1 GENERAL

1.1 DOCUMENTS

.1 This Specification forms part of the Contract Documents and is to be read, coordinated and implemented in conjunction with the Drawings and all other Contract Documents.

1.2 PROJECT DESCRIPTION

.1 The scope of work is to replace the existing timber half-structure with a new anchored sheet pile wall structure backfilled with lightweight fill and rebuilt with pavement to connect with the existing pavement. The work is expected to include the following general sequence of steps. Staged construction of the wall to facilitate access may be considered.

.1 Install sheet piles in accordance with the plans or similar approved sheet pile wall system.

.2 Remove the existing pavement and the timber half-structure in accordance with the plans. Remove part of the existing concrete wall to the west of the timber half-structure to install the sheet piles. However, leave in place the existing timber backwall and timber crib retaining wall to the east of the timber half-structure.

.3 Clear and dispose off-site all debris and loose man-made objects behind the sheet piles until the native slope is exposed.

.4 Install pressure-grouted ground anchors in accordance with the plans or similar approved system.

.5 Backfill the sheet pile wall with lightweight pumice aggregate and then vibro-compact it.

.6 Test and lock-off ground anchors.

.7 Install a permeable geotextile layer to separate the lightweight fill and the pavement.

.8 Construct the pavement.

.9 Establish a smooth transition to the existing roadway on each side of the project site.

.10 Place concrete barriers adjacent to the top of the sheet pile wall.

1.3 DESIGN SPECIFICATIONS

.1 2014 Canadian Highway Bridge Design Code (CHBDC S6-14) with British Columbia amendments.

.2 American Concrete Institute (ACI), Building Code Requirements for Concrete, ACI 318, 2014.

.3 American Institute of Steel Construction (AISC), Specification for Structural Steel Buildings, ANSI/AISC 360, 2016.

.4 American Welding Society (AWS), Structural Welding Code - Steel, ANSI/AWS D1.1, 2015.

.5 PTI DC35.1-14 Recommendations for Prestressed Rock and Soil Anchors.

.6 City of Vancouver Standard Detail Drawing C2.1 – Sidewalks: Commercial Sidewalk 1.8m – 2.4m.

1.4 DESIGN REFERENCES:

.1 EBA Engineering Consultants, Geotechnical design report - Retaining Wall at 3500 Bridgeway Avenue, August 2013.

.2 Federal Highway Administration (FHWA), Ground Anchors and Anchored Systems, Geotechnical Engineering Circular No. 4, FHWA-IF-99-015, June 1999.

.1 Tip embedment safety factor (FS): 1.5 (static); 1.1 (seismic)

.2 Global (slope) stability FS: 1.5 (static); 1.1 (seismic)

1.5 DESIGN PARAMETERS:

.1 Soil properties and ultimate transfer load per EBA (2013) report.

.2 Lightweight fill properties:

.1 Unit weight = 13 kN/m³

.2 Friction angle = 36°

.3 Ignored compaction surcharge per 2014 CHBDC §6.12.2.1(a) for a retaining system in which sufficient movement is permitted for earth pressure to develop a limiting active condition.

.4 Live load surcharge (0.8 m of fill = 0.8×13 = 10.4 kPa) per 2014 CHBDC §6.12.5

.5 PGA = 0.24 g per The EBA (2013) report.

.1 Horizontal seismic coefficient = 0.5 PGA

.2 Vertical seismic coefficient = 0.0

.3 For both anchored wall and global stability analyses

1.6 SURVEY DATUM

.1 Horizontal control is based on the North American Datum of 1983 (NAD83).

.2 Vertical control is based on the North American Vertical Datum of 1988 (NAVD88).

1.7 FIELD VERIFICATION

.1 The Contractor shall verify all existing conditions, elevations, dimensions and construction in the field and notify the Engineer of any discrepancies before proceeding with the work.

1.8 SUBMITTALS

.1 At least four (4) weeks before work is to begin, the Contractor shall submit to the Engineer for review and approval complete working drawings of the anchored wall system and design calculations describing the ground anchor system, and construction method statement. The Engineer shall approve or reject the contractor's working drawings within four (4) weeks of receipt of a complete submittal. No work on ground anchors shall begin until working drawings have been approved in writing by the Engineer. Such approval shall not relieve the Contractor of any responsibility under the contract documents for the successful completion of the work. The working drawing submittals shall include the following:

.1 A ground anchor schedule giving:

.1 Ground anchor number,

.2 Ground anchor design load,

.3 Type and size of tendon,

.4 Minimum total anchor length,

.5 Minimum bond length,

.6 Minimum tendon bond length, and

.7 Minimum unbonded length

.2 A drawing of the sheet pile wall, walers, ground anchor and the corrosion protection system, including details for the following:

.1 Layout drawings for sheet piling including fabricated sections that shall show complete piling dimensions, pair numbering system, connector details, installation sequence and location of installed piling per the pair numbering system, furnished pair lengths schedule, and templates and other temporary guide structures;

.2 Waler layout and details including splices, and welded stiffener and wedge plates;

.3 PVC plastic drain pipe layout and details;

.4 Spacers separating elements of the threaded bar and their location;

.5 Centralizers and their location;

.6 Unbonded length corrosion protection system;

.7 Bond length corrosion protection system;

.8 Anchorage and trumpet;

.9 Anchorage corrosion protection system;

.10 Drilled or formed hole size;

.11 Level of each stage of grouting; and

.12 Any revisions to structure details necessary to accommodate the ground anchor system intended for use.

.3 The grout mix design and procedures for placing the grout.

.4 Certificates of compliance for the following materials, if used. The certificate shall state that the material or assemblies to be provided will fully comply with the requirements of the contract documents.

.1 Sheet piles;

.2 Walers, and splice, stiffener, separator and wedge plates;

.3 Threaded bars;

.4 Portland cement;

.5 Prestressing hardware;

.6 Bearing plates; and

.7 Corrosion protection system.

.5 The contractor's construction method statement including:

.1 Complete descriptions of the installation procedure, sheet piling installation equipment and other installation appurtenances;

.2 All details of drilling and grouting, including means, methods and materials;

.3 Installation requirements and repair procedures for corrosion protection;

.4 Sequence of construction necessary to satisfy identified design requirements;

.5 Equipment to be used for testing and stressing and for measuring movement, including calibration records; and

.6 The construction quality plan, describing the testing and record keeping to be conducted, by whom and at what frequency.

.6 A list of qualified welders' names and certificates.

.2 The Contractor shall submit to the Engineer for review and approval or rejection mill test reports for the sheet pile, waler, plate and threaded bar steel. The Engineer shall approve or reject the materials within five (5) working days after receipt of the test reports. The materials shall not be incorporated in the work without the Engineer's approval.

.3 The Contractor shall submit to the Engineer for review and approval or rejection calibration data for each test jack, load cell, primary pressure gauge and reference pressure gauge to be used. The Engineer shall approve or reject the calibration data within five (5) working days after receipt of the data. Testing cannot commence until the Engineer has approved the jack, load cell, primary pressure gauge and reference pressure gauge calibrations.

.4 The Contractor shall submit to the Engineer within three (3) weeks after completion of the anchored wall work a report containing:

.1 Manufacturer's mill test reports for the threaded bars incorporated in the installation;

.2 Grouting records indicating the cement type, quantity injected and the grout pressures;

.3 Ground anchor test results and graphs;

.4 Record drawings showing sheet pile location and alignment, walers, splices and welded plates; and Record drawings showing location and orientation of each ground anchor, anchor capacity, anchorage, threaded bar, total anchor length, bond length, unbonded length, spacers, centralizers and corrosion protection system as installed.

2 PRODUCTS

2.1 STRUCTURAL STEEL:

.1 Sheet piles: ASTM A 572, Fy = 345 MPa, by Skyline Steel

Steel shapes: ASTM A 572, Fy = 345 MPa

Threaded bar: ASTM A 615 Grade 75

Plates: ASTM A 572, Fy = 345 MPa

Trumpet tube: ASTM A 53 Grade B

.2 The design life of the structure is 45 years. A corrosion allowance of 1.5 mm has been allowed for in the design of the sheet piles.

.3 All miscellaneous steel and bolts exposed to weather, except stainless steel, shall be hot-dipped galvanized after fabrication.

.4 Sheet pile sections, ground anchors and accessories per Skyline Steel

2.2 GROUND ANCHORS

.1 Ground anchors shall have class i (double) corrosion protection, per PTI DC35.1-14.

.1 Corrosion-inhibiting compound shall conform to PTI DC35.1-14 §4.6.

.2 Sheath for the unbonded length:

.1 Seamless polyethylene (PE) tube having a minimum wall thickness of 1.5 mm ± 0.025 mm. Polyethylene shall be classified by ASTM D 3350.

.2 Seamless polypropylene tube having a minimum wall thickness of 1.5 mm ± 0.025 mm. Polypropylene shall be classified by ASTM D 4101.

.3 Heat-shrinkable tube consisting of a radiation cross-linked polyolefin tube internally coated with an adhesive sealant. The minimum tube wall thickness before shrinking shall be 0.6 mm. The minimum adhesive sealant thickness shall be 0.5 mm.

.4 Corrugated polyvinyl chloride (PVC) tube having a minimum wall thickness of 0.75 mm.

.3 Encapsulation:

.1 Corrugated high-density polyethylene (HDPE) tube having a minimum wall thickness of 0.8 mm and conforming to AASHTO M 252 requirements.

.2 Deformed steel tube or pipe having a minimum wall thickness of 0.65 mm.

.3 Corrugated PVC tube having a minimum wall thickness of 0.75 mm.

.4 Fusion-bonded epoxy conforming to the requirements of ASTM D 3963, except that it shall have a film thickness of 0.4 mm.

2.3 GROUT

.1 Grout shall be pumpable and 21 MPa minimum unconfined compressive strength at time of stressing

2.4 FILL

.1 The backfill material shall be lightweight pumice aggregate with the following properties:

.1 Particle size 1/2” to 3” (12 to 76 mm)

.2 Dry density of 400 - 550 kg/m³ (loose to compacted)

.3 Saturated, surface dry density of 600 - 800 kg/m³ (loose to compacted)

.4 High strength to weight ratio

.5 R-value ~80, spec=50 min

.6 Durability index ~75, spec=35 min

.7 Near neutral pH

.8 Inert, non-corrosive

.2 The lightweight pumice aggregate shall be vibro-compacted to the following densities:

.1 Dry density of 550 kg/m³ (compacted) or

.2 Saturated, surface dry density of 800 kg/m³ (compacted).

.3 Lightweight concrete fill shall have a maximum cast weight density of 700 kg/m³ and a minimum 28-day unconfined compressive strength of 700 kPa.

.1 Air-entraining admixtures shall conform to the requirements of ASTM C 260.

.2 Foaming agent shall conform to the requirements of ASTM C 869.

2.5 DRAIN PIPE

.1 PVC plastic drain pipe:

.1 PVC material for the pipe and fittings shall meet the requirements of ASTM D 1784 for rigid poly (vinyl chloride) compounds and chlorinated poly (vinyl chloride) compounds, Class 12444-B

.2 The molded or extruded pipe shall conform to ASTM D 1785 for poly (vinyl chloride) (PVC) plastic pipe, schedule 80, PVC 1120

.3 The molded or extruded fittings shall conform to ASTM D2467 for socket-type poly (vinyl chloride) (PVC) plastic pipe fittings, Schedule 80, PVC I

.4 The solvent cement shall meet the requirements of ASTM D2564 for solvent cements for poly (vinyl chloride) (PVC) plastic pipe and fittings

3 EXECUTION

3.1 GENERAL

.1 The site inspections shall be performed by the Owner's Geotechnical and Structural representatives.

.2 Prior to commencing work, the Contractor shall locate in field any sanitary sewer pipes, manhole, watermain and other existing utilities. It is the Contractor's responsibility to protect conflicting existing utilities.

.3 Maintain services during demolition and construction sequence; coordinate and conduct demolition and construction operations such as to maintain continuous public safety, access, drainage and utility services to existing facilities requiring these services. Notify the Owner at least seven (7) days unless approved, in advance of interruption of any of these services.

.4 The Contractor is solely responsible for temporary shoring and construction loads required to produce the final structure shown on these drawings.

.5 At all times the Contractor shall be solely and completely responsible for conditions of the job site including stability of the structure in the temporary condition and the safety of persons and property.

.6 EBA (2013) report states: "it is considered likely that the timber crib retaining wall is supported by deadman anchors buried beneath the existing trail." The Contractor shall have proper equipment to remove any obstruction encountered during ground anchor installation and sheet pile installation.

3.2 SLOPE MOVEMENT MONITORING

.1 The ongoing slope movement surveying and monitoring program that is currently being carried out by EBA Engineering Consultants (EBA)/Tetra Tech shall be continued during and after the construction period with more frequent measurement as directed by EBA/Tetra Tech. The survey points on the half structure will be destroyed due to demolition. The Contractor shall coordinate with EBA/Tetra Tech to set up additional survey points in order to monitor the slope movement above and below the construction zone.

3.3 PAVEMENT:

.1 New pavement to meet City of Vancouver standards for light duty residential asphalt surfaced roads. Refer to “City of Vancouver Standard Detail Drawing C2.1 – Sidewalks: Commercial Sidewalk 1.8m – 2.4m”.

3.4 PRECAST CONCRETE ROADSIDE BARRIERS AND PEDESTRIAN SIDE WALK FENCE.

.1 Precast concrete roadside barriers to have scuppers that permit free flow of roadway drainage.

.2 Welded pedestrian sidewalk fence to be fabricated from 48mm o.d. to ASTM A53 Grade 240 MPa galvanized pipe and mounted on top of precast concrete roadside barrier.

.3 Minimum height of barrier and fence to be 1050 mm.

3.5 SHEET PILES

.1 Driving tolerances:

.1 Deviation normal to the wall line: ± 62.5 mm

.2 Cut-off elevation: ± 20 mm

.3 Tip elevation: as specified or deeper

.4 Deviation of verticality normal to line of pilings: ± 1%

.5 Deviation of verticality along line of pilings: ± 0.5%

.6 Anchor & waler elevation: ± 62.5 mm

.7 Threaded bar plan locations: ± 150 mm

.2 Finish tolerances

.1 The finish tolerances will depend on excavation, bracing, backfill and anchor tensioning methods, and those deviations will be either added or subtracted to the driving outcomes. The Engineer will evaluate the final as-built geometry on a case by case basis upon receipt of the data. For the purpose of performance monitoring during construction an additional 75 mm of deviation normal to the wall lines will be acceptable and the final deviation of verticality of the sheets normal to the line of pilings shall be less than 2.5%. Limited pushing and pulling the tops of the sheets as needed to get the final position as close to design position as is practicable will be allowed.

3.6 GROUND ANCHORS

.1 Ground anchor design, installation, testing and stressing shall be in general accordance with PTI DC35.1-14, unless noted otherwise, and the contract documents.

.2 Holes for anchors shall be drilled at the location, orientation (± 3 degrees inclination and/or lateral direction) and to the length shown in the working drawings.

.3 Prior to installation, threaded bars shall be free of dirt, rust or any other deleterious substances. Drill holes shall be clear of any soil, rock fragments or other materials which may prevent the proper placement of the threaded bar or grout.

.4 Threaded bars shall be placed per manufacturer's recommendations. Threaded bars shall be securely fastened in place to prevent movement during grouting and ensure that the threaded bar assembly is centrally located in the drill hole. Centralizers shall be provided at maximum intervals of 3 m with the deepest centralizer located 0.5 m from the end of the anchor and the upper centralizer for the bond zone located no more than 1.5 m from the top of the bond length. Spacers shall be provided at maximum intervals of 3 m and may be combined with centralizers.

.5 The grouting equipment shall produce a grout free of lumps and undispersed cement. The pump shall be equipped with a pressure gauge to monitor grout pressures. The pressure gauge shall be capable of measuring pressure of at least 1 MPa or twice the actual grout pressures used by the contractor, whichever is greater. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operation. The mixer should be capable of continuously agitating the grout.

.6 The grout shall be injected from the lowest point of the drill hole. The grout may be pumped through grout tubes, casing, hollow-stem-augers or drill rods. The quantity of the grout and the grout pressures shall be recorded. The grout pressures and grout takes shall be controlled to prevent excessive heave in cohesive soils or fracturing of rock formations.

.7 Pressure grouting shall not be used in the unbonded length zone.

.8 Ground anchors are designated in Table 1 below with their corresponding inclinations, design loads (DL) and lock-off loads.

Table 1: Ground Anchor Types

Ground anchor	Anchor inclination [°]	Design load (DL) [kN]	Lock-off load [kN]
A1	30	92	64
A2	30	109	74
A3	20	110	75
A4	30	109	74
A5	30	79	51

.9 Ground anchors shall be tested to 133% of the design load (DL). Each anchor shall be proof-tested. The first two installed anchors and at least 2% of the remaining anchors shall be performance-tested. Testing and other requirements shall be in accordance with PTI DC35.1-14 §8.3.2 for performance tests and §8.3.3 for proof tests.

.10 Acceptance criteria and procedures for ground anchor failing the criteria shall be in accordance with PTI DC35.1-14 §8.6 and §8.7, respectively.

.11 Ground anchors shall be locked-off to their specified lock-off load per procedures in PTI DC35.1-14 §8.4. Lift-off tests shall be conducted per PTI DC 35.1-14 §8.5 and §8.6.3.

END OF SECTION