

Part 1 General**1.1 DESCRIPTION**

- .1 The section describes requirements for the corrected maximum dry density for measurement of fill quantities.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C127-15, Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.
 - .2 ASTM D698-12e2, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - .3 ASTM D1557-12e1, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - .4 ASTM D4253-16, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

1.3 DEFINITIONS

- .1 Corrected maximum dry density is defined as:
 - .1 $D = D1 \times D2 / (F1 \times D2) + (F2 \times D1)$
 - .2 $D = (F1 \times D1) + (0.9 \times D2 \times F2)$
 - .3 Where: D = corrected maximum dry density kg/m³.
 - .1 F1 = fraction (decimal) of total field sample passing 19 mm sieve
 - .2 F2 = fraction (decimal) of total field sample retained on 19 mm sieve (equal to 1.00 - F1)
 - .3 D1 = maximum dry density, kg/m³ of material passing 19 mm sieve determined in accordance with Method C of ASTM D698.
 - .4 D2 = bulk density, kg/m³, of material retained on 19 mm sieve, equal to 1000G where G is bulk specific gravity (dry basis) of material when tested to ASTM C127.
 - .4 For free draining aggregates, determine D1 (maximum dry density) to ASTM D4253 dry method when directed by Departmental Representative.

Part 2 Products**2.1 NOT USED****Part 3 Execution****3.1 NOT USED****END OF SECTION**

Part 1 General

1.1 DESCRIPTION

- .1 The section describes requirements for quality, processing, and stockpiling of aggregate materials.

1.2 RELATED SECTIONS

- .1 Section 01 29 00 - Project Particulars and Measurement.
- .2 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .3 Section 01 33 00 - Submittal Procedures.

1.3 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM D4791-10, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

1.4 MEASUREMENT FOR PAYMENT

- .1 Aggregate materials will be measured for payment in accordance with Section 01 29 00.

1.5 SAMPLES

- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Allow continual sampling by Departmental Representative during production.
- .3 Provide Departmental Representative with access to source and processed material for sampling.
- .4 Install sampling facilities at discharge end of production conveyor, to allow Departmental Representative to obtain representative samples of items being produced. Stop conveyor belt when requested by Departmental Representative to permit full cross section sampling.
- .5 Pay cost of sampling and testing of aggregates which fail to meet specified requirements.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Divert unused granular materials from landfill to local quarry facility as approved by Departmental Representative.

Part 2 Products

2.1 MATERIALS

- .1 Aggregate quality: sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material, clay lumps or minerals, or other substances that would act in deleterious manner for use intended.
- .2 Flat and elongated particles of coarse aggregate: to ASTM D4791.
 - .1 Greatest dimension to exceed five times least dimension.
- .3 Fine aggregates satisfying requirements of applicable section to be one, or blend of following:
 - .1 Natural sand.
 - .2 Manufactured sand.
 - .3 Screenings produced in crushing of quarried rock, boulders, gravel or slag.
- .4 Coarse aggregates satisfying requirements of applicable section to be one of or blend of following:
 - .1 Crushed rock.
 - .2 Gravel and crushed gravel composed of naturally formed particles of stone.
 - .3 Light weight aggregate, including slag and expanded shale.

2.2 SOURCE QUALITY CONTROL

- .1 Inform Departmental Representative of proposed source of aggregates and provide access for sampling at least 4 weeks prior to commencing production.
- .2 If, in opinion of Departmental Representative, materials from proposed source does not meet, or cannot reasonably be processed to meet, specified requirements, locate an alternative source or demonstrate that material from source in question can be processed to meet specified requirements.
- .3 Advise Departmental Representative 4 weeks in advance of proposed change of material source.
- .4 Acceptance of material at source does not preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

Part 3 Execution

3.1 PREPARATION

- .1 Topsoil stripping

AGGREGATE MATERIALS

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- .1 Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected.
 - .2 Begin topsoil stripping of areas as directed by Departmental Representative after area has been cleared of brush, weeds and grasses and removed from site.
 - .3 Strip topsoil to depths as directed by Departmental Representative. Avoid mixing topsoil with subsoil.
 - .4 Stockpile in locations as directed by Departmental Representative. Stockpile height not to exceed 2 m.
 - .5 Dispose of topsoil as directed by Departmental Representative off site.
- .2 Aggregate source preparation
- .1 Prior to excavating materials for aggregate production, clear and grub area to be worked, and strip unsuitable surface materials. Dispose of cleared, grubbed and unsuitable materials as directed by Departmental Representative and as approved by authority having jurisdiction.
 - .2 Where clearing is required, leave screen of trees between cleared area and roadways as directed.
 - .3 Clear, grub and strip area ahead of quarrying or excavating operation sufficient to prevent contamination of aggregate by deleterious materials.
 - .4 When excavation is completed dress sides of excavation to nominal 1.5:1 slope, and provide drains or ditches as required to prevent surface standing water.
 - .5 Trim off and dress slopes of waste material piles and leave site in neat condition.
- .3 Processing
- .1 Process aggregate uniformly using methods that prevent contamination, segregation and degradation.
 - .2 Blend aggregates, if required, to obtain gradation requirements, percentage of crushed particles, or particle shapes, as specified. Use methods and equipment approved by Departmental Representative.
 - .3 Wash aggregates, if required to meet specifications. Use only equipment approved by Departmental Representative.
 - .4 When operating in stratified deposits use excavation equipment and methods that produce uniform, homogeneous aggregate.
- .4 Handling
- .1 Handle and transport aggregates to avoid segregation, contamination and degradation.
- .5 Stockpiling
- .1 Stockpile aggregates on site in locations as indicated unless directed otherwise by Departmental Representative. Do not stockpile on completed pavement surfaces.
 - .2 Stockpile aggregates in sufficient quantities to meet Project schedules.

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- .3 Stockpiling sites to be level, well drained, and of adequate bearing capacity and stability to support stockpiled materials and handling equipment.
 - .4 Except where stockpiled on acceptably stabilized areas, provide compacted sand base not less than 300 mm in depth to prevent contamination of aggregate. Stockpile aggregates on ground but do not incorporate bottom 300 mm of pile into Work.
 - .5 Separate different aggregates by strong, full depth bulkheads, or stockpile far enough apart to prevent intermixing.
 - .6 Do not use intermixed or contaminated materials. Remove and dispose of rejected materials as directed by Departmental Representative within 48 h of rejection.
 - .7 Stockpile materials in uniform layers of thickness as follows:
 - .1 Max 1.5 m for coarse aggregate and base course materials.
 - .2 Max 1.5 m for fine aggregate and sub-base materials.
 - .3 Max 1.5 m for other materials.
 - .8 Uniformly spot-dump aggregates delivered to stockpile in trucks and build up stockpile as specified.
 - .9 Do not cone piles or spill material over edges of piles.
 - .10 Do not use conveying stackers.
 - .11 During winter operations, prevent ice and snow from becoming mixed into stockpile or in material being removed from stockpile.

3.2 CLEANING

- .1 Leave aggregate stockpile site in tidy, well drained condition, free of standing surface water.
- .2 Leave any unused aggregates in neat compact stockpiles as directed by Departmental Representative.
- .3 For temporary or permanent abandonment of aggregate source, restore source to condition meeting requirements of authority having jurisdiction.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

- .1 The section describes requirements for removal and grubbing of underbrush and other surface materials.

1.2 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Section 01 33 00 - Submittal Procedures.

1.3 MEASUREMENT PROCEDURES

- .1 Clearing and grubbing will not be measured for payment and is to be considered incidental to the work.

1.4 REFERENCES

- .1 U.S. Environmental Protection Agency (EPA)/Office of Water
 - .1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.5 DEFINITIONS

- .1 Clearing consists of cutting off trees and brush vegetative growth to not more than specified height above ground and disposing of felled trees, previously uprooted trees and stumps, and surface debris.
- .2 Close-cut clearing consists of cutting off standing trees, brush, scrub, roots, stumps and embedded logs, removing at, or close to, existing grade and disposing of fallen timber and surface debris.
- .3 Clearing isolated trees consists of cutting off to not more than specified height above ground of designated trees, and disposing of felled trees and debris.

1.6 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.7 QUALITY ASSURANCE

- .1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.
- .2 Safety Requirements: worker protection.

- .1 Workers must wear gloves, respirators, dust masks, long sleeved clothing, eye protection, protective clothing, when applying herbicide materials.
- .2 Workers must not eat, drink or smoke while applying herbicide material.
- .3 Clean up spills of preservative materials immediately with absorbent material and safely discard to landfill.

1.8 STORAGE AND PROTECTION

- .1 Prevent damage to, fencing, trees, landscaping, natural features, bench marks, existing buildings, existing pavement, utility lines, site appurtenances, water courses, and root systems of trees which are to remain.
 - .1 Repair damaged items to approval of Departmental Representative.
 - .2 Replace trees designated to remain, if damaged, as directed by Departmental Representative.

1.9 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Consider felled timber from which saw logs, pulpwood, posts, poles, ties, or fuel wood can be produced as saleable timber.
 - .1 Trim limbs and tops, and saw into saleable lengths.
 - .2 Stockpile adjacent to site.

Part 2 Products**2.1 MATERIALS**

- .1 Bituminous based paint of standard manufacture specially formulated for tree wounds.
- .2 Soil Material for Fill:
 - .1 Excavated soil material: free of debris, roots, wood, scrap material, vegetable matter, refuse, soft unsound particles, deleterious, or objectionable materials.
 - .2 Remove and store soil material for reuse.

Part 3 Execution**3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL**

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

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- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 PREPARATION

- .1 Inspect site and verify with Departmental Representative, items designated to remain.
- .2 Locate and protect utility lines: preserve in operating condition active utilities traversing site.
 - .1 Notify Departmental Representative immediately of damage to or when unknown existing utility lines are encountered.
 - .2 When utility lines which are to be removed are encountered within area of operations, notify Departmental Representative in ample time to minimize interruption of service.
- .3 Notify utility authorities before starting clearing.
- .4 Keep roads and walks free of dirt and debris.

3.3 APPLICATION

- .1 Manufacturer's instructions: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.4 ISOLATED TREES

- .1 Cut off isolated trees as directed by Departmental Representative at height of not less than 150 mm above ground surface.
- .2 Leave small portion of stump and entire root system of all trees removed fully in place.
- .3 Prune individual trees as indicated.
- .4 Trim trees designated to be left standing within cleared areas of dead branches 4 cm or more in diameter; and trim branches to heights as indicated.
- .5 Cut limbs and branches to be trimmed close to bole of tree or main branches.
- .6 Paint cuts more than 3 cm in diameter with approved tree wound paint.

3.5 UNDERBRUSH CLEARING

- .1 Clear underbrush from areas as indicated at ground level.

3.6 REMOVAL AND DISPOSAL

- .1 Remove cleared materials off site to disposal area designated by Departmental Representative.
- .2 Cut timber greater than 125mm diameter to 600 mm lengths and stockpile as indicated. Stockpiled timber becomes property of Departmental Representative.
- .3 Dispose of cleared materials by removal to location designated in Waste Management Plan.
- .4 Remove diseased trees identified by Departmental Representative and dispose of this material to approval of Departmental Representative.

3.7 FINISHED SURFACE

- .1 Leave ground surface in condition suitable for immediate grading operations to approval of Departmental Representative.

3.8 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

- .1 This section describes requirements for removal of rock.

1.2 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Section 01 33 00 - Submittal

1.3 MEASUREMENT FOR PAYMENT

- .1 Measurement for payment will be according to Section 01 29 00.

1.4 REFERENCES

- .1 All applicable laws and regulations shall be followed, including:
 - .1 Federal legislation:
 - .1 <http://www.nrcan.gc.ca/explosives/acts-regulations/9841>
 - .2 Provincial legislation:
 - .1 <https://www.novascotia.ca/just/regulations/regs/ohsblasting.htm>

1.5 DEFINITIONS:

- .1 Rock: any solid material in excess of 0.25 m³ and which cannot be removed by means of heavy duty mechanical excavating equipment with 0.95 to 1.15 m³ bucket. Frozen material not classified as rock.
- .2 Wall control blasting: a blasting method using carefully spaced and aligned drill holes intended to produce a relatively flat rock surface, generally characterized by noticeable drill hole traces, with a minimum of blast induced fractures beyond the rock excavation limits specified in the Contract Documents. Wall control blasting techniques are cushion blasting, line drilling and pre-shearing.
- .3 Cushion blasting: the placing of a single row of lightly loaded closely spaced holes along the excavation limits as specified in the Contract Documents and firing them coincident with the main excavation blast as the last delay sequence to remove rock inside the cut limits.
- .4 Line drilling: the placing of a single row of very closely spaced holes without explosives along the rock excavation limits specified in the Contract Documents.
- .5 Pre-shearing: the placing of a single row of closely spaced lightly loaded holes placed along the rock excavation limits specified in the Contract Documents, which are fired prior to the main excavation blast.

ROCK REMOVAL

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- .6 Rock face: the vertical or near vertical face between the top of the existing rock surface and West Hall's Harbour Road side slopes.
- .7 PPV: peak particle velocity.

1.6 SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Before blasting work begins the Contractor shall obtain a blasting permit from Small Craft Harbours via the Departmental Representative and shall comply with all conditions of the permit.
- .3 Provide a blasting design consisting of a detailed description of the methodology proposed to accomplish blasting control. Have blast design stamped by a professional engineer licensed to practice in the Province of Nova Scotia.
- .4 Blasting Submittals: submit for approval, written proposal of operations for removal of rock by blasting to Departmental Representative and local authorities having jurisdiction.
 - .1 Prior to blasting: Indicate proposed method of carrying out work, types and quantities of explosives to be used, loading charts and drill hole patterns, type of caps, blasting techniques, blast protection measures for items such as flying rock, vibration, dust and noise control. Include details on protective measures, time of blasting and other pertinent details.
 - .2 During blasting: submit records to Departmental Representative at end of each shift. Maintain complete and accurate record of drilling and blasting operations.
- .5 Qualification Statements:
 - .1 Retain licensed explosives expert to program and supervise blasting work, to interpret recommendations of pre-blasting report, and to determine precautions, preparation and operations techniques.
 - .2 Submit documentation verifying explosives expert's qualifications.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Store explosives in accordance with the Canadian Explosives Act and transport, handle and use in a manner prescribed by the manufacturer.

1.8 QUALITY ASSURANCE

- .1 Blaster must:

ROCK REMOVAL

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- .1 Along with the Contractor, be responsible for the implementation of the Explosives Management Program.
- .2 Have a valid blaster's safety certificate and a valid temporary magazine license if explosives are being stored.
- .3 Possess a thorough working knowledge of the Federal Explosives Act and Provincial Regulations.
- .4 Possess specialized training in storage, handling and detonation of explosives.
- .2 Blasting Survey and Monitoring:
 - .1 Departmental Representative will visit property holders of adjacent buildings and structures to determine existing conditions and describe blasting and seismic recording operations and obtain their permission for setting up seismographs.
 - .2 Seismographic monitoring will be conducted during entire progress of blasting operations.
- .3 Blasting and Vibration Control:
 - .1 Reduce ground vibrations to avoid damage to structures or remaining rock mass.
 - .2 In general, as there are other structures and buildings in the immediate vicinity, vibration from blasting not to exceed the Peak Particle Velocity (PPV) limits shown in the table below.

Frequency of Ground Vibration (Hertz)	Maximum Allowable PPV (mm/s)
15 or less	12.5
16 to 20	19.0
21 to 25	23.0
26 to 30	30.5
31 to 35	33.0
36 to 40	38.0
40 or greater	50.0
 - .3 Blasting not permitted within distance of 30m of fresh concrete or grout poured within 72 hours.
 - .4 Blasting not to be carried out until existing wharf is completely removed to the limits indicated in the drawings.

Part 2 Products

2.1 Materials

- .1 Not used.

Part 3 Execution

3.1 ROCK REMOVAL

- .1 Notify Departmental Representative prior to planned activities.
- .2 Perform excavation in accordance with Erosion and Sedimentation Control Plan.

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- .3 Co-ordinate this Section with Section 01 35 29 - Health and Safety Requirements.
 - .4 Prior to any rock removal, allow exposed rock surfaces to be inspected by professional geotechnical engineer designated by Departmental Representative as required.
 - .5 Remove obstructions, ice and snow from surfaces to be excavated within limits indicated.
 - .6 Excavations must not interfere with bearing capacity or stability of adjacent foundations or roads.
 - .7 Remove rock to alignments, profiles, and cross sections as indicated.
 - .8 Explosive blasting is not permitted at locations indicated or as directed by Departmental Representative.
 - .1 Do blasting operations in accordance with local and provincial codes and requirements of authority having jurisdiction.
 - .9 Use rock removal procedures to produce uniform and stable excavation surfaces. Minimize overbreak, and to avoid damage to adjacent structures and rock slopes.
 - .10 Excavate rock to horizontal surfaces.
 - .11 Use pre-shearing, cushion blasting or other smooth wall drilling and blasting techniques unless specified otherwise or directed by Departmental Representative.
 - .12 Remove boulders and fragments which may slide or roll into excavated areas.
 - .13 Correct unauthorized rock removal at no extra cost, to satisfaction of Departmental Representative.
 - .14 Notify Departmental Representative when bottom of excavation is reached.

3.2 BLASTING

- .1 Conduct blasting operations in accordance with:
 - .1 Explosives Act of Canada.
 - .2 Explosives Regulations.
 - .3 Nova Scotia Occupational Health and Safety Act Section 82, Blasting Safety Regulations.
- .2 Use only qualified blaster journeypersons to carry out blasting operations. Provide explosive vehicle certificate to Departmental Representative upon request.
- .3 Prior to detonation, give sufficient warning in every direction and confirm all persons have reached a place of safety before detonation.

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- .4 Remove overbreak as directed by Departmental Representative.
 - .5 Do not disturb utility lines due to blasting. Protect existing utilities. Immediately inform the authority having jurisdiction if any utility is affected.
 - .6 Use one (1) or more wall control technique to produce the rock space as specified. Determine the spacing and diameter of drill holes for wall control blasting.
 - .7 Controlled blasting is defined as the establishment of a shear plane in rock along the line of the backslope face by using controlled explosives and suitably spaced drill holes.
 - .8 Perform a test line blast control (pre-split or cushion blasting) outside of the final slope line.

3.3 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Rock Disposal:
 - .1 Dispose of surplus removed rock off site as indicated in accordance with Section 01 74 21.
 - .2 Do not dispose removed rock into landfill. Send material to appropriate quarry location as approved by Departmental Representative.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21.

3.4 PROTECTION

- .1 Prevent damage to surroundings and injury to persons in accordance with Section 01 50 00 - Temporary Facilities. Erect fencing, post guards, sound warnings and display signs when blasting to take place.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

- .1 This section describes requirements for excavating, trenching, and backfilling.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 35 43 - Environmental Protection Procedures for Marine Work.
- .3 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .4 Section 02 41 13 - Selective Site Demolition.
- .5 Section 31 32 19.01 - Geotextiles.

1.3 MEASUREMENT PROCEDURES

- .1 Excavated materials will be measured in accordance with Section 01 29 00.
- .2 Shoring, bracing, cofferdams, underpinning and de-watering of excavation if required will not be measured separately for payment.
- .3 Backfilling to authorized excavation limits will be measured in cubic metre place measure for each type of material specified. Compacting of material in place to be considered incidental to backfilling.

1.4 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C117-13, Standard Test Method for Material Finer than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C136-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM D422-63(2007), Standard Test Method for Particle-Size Analysis of Soils.
 - .4 ASTM D698-00a e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft) (600 kN-m/m).
 - .5 ASTM D1557-02 e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft) (2,700 kN-m/m).
 - .6 ASTM D4318-10, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A3000-13, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
 - .1 CSA-A3001-13, Cementitious Materials for Use in Concrete.
 - .2 CSA-A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

1.5 DEFINITIONS

- .1 Excavation classes: two classes of excavation will be recognized; common excavation and rock excavation.
 - .1 Rock : solid material in excess of 0.25m³ ; and which cannot be removed by means of heavy duty mechanical excavating equipment with 0.95 to 1.15 m³ bucket. Frozen material not classified as rock.
 - .2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation.
- .2 Unclassified excavation: excavation of deposits of whatever character encountered in Work.
- .3 Topsoil:
 - .1 Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
 - .2 Material reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and free from cobbles, stumps, roots, and other objectionable material larger than 25 millimeters in any dimension.
- .4 Waste material: excavated material unsuitable for use in Work or surplus to requirements.
- .5 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of Work.
- .6 Recycled fill material: material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.
- .7 Unsuitable materials:
 - .1 Weak, chemically unstable, and compressible materials.
 - .2 Frost susceptible materials:
 - .1 Fine grained soils with plasticity index less than 10 when tested to ASTM D4318, and gradation within limits specified when tested to ASTM D422 and ASTM C136: Sieve sizes to CAN/CGSB-8.2.
 - .2 Table:

Sieve Designation	% Passing
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EXCAVATING, TRENCHING, AND BACKFILLING

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Sieve Designation	% Passing
2.00 mm	100
0.10 mm	45 - 100
0.02 mm	10 - 80
0.005 mm	0 - 45

- .3 Coarse grained soils containing more than 20% by mass passing 0.075 mm sieve.
- .8 Unshrinkable fill: very weak mixture of cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

1.6 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Quality Control: in accordance with Section 01 45 00 - Quality Control:
 - .1 Submit condition survey of existing conditions as described in EXISTING CONDITIONS article of this Section.
 - .2 Submit for review by Departmental Representative proposed dewatering and heave prevention methods as described in PART 3 of this Section.
 - .3 Submit to Departmental Representative written notice at least 7 days prior to excavation work, to ensure cross sections are taken.
 - .4 Submit to Departmental Representative written notice when bottom of excavation is reached.
 - .5 Submit to Departmental Representative testing, inspection results and report as described in PART 3 of this Section.
- .3 Preconstruction Submittals:
 - .1 Submit construction equipment list for major equipment to be used in this section prior to start of Work.
 - .2 Submit records of underground utility locates, indicating: location plan of existing utilities as found in field, clearance record from utility authority, location plan of relocated and abandoned services, as required.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Inform Departmental Representative at least 4 weeks prior to beginning Work, of proposed source of fill materials and provide access for sampling.
 - .3 Upon request, submit 70kg samples of type of fill specified including representative samples of excavated material.
 - .4 Upon request, ship samples prepaid to Departmental Representative, in tightly closed containers to prevent contamination and exposure to elements.

1.7 QUALITY ASSURANCE

- .1 Qualification Statement: submit proof of insurance coverage for professional liability.
- .2 Submit design and supporting data at least 2 weeks prior to beginning Work.
- .3 Design and supporting data submitted to bear stamp and signature of qualified professional engineer registered or licensed in Province of Nova Scotia, Canada.
- .4 Keep design and supporting data on site.
- .5 Engage services of qualified professional Engineer who is registered or licensed in Province of Nova Scotia, Canada in which Work is to be carried out to design and inspect cofferdams, shoring, bracing and underpinning required for Work.
- .6 Do not use soil material until written report of soil test results are reviewed and approved by Departmental Representative.
- .7 Health and Safety Requirements:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Divert excess aggregate materials from landfill to local quarry or recycling facility for reuse as directed by Departmental Representative.

1.9 EXISTING CONDITIONS

- .1 Examine geotechnical report available at PWGSC office: 1713 Bedford Row, Halifax Nova Scotia.
- .2 Buried services:
 - .1 Before commencing work establish location of buried services on and adjacent to site.
 - .2 Arrange with appropriate authority for relocation of buried services that interfere with execution of work: pay costs of relocating services.
 - .3 Remove obsolete buried services within 2 m of foundations: cap cut-offs.
 - .4 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.

- .5 Prior to beginning excavation Work, notify Departmental Representative and authorities having jurisdiction and establish location and state of use of buried utilities and structures. Departmental Representative and/or authorities having jurisdiction to clearly mark such locations to prevent disturbance during Work.
- .6 Confirm locations of buried utilities by careful test excavations.
- .7 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered.
- .8 Where utility lines or structures exist in area of excavation, obtain direction of Departmental Representative before removing or re-routing. Costs for such Work to be paid by Departmental Representative.
- .9 Record location of maintained, re-routed and abandoned underground lines.
- .10 Confirm locations of recent excavations adjacent to area of excavation.
- .3 Existing buildings and surface features:
 - .1 Conduct, with Departmental Representative, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks, pavement, survey bench marks and monuments which may be affected by Work.
 - .2 Protect existing buildings and surface features from damage while Work is in progress. In event of damage, immediately make repair as directed by Departmental Representative.
 - .3 Where required for excavation, cut trees or branches as directed by Departmental Representative in accordance with Section 31 11 00 - Clearing and Grubbing.

Part 2 Products

2.1 MATERIALS

- .1 Type 1 and Type 2 fill: properties to Section 31 05 16 - Aggregate Materials, and the following requirements:
 - .1 Crushed, pit run or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.2.
 - .3 Table:

<u>Sieve Designation</u>	<u>% Passing</u>	
	<u>Type 1</u>	<u>Type 2</u>
80 mm	-	100
56 mm	-	70-100
28 mm	-	50-80
20 mm	100	-
14 mm	50-85	35-65
5 mm	20-50	20-50
1.25 mm	-	-
0.160 mm	5-12	3-10

EXCAVATING, TRENCHING, AND BACKFILLING

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<u>Sieve Designation</u>	<u>% Passing</u>	
	<u>Type 1</u>	<u>Type 2</u>
0.080 mm	3-8	0-7

- .2 Type 3 fill: selected material from excavation or other sources, approved by Departmental Representative for use intended, unfrozen and free from rocks larger than 75mm, cinders, ashes, sods, refuse or other deleterious materials.

- .3 Type C1 Fill:

<u>Sieve Size</u>	<u>Percent Passing</u>
250mm	100
150	20-35
56	0-10

- .4 Unshrinkable fill: proportioned and mixed to provide:

- .1 Maximum compressive strength of 0.4 MPa at 28 days.
- .2 Maximum cement content of 25kg/m ; with 40% by volume fly ash replacement: to CSA-A3001, Type GU.
- .3 Minimum strength of 0.07MPa at 24 h.
- .4 Concrete aggregates: to CSA-A23.1/A23.2.
- .5 Cement: Type GU.
- .6 Slump: 160 to 200 mm.

- .5 Geotextiles: to Section 31 32 19.01 - Geotextiles.

Part 3 Execution

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 SITE PREPARATION

- .1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.
- .2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly in accordance with Section 02 41 13 - Selective Site Demolition.

3.3 PREPARATION/PROTECTION

- .1 Protect existing features in accordance with Section 01 56 00 - Temporary Barriers and Enclosures and applicable local regulations.
- .2 Keep excavations clean, free of standing water, and loose soil.
- .3 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Departmental Representative approval.
- .4 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.
- .5 Protect buried services that are required to remain undisturbed, including the sluice way at the south end of Hall's Harbour.

3.4 STRIPPING OF TOPSOIL

- .1 Begin topsoil stripping of areas as directed by Departmental Representative after area has been cleared of brush, weeds, and grasses and removed from site.
- .2 Strip topsoil to depths as directed by Departmental Representative.
 - .1 Do not mix topsoil with subsoil.
- .3 Stockpile in locations as directed by Departmental Representative.
 - .1 Stockpile height not to exceed 2 m and should be protected from erosion.
- .4 Dispose of unused topsoil off site.

3.5 STOCKPILING

- .1 Stockpile fill materials in areas designated by Departmental Representative.
 - .1 Stockpile granular materials in manner to prevent segregation.
- .2 Protect fill materials from contamination.
- .3 Implement sufficient erosion and sediment control measures to prevent sediment release off construction boundaries and into water bodies.

3.6 COFFERDAMS, SHORING, BRACING AND UNDERPINNING

- .1 Maintain sides and slopes of excavations in safe condition by appropriate methods and in accordance with Section 01 35 29.06 - Health and Safety Requirements and Health and Safety Act for the Province of Nova Scotia.
 - .1 Where conditions are unstable, Departmental Representative to verify and advise methods.

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- .2 Construct temporary Works to depths, heights and locations as indicated and approved by Departmental Representative.
 - .3 During backfill operation:
 - .1 Unless otherwise indicated or directed by Departmental Representative, remove sheeting and shoring from excavations.
 - .2 Do not remove bracing until backfilling has reached respective levels of such bracing.
 - .3 Pull sheeting in increments that will ensure compacted backfill is maintained at elevation at least 500mm above toe of sheeting.
 - .4 When sheeting is required to remain in place, cut off tops at elevations as indicated.
 - .5 Upon completion of substructure construction:
 - .1 Remove cofferdams, shoring and bracing.
 - .2 Remove excess materials from site and restore watercourses as indicated and as directed by Departmental Representative.

3.7 DEWATERING AND HEAVE PREVENTION

- .1 Keep excavations free of water while Work is in progress.
- .2 Provide for Departmental Representative review and approval details of proposed dewatering or heave prevention methods, including dikes, well points, and sheet pile cut-offs.
- .3 Avoid excavation below groundwater table if quick condition or heave is likely to occur.
 - .1 Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.
- .4 Protect open excavations against flooding and damage due to surface run-off.
- .5 Dispose of water in accordance with Section 01 35 43 - Environmental Procedures to approved runoff areas and in manner not detrimental to public and private property, or portion of Work completed or under construction.
 - .1 Provide and maintain temporary drainage ditches and other diversions outside of excavation limits.
- .6 Provide flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to storm sewers, watercourses or drainage areas.

3.8 EXCAVATION

- .1 Advise Departmental Representative at least 7 days in advance of excavation operations for initial cross sections to be taken.
- .2 Excavate to lines, grades, elevations and dimensions as indicated and as directed by Departmental Representative.

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- .3 Remove concrete, masonry, paving, walkways, demolished foundations and rubble and other obstructions encountered during excavation in accordance with Section 02 41 13 - Selective Site Demolition.
 - .4 Excavation must not interfere with bearing capacity of adjacent foundations.
 - .5 Do not disturb soil within branch spread of trees or shrubs that are to remain.
 - .1 If excavating through roots, excavate by hand and cut roots with sharp axe or saw.
 - .6 For trench excavation, unless otherwise authorized by Departmental Representative in writing, do not excavate more than 30m of trench in advance of installation operations and do not leave open more than 15m at end of day's operation.
 - .7 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Departmental Representative.
 - .8 Restrict vehicle operations directly adjacent to open trenches.
 - .9 Dispose of surplus suitable excavated material in approved location on site and unsuitable excavated material in approved location off site.
 - .10 Do not obstruct flow of surface drainage or natural watercourses. Protect sluice way and sluice way reservoir throughout construction.
 - .11 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
 - .12 Notify Departmental Representative when bottom of excavation is reached.
 - .13 Obtain Departmental Representative approval of completed excavation.
 - .14 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Departmental Representative.
 - .15 Correct unauthorized over-excavation as follows:
 - .1 Fill under bearing surfaces and footings with Type 2 fill compacted to not less than 100% of corrected Standard Proctor maximum dry density in accordance with Section 31 05 10 - Corrected Maximum Dry Density for Fill.
 - .2 Fill under other areas with Type 2 fill compacted to not less than 95% of corrected Standard Proctor maximum dry density in accordance with Section 31 05 10 - Corrected Maximum Dry density for Fill.
 - .16 Hand trim, make firm and remove loose material and debris from excavations.

- .1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.
- .2 Clean out rock seams and fill with concrete mortar or grout to approval of Departmental Representative.
- .17 Install geotextiles in accordance with Section 31 32 19.01 - Geotextiles.

3.9 **FILL TYPES AND COMPACTION**

- .1 Use types of fill as indicated or specified below. Compaction densities are percentages of maximum densities obtained from ASTM D698 in accordance with Section 31 05 10 - Corrected Maximum Dry Density for Fill.
 - .1 Exterior side of perimeter walls: use Type 3 fill to subgrade level. Compact to 95% of corrected maximum dry density.
 - .2 Under concrete slabs: provide 100mm compacted thickness base course of Type 2 fill as indicated to underside of slab. Compact base course to 100%.
 - .3 Retaining walls:
 - .1 Geogrid reinforced walls: use Type 2 fill to subgrade level on high side for plan area where geogrid is present and compact to 95%. For remaining portion, use Type 3 fill compacted to 95%.
 - .2 Non-reinforced walls: use Type 2 fill to subgrade level on high side for minimum 500mm from back of wall and compact to 95%. For remaining portion, use Type 3 fill compacted to 95%.
 - .4 Place unshrinkable fill in areas as indicated.

3.10 **BEDDING AND SURROUND OF UNDERGROUND SERVICES**

- .1 Place and compact granular material for bedding and surround of underground services if encountered as required by authority having jurisdiction.
- .2 Place bedding and surround material in unfrozen condition.

3.11 **BACKFILLING**

- .1 Vibratory compaction equipment not to be used within 15m of sluice way. Contractor to monitor sluice way and sluice way slopes throughout construction and protect. Reinstate to existing conditions if disturbed at contractors expense.
- .2 Do not proceed with backfilling operations until completion of following:
 - .1 Departmental Representative has inspected and approved installations.
 - .2 Departmental Representative has inspected and approved of construction below finish grade.

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- .3 Inspection, testing, approval, and recording location of underground utilities.
 - .4 Removal of concrete formwork.
 - .5 Removal of shoring and bracing; backfilling of voids with satisfactory soil material.
 - .3 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.
 - .4 Do not use backfill material which is frozen or contains ice, snow or debris.
 - .5 Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.
 - .6 Backfilling around installations:
 - .1 Place bedding and surround material as specified elsewhere.
 - .2 Do not backfill around or over cast-in-place concrete within 24 hours after placing of concrete.
 - .3 Place layers simultaneously on both sides of installed Work to equalize loading where applicable.
 - .4 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:
 - .1 Permit concrete to cure for minimum 14 days or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from Departmental Representative:
 - .2 If approved by Departmental Representative, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Departmental Representative.
 - .7 Place unshrinkable fill in areas as indicated.
 - .8 Consolidate and level unshrinkable fill with internal vibrators.
 - .9 Install drainage and geotextile filter systems in backfill as indicated and as directed by Departmental Representative.

3.12 RESTORATION

- .1 Upon completion of Work, remove waste materials and debris in accordance to Section 01 74 21 - Construction/Demolition Waste Management and Disposal, trim slopes, and correct defects as directed by Departmental Representative.
- .2 Replace topsoil as directed by Departmental Representative.
- .3 Reinstate pavements and walkways disturbed by excavation to thickness, structure and elevation which existed before excavation.
- .4 Reinstate stairs to walking trail to the West if disturbed during construction to condition which existed before excavation.

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- .5 Clean and reinstate areas affected by Work as directed by Departmental Representative.
 - .6 Use temporary plating to support traffic loads over unshrinkable fill for initial 24 hours.
 - .7 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Section 01 50 00 - Temporary Facilities.
- .3 Section 02 41 13 - Selective Site Demolition.
- .4 Section 31 11 00 - Clearing and Grubbing.
- .5 Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .6 Section 31 05 10 - Corrected Maximum Dry Density for Fill.
- .7 Section 32 11 16.01 - Granular Sub-base.

1.2 MEASUREMENT PROCEDURES

- .1 Measurement will be in accordance with Section 01 29 00.
- .2 No separate payment for:
 - .1 Excavating unnecessarily beyond lines established by Departmental Representative, with exception of unavoidable slide material. Do not measure slide material, when such slides are attributable to negligence.
 - .2 Ripping and/or drilling and blasting of material.
 - .3 Scarifying or benching existing slopes or existing road surfaces.
 - .4 Removing and disposing of roots, stumps and other materials excavated during waste operation.
 - .5 Burying existing culverts from old road.
 - .6 Removing unsuitable material from embankment attributable to negligence.
 - .7 Shattering rock to 300 mm below subgrade elevation.
 - .8 Scaling and removing loose rock from rock face.
 - .9 Watering, drying and compacting.
 - .10 Finishing.

1.3 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM D698-12, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,000 ft-lbf/ft³) (600 kN-m/m³).

1.4 DEFINITIONS

- .1 Rock Excavation: excavation of:

- .1 Material from solid masses of igneous, sedimentary or metamorphic rock which, prior to removal, was integral with parent mass. Material that cannot be ripped with reasonable effort from Caterpillar D9L or equivalent to be considered integral with parent mass.
- .2 Boulder or rock fragments measuring in volume one (1) cubic metre or more.
- .2 Common Excavation: excavation of materials that are not Rock Excavation or Stripping.
- .3 Unclassified Excavation: excavation of whatever character other than stripping encountered in the work.
- .4 Free Haul: distance that excavated material is hauled without compensation. Free haul distance to be 0.5 km.
- .5 Stripping: excavation of organic material covering original ground.
- .6 Over Haul: authorized hauling in excess of free haul distance that excavated material is moved.
- .7 Embankment: material derived from usable excavation and placed above original ground or stripped surface up to top of subgrade.
- .8 Waste Material: material unsuitable for embankment, embankment foundation or material surplus to requirements.
- .9 Borrow Material: material obtained from areas outside right-of-way and required for construction of embankments or for other portions of work.
- .10 Topsoil: material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.

1.5 QUALITY ASSURANCE

- .1 Regulatory Requirements:
 - .1 Adhere to regulations of authority having jurisdiction when blasting is required.
 - .2 Adhere to Provincial and National Environmental requirements when potentially toxic materials are involved.
- .2 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Divert excess materials from landfill to site approved by Departmental Representative.

Part 2 Products

2.1 MATERIALS

- .1 Embankment materials require approval by Departmental Representative.
- .2 Material used for embankment not to contain more than 3% organic matter by mass, frozen lumps, weeds, sod, roots, logs, stumps or other unsuitable material.
- .3 Borrow material:
 - .1 Obtain from sources as indicated or as designated by Departmental Representative.
 - .2 Obtain from borrow pit approved by Departmental Representative.

Part 3 Execution

3.1 COMPACTION EQUIPMENT

- .1 Compaction equipment must equivalent of one 12 tonne vibratory packer capable of obtaining required densities in materials on project. Equipment that does not achieve specified densities must be replaced or supplemented.
- .2 Operate minimum equivalent of one 12 tonne vibratory packer continuously in each embankment when placing material.

3.2 WATER DISTRIBUTORS

- .1 Apply water with equipment capable of uniform distribution.

3.3 EXCAVATING

- .1 General:
 - .1 Notify Departmental Representative when waste materials are encountered and remove to depth and extent directed.
 - .2 Subcut 500mm below subgrade in cut sections unless otherwise directed. Compact top 150 mm below subcut to minimum 95% maximum dry density, ASTM D698 (AASHTO T99). Replace with approved embankment material and compact.
 - .3 Treat ground slopes, where subgrade is on transition from excavation to embankment, at grade points as directed by Departmental Representative.
 - .4 Treat ground slopes, where subgrade is on transition from excavation to embankment, at grade points as directed by Departmental Representative.
- .2 Drainage:
 - .1 Maintain profiles, crowns and cross slopes to provide good surface drainage.
- .3 Rock excavation:

ROADWAY EMBANKMENTS

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- .1 Notify Departmental Representative, when material appearing to conform to classification for rock is encountered, to enable measurements to be made to determine volume of rock. Provide 12 hour notification.
- .4 Borrow Excavation:
 - .1 Completely use in embankments, suitable materials removed from right-of-way excavations before taking material from borrow areas.
 - .2 Obtain embankment materials, in excess of what is available from cut areas, from designated borrow areas.
 - .1 Departmental Representative to designate extent of borrow areas and allowable depth of excavation.
 - .2 Remove waste and stripping material from borrow pits to designated locations.
 - .3 Slope edges of borrow areas to minimum 2:1 and provide drainage as directed.
 - .4 Trim and leave borrow pits in condition to permit accurate measurement of material removed.

3.4 EMBANKMENTS

- .1 Scarify or bench existing slopes in side hill or sloping sections to ensure proper bond between new materials and existing surfaces. Method used to be subject to prior approval of Departmental Representative.
- .2 Break up or scarify existing road surface prior to placing embankment material.
- .3 Do not place material which is frozen nor place material on frozen surfaces except in areas authorized.
- .4 Maintain crowned surface during construction to ensure ready run-off of surface water.
- .5 Drain low areas before placing materials.
 - .1 Place and compact to full width in layers not exceeding 200mm loose thickness. Departmental Representative may authorize thicker lifts if specified compaction can be achieved and if material contains more than 25% by volume stone and rock fragments larger than 100 mm.
- .6 Where material consists of rock:
 - .1 Place to full width in layers of sufficient depth to contain maximum sized rocks, but in no case is layer thickness to exceed 1m.
 - .2 Distribute rock material to fill voids with smaller fragments to form compact mass.
 - .3 Fill surface voids at subgrade level with rock spalls or selected material to form earth-tight surface.

- .4 Do not place boulders and rock fragments with dimensions exceeding 150mm within 300 mm of pavement subgrade elevation.
- .7 Deductions from excavation will be made for overbuild of embankments.

3.5 SUBGRADE COMPACTION

- .1 Break material down to sizes suitable for compaction and mix for uniform moisture to full depth of layer.
- .2 Compact each layer to minimum 95% maximum dry density, ASTM D698 (AASHTO T99) except top 150 mm of subgrade. Compact top 150 mm to 100% maximum dry density.
- .3 Add water or dry as required to bring moisture content of materials to level required to achieve specified compaction.

3.6 FINISHING

- .1 Shape entire roadbed to within 25 mm of design elevations.
- .2 Finish slopes, ditch bottoms and borrow pits true to lines, grades and drawings where applicable. Scale slope by removing loose fragments, for cut slopes in bedrock steeper than 1:1.
- .3 Remove rocks over 150 mm in dimension from slopes and ditch bottoms.
- .4 Hand finish slopes that cannot be finished satisfactorily by machine.
- .5 Round top of backslope 1.5 m both sides of top of slope.
- .6 Run tractor tracks over slopes exceeding 3 m in height to leave tracks parallel to centreline of highway.
- .7 Trim between constructed slopes and edge of clearing to provide drainage and free of humps, sags and ruts.

3.7 PROTECTION

- .1 Maintain finished surfaces in condition conforming to this section until acceptance by Departmental Representative.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation of polymeric geotextiles used in
 revetments, breakwaters, retaining wall structures, filtration,
 drainage structures, roadbeds and railroad beds purpose of which is
 to:
 - .1 Separate and prevent mixing of granular materials of different
 grading.
 - .2 Act as hydraulic filters permitting passage of water while
 retaining soil strength of granular structure.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management And
 Disposal.
- .3 Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .4 Section 31 24 13 - Roadway Embankments.

1.3 MEASUREMENT PROCEDURES

- .1 Geotextiles will not be measured separately for payment and shall be
 considered incidental to other sections of the work as required.

1.4 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM D4491-15, Standard Test Methods for Water Permeability of
 Geotextiles by Permittivity.
 - .2 ASTM D4595-11, Standard Test Method for Tensile Properties of
 Geotextiles by the Wide-Width Strip Method.
 - .3 ASTM D4716-14, Test Method for Determining the (In-Plane) Flow
 Rate Per Unit Width and Hydraulic Transmissivity of a
 Geosynthetic Using a Constant Head.
 - .4 ASTM D4751-12, Standard Test Method for Determining Apparent
 Opening Size of a Geotextile.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-4.2 No. 11.2-M89(2013), Textile Test Methods - Bursting
 Strength - Ball Burst Test.
 - .2 CAN/CGSB-148.1, Methods of Testing Geotextiles and Complete
 Geomembranes.
 - .1 No.2-M85, Methods of Testing Geosynthetics - Mass per Unit
 Area.

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- .2 No.3-M85, Methods of Testing Geosynthetics - Thickness of Geotextiles.
- .3 No.6.1-93, Methods of Testing Geotextiles and Geomembranes - Bursting Strength of Geotextiles Under No Compressive Load.
- .4 No.7.3-92, Methods of Testing Geotextiles and Geomembranes - Grab Tensile Test for Geotextiles.
- .5 No. 10-94, Methods of Testing Geosynthetics - Geotextiles - Filtration Opening Size.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CAN/CSA-G164-M92(R2013), Hot Dip Galvanizing of Irregularly Shaped Articles.
- .4 Ontario Provincial Standard Specifications (OPSS)
 - .1 OPSS 1860-April 2012, Material Specification for Geotextiles.

1.5 SUBMITTALS

- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit to Departmental Representative following samples at least 4 weeks prior to beginning Work.
 - .1 Minimum length of 2 m of roll width of geotextile.
 - .2 Minimum of 1 m seam with at least 600 mm of geotextile on both sides of seam.
- .3 Submit to Departmental Representative copies of mill test data and certificate at least 4 weeks prior to start of Work, and in accordance with Section 01 33 00 - Submittal Procedures.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 During delivery and storage, protect geotextiles from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 MATERIAL

- .1 Geotextile: non-woven synthetic fibre fabric, unaffected by action of oil or salt water and not subject to attack by insects or rodents, supplied in rolls.
 - .1 Composed of: polyester and/or polypropylene fabric.
 - .2 Roll width: 3.5 m minimum.
 - .3 Roll length: 100m minimum.
- .2 Physical properties:
 - .1 Thickness: to CAN/CGSB-148.1, No.3.
 - .2 Mass per unit area: to CAN/CGSB-148.1, No.2, minimum 230 g/m².
 - .3 Grab tensile strength and elongation: to CAN/CGSB-148.1, No.7.3.
 - .1 Breaking force: minimum 900 N, wet condition.
 - .2 Elongation at future: minimum 50%.
- .3 Hydraulic properties:
 - .1 Apparent opening size (AOS): to ASTM D4751, 80 micrometres.
 - .2 Filtration opening size (FOS): to CAN/CGSB-148.1 No.10.
 - .3 Permittivity: to ASTM D4491, 1.4 per s.
- .4 Securing pins and washers: to CAN/CSA-G40.21, Grade 300W, hot-dipped galvanized with minimum zinc coating of 600 g/m² to CAN/CSA G164.
- .5 Factory seams: sewn in accordance with manufacturer's recommendations.
- .6 Thread for sewn seams: equal or better resistance to chemical and biological degradation than geotextile.

Part 3 Execution

3.1 INSTALLATION

- .1 Place geotextile material by unrolling onto surfaces as indicated in orientation, manner and locations indicated. Retain in vertical position against crib timbers with nailed 38x89 treated timber.
- .2 Place geotextile material smooth and free of tension stress, folds, wrinkles and creases.
- .3 Place geotextile material on sloping surfaces in one continuous length from toe of slope to upper extent of geotextile.
- .4 Overlap each successive strip of geotextile 600 mm over previously laid strip.
- .5 Join successive strips of geotextile by sewing.

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- .6 Pin successive strips of geotextile with securing pins at 600mm interval at midpoint of lap.
 - .7 Protect installed geotextile material from displacement, damage or deterioration before, during and after placement of material layers.
 - .8 After installation, cover with overlying layer within 4h of placement with the exception of vertical timber crib surfaces - protect vertical surface geotextiles from damage prior to backfilling.
 - .9 Replace damaged or deteriorated geotextile to approval of Departmental Representative.
 - .10 Place and compact soil layers in accordance with Section 31 23 33.01 - Excavating Trenching and Backfilling, 31 24 13 - Roadway Embankments.

3.2 CLEANING

- .1 Remove construction debris from Project site and dispose of debris in an environmentally responsible and legal manner.

3.3 PROTECTION

- .1 Vehicular traffic not permitted directly on geotextile.

END OF SECTION



Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Materials, applications, and installation of crushed rock mattresses to provide uniform bearing surface for support of timber cribs.

.2 Related Sections:

- .1 Section 01 35 29 - Health and Safety Requirements.
- .2 Section 01 35 43 - Environmental Protection Procedures for Marine Work.
- .3 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.2 Measurement Procedures:

- .1 Measure crushed rock mattress as cubic metres place measure in accordance with Section 01 29 00.

1.3 REFERENCES

.1 American Society for Testing and Materials International, (ASTM).

- .1 ASTM C127-15, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
- .2 ASTM C136M-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

.2 Canadian General Standards Board (CGSB).

- .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

1.4 QUALITY ASSURANCE

.1 Health and Safety:

- .1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Environmental Protection:

- .1 Provide erosion and sediment control measure to prevent migration of suspended sediments in downstream areas and erosion of on-site soils/sediments during execution of Work in accordance with Section 01 35 43.

- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Divert left over aggregate material from landfill to a local recycling facility as reviewed by Departmental Representative.

Part 2 Products

2.1 MATERIALS

- .1 Mattress material to following requirements:
 - .1 Crushed quarry stone consisting of hard durable particles free from clay lumps, frozen material and other deleterious materials, and free from splits, seams or defects likely to impair its soundness during handling or under action of water.
 - .2 Relative density (formally specific gravity): to ASTM C127, not less than 2.65.
 - .3 Gradations: to ASTM C136.
 - .4 Sieve sizes: to CAN/CGSB-8.2.
 - .1 Bottom Layer (Coarse Stone): Well-graded with a maximum size of 200mm and not more than 10% passing the 4.75mm sieve.
 - .2 Top 300 mm Leveling Layer: Clear stone with a maximum size of 56mm and not more than 5% passing the 4.75mm sieve.

Part 3 Execution

3.1 PREPARATION

- .1 Inspect area and determine that grade, as indicated, has been reached to allow for required thickness of rock mattress.

3.2 PLACEMENT

- .1 Ensure that no frozen material is used in placing.
- .2 Do not place mattress material until bottom area has been reviewed by Departmental Representative.
- .3 Place mattress materials to dimensions as indicated.
- .4 Prevent segregation in placing of material sizes.
- .5 Do not place material during weather judged unsuitable by Departmental Representative.
- .6 Place material immediately prior to planned placement of timber cribs.

- .7 Level top surface of mattress to specified grade and compact at low tide.

3.3 TOLERANCES

- .1 Surface of mattress to be parallel with elevation as indicated within 25 mm of elevations as indicated.
- .2 Establish mean elevation from spot elevations taken at 1 m intervals.
 - .1 Do not allow spot elevation to differ more than 25 mm from mean.

END OF SECTION

Part 1 General**1.1 RELATED SECTIONS**

- .1 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Section 31 32 19.01 - Geotextiles.

1.2 MEASUREMENT PROCEDURES

- .1 Measure rip-rap in accordance with Section 01 29 00.

1.3 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM C144-11, Standard Specification for Aggregate for Masonry Mortar.
 - .2 ASTM C618-15, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
- .2 Canadian Standards Association (CSA)
 - .1 CAN/CSA-A23.1-14, Concrete Materials and Methods of Concrete Construction.
 - .2 CAN/CSA-A3000-13, Cementitious Materials Compendium.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Collect and separate plastic, paper packaging, corrugated cardboard in accordance with Waste Management Plan.
- .3 Place materials defined as hazardous or toxic in designated containers.
- .4 Fold up metal banding, flatten and place in designated area for recycling.
- .5 Divert left over aggregate materials from landfill to local quarry facility for reuse as approved by Departmental Representative.
- .6 Divert left over hardened cement materials from landfill to local quarry facility for reuse as approved by Departmental Representative.
- .7 Divert left over geotextiles to local plastic recycling facility as approved by Departmental Representative.

Part 2 Products

2.1 RIP RAP

- .1 Hard, dense with relative density (formally specific gravity) not less than 2.65, durable quarry stone, free from seams, cracks or other structural defects, to meet following size distribution for use intended:

.1 Armour rip-rap:

- .1 Not more than 10% of total volume of stones with individual volume less than 30 dm³.
- .2 Not less than 50% of total volume of stones with individual volume of 225 dm³ or more.
- .3 Remaining percentage of total volume to have uniform distribution of stones between 30 and 225 dm³ size.

.2 Heavy rip-rap:

- .1 Not more than 10% of total volume of stones with individual volume less than 30 dm³.
- .2 Not less than 50% of total volume of stones with individual volume of 140 dm³ or more.
- .3 Remaining percentage of total volume to have uniform distribution of stones between 30 and 140 dm³ size.

.3 Random rip-rap:

- .1 Not more than 10% of total volume of stones with individual volume less than 15 dm³.
- .2 Not less than 50% of total volume of stones with individual volume of 85 dm³ or more.
- .3 Remaining percentage of total volume to have uniform distribution of stones between 15 and 85 dm³ size.

.4 Hand placed rip-rap:

- .1 Minimum size of individual stones 10 dm³.
- .2 Not less than 75% of total volume of stones with individual volume of 25 dm³ or more.
- .3 Supply rock spalls or cobbles to fill open joints.

2.2 WELL GRADED ROCK FILL

- .1 Well Graded Rock Fill placed over the back cells of the timber crib as detailed on the project drawings to have the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
300mm	100
56mm	60-100
5mm	15-50
80mm	0-7

2.3 CEMENT MORTAR

- .1 Cement: to CAN/CSA-A3000, type 10.
- .2 Sand for mortar: to ASTM C144.

- .3 Mortar mix: 1 part by volume of cement to 3 parts sand, to consistency approved by Departmental Representative.
- .4 Fly ash cement with 40% fly ash replacement: to ASTM C618.

2.4 GEOTEXTILE FILTER

- .1 Geotextile: in accordance with Section 31 32 19.01 - Geotextiles.

Part 3 Execution

3.1 PLACING

- .1 Where rip-rap is to be placed on slopes, excavate trench at toe of slope to dimensions as indicated.
- .2 Fine grade area to be rip-rapped to uniform, even surface. Fill depressions with suitable material and compact to provide firm bed.
- .3 Place geotextile on prepared surface in accordance with Section 31 32 19.01- Geotextiles and as indicated. Avoid puncturing geotextile. Vehicular traffic over geotextile not permitted.
- .4 Place rip-rap to thickness and details as indicated.
- .5 Place stones in manner approved by Departmental Representative to secure surface and create a stable mass. Place larger stones at bottom of slopes.
- .6 Hand placing:
 - .1 Use larger stones for lower courses and as headers for subsequent courses.
 - .2 Stagger vertical joints and fill voids with rock spalls or cobbles.
 - .3 Finish surface evenly, free of large openings and neat in appearance.
- .7 Mortar:
 - .1 Use mortar within one hour after water has been added. Do not add additional water after initial mixing.
 - .2 Begin applying mortar at bottom courses and work upwards completely filling voids except for sub drainage relief holes as indicated, and leaving outer faces of stones exposed. Remove excess mortar to expose faces of stones as indicated.
 - .3 Cure and protect mortar in accordance with CAN/CSA-A23.1 by using absorptive mats or keeping fabric continuously wet.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

- .1 This section specifies requirements for installation of treated timber and necessary fastenings for fabrication, placing, and ballasting of timber cribwork.
- .2 Contractor will be required to supply and install ballast material to ensure all cribwork is fully ballasted.

1.2 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Section 06 05 73 - Wood Treatment.
- .3 Section 31 05 16 - Aggregate Materials.
- .4 Section 31 32 19.01 - Geotextiles.
- .5 Section 31 36 19 - Gabion Mattresses.

1.3 MEASUREMENT PROCEDURES

- .1 Timber cribwork to be measured in accordance with Section 01 29 00 and as follows:
 - .1 Treated Timber Cribwork: to be measured in cubic metres (m³) of completed work which includes excavation, ballast stone, upper level gravel, fastenings, geotextile, and all plant, labour, materials and equipment necessary to perform work.
 - .2 Measure timber cribwork in cubic metres determined by product and use following dimensions measured in place:
 - .1 Height: average of measurements taken at each vertical from bottom of lowest timber to top side of uppermost course of timber.
 - .2 Width: average of measurements between outside faces of exterior longitudinal timbers, each width measured on top ties of each row of cross ties.
 - .3 Length: measured horizontally along centre-line of crib between outside faces of exterior cross ties.
 - .3 Demolition of the existing crib, excavation for the crib mattress and all associated site work and disposal requirements shall be included in the Demolition and Removals lump sum per Section 01 29 00.
 - .4 Ballast over partial Timber Cribwork: Additional ballast material required to ballast partially ballasted rear timber cribwork to be considered incidental to the installation of the timber crib work and is to be included in the crib unit price per cubic metre of crib installed.

- .5 Measurements of the vertical lengths, transverse plan width and longitudinal plan lengths, will be taken in the presence of both the Contractor and the Departmental Representative and will be verified and signed by both parties on the site to avoid any disputes.

1.4 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .2 ASTM C136M-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- .2 American Wood-Preserver's Association (AWPA)
 - .1 AWPA M4-15, Standard for the Care of Preservative - Treated Wood Products.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.
 - .2 CSA-G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .3 CAN/CSA G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .4 CSA-O80 Series-08(R2012), Wood Preservation.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .5 Canadian Wood Council
 - .1 Wood Design Manual - 2010.
- .6 National Lumber Grades Authority (NLGA)
 - .1 Standard Grading Rules for Canadian Lumber 2014 edition.

1.5 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Ballast:
 - .1 Submit proposed placing method for ballast to Departmental Representative for approval, prior to placing of ballast
- .3 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.

1.6 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.
- .3 Worker protection:
 - .1 Workers must wear gloves, respirators, dust masks, long sleeved clothing, eye protection, and protective clothing when handling, drilling, sawing, cutting or sanding preservative treated wood and applying preservative materials.
 - .2 Workers must not eat, drink or smoke while applying preservative material.
 - .3 Clean up spills of preservative materials immediately with absorbent material. Safely discard of adsorbent material to sanitary landfill.

1.7 WASTE MANAGEMENT

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Place materials defined as hazardous or toxic in designated containers.
- .3 Ensure emptied containers are sealed and stored safely.
- .4 Do not dispose of preservative treated wood through incineration.
- .5 Do not dispose of preservative treated wood with other materials destined for recycling or reuse.
- .6 Dispose of treated wood, end pieces, wood scraps and sawdust at a sanitary landfill.
- .7 Dispose of unused preservative material at an official hazardous material collections site. Do not dispose of unused preservative material into sewer system, streams, lakes, oceans, on ground or in any other location where they will pose a health or environmental hazard.

Part 2 Products

2.1 MATERIALS

- .1 Timber: use timber graded and stamped in accordance with applicable grading rules and standards of associations or agencies approved to grade lumber by Canadian Lumber Standards Accreditation Board of CSA.
 - .1 Allowable Species: Eastern Hemlock, Douglas Fir, and Pacific Coast Hemlock.
 - .2 Grade: No. 1 Structural.
 - .3 Grading authority: NLGA.

- .4 Preservative treatment: To CSA 080 for coastal waters and Section 06 05 73. Supply timbers in lengths required. Cut and field treat timbers only as may be necessary to suit the site conditions. Contractor will have on site sufficient lengths and thickness of treated timber to permit levelling of cribs after ballasting operations.
- .2 Miscellaneous steel:
 - .1 Hot dip galvanized: to CAN/CSA-G164.
 - .2 Wire nails, spikes, staples: to CSA-B111.
 - .3 Bolts, nuts: to ASTM A307.
 - .4 Ogee Washers: to ASTM A48.
 - .5 Round Plate Washers: to ASTM A307 and G40.21.
- .3 Ballast for filling cribs to following requirements:
 - .1 Stone, consisting of hard durable particles free from clay lumps, organic material and other deleterious materials.
 - .2 Dry density in place: minimum 2150 kg/m³.
 - .3 Ballast stone in the lower part of the cribs to be well graded with maximum sizes not exceeding 400mm on any side and minimum size of not less than 250mm on any side.
 - .4 Gradations of ballast stone above the level of continuous timber blocking to be well-graded with a maximum size of 200mm with 50% passing the 75mm sieve and not more than 1% passing the 25mm sieve.
 - .5 Gravel at underside of concrete slab: evenly graded pit run or crushed stone, maximum size, 50mm, with not more than 8% passing the 0.075mm sieve. Separate ballast stone from gravel with geotextile in accordance with Section 31 32 19.01 Geotextiles.
- .4 Crushed rock mattress:
 - .1 Materials in accordance with Section 31 36 19 - Gabion Mattresses.

Part 3 Execution

3.1 PREPARATION

- .1 Place and level crushed rock mattress in accordance with Section 31 36 19 - Gabion Mattresses.
- .2 Before construction, stockpile sufficient ballast to completely fill cribs.
- .3 Take accurate measurements of crushed rock mattress surface and construct crib bottom to match base configuration.
- .4 Cribs out of alignment or not correctly located to be replaced in correct position.

3.2 APPLICATION

- .1 Manufacturer's instructions: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.3 CRIB CONSTRUCTION

- .1 Precut and pre-bore timber prior to preservative treatment.
- .2 Bore holes for drift bolts 1.5 mm smaller diameter than bolt and for full length of bolt. Bore holes for machine bolts to same diameter as bolts.
- .3 Levelling pieces:
 - .1 Place timber levelling pieces beneath bottom timbers to conform to shape of base mattress area.
 - .2 Place levelling pieces horizontally.
 - .3 Secure succeeding pieces at intersections of bottom timbers and vertical posts, and other levelling pieces with machine bolts.
- .4 Bottom timbers:
 - .1 Place bottom timbers lengthwise, and crosswise to form bottom three courses of cribs.
 - .2 Crosswise bottom timbers to be of one piece.
 - .3 Lengthwise bottom timbers to be of one piece.
 - .4 Secure three courses of bottom timbers together with machine bolts at every intersection with each other and with vertical posts.
- .5 Ballast floor:
 - .1 Place ballast floor on pockets on bottom course of timbers.
 - .2 Secure each ballast floor timber to bottom timbers as indicated on drawings securing adjacent ballast floor timbers to same bottom timber.
- .6 Longitudinals:
 - .1 Longitudinal timbers to be one piece.
 - .2 Longitudinals minimum 4.88 m long.
 - .3 Secure longitudinals to intersection of cross ties with drift bolt and to intersection of vertical posts with machine bolt every course of longitudinals.
- .7 Cross ties:
 - .1 Cross ties to be one piece.
 - .2 Secure cross ties to intersection of longitudinals with drift bolt and to intersection of vertical posts with machine bolt at every cross tie course.
 - .3 Countersink machine bolts connecting cross tie to vertical posts on outside of cross ties between adjacent crib units.

- .4 Secure cross ties together with machine bolts between adjacent crib units. Use a minimum of 3 machine bolts per cross tie level evenly spaced between verticals.
- .8 Vertical posts: one length from bottom of cribwork to top of cribwork.
- .9 Blocking: place filler blocking timber as indicated on front face, from elevation 13.15 m chart datum to elevation 11.81 m chart datum.
 - .1 Cut blocking to exact lengths required.
 - .2 Blocking of same size and material as crossties and longitudinal timbers.
 - .3 Secure blocking with drift bolts to timbers immediately below as indicated on drawings.

3.4 HANDLING TREATED TIMBER

- .1 Handle treated material without damaging original treatment.
 - .1 Replace treated timber with major damage to original treatment, as instructed by Departmental Representative.
- .2 Field treatment: apply and saturate cuts, minor surface damage, abrasions, and nail and spike holes with preservative to CAN/CSA-080 Series.

3.5 BALLAST

- .1 Place ballast to avoid damage to timber cribwork.
- .2 Place ballast so that differential height of fill between adjacent cells, at any time, will be less than 1 m.
- .3 Pockets of cribs to be ballasted to within 100mm of top of crib timbers to elevation 13.05m.
- .4 Hand place final layer of ballast stone to ensure an even surface for placement of the gravel layer.

3.6 GRAVEL

- .1 Install a 100mm layer of gravel over the top of ballast to form a base for the reinforced concrete deck.
- .2 Separate the gravel layer from the top of the ballast by a layer of geotextile in accordance with Section 31 32 19.01 Geotextiles.
- .3 Install gravel to grade required and compact in preparation for concrete deck work.
- .4 Clean any loose gravel off timber surface prior to placement of concrete deck.

3.7 TOLERANCES

- .1 1 in 300 in overall dimensions.

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- .2 Locate cribs within 50 mm of location as indicated. Horizontal misalignment tolerance to be within 50 mm along outside face.

3.8 PROTECTION

- .1 Protect work from damage resulting from work on other sections and from damage resulting from environmental conditions.
- .2 Repair or replace portion or entire crib at no additional cost if damaged during construction.

3.9 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General**1.1 SUMMARY**

- .1 This Section includes furnishing all materials and labour required for the design and construction of a precast concrete modular block (PMB) retaining wall with geosynthetic reinforcement (required). Precast modular block retaining wall blocks under this section shall be cast utilizing a wet-cast concrete mix and exhibit a final handling weight in excess of 1,000 pounds (450 kg) per unit.
- .2 Scope of Work: The work shall consist of furnishing materials, labor, equipment and supervision for the construction of a precast modular block (PMB) retaining wall structure in accordance with the requirements of this section and in acceptable conformity with the lines, grades, design and dimensions shown in the project site plans.

1.2 REFERENCES

- .1 Where the specification and reference documents conflict, the Departmental Representative will make the final determination of the applicable document.
- .2 Definitions:
 - .1 Precast Modular Block (PMB) Unit - machine-placed, "wet cast" concrete modular block retaining wall facing unit.
 - .2 Geotextile - a geosynthetic fabric manufactured for use as a separation and filtration medium between dissimilar soil materials.
 - .3 Geogrid - a geosynthetic material comprised of a regular network of tensile elements manufactured in a mesh-like configuration of consistent aperture openings. When connected to the PMB facing units and placed in horizontal layers in compacted fill, the geogrid prevents lateral deformation of the retaining wall face and provides effective tensile reinforcement to the contiguous reinforced fill material.
 - .4 Drainage Aggregate - clean, crushed stone placed within and immediately behind the precast modular block units to facilitate drainage and reduce compaction requirements immediately adjacent to and behind the precast modular block units.
 - .5 Unit Core Fill - clean, crushed stone placed within the hollow vertical core of a precast modular block unit. Typically, the same material used for drainage aggregate as defined above.
 - .6 Foundation Zone - soil zone immediately beneath the leveling pad and the reinforced zone.
 - .7 Retained Zone - soil zone immediately behind the drainage aggregate and wall infill for wall sections designed as modular gravity structures. Alternatively, in the case of wall sections designed with geosynthetic soil reinforcement, the retained zone is the soil zone immediately behind the reinforced zone.

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- .8 Reinforced Zone - structural fill zone within which successive horizontal layers of geogrid soil reinforcement have been placed to provide stability for the retaining wall face. The reinforced zone exists only for retaining wall sections that utilize geosynthetic soil reinforcement for stability.
 - .9 Reinforced Fill - structural fill placed within the reinforced zone.
 - .10 Leveling Pad - hard, flat surface upon which the bottom course of precast modular blocks are placed. The leveling pad may be constructed with crushed stone, cast-in-place, or precast concrete. A leveling pad is not a structural footing.
 - .11 Wall Infill - the fill material placed and compacted between the drainage aggregate and the excavated soil face in retaining wall sections designed as modular gravity structures.
- .3 Reference Standards
- .1 Design:
 - .1 CAN/CSA S6-14 Canadian Highway Bridge Design Code.
 - .2 Canadian Foundation Engineering Manual, 2006.
 - .3 AASHTO LRFD Bridge Design Specifications, 7th Edition, 2014.
 - .4 International Building Code, 2012 Edition.
 - .5 FHWA-NHI-10-024 Volume I and GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes.
 - .6 FHWA-NHI-10-025 Volume II and GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes.
 - .2 Precast Modular Block Units
 - .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM C94 - Standard Specification for Ready-Mixed Concrete.
 - .2 ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - .4 ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
 - .5 ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
 - .6 ASTM C666 - Standard Test Method for Concrete Resistance to Rapid Freezing and Thawing.
 - .7 ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
 - .8 ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete.
 - .9 ASTM C1611 - Standard Test Method for Slump Flow of Self-Consolidating Concrete.
 - .10 ASTM D6638 - Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement

- and Segmental Concrete Units (Modular Concrete Blocks).
- .11 ASTM D6916 - Standard Test Method for Determining Shear Strength Between Segmental Concrete Units (Modular Concrete Blocks).
- .3 Geosynthetics
 - .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM D1248-12, Standard Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable.
 - .2 ASTM D4101-14e1, Standard Specification for Polypropylene Injection and Extrusion Materials.
 - .3 ASTM D4218-15, Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique.
 - .4 ASTM D5262-07(2012), Standard Test Method for Evaluating the Unconfined Tension Creep Behaviour of Geosynthetics.
 - .5 ASTM D6637-15, Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method.
 - .2 Drexel University - Geosynthetic Research Institute (GRI)
 - .1 GRI GG2-05, Geogrid Junction Strength.
 - .4 Drainage Pipe
 - .1 ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - .2 ASTM F2648 - Standard Specification for 50 to 1500 mm Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.

1.3 MEASUREMENT AND PAYMENT

- .1 Measurement for payment shall be in accordance with Section 01 29 00.

1.4 PRECONSTRUCTION MEETING

- .1 If directed by the Departmental Representative, the General Contractor shall schedule a preconstruction meeting at the project site prior to commencement of retaining wall construction. Participation in the preconstruction meeting shall be required of the General Contractor, Retaining Wall Design Engineer, Retaining Wall Installation Contractor, Grading Contractor and Inspection Engineer. The General Contractor shall provide notification to all parties at least 10 calendar days prior to the meeting.
 - .1 Preconstruction Meeting Agenda:
 - .1 The Retaining Wall Design Engineer shall explain all aspects of the retaining wall construction drawings.
 - .2 The Retaining Wall Design Engineer shall explain the required bearing capacity of soil below the retaining wall structure and the shear strength of in-situ soils assumed in the retaining wall design to the Inspection Engineer.

- .3 The Retaining Wall Design Engineer shall explain the required shear strength of fill soil in the reinforced, retained and foundation zones of the retaining wall to the Inspection Engineer.
- .4 The Retaining Wall Design Engineer shall explain any measures required for coordination of the installation of utilities or other obstructions in the reinforced or retained fill zones of the retaining wall.
- .5 The Retaining Wall Installation Contractor shall explain all excavation needs, site access and material staging area requirements to the General Contractor and Grading Contractor.

1.5 SUBMITTALS

.1 Product Data

- .1 At least 14 days prior to construction, the General Contractor shall submit a minimum of six (6) copies of the retaining wall product submittal package to the Departmental Representative for review and approval. The submittal package shall include technical specifications and product data from the manufacturer for the following:
 - .1 Precast Modular Block System brochure
 - .2 Precast Modular Block concrete test results as follows:
 - .1 28-day compressive strength
 - .2 Air content
 - .3 Slump or Slump Flow (as applicable)
 - .4 Drainage Pipe
 - .5 Geotextile
 - .6 Geosynthetic Soil Reinforcement (required for the retaining wall design). The contractor shall provide certified manufacturer test reports for the geosynthetic soil reinforcement material in the manufactured roll width specified. The test report shall list the individual roll numbers for which the certified material properties are valid.
- .2 Retaining Wall Design Calculations and Construction Shop Drawings. At least 14 days prior to construction, the General Contractor shall furnish six (6) sets of construction shop drawings and six (6) copies of the supporting structural calculations report to the Departmental Representative for review and approval. This submittal shall include the following:
 - .1 Signed, sealed and dated drawings and engineering calculations prepared in accordance with these specifications.
 - .2 Qualifications Statement of Experience of the Retaining Wall Design Engineer. Design Engineer to be licensed to practice Engineering in the Province of Nova Scotia.
 - .3 Certificate of Insurance of the Retaining Wall Design Engineer.
- .3 Construction Shop Drawings

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- .1 The Retaining Wall Design Engineer shall coordinate the retaining wall construction shop drawing preparation with the project Civil Engineer, project Geotechnical Engineer and Departmental Representative. The General Contractor shall furnish the Retaining Wall Design Engineer the following project information required to prepare the construction shop drawings. This information shall include, but is not limited to, the following:
 - .1 Current versions of the site, grading, drainage, utility, erosion control, landscape, and irrigation plans;
 - .2 Electronic CAD file of the civil site plans listed in (1);
 - .3 Report of geotechnical investigation and all addenda and supplemental reports;
 - .4 Recommendations of the project Geotechnical Engineer regarding effective stress shear strength and total stress shear strength (when applicable) parameters for in-situ soils in the vicinity of the proposed retaining wall(s) and for any fill soil that may potentially be used as backfill in retained and/or foundation zones of the retaining wall.
 - .4 The Retaining Wall Design Engineer shall provide the Departmental Representative with a certificate of professional liability insurance verifying the minimum coverage limits of \$1 million per claim and \$1 million aggregate.
 - .5 Design of the precast modular block retaining wall shall satisfy the requirements of this section. Where local design or building code requirements exceed these specifications, the local requirements shall also be satisfied.
 - .6 The Retaining Wall Design Engineer shall note any exceptions to the requirements of this section by listing them at the bottom right corner of the first page of the construction shop drawings.
 - .7 Approval or rejection of the exceptions taken by the Retaining Wall Engineer will be made in writing as directed by the Departmental Representative.
 - .8 The precast modular block design, except as noted herein, shall be based upon CAN/CSA S6-14 Load and Resistance Factor Design (LRFD) methodology.
 - .9 In the event that a conflict is discovered between these specifications and a reasonable interpretation of the design specifications and methods referenced in CAN/CSA S6-14, these specifications shall prevail.
 - .10 Soil Shear Parameters. The Retaining Wall Design Engineer shall prepare the construction shop drawings based upon soil shear strength parameters from the available project data and the recommendations of the project Geotechnical Engineer. If insufficient data exists to develop the retaining wall design, the Retaining Wall Design Engineer shall communicate the specific deficiency of the project information or data to the Departmental Representative in writing.

- .11 Allowable bearing pressure requirements for each retaining wall shall be clearly shown on the construction drawings.
- .12 Seismic Stability. Seismic loading shall be evaluated in accordance with CAN/CSA S6-14.
- .13 Global Stability. Overall (global) stability including sliding, overturning and bearing shall be evaluated in accordance with the Canadian Foundation Engineering Manual and CAN/CSA S6-14 and clearly documented in the retaining wall design calculations.

1.6 QUALITY ASSURANCE

- .1 Retaining Wall Installation Contractor Qualifications. In order to demonstrate basic competence in the construction of precast modular block walls, the Retaining Wall Installation Contractor shall document compliance with the following:
 - .1 Experience.
 - .1 Retaining Wall Installation Contractor must be a certified Precast Modular Block Retaining Wall Installation Contractor as demonstrated by satisfactory completion of a certified precast modular block retaining wall installation training program administered by the precast modular block manufacturer.
 - .2 Retaining Wall Design Engineer Qualifications and Statement of Experience. The Retaining Wall Design Engineer shall submit a written statement affirming that he or she has the following minimum qualifications and experience.
 - .1 The Retaining Wall Design Engineer shall be licensed to practice in the Province of Nova Scotia.
 - .2 The Retaining Wall Design Engineer shall be independently capable of performing all internal and external stability analyses, including those for seismic loading, compound stability, rapid draw-down and deep-seated, global modes of failure.
 - .3 The Retaining Wall Design Engineer shall affirm in writing that he or she has personally supervised the design of the retaining walls for the project that the design considers all the requirements listed in Clause 1.5 - Submittals and that he or she accepts responsibility as the design engineer of record for the retaining walls constructed on the project.
 - .4 In lieu of these specific requirements, the engineer may submit alternate documentation demonstrating competency in Precast Modular Block retaining wall design.
 - .5 The Departmental Representative reserves the right to reject the design services of any engineer or engineering firm who, in the sole opinion of the Departmental Representative, does not possess the requisite experience or qualifications.

1.7 QUALITY CONTROL

- .1 The Departmental Representative or delegate shall review all submittals for materials, design, Retaining Wall Design Engineer qualifications and the Retaining Wall Installation Contractor qualifications.

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- .2 The General Contractor shall retain the services of an Inspection Engineer who is experienced with the construction of precast modular block retaining wall structures to perform inspection and testing. The cost of inspection shall be the responsibility of the General Contractor. Inspection shall be continuous throughout the construction of the retaining walls.
- .3 The Inspection Engineer shall perform the following duties:
- .1 Inspect the construction of the precast modular block structure for conformance with construction shop drawings and the requirements of this specification.
 - .2 Verify that soil or aggregate fill placed and compacted in the reinforced, retained and foundation zones of the retaining wall conforms with this specification and exhibits the shear strength parameters specified by the Retaining Wall Design Engineer.
 - .3 Verify that the shear strength of the in-situ soil assumed by the Retaining Wall Design Engineer is appropriate.
 - .4 Inspect and document soil compaction in accordance with these specifications:
 - .1 Required dry unit weight
 - .2 Actual dry unit weight
 - .3 Allowable moisture content
 - .4 Actual moisture content
 - .5 Pass/fail assessment
 - .6 Test location - wall station number
 - .7 Test elevation
 - .8 Distance of test location behind the wall face
 - .9 Verify that all excavated slopes in the vicinity of the retaining wall are bench-cut as directed by the project Geotechnical Engineer.
 - .10 Notify the Retaining Wall Installation Contractor of any deficiencies in the retaining wall construction and provide the Retaining Wall Installation Contractor a reasonable opportunity to correct the deficiency.
 - .11 Notify the General Contractor, Departmental Representative and Retaining Wall Design Engineer of any construction deficiencies that have not been corrected timely.
 - .12 Document all inspection results.
 - .13 Test compacted density and moisture content of the retained backfill with the following frequency:
 - .1 At least once per every 400 mm of vertical wall construction.
 - .14 The General Contractor's engagement of the Inspection Engineer does not relieve the Retaining Wall Installation Contractor of responsibility to construct the proposed retaining wall in accordance with the approved construction shop drawings and these specifications.
 - .15 The Retaining Wall Installation Contractor shall inspect the on-site grades and excavations prior to construction and

notify the Retaining Wall Design Engineer and General Contractor if on-site conditions differ from the elevations and grading conditions depicted in the retaining wall construction shop drawings.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 The Retaining Wall Installation Contractor shall inspect the materials upon delivery to ensure that the proper type, grade and color of materials have been delivered.
- .2 The Retaining Wall Installation Contractor shall store and handle all materials in accordance with the manufacturer's recommendations as specified herein and in a manner that prevents deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, UV exposure or other causes. Damaged materials shall not be incorporated into the work.
- .3 Geosynthetics
 - .1 All geosynthetic materials shall be handled in accordance with ASTM D4873. The materials should be stored off the ground and protected from precipitation, sunlight, dirt and physical damage.
- .4 Precast Modular Blocks
 - .1 Precast modular blocks shall be stored in an area with positive drainage away from the blocks. Be careful to protect the block from mud and excessive chipping and breakage. Precast modular blocks shall not be stacked more than three (3) units high in the storage area.
- .5 Drainage Aggregate and Backfill Stockpiles
 - .1 Drainage aggregate or backfill material shall not be piled over unstable slopes or areas of the project site with buried utilities.
 - .2 Drainage aggregate and/or reinforced fill material shall not be staged where it may become mixed with or contaminated by poor draining fine-grained soils such as clay or silt.

Part 2 Materials

2.1 PRECAST MODULAR BLOCK RETAINING WALL UNITS

- .1 All units for the project shall be obtained from the same manufacturer. The manufacturer shall be licensed and authorized to produce the retaining wall units by the precast modular block system patent holder/licensor and shall document compliance with the published quality control standards of the proprietary precast modular block system licensor for the previous three (3) years or the total time the manufacturer has been licensed, whichever is less.
- .2 Concrete used in the production of the precast modular block units shall be first-purpose, fresh concrete. It shall not consist of returned, reconstituted, surplus or waste concrete. It shall be an

original production mix meeting the requirements of ASTM C94 and exhibit the following:

- .1 Minimum 28-day compressive strength of 35 MPa.
- .2 Shall be free of water soluble chlorides and chloride based accelerator admixtures.
- .3 6% +/- 1½% air-entrainment in conformance ASTM C94.
- .4 Maximum slump of 125 mm +/- 40 mm per ASTM C143 for conventional concrete mix designs.
- .5 Slump Flow for Self-Consolidating Concrete (SCC) mix designs shall be between 450 mm and 800 mm as tested in accordance with ASTM C1611.
- .6 Each concrete block shall be cast in a single continuous pour without cold joints. With the exception of half-block units, corner units and other special application units, the precast modular block units shall conform to the nominal dimensions listed in the manufacturer's published literature as submitted per Clause 1.5 - Submittals.
- .7 The precast modular block unit face texture shall be selected by the Departmental Representative from the available range of textures available from the precast modular block manufacturer.
- .8 The block color shall be natural concrete without pigmentation.
- .9 All precast modular block units shall be sound and free of cracks or other defects that would interfere with the proper installation of the unit, impair the strength or performance of the constructed wall. PMB units to be used in exposed wall construction shall not exhibit chips or cracks in the exposed face or faces of the unit that are not otherwise permitted. Chips smaller than 38 mm in its largest dimension and cracks not wider than 0.25 mm and not longer than 25% of the nominal height of the PMB unit shall be permitted. PMB units with bug holes in the exposed architectural face smaller than 19 mm in its largest dimension shall be permitted. Bug holes, water marks, and color variation on non-architectural faces are acceptable. PMB units that exhibit cracks that are continuous through any solid element of the PMB unit shall not be incorporated in the work regardless of the width or length of the crack.
- .10 Value Engineering Alternates. The Departmental Representative may evaluate and accept systems that meet the requirements of this specification after the bid date that provide a minimum cost savings of 20%.

2.2

GEOGRID REINFORCEMENT

- .1 Geogrid reinforcement shall be a woven or knitted PVC coated geogrid manufactured from high-tenacity PET polyester fiber with an average molecular weight greater than 25,000 ($M_n > 25,000$) and a carboxyl end group less than 30 ($CEG < 30$). The geogrid shall be furnished in prefabricated roll widths of certified tensile strength by the manufacturer. No cutting of geogrid reinforcement to widths less than manufacturer's roll width and as required by the shop drawings will be allowed under any circumstances.

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- .2 The ultimate tensile strength (T_{ult}) of the geogrid reinforcement shall be measured in accordance with ASTM D6637 and meet the requirements required by the retaining wall design and to the satisfaction of the project Geotechnical Engineer.
 - .3 Geogrid - Soil Friction Properties
 - .1 Friction factor, F^* , shall be equal to or greater than $2/3 \tan \phi$, where ϕ is the effective angle of internal friction of the reinforced fill soil.
 - .2 Linear Scale Correction Factor, α , shall be equal to or greater than 0.8.
 - .4 Long-Term Tensile Strength (T_{al}) of the geogrid reinforcement shall be calculated in accordance with Section 3.5.2 of FHWA-NHI-10-024 and as provided in this specification.
 - .5 The creep reduction factor (RF_{CR}) shall be determined in accordance with Appendix D of FHWA-NHI-10-025 for a minimum 75 year design life.
 - .6 Minimum installation damage reduction factor (RF_{ID}) shall be 1.25. The value of RF_{ID} shall be based upon documented full-scale tests in a soil that is comparable to the material proposed for use as reinforced backfill in accordance with ASTM D5818.
 - .7 Minimum durability reduction factor (RF_D) shall be 1.3 for a soil pH range of 3 to 9. Note: PET coated geogrid not recommended for use outside of this pH range.
 - .8 Connection between the PMB retaining wall unit and the geogrid reinforcement shall be determined from short-term testing per the requirements of FHWA NHI-10-025, Appendix B.4 for a minimum 75-year design life.
 - .9 The minimum value of T_{al} for geogrid used in design of a reinforced precast modular block retaining wall shall be 29 kN/m or greater.
 - .10 The minimum length of geogrid reinforcement shall be the greater of the following:
 - .1 0.7 times the wall design height, H .
 - .2 1.83 m.
 - .3 The length required by design to meet internal stability, compound stability, external stability requirements, soil bearing pressure requirements and constructability requirements.
 - .11 Constructability Requirements. Geogrid design embedment length shall be measured from the back of the precast modular block facing unit and shall be consistent for the entire height of a given retaining wall section.
 - .12 Geogrid shall be firmly gripped against pullout by top and bottom precast modular block unit when installed.

2.3 GEOTEXTILE

- .1 Nonwoven geotextile fabric shall be placed as indicated on the retaining wall construction shop drawings. The nonwoven geotextile fabric shall meet the requirements Class 3 construction survivability in accordance with AASHTO M 288.

2.4 DRAINAGE AGGREGATE AND WALL INFILL

- .1 Drainage aggregate (and wall infill for retaining walls designed as modular gravity structures) shall be a durable crushed stone conforming to NSTIR Type 1 or Type 2 gravel as approved by the project Geotechnical Engineer and meeting the following gradation:

<u>Sieve Designation</u>	<u>% Passing</u>	
	<u>Type 1</u>	<u>Type 2</u>
80 mm	-	100
56 mm	-	70-100
28 mm	-	50-80
20 mm	100	-
14 mm	50-85	35-65
5 mm	20-50	20-50
1.25 mm	-	-
0.160 mm	5-12	3-10
0.080 mm	3-8	0-7

2.5 REINFORCED FILL

- .1 Material used as reinforced backfill material in the reinforced zone (if applicable) shall be an approved granular Type 1 or Type 2 fill material and shall exhibit a minimum effective internal angle of friction, $\phi = 34$ degrees at a maximum 2% shear strain
- .2 The reinforced backfill material shall be free of sod, peat, roots or other organic or deleterious matter including, but not limited to, ice, snow or frozen soils. Materials passing 0.5mm sieve shall have a liquid limit less than 25 and plasticity index less than 6 per ASTM D4318. Organic content in the backfill material shall be less than 1% per and the pH of the backfill material shall be between 5 and 8.
- .3 Reinforced backfill shall not be comprised of crushed or recycled concrete, recycled asphalt, bottom ash, shale or any other material that may degrade, creep or experience a loss in shear strength or a change in pH over time.

2.6 LEVELING PAD

- .1 The precast modular block units shall be placed on a leveling pad constructed from crushed stone or concrete (min $f'c = 20\text{MPa}$ at 28 days). The leveling pad shall be constructed to the dimensions and limits shown on the retaining wall design drawings prepared by the Retaining Wall Design Engineer.

- .2 Crushed stone used for construction of a granular leveling pad shall meet the requirements of the drainage aggregate and wall infill in clause 2.5 or a preapproved alternate material.

2.7 DRAINAGE

- .1 Drainage Pipe
 - .1 Drainage collection pipe shall be a 100 mm diameter, perforated, HDPE with a minimum pipe stiffness of 150 kPa per ASTM D2412.
 - .2 The drainage pipe shall be manufactured in accordance with ASTM D1248 for HDPE pipe and fittings.

Part 3 Execution

3.1 GENERAL

- .1 All work shall be performed in accordance with OSHA safety standards, state and local building codes and manufacturer's requirements.
- .2 The General Contractor is responsible for the location and protection of all existing underground utilities. Any new utilities proposed for installation in the vicinity of the retaining wall, shall be installed concurrent with retaining wall construction. The General Contractor shall coordinate the work of subcontractors affected by this requirement.
- .3 New utilities installed below the retaining wall shall be backfilled and compacted to a minimum of 98% maximum dry density per ASTM D698 standard proctor.
- .4 The General Contractor is responsible to ensure that safe excavations and embankments are maintained throughout the course of the project. Slope or shore excavation as necessary for safety and for conformance with applicable OSHA requirements.
- .5 All work shall be inspected by the Inspection Engineer as directed by the Departmental Representative.

3.2 EXAMINATION

- .1 Prior to construction, the General Contractor, Grading Contractor, Retaining Wall Installation Contractor and Inspection Engineer shall examine the areas in which the retaining wall will be constructed to evaluate compliance with the requirements for installation tolerances, worker safety and any site conditions affecting performance of the completed structure. Installation shall proceed only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

- .1 Fill Soil.

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- .1 The Inspection Engineer shall verify that reinforced backfill placed in the reinforced soil zone satisfies the criteria of this section.
 - .2 The Inspection Engineer shall verify that any fill soil installed in the foundation and retained soil zones of the retaining wall satisfies the specification of the Retaining Wall Design Engineer as shown on the construction drawings.
- .2 Excavation.
- .1 The Grading Contractor shall excavate to the lines and grades required for construction of the precast modular block retaining wall as shown on the construction drawings. The Grading Contractor shall minimize over-excavation. Excavation support, if required, shall be the responsibility of the Grading Contractor.
 - .2 Over-excavated soil shall be replaced with compacted fill in conformance with the specifications of the Retaining Wall Design Engineer and Section 31 23 33.01 - Excavating, Trenching and Backfilling of these project specifications.
- .3 Foundation Preparation.
- .1 Prior to construction of the precast modular block retaining wall, the leveling pad area and undercut zone (if applicable) shall be cleared and grubbed. All topsoil, brush, frozen soil and organic material shall be removed including existing crib timbers not designated to remain. Additional foundation soils found to be unsatisfactory beyond the specified undercut limits shall be undercut and replaced with approved fill as directed by the project Geotechnical Engineer. The Inspection Engineer shall ensure that the undercut limits are consistent with the requirements of the project Geotechnical Engineer and that all soil fill material is properly compacted according to project specifications. The Inspection Engineer shall document the volume of undercut and replacement.
 - .2 Following excavation for the leveling pad and undercut zone (if applicable), the Inspection Engineer shall evaluate the in-situ soil in the foundation and retained soil zones.
 - .1 The Inspection Engineer shall verify that the shear strength of the in-situ soil assumed by the Retaining Wall Design Engineer is appropriate. The Inspection Engineer shall immediately stop work and notify the Departmental Representative if the in-situ shear strength is found to be inconsistent with the retaining wall design assumptions.
 - .2 The Inspection Engineer shall verify that the foundation soil exhibits sufficient ultimate bearing capacity to satisfy the requirements indicated on the retaining wall construction shop drawings.
- .4 Leveling Pad.
- .1 The leveling pad shall be constructed to provide a level, hard surface on which to place the first course of precast modular block units. The leveling pad shall be placed in the dimensions

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- shown on the retaining wall construction drawings and extend to the limits indicated.
- .2 Crushed Stone Leveling Pad. Crushed stone shall be placed in uniform maximum lifts of 150 mm. The crushed stone shall be compacted by a minimum of 3 passes of a vibratory compactor capable of exerting 8.9 kN of centrifugal force and to the satisfaction of the Inspection Engineer.
 - .3 Concrete Leveling Pad. The concrete shall be placed in the same dimensions as those required for the crushed stone leveling pad. If cast-in-place construction is used, the Retaining Wall Installation Contractor shall erect proper forms as required to ensure the accurate placement of the concrete leveling pad according to the retaining wall construction drawings.
- .5 Precast Modular Block Retaining Wall Installation
- .1 The precast modular block structure shall be constructed in accordance with the construction drawings, these specifications and the recommendations of the retaining wall system component manufacturers. Where conflicts exist between the manufacturer's recommendations and these specifications, these specifications shall prevail.
 - .2 Drainage components. Pipe, geotextile and drainage aggregate shall be installed as shown on the construction shop drawings.
 - .3 Precast Modular Block Installation
 - .1 The first course of block units shall be placed with the front face edges tightly abutted together on the prepared leveling pad at the locations and elevations shown on the construction drawings. The Retaining Wall Installation Contractor shall take special care to ensure that the bottom course of block units are in full contact with the leveling pad, are set level and true and are properly aligned according to the locations shown on the construction drawings.
 - .1 Units shall be within 3mm of level from end to end and from front to back. Adjacent units should be in contact. If possible, begin placing units at the lowest section of the wall.
 - .2 Backfill shall be placed in front of the bottom course of blocks prior to placement of subsequent block courses. Nonwoven geotextile fabric shall be placed in the joints between adjacent blocks. Drainage aggregate shall be placed in the joints between adjacent blocks to a minimum distance of 300 mm behind the block unit to ensure that no fines can pass through the joints in the wall.
 - .3 Drainage aggregate shall be placed in 200mm maximum lifts and compacted by a minimum of three (3) passes of a vibratory plate compactor capable exerting a minimum of 8.9 kN of centrifugal force.
 - .4 Unit core fill shall be placed in the precast modular block unit. Fill all voids between and within the blocks with granular unit fill. The core fill shall completely fill the voids to the level of the top of the block unit. The top of

the block unit shall be broom-cleaned prior to placement of subsequent block courses. No additional courses of precast modular blocks may be stacked before the unit core fill is installed in the blocks on the course below.

- .5 Nonwoven geotextile fabric shall be placed between the drainage aggregate and the reinforced fill (reinforced wall design) as required on the retaining wall construction drawings.
- .6 Geogrid, drainage aggregate, unit core fill, geotextile and properly compacted backfill shall be complete and in-place for each course of block units before the next course of blocks is stacked.
- .7 The elevation of retained soil fill shall not be less than $\frac{1}{2}$ a block course below the elevation of the reinforced backfill throughout the construction of the retaining wall.
- .8 If included as part of the precast modular block wall design, cap units shall be secured with an adhesive in accordance with the precast modular block manufacturer's recommendation.

.6 Geogrid Reinforcement Installation

- .1 Geogrid reinforcement shall be installed at the locations and elevations shown on the construction drawings on level fill compacted to the requirements of this specification.
- .2 Continuous strips of geogrid reinforcement shall be placed horizontally on compacted backfill. Orient the geogrid with the strong axis (machine direction) placed perpendicular to the wall face. Place geogrid to the embedment length shown on the construction plans. The strips shall be staked or anchored as necessary to maintain a taut condition.
- .3 Reinforcement length (L) of the geogrid reinforcement is measured from the back of the precast modular block unit. The cut length (L_c) is two times the reinforcement length plus additional length through the block facing unit or as required by the Retaining Wall Engineer's calculation.
- .4 The geogrid strip shall be continuous throughout its entire length and may not be spliced. The geogrid shall be furnished in nominal, prefabricated roll widths as required by the shop drawings. No field modification of the geogrid roll width shall be permitted.
- .5 Neither rubber tire nor track vehicles may operate directly on the geogrid. Construction vehicle traffic in the reinforced zone shall be limited to speeds of less than 8 km/h) once a minimum of 200 mm of compacted fill has been placed over the geogrid reinforcement. Sudden braking and turning of construction vehicles in the reinforced zone shall be avoided.

.7 Construction Tolerance.

- .1 Allowable construction tolerance of the retaining wall shall be as follows:

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- .1 Deviation from the design batter and horizontal alignment, when measured along a 3 m straight wall section, shall not exceed 19 mm.
 - .2 Deviation from the overall design batter shall not exceed 13 mm per 3 m of wall height.
 - .3 The maximum allowable offset (horizontal bulge) of the face in any precast modular block joint shall be 13 mm.
 - .4 The base of the precast modular block wall excavation shall be within 50 mm of the staked elevations, unless otherwise approved by the Inspection Engineer.
 - .5 Differential vertical settlement of the face shall not exceed 50mm along any 10 m of wall length.
 - .6 The maximum allowable vertical displacement of the face in any precast modular block joint shall be 13 mm.
 - .7 The wall face shall be placed within 50 mm of the horizontal location staked.
- .8 Wall Infill and Reinforced Backfill Placement
- .1 Backfill material placed immediately behind the drainage aggregate shall be compacted as follows:
 - .1 98% of maximum dry density at $\pm 2\%$ optimum moisture content per ASTM D698 standard proctor.
 - .2 Compactive effort within 0.9 m of the back of the precast modular blocks should be accomplished with walk-behind compactors. Compaction in this zone shall be within 95% of maximum dry density as measured in accordance with ASTM D698 standard proctor. Heavy equipment should not be operated within 0.9 m of the back of the precast modular blocks.
 - .3 Backfill material shall be installed in lifts that do not exceed a compacted thickness of 200 mm.
 - .4 At the end of each work day, the Retaining Wall Installation Contractor shall grade the surface of the last lift of the granular wall infill to a $3\% \pm 1\%$ slope away from the precast modular block wall face and compact it.
 - .5 The General Contractor shall direct the Grading Contractor to protect the precast modular block wall structure against surface water runoff at all times through the use of berms, diversion ditches, silt fence, temporary drains and/or any other necessary measures to prevent soil staining of the wall face, scour of the retaining wall foundation or erosion of the reinforced backfill or wall infill.
- .9 Obstructions in the Infill and Reinforced Fill Zone
- .1 The Retaining Wall Installation Contractor shall make all required allowances for obstructions behind and through the wall face in accordance with the approved construction shop drawings.
 - .2 Should unplanned obstructions become apparent for which the approved construction shop drawings do not account, the affected portion of the wall shall not be constructed until the Retaining Wall Design Engineer can appropriately address the required procedures for construction of the wall section in question.

3.4 COMPLETION

- .1 For walls supporting unpaved areas, a minimum of 300 mm of compacted, low-permeability (10^{-4} cm/s or less) fill shall be placed over the granular wall infill zone of the precast modular block retaining wall structure. The adjacent retained soil shall be graded to prevent ponding of water behind the completed retaining wall.
- .2 The General Contractor shall confirm that the as-built precast modular block wall geometries conform to the requirements of this section. The General Contractor shall notify the Departmental Representative of any deviations and make good the work to the satisfaction of the Departmental Representative.

3.5 CLEANING

- .1 Use cleaning methods as reviewed by Departmental Representative before cleaning soiled precast concrete surfaces.

END OF SECTION