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4.1 SECTION 1 – SUPPLY AND INSTALLATION OF CORRUGATED STEEL PIPE CULVERTS

4.1.1 DESCRIPTION

Supply and Installation of Corrugated Steel Pipe Culverts consists of the supply and installation of Corrugated Steel Pipe (CSP) Culverts less than 1500 mm equivalent diameter in accordance with these Specifications and to the lines, dimensions and grades shown on the Drawings, or as designated by the Engineer.

4.1.2 MATERIALS

4.1.2.1 General

a) Culverts, sloped end sections, couplers, bolts and hardware shall be supplied by the Contractor.
b) Galvanized corrugated steel pipe culverts, sloped end sections, couplers, bolts and hardware shall be fabricated and supplied in accordance with the latest edition of the Canadian Standards Association CAN/CSA-G401 specifications.
c) Previously installed culverts shall not be used.
d) All culverts supplied shall be clearly marked with the following information at intervals of not more than 3 m:
    i) Manufacturer's Name or Trademark
    ii) Nominal Thickness and Type of Metal
    iii) Specification Designation
    iv) Plant Designation Code
    v) Date of Manufacture

4.1.2.2 Recorrugated Ends

Culverts shall be helically corrugated, and the ends shall be recorrugated to provide annular corrugations for coupling purposes.

The minimum length of annular corrugated culvert ends shall be 300 mm for culvert diameters of 900 mm or less and 600 mm for culvert diameters greater than 900 mm.

4.1.2.3 Sloped End Sections

All culverts shall have prefabricated sloped end sections supplied in accordance with Standard Drawing SD-400-01-51 "Standard Sloped End Sections".

4.1.2.4 Couplers

Couplers shall be annular corrugated band type not less than 600 mm wide and shall have a minimum of three bolts per coupler for culvert diameters of 800 mm or greater.

4.1.2.5 Termination of Lock Seams

For culvert diameters of 1000 mm or greater, lock seams terminating at the cut edges of slopes or square ended sections shall have a 50 mm length fillet weld run along the lock seam at each cut edge. The weld and surrounding area shall be recoated with the appropriate material in accordance with the latest edition of the Canadian Standards Association CAN/CSA-G401 specifications.

4.1.2.6 Cut Edges

All cut edges of a sloped or square end section shall be made smooth by grinding so that all of the burrs are removed. Edges of sheets or culverts saw cut after coating, including the exposed edges of sloped end sections shall be recoated with the appropriate material in accordance with the latest edition of Canadian Standards Association CAN/CSA-G401 specifications.

4.1.2.7 Wall Thicknesses

For culvert diameters from 600 mm to 1200 mm, the culvert wall thickness shall be 2.8 mm. For culvert diameters more than 1200 mm and less than 1500 mm, the culvert wall thickness shall be 3.5 mm.

4.1.2.8 Corrugation Profile Dimensions

All culvert and coupler corrugation profile dimensions shall be 68 mm by 13 mm.

4.1.2.9 Geotextile

Refer to Division 3 Grading for the geotextile material Specifications.

4.1.2.10 Bedding and Backfill

The Contractor shall use aggregate materials for the culvert base, bedding and structural backfill as indicated on the Drawings.

4.1.2.11 Clay Cut-Off Curtains

During culvert excavation, if permafrost is encountered, a clay cut-off curtain or equivalent will be installed on the upstream end of the culvert pipe as shown on the Drawings. Suitable clay materials found on site may be used for the cut-off curtain or as approved by the Engineer. The clay cut-off material should be medium plastic, with Liquid Limits in the range of 30 to 50% and Plastic Limits in the range of 15 to 30%.

4.1.2.12 Steam Pipes

The Contractor shall supply and install steam piping for all culverts. The Contractor's attention is referred to, Standard Drawing SD-400-01-54 "Typical Steam Pipe and Hanger Detail", for the materials required for the supply and installation of the steam piping. The steam pipes shall be 12.5 mm inside diameter black iron with vertical extensions 1.6 m in length above each end of the culvert. The vertical extensions shall be threaded and capped. The Contractor shall provide support for the vertical extensions subject to approval by the Engineer.

4.1.2.13 Riprap

Refer to Division, 4 Section 3 Hand-Placed and Random Riprap for riprap material Specifications, unless otherwise specified in the Contract Documents.

4.1.3 CONSTRUCTION

4.1.3.1 Quality Control

General

Quality control and testing is the responsibility of the Contractor throughout every stage of the Work, from the supply of culvert materials to the final accepted product.

Tests performed by the Department will not be considered to be quality control tests.

The Contractor shall provide, pay for and maintain equipment and qualified personnel to carry out all field testing necessary to determine and monitor the characteristics of the materials produced and incorporated into the Work and the final product produced.

Compaction Testing Requirements

The Contractor's quality control and quality control testing program shall include the carrying out of all compaction density and moisture testing required for the construction of culvert foundations, bedding and structural backfill materials in accordance with the Specifications.

The Contractor shall establish the standard Proctor maximum dry density at the optimum moisture content in

accordance with the latest edition of ASTM D698, for each source, type, Designation and Class of material incorporated into the Work. Original copies of all worksheets and laboratory test results shall be submitted to the Engineer prior to the commencement of culvert installation operations.

The Contractor shall carry out compaction testing utilizing nuclear equipment in accordance with the latest edition of ASTM D698, at the specified frequency and in such a manner that each layer of the culvert foundation, bedding, and structural backfill materials are thoroughly and adequately tested.

All compaction test results for completed culvert foundations, beddings and structural backfill operations shall be submitted to the Engineer for verification of compliance with the Specifications, upon completion of each culvert installation operation.

Quality Acceptance

Within this Specification, certain requirements, limits and tolerances are specified regarding the quality of materials and workmanship to be supplied. Compliance with these requirements, limits and tolerances may be measured and the Work accepted or rejected based on Department quality assurance test results.

The Engineer and their representatives reserve the right to sample, test, inspect and monitor the quality of material being utilized and incorporated into the Work by the Contractor at any time and as often as they deem necessary. The Contractor shall cooperate with the Engineer and their representatives for such sampling, testing, inspecting and monitoring. The Engineer is under no obligation to provide the Contractor with test results and this testing shall in no way relieve the Contractor of their responsibility to construct culverts, bedding and backfill that meet the Specifications in all respects. The Contractor shall provide, at their own expense, such stands, sampling devices and other facilities as the Engineer may require to safely obtain representative samples of the materials being utilized and incorporated into the Work.

The Department may elect to perform quality assurance testing. Where quality assurance testing is performed, the materials testing laboratory used by the Department will not be located at the project site. Quality assurance test results will be available in approximately 10 days from the date of sampling.

4.1.3.2 Survey, Layout, Staking and Grading Requirements

a) The Contractor shall provide and pay for qualified personnel to carry out all surveying required for the accurate installation of culverts and the accurate placement and control of culvert foundation, bedding and structural and backfill construction operations. This shall include the excavation of existing embankments and the removal of existing culverts, where applicable, and the control of overbuilding and the quantity of any materials placed beyond the specified grading tolerances.
   The Contractor's survey requirements may include, but are not limited to, establishment of benchmarks, baseline layout, slope staking, grade staking and grading, ditch alignment staking and grading, shoulder and trim staking and referencing.
   The finished foundation, bedding and structural and backfill surfaces shall not deviate more than 30 mm from the required grade and cross-section.
b) The Contractor shall notify the Engineer when the culvert installation has been completed in accordance with the Specifications and shall provide ample opportunity for the Engineer to take measurements, at their discretion, prior to the commencement or continuance of embankment construction operations.
   The Engineer will not take measurements of the culvert installation at any time prior to notification by the Contractor that the culvert installation has been completed in accordance with the Specifications, nor will the Engineer be obliged to notify the Contractor of any deficiencies, after the

measurements have been completed.

The completion of culvert installation measurements by the Engineer shall in no way constitute acceptance of the culvert materials or culvert installation by the Engineer.

4.1.3.3 Excavation

a) Culvert installation locations and design grades will be provided by the Engineer. All surveying and layout required for the excavation and installation of culverts shall be carried out by the Contractor. Culvert excavations shall be carried out to the lines and dimensions indicated on the applicable Standard Drawings or Drawings. Culvert locations may be changed to suit the site conditions and the Engineer will fix the location at the site.

b) Where culvert installation or removal is required on roadways which must remain in service during construction, the Contractor shall carry out the installation or removal operation by either constructing and maintaining a detour or by working on one half of the roadway while maintaining adequately controlled and signed traffic flow on the other half of the roadway. The Contractor shall ensure that all traffic is safely accommodated at all times. Details of all proposed traffic accommodation methodologies shall be provided in the Contractor's Traffic Accommodation Strategy. The Work above will be considered incidental and will not be measured separately for payment.

c) If temporary watercourse or channel diversion is required in conjunction with a culvert installation, the Contractor shall acquire approval for the diversion from the appropriate regulatory authority prior to commencement of excavation. The Contractor is to assume full responsibility for maintaining a dry excavation during placement of granular bedding and backfill. Erosion and sediment control structures, silt fencing, shall be installed as required. The Work above will be considered incidental and will not be measured separately for payment.

4.1.3.4 Preparation of Bedding and Foundation

a) The culvert bed shall be firm, sound and uniform throughout its entire area. All soft, yielding or unsuitable material encountered at the foundation grade of the culvert excavation shall be sub-excavated to a depth determined by the Engineer and replaced with gravel material or other material specified by the Engineer.

b) Material used for bedding shall consist of gravel material or other materials as specified on the Drawings. The selection, excavation, loading, hauling, placing and compacting of bedding and foundation material will not be measured separately for payment and shall be considered incidental to the Work.

c) All bedding and foundation material shall be free from frozen lumps and organic material.

d) The bedding and foundation material shall be free from stones of a diameter larger than 80 mm in the long dimension.

e) The bedding and foundation material shall be compacted to a minimum of 100% of the standard Proctor maximum dry density at the optimum moisture content in accordance with the latest edition of ASTM D698, in lifts not exceeding 150 mm in depth. Each layer shall be thoroughly compacted and tested in at least three locations, with each location tested meeting the compaction requirements as specified above. Testing locations will be chosen randomly covering the entire bedding area.

f) Geotextile materials as specified shall be installed, with a minimum 1.0 m lap length, for the entire length and width of the culvert foundation and to sides of the trench walls to limits indicated on the appropriate Drawings for permafrost or non-permafrost installation locations.

4.1.3.5 Installation

a) Culverts shall be installed on the prepared bed, true to the lines, dimensions and grades established as per the Drawings.
b) Culverts shall be placed with the inside circumference laps pointing downstream. The longitudinal laps shall be located at the side or quarter points.
c) Separate sections of the culverts shall be firmly and securely joined with couplers in accordance with the manufacturer's instructions. At all coupling and joint areas, depressions shall be constructed in the culvert bed so that the culvert is uniformly supported along its entire length.
d) The Contractor shall use due care when installing culverts to avoid damage to the culverts. Damaged culverts shall be removed and replaced by the Contractor at their expense.

4.1.3.6 Backfilling

a) The placing of structural backfill material around the culvert shall be carried out to the lines and dimensions indicated on the applicable Standard Drawing or Drawings.
b) Material used for structural backfill around culverts shall consist of select gravel or soil and granular pit run as specified or approved by the Engineer. The selection, excavation, loading, hauling, placing and compacting of structural backfill material will not be measured separately for payment and shall be considered incidental to the Work.
c) Structural backfill under the haunches of culverts shall be compacted using suitable hand-held pneumatic, mechanical or power tools.
d) All backfill material shall be free from frozen lumps and organic material.
e) The structural backfill material shall be free from stones of a diameter larger than 80 mm measured in the long direction.
f) The structural backfill material shall be compacted to a minimum of 98% of the standard Proctor maximum dry density at the optimum moisture content in accordance with the latest edition of ASTM D698. Each layer shall be thoroughly compacted and tested in at least three locations both sides of the culvert, with each location tested meeting the compaction requirements as specified above. Testing locations will be chosen randomly covering the entire backfilling area.
g) The structural backfill shall be placed, simultaneously and uniformly on both sides of the culvert in lifts not exceeding 150 mm in depth.
h) Backfilling of the remainder of the culvert excavation, beyond the immediate region of the culvert shall be carried out in accordance with "Embankment Construction" (Division 3, Section 6).
i) Compaction equipment shall be operated parallel to the longitudinal axis of the culvert until sufficient fill has been placed to proceed with the construction of the embankment in the normal manner.
j) The remainder of the embankment construction over the installation may then proceed in accordance with "Embankment Construction" (Division 3, Section 6).
k) Unless otherwise approved by the Engineer or the Department in advance and in writing, vehicular traffic and construction equipment shall not cross over a culvert until the backfill has been constructed and compacted to a minimum depth of 600 mm over the highest point of the culvert.
l) The Contractor shall provide erosion protection for all slopes at culvert installations. Slope protection shall be provided in the form of riprap as per the Drawings.
m) No work (preparation of bedding and backfilling) for the installation of the culvert will be performed when the temperature in the next 24 hours is expected to be below 0° C as forecasted by Environment Canada's website for the site or nearest location.

4.1.3.7 Extension of Existing Culverts

The extension of existing culverts will be considered as new installations. Where an existing culvert is to be extended, the removal, salvage and reinstallation of an existing sloped end section may be required.

Where the existing culvert was manufactured to imperial dimensions and the new culvert is manufactured to metric dimensions and a mismatch occurs at the joint, the Contractor shall adequately calk the joint with oakum and shall ensure that a water-resistant joint is obtained.

4.1.3.8 Schedule of Installation

Culvert installations shall be completed as far in advance of earthmoving and surfacing operations as possible.

4.1.3.9 Culvert Markers

The Contractor shall supply and install "Iceworm Advantage Culvert Savers" (culvert markers) to the manufacturer's specifications and standards at the ends of each culvert. If the reinstallation of existing culvert markers is specified, the Contractor shall reinstall the markers at the ends of each culvert as outlined above.

4.1.4 MEASUREMENT

4.1.4.1 Supply and Installation

The quantity of Corrugated Steel Pipe Culvert to be measured for payment will be the number of linear metres of the sizes of culvert specified, acceptably fabricated, supplied and installed in accordance with these Specifications. Measurements will be based on the total invert length of culvert supplied and installed, including sloped end sections.

The supply and installation of couplers, bolts and hardware necessary for the installation of culverts will not be measured separately for payment and shall be considered incidental to the culvert supply and installation.

The supply and installation of geotextiles and culvert inlet/outlet riprap as per the Specifications and Drawings will not be measured separately for payment and shall be considered incidental to the culvert supply and installation.

4.1.4.2 Excavation and Backfilling for Culvert Installation

Quantities of culvert excavation and backfill material will not be measured separately for payment and shall be considered incidental to the culvert supply and installation operation. There will be no additional payment for excavation beyond the lines and grades shown on the Drawings without prior approval of the Engineer.

4.1.4.3 Temporary Channel Diversion

The provision of a temporary channel diversion will not be measured separately for payment and shall be considered incidental to the culvert supply and installation operation.

4.1.4.4 Culvert Installation and Removal on Roadways in Service

The staging of construction required for culvert installations or removals on roadways in service will not be measured separately for payment and shall be considered incidental to the culvert supply and installation operation.

The construction, maintenance and subsequent removal of detours will not be measured separately for payment and shall be considered incidental to the culvert supply and installation operation.

4.1.4.5 Extension of Existing Culverts

The removal, salvage and reinstallation of existing sloped end sections will not be measured separately for

payment and shall be considered incidental to the culvert supply and extension operation.

4.1.4.6 Accommodation of Traffic

Work required for the safe, controlled and signed accommodation of traffic during installation or removal of culverts will not be measured separately for payment and shall be considered incidental to the culvert supply and installation operation.

4.1.4.7 Caulking of Joints

The installation of oakum in joints, if required, will not be measured separately for payment and shall be considered incidental to the culvert supply and extension operation.

4.1.4.8 Damaged or Lost Culvert Materials

The replacement of any lost or damaged culvert material will not be measured separately for payment and shall be considered incidental to the culvert supply and installation operation.

4.1.4.9 Culvert Markers

The supply and installation of "Ice Worm Advantage Culvert Savers" (culvert markers), and the reinstallation of existing culvert markers if specified, will not be measured separately for payment and shall be considered incidental to the culvert supply and installation operation.

4.1.4.10 Geotextile Materials

The supply and installation of geotextile materials, in accordance with the Drawings, will not be measured separately for payment and shall be considered incidental to the culvert supply and installation operation.

4.1.4.11 Clay Cut-Off Curtains

The supply and installation of clay cut-off curtain material, in accordance with the Drawings, will not be measured separately for payment and shall be considered incidental to the culvert supply and installation operation.

4.1.4.12 Steam Pipes

The supply and installation of steam pipes, in accordance with the Drawings, will not be measured separately for payment and shall be considered incidental to the culvert supply and installation operation.

4.1.4.13 Riprap

The supply and installation of riprap will not be measured separately for payment and shall be incidental with the culvert supply and installation operation.

4.1.5 BASIS OF PAYMENT

Payment for Supply and Install Corrugated Steel Pipe Culverts will be at the Contract unit price per linear metre for the various sizes of culverts specified.

Payment for Supply and Install Corrugated Steel Pipe Culvert Extensions will be at the Contract unit price per linear metre for the various sizes of culvert extensions specified.

The unit price shall be compensation in full for the construction and removal of detours, traffic control and accommodation, temporary channel diversion, dewatering, fabricating, supplying, unloading, storing, handling and hauling the culvert materials and hardware, excavating, preparing the bed, installing and assembling the culvert, caulking, producing, selecting, excavating, loading, geotextile materials, riprap, steam pipes, clay cut-off curtains, hauling and placing foundation, bedding and structural and backfill materials, compacting,

disposing of surplus materials, the supply of water, drying, the fabricating, supplying and installing of culvert markers, the reinstalling of existing culvert markers, all surveying, quality control and quality control testing, reporting and certification and the supply of all equipment, labour, materials, tools and incidentals necessary to complete the Work in accordance with the Specifications.

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4.2 SECTION 2 – CULVERT REMOVAL

4.2.1 DESCRIPTION

Culvert Removal consists of the removal of embedded culverts shown on the Drawings or as designated by the Engineer.

4.2.2 MATERIALS

Not applicable.

4.2.3 CONSTRUCTION

4.2.3.1 Excavation

Culvert excavations shall be carried out to the lines and dimensions indicated on the Drawings or as designated by the Engineer.

Where culvert removal is required on roadways which must remain in service during construction, the Contractor shall carry out the removal operation by either constructing and maintaining a detour or by working on one half of the roadway, while maintaining adequately controlled and signed traffic flow on the other half of the roadway. The Contractor shall ensure that all traffic is safely accommodated at all times. Details of all proposed traffic accommodation methodologies shall be provided in the Contractor's Traffic Accommodation Strategy.

4.2.3.2 Removal and Disposal

Where the removal and disposal of existing culverts or drainage structures from the roadbed, ditches or other waterways is specified, all culvert materials, including existing culvert markers, shall become the property of the Contractor.

The crushing and burying of existing culverts is not permitted on the site. The Contractor shall remove and properly dispose of the excavated culvert materials to the satisfaction of all authorities having jurisdiction.

4.2.3.3 Removal and Salvage

Where the removal and salvage of existing culverts or drainage structures from the roadbed, ditches or other waterways is specified, the Contractor shall carefully excavate, remove and neatly store the materials, including culvert markers, at locations approved by the Engineer. All culvert materials shall remain the property of the Department.

If a culvert or culvert marker specified for salvage is damaged beyond use by the Contractor during the removal operation, due to their negligence, the Contractor shall replace the damaged culvert or marker at their own expense.

4.2.3.4 Culvert Markers

The Contractor shall dispose of or salvage existing culvert markers in conjunction with the specified culvert disposal or salvage operation.

4.2.4 MEASUREMENT AND PAYMENT

4.2.4.1 Culvert Removal

The removal of culverts, including sloped ends, will not be measured separately for payment and shall be considered incidental to the Work.

4.2.4.2 Culvert Removal on Roadways in Service

The staging of construction required for culvert removals on roadways in service will not be measured separately for payment and shall be considered incidental to the Work.

The construction, maintenance and subsequent removal of detours will not be measured separately for payment and shall be considered incidental to the Work.

4.2.4.3 Culvert Disposal

The removal and offsite disposal costs of culvert materials will not be measured separately for payment and shall be considered incidental to the Work.

4.2.4.4 Culvert Salvage

The salvage and storing of culvert materials will not be measured separately for payment and shall be considered incidental to the Work.

4.2.4.5 Accommodation of Traffic

Work required for the safe, controlled and signed accommodation of traffic during removal of culverts will not be measured separately for payment and shall be considered incidental to the Work.

4.2.4.6 Damaged Culvert Materials

The replacement of culvert materials damaged where salvage is specified will not be measured separately for payment and shall be considered incidental to the Work.

4.2.4.7 Culvert Markers

The removal and disposal or salvage of existing culvert markers will not be measured separately for payment and shall be considered incidental to the Work.

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4.3 SECTION 3 – HAND-PLACED AND RANDOM RIPRAP

4.3.1 DESCRIPTION

Hand-Placed and Random Riprap shall consist of a protective covering of stone constructed on an earth bed or granular filter blanket. Riprap shall be constructed at the locations and in conformity with the lines, grades, and dimensions shown on the Drawings or as designated by the Engineer.

4.3.2 MATERIALS

The Contractor shall supply all materials required for the Work.

Riprap materials, for culverts and other drainage work, shall consist of hard and durable field stone, boulders, or quarry rock. All riprap shall be verified by testing as non-PAG (Potential Acid Generating) with low Metals Leaching potential. No stone shall be less than 150 mm in its smallest dimension. For the purpose of this Specification, dimension is defined as being length, width, and depth.

Riprap material for bridges shall consist of hard and durable field stones, boulders or quarry rocks. At least 80% of the stone shall have a volume of not less than 0.014 m^3 each.

4.3.3 CONSTRUCTION

4.3.3.1 Excavation

Hand-Placed Riprap

Aprons and slopes to be riprapped shall be excavated to provide an adequate foundation upon which the riprap shall rest, as shown on the Drawings or as specified by the Engineer. The whole area to be riprapped shall be trimmed to a uniform and even surface.

Random Riprap

If required, a shelf or ledge shall be excavated to permit dumping of the stone.

4.3.3.2 Placing

Hand-Placed Riprap

Stones shall be placed, by hand, to the required length, width and thickness. Stones shall be placed so that the largest dimension is perpendicular to the slope, unless such dimension is greater than the specified thickness of the riprap. The largest stones shall be placed in the bottom rows. No shaping of stones will be required. Stones shall be laid in close contact and supported by the prepared foundation material.

Random Riprap

Random riprap shall be dumped onto the surface to be riprapped. Sufficient hand work shall be performed to produce a uniform surface and the depth shown on the Drawings, to the satisfaction of the Engineer.

4.3.4 MEASUREMENT

a) No separate measurement will be made for hand placed riprap or random riprap unless there is a separate bid item in the unit price table. Hand placed riprap and random riprap shall be considered incidental to the Work.
b) Measurements will be based on surface area and average thickness of the riprap.
c) Hand Placed Riprap will be measured in place, in cubic metres, except that riprap for culverts may be based on design quantities specified on the Drawings.
d) Random Riprap will be measured in cubic metres or tonnes.
The volume of riprap dumped or placed into water, or other sites where in-place measurements are impractical, will be computed from the volumetric capacity of the vehicle.

4.3.5 BASIS OF PAYMENT

Payment for Hand-Placed Riprap and/or Random Riprap will not be measured separately for payment unless there is a separate bid item in the unit price table.

Payment for Hand-Placed Riprap and/or Random Riprap will be at the Contract unit price per cubic metre or per tonne, measured as provided above.

The unit price will be compensation in full for excavating and preparing the bed, loading, hauling, unloading, and placing the stones and the supply of all materials, equipment, labour, tools and incidentals necessary to complete the Work in accordance with the Specifications.

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4.4 SECTION 4 – SAND BAG RIPRAP

4.4.1 DESCRIPTION

Sand Bag Riprap consists of a protective covering of sand bag riprap constructed on an earth bed, at the locations and in conformity with the lines, grades and dimensions shown on the Drawings or as designated by the Engineer.

4.4.2 MATERIALS

The Contractor shall supply the granular material, the Portland cement, the burlap bags and any other necessary materials. The bags will be made of 285 grams per square metre jute. The dimensions of the bags shall be 370 mm by 685 mm. The top of each bag shall be hemmed. The bags shall be of sufficient strength to permit them to be lifted by the top corners of the bag when filled with the applicable materials.

The granular material may be pit run, screened or crushed. The granular material shall consist of fragments of durable rock, free from undesirable quantities of soft or flaky particles, shale, loam or other deleterious materials and must be approved by the Engineer prior to being incorporated into the Work.

Granular material which will not pass a 50 mm square opening shall be excluded. The portion of material passing the 4.75 mm Sieve (No. 4 U.S. Standard) shall not be greater than 50% of the material by weight. The portion of the material passing the 0.075 mm Sieve (No. 200 U.S. Standard) shall not exceed 5% of the material by weight.

Cement shall be General-Use (GU) Portland cement conforming to the requirements of the current specifications for such as issued by the Canadian Standards Association. CSA-A3001. Up to 25% by mass of the Portland cement can be substituted with a supplementary cementitious material.

At the discretion of the Department, the use of any cement may be held up pending the results of tests to ensure that the cement conforms up to the requirements as specified.

4.4.3 CONSTRUCTION

4.4.3.1 Excavating

Aprons and slopes to be riprapped shall be excavated to provide an adequate foundation upon which the riprap shall rest as shown on the Drawings or specified by the Engineer. The whole area to be riprapped shall be trimmed to a uniform and even surface. The entire base shall be thoroughly compacted to provide a smooth and firm foundation of uniform density.

4.4.3.2 Mixing

Eight parts of granular material and one part of Portland cement by weight or such proportions as determined by the Engineer, shall be mixed in a batch mixer until the granular material is uniformly coated with cement.

4.4.3.3 Filling Bags

The bags shall be filled 70% full, with the dry mixture. Each bag shall be securely sewn or stapled to form a straight edge closure.

4.4.3.4 Placing

a) The bags shall be placed by hand, within 30 minutes after mixing of the concrete, in their final position on the prepared base, to the required length, width and thickness. The riprap shall be commenced in a trench below the toe of the slope. The bags shall be placed in horizontal rows. Each bag shall be firmly bedded into the slope and securely butted against the adjacent bags. The tied end of the bag shall rest

on and against the face of the slope.

Each row of bags shall overlap the preceding row of bags by at least 250 mm. The joints in adjacent rows shall be staggered. All earth and other debris shall be removed from the surface of bags in place before succeeding rows of bags are placed. Not more than five courses of sacks shall be placed in any tier before such time as initial set has taken place in the first course of any such tier.

The riprap shall have a minimum thickness of 150 mm measured perpendicular to the slope, and its surface shall not vary from the theoretical surface by 80 mm at any point.

b) Sand bag riprap shall not be placed during heavy rain, snow, freezing temperatures or other unsuitable conditions. Sand bag riprap shall not be placed it appears likely that the temperature will fall below 5°C within the next 24 hours, unless special precautions approved by the Engineer are taken.

4.4.3.5 Watering

Water shall be sprayed onto the surface of each row. Excess water shall not be applied. Each layer of riprap shall be thoroughly wetted with water and shall be kept moist for a period of 24 hours by sprinkling or other means approved by the Engineer.

4.4.4 MEASUREMENT

The volume of Sand Bag Riprap will be measured in cubic metres in place. The surface area and thickness of the riprap will be measured to compute the volume.

Cement for Sand Bag Riprap shall be measured in kilograms acceptably incorporated into the construction of sand bag riprap in accordance with these Specifications.

4.4.5 BASIS OF PAYMENT

Payment for Sand Bag Riprap will be at the Contract unit price per cubic metre, measured as provided above.

The unit price will be compensation in full for excavating and preparing the bed, supplying granular material, mixing the Portland cement and granular material, supplying, filling and placing the bags, supplying the water, watering the riprap and the supply of all materials, equipment, labour, tools and incidentals necessary to complete the Work in accordance with the Specifications.

Cement for Sand Bag Riprap will be paid for at the Contract unit price for this item, measured as provided above, complete in place and accepted.

The unit price will be compensation in full for all costs of cement, hauling, storing and the supply of all materials, equipment, labour, tools and incidentals necessary to complete the Work in accordance with the Specifications.