Part 1 General

1.1 Related Requirements

.1 Section 31 37 00 – Rip Rap

.2 Section 32 15 40 – Crushed Stone Surfacing.

1.2 References

.1 ASTM International

.1 ASTM D698-07e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft³) (600kN-m/m³).

.2 CSA International

.1 CSA A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.2 CSA A3000-08, Cementitious Materials Compendium.

1.3 Action And Informational Submittals

.1 Submit in accordance with Section 01 33 01 – Shop Drawings, Product Data, and Samples.

.2 Samples: submit to designated testing agency, 23 kg sample of backfill for fill material proposed for use, no later than 1 week before backfilling or filling work.

.3 Site Quality Control Submittals: submit in accordance with Section 01 45 00 - Quality Control.

.1 Submit condition survey of existing conditions as described in EXISTING CONDITIONS article.

.2 Submit testing and inspection reports as described in PART 3 - FIELD QUALITY CONTROL.

.4 Sustainable Design Submittals:

.1 Erosion and Sedimentation Control: submit erosion and sedimentation control plan in accordance with authorities having jurisdiction.

.2 Construction Waste Management:

.1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

Part 2 Products

2.1 Materials

.1 The supply of fill material shall be in accordance with the following requirements :

.1 Type I Fill:

.1 Material to consist of a crushed 75mm minus well graded gravel with less than 5% fines (material passing the 0.075mm sieve).

.2 Gradation to meet BCMoT base course 75mm WGB as shown on Table 202-C in the BCMoT 2012 Standard Specifications.

.2 Type 2 Fill Material:

.1 Material to consist of 25mm minus gravel with less than 5% fines.

.2 Gradation to meet BCMoT base course 25mm WGB specification.

.3 Existing excavated material may be re-used after stockpiling if acceptable to the Departmental Representative.

Part 3 Execution

3.1 Examination

.1 Evaluation and Assessment:

.1 Before commencing work verify locations of buried services on and adjacent to site.

3.2 Preparation

.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 sediment and erosion control plan, specific to site, or 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.

.2 Protection of in-place conditions:

.1 Protect excavations from freezing.

.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's 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.

.3 Removal:

.1 Remove trees, stumps, logs, brush, shrubs, bushes, vines, undergrowth, rotten wood, dead plant material, exposed boulders and debris within areas designated on drawings.

3.3 Excavation

.1 Shore and brace excavations, protect slopes and banks and perform work in accordance with Provincial regulations.

.2 Strip topsoil over areas to be covered by new construction, over areas where grade changes are required, and so that excavated material may be stockpiled without covering topsoil.

.1 Stockpile topsoil on site for later use.

.3 Excavate as required to carry out work.

.1 Do not disturb soil or rock below bearing surfaces.

.2 Notify Departmental Representative when excavations are complete.

.3 If bearings are unsatisfactory, additional excavation will be authorized in writing and paid for as additional work.

.4 Excavation taken below depths shown without Departmental Representative's written authorization to be filled with concrete of same strength as for footings at Contractor's expense.

3.4 Field Quality Control

.1 Testing of materials and compaction of backfill and fill will be carried out by testing laboratory designated by Departmental Representative.

.2 Not later than 1 week minimum before backfilling or filling, submit to designated testing agency, samples of backfill as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.3 Do not begin backfilling or filling operations until material has been approved for use by Departmental Representative.

.4 Not later than 48 hours before backfilling or filling with approved material, notify Departmental Representative to allow compaction tests to be carried out by designated testing agency.

3.5 Backfilling

.1 Remove snow, ice, construction debris, organic soil and standing water from spaces to be filled.

.2 Lateral support: maintain even levels of backfill around structures as work progresses, to equalize earth pressures.

.3 Compaction of subgrade: compact existing subgrade under walks, paving, and slabs on grade, to same compaction as fill.

.1 Fill excavated areas with selected subgrade material or gravel and sand, compacted as specified for fill.

.4 Placing:

.1 Place backfill, fill and base course material in 150 mm lifts: add water as required to achieve specified density.

.5 Compaction: compact each layer of material to following densities for material to ASTM D698:

.1 To underside of base courses: 95%.

.2 Base courses: 100%.

.6 Against foundations (except as applicable to trenches and under slabs and paving): excavated material or imported material with no stones larger than 200 mm diameter within 600 mm of structures.

3.6 Grading

.1 Grade so that water will drain away from walls to disposal areas approved by Departmental Representative.

.1 Grade to be gradual between finished spot elevations shown on drawings.

3.7 Cleaning

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Dispose of cleared and grubbed material off site daily.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 Related Requirements

.1 Section 31 00 00.01 - Earthwork Short Form.

1.2 Waste Management And Disposal

.1 Separate and recycle waste materials in accordance with Section 01 74 19 - Waste Management And Disposal.

.2 Divert left over aggregate materials from landfill to local facility for reuse as approved by Departmental Representative.

.3 Divert left over hardened cement materials from landfill to local facility for reuse as approved by Departmental Representative.

.4 Divert left over geotextiles to local plastic recycling facility as approved by Departmental Representative.

Part 2 Products

2.1 Stone

.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 15% of gradation of stones with individual rock mass less than 5 kg.

.2 Not less than 50% of gradation of stones with individual rock mass less than 50 kg.

.3 More than 15% of gradation of stones with individual rock mass greater than 150 kg.

For visual comprehension, the approximate average dimension of Class 50 kg rock is 330mm.

2.2 Geotextile Filter

.1 Geotextile: medium weight non-woven.

.1 Width: 3.8 m minimum.

.2 Length: 110 m minimum.

.3 Composed of: minimum 85% by mass of polypropylene with inhibitors added to base plastic to resist deterioration by ultra-violet and heat exposure.

.2 Physical properties:

.1 Grab tensile strength and elongation: to CAN/CGSB-148.1, No.7.3.

.1 Breaking force: minimum 500 N, wet condition.

.2 Elongation at future: 50% maximum.

.2 CBR Puncture: minimum 1380 N, wet condition.

.3 Hydraulic properties:

.1 Apparent opening size (AOS): to ASTM D4751, 0.212 micrometres.

.2 Filtration opening size (FOS): to CAN/CGSB-148.1 No.10.

.3 Permitivity: to ASTM D4491, 1.7 pers.

.4 Securing pins and washers: to CSA G40.21, Grade 300W, hot-dipped galvanized with minimum zinc coating of 600 g/m²to ASTM A123/A123M.

.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 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 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.

END OF SECTION

Part 1 General

1.1 Related Sections

.1 Section 03 30 00.01 – Cast-in-Place Concrete.

Part 2 Products

2.1 Materials

.1 Steel Casing: 219mm outside diameter x 8.18mm wall to ASTM A53. Yield Strength: 240MPa (weldable grade). Tensile Strength: 410MPa. Splice by complete joint penetration groove welds. Weld to CSA W59 and CSA W59S1 (welding electrodes to CSA W48 series). Welding certification of companies: to CSA W47.1 and CSA W47.1S1.

.2 Anchors shall be double corrosion protection Dywidag threadbars conforming to CSA Standard G30.18M, Grade fy=517/fu=690 MPa for 35mm diameter bars with surface deformations for anchorages and coupling. The anchors shall be complete with compatible hardware. Diameters of threadbars to be as specified on drawings.

.3 The anchor shall have appropriate corrosion inhibitor applied over its full length. The threadbar shall be installed and grouted up to the top of the minimum required bond length. The anchor load shall be transferred to the soil/rock through the bond length by means of soil or rock/cement grout bond.

.4 Nuts and couplers of the anchors shall be made from steel material conforming to ASTM C1035 or C1045 and shall develop at least 125% of the guaranteed ultimate strength of the threadbar.

.5 Anchorage bearing plates shall conform to CSA G40.21, Grade 350 W. Plate dimensions given on the drawings are minimum and it is the anchor manufacturers' sole responsibility to provide a plate size that does not overstress the concrete and with a tapered hole for proper seating of the anchor nut.

.6 Bottom and top end caps shall be designed by the manufacturer of the anchor to facilitate the grouting process. The foundations shall be formed after the threadbar anchors have been installed and tested. On completing prestressing the anchor, cement grout should be pumped through a nipple in the anchorage bearing plate to protect the length of the threadbar anchor within the depth of the new foundation. Also, a cap filled with grease should be installed to protect the nut at the head of the anchor from corrosion.

.7 Outside spacers shall be provided at a maximum spacing of 2 metres on centre to maintain the concentric position of the pre-assembled double corrosion protected anchor in the drilled hole in the ground. Spacers shall be a non-corroding type.

.8 Grout shall be Portland Cement Type 10 or 30 with a water-cement ratio

of not greater than 0.40 having a minimum compressive strength of 20 MPA after 24 hours and 35 MPA after 7 days. Grout shall be pre-mixed, non-shrink type and be in accordance with the requirements of CSA/CAN 3-A5, CSA A23.1 and A23.2. Grout strength at the time of stressing shall not be less than 35 MPA.

.9 Soil anchors shall be designed for the loads indicated on the drawings by a Professional Geotechnical Engineer registered in the Province of British Columbia retained by the Contractor.

.10 Submit anchor shop drawings and grout mix design for Departmental Representative's approval prior to installation. All shop drawings and mix designs are to bear the seal and signature of a Professional Geotechnical Engineer registered in the Province of British Columbia.

Part 3 Installation

3.1 General

.1 All anchor installation work shall be carried out in accordance with the approval of the Contractor's Geotechnical Engineer.

.2 The Contractor shall supply all materials, labour and equipment to install, test and tension the anchors in accordance with the drawings and these special provisions.

.3 Installation procedures shall conform to all applicable sections of the Post-Tensioning Institute, "Recommendations for Prestressed Rock and Soil Anchors", 1996 edition, unless noted otherwise.

.4 The anchor installation Contractor shall demonstrate his experience and expertise in installing anchors in similar conditions as encountered at this site.

.5 Anchors shall be handled and protected prior to installation in such a manner as to avoid corrosion and physical damage thereto. Damaged anchors shall be replaced at the Contractor's expense.

.6 The drill holes shall not be less than 200 mm diameter. Anchor holes shall be drilled within a tolerance of 3 degrees from the design orientation angles. Holes shall enter the ground at a position within 25 mm of the design plan and elevation locations.

.7 Drilling equipment may be percussion, rotary, or any type able to supply a hole of appropriate diameter and free of bends or protrusions so as to adequately accommodate the anchor without undue softening or loosening of the surrounding ground.

.8 The Contractor shall take steps to use drilling methods and compressors that limit noise levels to 75 dB or less at distances of 6 m or greater.

.9 Casing is required for drilling through all materials except intact rock.

.10 Holes shall be drilled to a minimum of 500 mm beyond the full minimum design length so that debris that may collect in the bottom of

the boreholes does not foul the bonded anchor length.

.11 Primary grout for bond length shall be introduced at the bottom of the drill hole using a full length tremie grout tube.

.12 Grouting pressures shall be selected to prevent grout migration into the watercourse.

.13 Grouting shall be closely monitored and appropriate action taken to prevent and contain any migration into the watercourse.

.14 If the total grout volume consumed in any hole exceeds three times the theoretical volume of the drill hole, work shall be stopped and the Contractor's Geotechnical Engineer and Departmental Representative notified immediately.

.15 Grouting equipment shall be capable of continuous mechanical mixing that will produce uniform and thoroughly mixed grout. Grouting equipment shall be capable of providing grout pressure of up to 1.5MPa.

.16 Coupling of anchor tendons shall be limited to the minimum number necessary to permit installation within the available space

.17 After acceptance of the required tests as specified hereafter and final tension adjustment of the anchor, grouting for filling the anchor head cavity shall be carried out. Grout shall be introduced at the lowest points using tremie tube. The holes and cavity shall be continuously filled until the grout emerges from the vent openings at the top of the anchors.

.18 The grouting procedures and required grouting pressure are the Contractor's sole responsibility. These procedures and the selected grouting pressure should be modified as necessary, with the approval of the Geotechnical Engineer, to ensure that the anchors are capable of developing the tensile and compressive loads as indicated on the drawings and to meet the acceptance criteria as specified hereafter.

.19 All anchors are expected to meet the testing acceptance criteria after the first stage grouting. The provisions of the post-grouting system in each anchor are for unexpected ground conditions only, for example, where the total grout volume consumed in the hole during the first stage grouting exceeds three times the theoretical volume of the drill hole.

.20 Submit anchor installation and grouting procedures including grouting pressure for Departmental Representative's review prior to installation of the anchors. The submissions shall bear the seal and signature of a Professional Geotechnical Engineer registered in the Province of British Columbia to certify the installation and grouting procedures are adequate for meeting the acceptance criteria.

3.2 Anchor Testing and Stressing

.1 Install anchors to develop the design tension and compression load and test load shown on the drawings

.2 Carry out performance, proof and creep tests in accordance with these

specifications by a Professional Geotechnical Engineer retained by the Contractor and approved by the Departmental Representative.

.3 Supply and erect equipment, and temporary structures necessary for making tests and stressing bars. Supply a qualified operator to operate jacks and maintain test loads throughout duration of tests. Anchor stressing against concrete foundations or the ground surface will not be permitted.

.4 Testing shall be reviewed by the Contractor's Geotechnical Engineer. Notify the Departmental Representative 48 hours prior to testing the anchors.

.5 Provide a centre hold jack and hydraulic pressure pump for stressing or testing of the anchors. The hydraulic jack and pressure gauge shall be calibrated specifically for this project with calibration no more than 30 days before use. A copy of the calibration record shall be submitted to the Contractor's Geotechnical Engineer for review before use. The pressure gauge shall have an accuracy of + 1%. Each jack gauge unit used on the job site shall be accompanied with a dated calibration chart.

.6 Care shall be taken that the bars are concentrically located in the annular areas and that the axes of the bars and load cell are parallel to prevent eccentricities.

.7 At each load increment, the elongation of the bar shall be measured and recorded to the nearest 0.025 mm (0.001 inches) with respect to an independent fixed reference point. The Contractor shall provide the independent fixed reference point; provide the necessary devices and instruments for measuring bar elongation.

.8 Stressing shall not be performed until after the grout has reached a minimum compressive strength of 35 MPA. Three grout test cylinders shall be provided for each production anchor by the Contractor to permit cylinder compressive testing to be carried out by an outside testing agency.

.9 Test Anchors

.1 Tension and compression tests shall be carried out on the initial production anchors to confirm the load capacity of the 35mm diameter bar. Two separate tests shall be made.

.2 Tension and compression tests can be made on the same test anchor. The tension tests should be completed and accepted before the compression test is conducted on the same bar.

.3 The anchor should be tested using the following sequence of loads for both tension and compression tests (P = test load):

0.1P (seating load)

0.25 P

0.5 P

0.25 P – unloading

0.5 P
0.75 P
0.5 P – unloading
0.25 P
0.5 P
0.75 P
1.0 P
Creep test for 30 minutes
0.75 P – unloading
0.5 P
0.25 P
0.15 P (lock-off load)
Each load increment should be held for 1 minute or until movement has stopped.

.10 Anchor Proof Testing

.1 The Contractor shall proof test every possible anchor to its tension and compression load shown on the drawings using a single load-unload cycle. Load increments (or decrements) equal to 25% of the maximum design load shall be used with 2 minute time durations for each load-unload increment. The last load increment at maximum design load shall be held for 10 minutes with readings taken at 0, 30 second, 2 minutes, 5 minutes, and 10 minutes. If the movement between the 1 minute and the 10 minute reading is 2 mm or more, the load shall be maintained for an additional 45 minutes and the movement recorded.

.2 The criteria for acceptance of the proof test is that the total elastic movement measured in performance tests should exceed 80% of the theoretical elastic elongation of the free stressing length, and be less than the theoretical elastic elongation of the free stressing length plus 50% of the bond length. Futhermore, the creep movement measured at maximum load level should not exceed 2mm during the final time increment

.11 All test data shall be recorded by the Contractor on preprinted forms supplied by the anchor manufacturer. Information to be recorded will include:

- Project Identification
- Anchor Reference Number
- Location
- Type of Anchor and Diameter

- Diameter of Drill Hole
- Date of Boring
- Date of Grouting
- Date of Stressing
- Consistency, colour, structure and type, and penetration rate of/through the various materials encountered in drilling
- Length of Free Anchor Length
- Length of Bonded Anchor Length
- Grout Quantity
- Grout Pressures
- Grout Test Results
- Grout Mix Preparation and Additives
- Maximum and Minimum Daily Site Temperate during Drilling and Grouting
- Description of Any Special Installation Procedures Used
- Notation of Any Unusual Occurrences during Installation
- Duration of Grouting
- Load Extension Graph During Stressing
- Date of Acceptance
- Details of Instrumental Used to Measure Anchor Movement.
- Testing Procedures
- Temperature and Weather Conditions During Test
- Tabulation of All Load Time Movement Reading
- Gauges, Scales and Reference Points Identified
- Details of Adjustments Made to Field Date and Explanation
- Notation of Any Unusual Occurrences During Testing
- Test Jack, Load Cell and Other Required Calibration Report.

These Recorded Data shall be submitted to the Contractor's Geotechnical Engineering and Departmental Representative for review after testing.

.12 Acceptance criteria for each anchor test shall be in accordance with the Post Tensioning institute "Recommendations for Pre-stressed Rock and Soil Anchors" 1996.

.13 At the Contractor's Geotechnical Engineer's option, anchors which fail

any or all of the acceptance criteria will be re-tested, de-rated or replaced.

.14 After anchors have been proof tested, the anchors are to be de-tensioned to permit construction of concrete footings, as shown on the drawings. Following adequate set-up of the concrete footings, the anchors are to be tensioned and locked off to the levels shown on the drawings.

.15 Anchors which meet the acceptance criteria shall be locked off at the lock off loads on the drawings.

.16 At the completion of the work of this section, the Contractor shall supply to the Departmental Representative a sealed report by a BC Professional Geotechnical engineer certifying that the installation of the anchors conforms to the requirements of the drawings and specifications.

END OF SECTION