load side of each circuit breaker phase and neutral. Readings shall be made at nighttime and daytime with the lighting system in normal operation.

The lamps shall not be removed or inserted when the power is on.

679.09 ACCEPTANCE. The lighting system shall be completely operable and energized at least 30 days prior to the acceptance of the project and shall be operated each night at the Contractor's expense. The Contractor shall replace all defective parts of the system prior to acceptance of the project. The Contractor shall adjust the luminaire photoelectric switch, if required, so that operation is satisfactory to the Engineer prior to acceptance.



The Contractor shall be responsible for all power costs through project acceptance or the end of the test period, whichever is later.

679.10 METHOD OF MEASUREMENT. The quantity of Direct Burial Cable for Street Lighting to be measured for payment will be the number of meters (linear feet) of cable installed in the complete and accepted work, as measured from pole base to pole base.

The quantity of Light Pole Base to be measured for payment will be the number of each base installed in the complete and accepted work.

The quantity of Extend Light Pole Base to be measured for payment will be the number of each light pole base extended in the complete and accepted work.

The quantity of Breakaway Feature for Light Pole to be measured for payment will be the number of each breakaway feature (approved transformer base, breakaway coupling, etc.) installed in the complete and accepted work.

The quantity of Removing and Resetting Light Pole to be measured for payment will be the number of each light pole completely reset on a new or existing concrete base in the complete and accepted work.

The quantity of Light Pole to be measured for payment will be the number of each light pole, with pole tag and internal wiring, installed on an existing concrete base in the complete and accepted work.

The quantity of Bracket Arm to be measured for payment will be the number of each, with internal wiring, installed in the complete and accepted work.

The quantity of Luminaire to be measured for payment will be the number of each, with photocell, connected both mechanically and electrically in the complete and accepted work.

The accepted quantity of Power Drop Stanchion, Street Lighting to be measured for payment will be the number of each stanchion installed in the complete and accepted work.

679.11 BASIS OF PAYMENT. Street Lighting item prices shall be full compensation for furnishing, transporting, handling, and placing the materials specified. Connections to power source, circuit testing, and the furnishing of all labor, tools, equipment, and incidentals necessary to complete the work will be incidental to other items.

The accepted quantity of Direct Burial Cable for Street Lighting will be paid for at the Contract unit price per meter (linear foot).

The accepted quantities of Light Pole Base, Extend Light Pole Base, Breakaway Feature for Light Pole, Removing and Resetting Light Pole, Light Pole, Bracket Arm, Luminaire, and Power Drop Stanchion, Street Lighting will be paid for at the Contract unit price for each.

Payment will be full compensation for furnishing, transporting, handling, and installing the materials and equipment specified. This includes, but is not limited to, excavation, backfill, concrete, cover plate and frame, anchor bolts, mast, bracket or mast arms, poles, bases, luminaires, ballasts, lamps, transformer enclosures, breakaway devices, wiring, pole identification, necessary fusing, connections to power sources, circuit testing, circuit breakers, photoelectric cells, grounding, hardware, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

For new construction, fusing in the light pole base, wiring within the pole and base, including within breakaway features, and pole identification are part of the costs included in the Contract item Light Pole. Wiring and fusing within bracket arms are part of the costs included in the Contract item Bracket Arm. Ballasts, lamps, and photoelectric devices are part of the costs included in the Contract item Luminaire.

For rehabilitation work, wiring and fusing within poles, bases, and bracket arms will be paid for under the Contract item Electrical Wiring in Section 678.

Circuit testing and connections to power sources will not be paid for separately but will be considered incidental to the Contract items that include the costs of wiring.

The cost of furnishing and installing electrical conduit, wired conduit, electrical wiring, electrical conduit sleeve, pull boxes, and junction boxes will be paid for under the applicable Contract items of Section 678.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
679.16 Direct Burial Cable for Street Lighting	Meter (Linear Foot)
679.21 Light Pole Base	Each
679.22 Extend Light Pole Base	Each
679.23 Breakaway Feature for Light Pole	Each
679.25 Removing and Resetting Light Pole	Each
679.45 Light Pole	Each
679.47 Bracket Arm	Each
679.50 Luminaire	Each
679.55 Power Drop Stanchion, Street Lighting	Each

SECTION 680 - TRAVEL INFORMATION SIGNS

680.01 DESCRIPTION. This work shall consist of furnishing, erecting, and maintaining travel information signs and information plazas.

.680.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Peastone.....	704.11
Paint for Traffic Signs .....	708.06
Structural Timber and Lumber .....	709.01
Nonstructural Lumber .....	709.02
Timber Preservative.....	726.01
Signs Posts.....	750.01
High Density Overlaid Plywood.....	750.06
Retroreflective Sheeting .....	750.08
Plastic Lettering Film .....	750.10
Assembly Hardware .....	750.12

All materials shall be in conformance with the State of Vermont Travel Information Council Standards Manual.

The colors used for specific signs, symbols, and plaques shall be as shown on the Plans and shall provide an acceptable match to the appropriate color chip in FED-STD-595B.

Color	Chip Number
Black	Chip No. 17038
White	Chip No. 17875
Magenta	Chip No. 11158
Brown	Chip No. 10100
Orange	Chip No. 12501
Gray	Chip No. 16373

The color of retroreflective material shall be Silver-White #2.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

680.03 PLANS. Plans for travel information signs, associated components, and work required will consist of assembly drawings of information plazas, standard drawings, location and site plan, and order forms detailing the work to be performed at each specified location.

680.04 SIGN POSTS. The installation of steel and aluminum sign posts shall conform to the requirements of Section 675. Posts shall be set to the depth shown on the Plans.

When wooden posts are specified, travel information signs shall be mounted on two 100 by 100 mm (4 × 4 inch) nominal wooden posts, S4S. The posts shall be set plumb and true in holes excavated to a minimum depth of 1 m (3 feet). That portion of the post to be in contact with or within 225 mm (9 inches) of the ground shall be pressure treated with an approved preservative.

680.05 SIGNS. Travel and business information signs shall be prepared and installed according to the requirements of Section 675, except as modified by this Subsection. The base material for all signs shall be 16 mm (2/3 inch) nominal thickness acrylic overlaid plywood.

All lettering, mileage numerals, and directional arrows shall be formed from retroreflective sheeting. Basic travel information symbols for use on sign boards carrying only travel information symbols shall be reflectorized either by silk-screening the background color on retroreflective sheeting or by applying reflective symbols on acrylic material of the appropriate color. All other travel information symbols and background material shall be non-reflectorized and shall be of the colors shown on the Plans.

Commercial logos, furnished by others, will be applied to certain signs as shown on the Plans.

680.06 INFORMATION PLAZAS. Information plazas shall be constructed at locations shown on the Plans or directed by the Engineer. The information plaza shall be constructed from materials shown on the Plans and shall be erected as shown on the Plans. The plazas shall also be erected in conformance with the Travel Information Council Standards Manual.

The area in which the information plaza is erected shall be reasonably level and unobstructed in order to provide for easy circulation by pedestrians. In areas subject to vehicular traffic, a 2.5 m (8 feet) length of curbing shall be installed parallel to the axis of the structure for the separation of vehicular and pedestrian traffic. Pedestrian traffic areas shall be excavated and surfaced with 300 mm (12 inches) of peastone.

The relocation of an existing information plaza shall consist of removing the information plaza from its present location and reinstalling it on new posts or concrete bases at the location specified. The reinstallation shall be made as shown on the Plans and shall include the necessary electrical connections, grading, and curb installation if necessary. Removal and disposal of the original mounting posts and curb, if any, and any necessary cleanup of the original site shall also be considered to be included in the relocation item.

An information plaza that is damaged during its removal and resetting due to negligence on the part of the Contractor shall be repaired or components replaced by the Contractor at no additional cost to the Agency.

Information plaza lighting and electrical circuitry shall be as shown on the Plans. The plazas shall be lighted during the hours of darkness under the control of a suitably designed photoelectric device. All electrical materials and installation methods shall conform to the provisions of the National Electrical Safety Code and all electrical work shall be in accordance with State and local regulations.

680.07 MAGNETIC PLAZA INFORMATION PLAQUES. When indicated in the Contract, the Contractor shall furnish magnetic plaques of the sizes and types indicated on the order form, complete with the legend provided on the order form.

Type A plaques shall have space reserved for the application of a commercial logo to be furnished by others. The plaques shall be installed by others.

The graphics shall be white on a square panel of magnetic vinyl in the color specified. Graphics shall be of the nominal sizes indicated below:

Plaque Size	Heading	Text	Type A Logo
150 mm square (6 inches square)	48 point	18 point	38 mm square (1 1/2 inches square)

680.08 SYMBOLS. When called for in the Contract, the Contractor shall furnish travel information symbols as ordered by the Engineer. The symbols shall consist of a self-adhesive acrylic background with the appropriate symbol superimposed, all of the size and color specified. The symbols shall be installed by others.

680.09 METHOD OF MEASUREMENT. The quantity of Travel Information Sign and Business Directional Sign to be measured for payment will be the number of square meters (square feet) of sign(s) installed in the complete and accepted work.

The quantity of Travel Information Plaza or Relocate Information Plaza to be measured for payment will be the number of each plaza installed or relocated in the complete and accepted work.

The quantity of Magnetic Information Plaque, of the type specified, Travel Information Symbol, or Overlay for Travel Information Signs will be measured for payment as the number of plaques, symbols, and overlays furnished in the complete and accepted work.

680.10 BASIS OF PAYMENT. The accepted quantity of Travel Information Sign and Business Directional Sign will be paid for at the Contract unit price per square meter (square foot). Payment will include furnishing the sign complete with letter and symbol text and installing the sign as part of a unit at the location specified.

Sign posts for Travel Information Signs will be paid for at the Contract unit price for the appropriate Contract item for sign posts under Section 675.

The accepted quantity of Travel Information Plaza will be paid for at the Contract unit price per each. Payment will include excavation, preparation, and grading of the area; furnishing and placing backfill material; furnishing and placing protective curb where required; and the information plaza complete with electrical service.

The accepted quantity of Relocate Information Plaza will be paid for at the Contract unit price per each. Payment will include disassembly of the plaza, disposal of the original posts, cleanup of the original area, and reinstallation of the plaza on new posts or base at the location specified, complete with prepared, graded, and curbed area and electrical service.

The accepted quantity of Magnetic Information Plaque, of the type specified, and Travel Information Symbol will be paid for at the Contract unit price per each. Payment will be full compensation for furnishing the materials specified with the required text or symbols superimposed.

The accepted quantity of Overlay for Travel Information Sign will be paid for at the Contract unit price per each. Payment will include furnishing the acrylic background of the color specified, placing the required text on the background, and installation of the overlay on the sign panel at the location specified.

Payment for the above Contract unit prices will be full compensation for performing the work specified and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
680.20 Travel Information Sign	Square Meter (Square Foot)
680.25 Business Directional Sign	Square Meter (Square Foot)
680.30 Travel Information Plaza	Each
680.40 Relocate Information Plaza	Each
680.65 150 mm (6 inch) Magnetic Information Plaque, Type A	Each
680.66 150 mm (6 inch) Magnetic Information Plaque, Type B	Each
680.70 Travel Information Symbol	Each
680.72 Overlay for Travel Information Sign	Each