

SITE LOCATION PLAN

Scale: NTS

RETAINING WALL SPECIFICATIONS

1.0 GENERAL

- 1.1 Wall Design Engineer:
The Wall Design Engineer is Horizon Engineering Inc.
Phone: 604-990-0546
Fax: 604-990-0583
- 1.2 Reference Documents
 - McElhanney Consulting Services Ltd., Illecillewaet Curve Safety Improvements - Phase 1A Drawings, dated March 2018.
 - McElhanney Consulting Services Ltd., Retaining Wall at TCH KM 28.0 drawing received March 1, 2018 August 17, 2017.
 - Golder Associates, TransCanada Highway - Illecillewaet Curve/Summit Ponding at Rogers Pass Glacier National Park British Columbia - Final Geotechnical Report dated July 27, 2016.
 - Golder Associates, Technical Memorandum dated August 10, 2017.
 - AASHTO Standard Specialization for Highway Bridges (2012).
 - Parks Canada Agency, Construction Specification titled "Section 32 32 34, Reinforced Soil Retaining Walls (Project No. 566-04)", pages 144 to 149.
- 1.3 Soil
Defined as earth that can be removed by hydraulic excavation equipment suitably equipped and in good repair. Based on the Geotechnical Report by Golder Associates, the material expected at the bases of the retaining walls comprises compact to dense silty sand to gravelly silty sand fill.

Per the Golder Associates Technical Memorandum, internal angles of friction for the subgrade and for soil behind the reinforced zone at location(s) governing global stability are 38 and 36 degrees respectively. The Contractor's Geotechnical Engineer to attend at site to confirm, especially for wall subgrade in area underlain by existing trench backfill for Culvert #27d. The aforementioned report specifies the minimum embedment depths which are reflected on Table: Retaining Wall Design. We note that these embedment depths could be less than frost penetration depth of 1.2 to 1.5m per the following documents:
 - District of 100 Mile House, Bylaw No. 695, 1996, and
 - DOW Chemical, Freezing Index Map for Canada, November 2008, and
 - BC Ministry of Agriculture and Lands, Winter Considerations (order no. 590.307-1), January 2006.This is addressed in Golder Associates' Aug 10, 2017 Technical Memorandum by subexcavation of frost susceptible material and replacing with suitable soil as shown on Typical Sections on G2. The Contractor's Geotechnical Engineer shall be onsite during construction to verify the design parameters and confirm the suitability of the existing subgrade prior to wall installation.
- 1.4 Stability
Any soil movement or deterioration to be reported immediately to the Contractor's Geotechnical Engineer and Horizon Engineering.
- 1.5 Hoarding
Ensure hoarding, adequately braced, is provided on all perimeter slopes. Hoarding should meet the requirements of the Ministry of Transportation and Infrastructure and Worksafe BC.

- 1.6 Erosion Control
Unless noted otherwise, or directed otherwise by the Contractor's Geotechnical Engineer, protect all soil slopes with 6 x 6 x 10/10 WVM on 6 mil polyethylene sheet. Mesh is to be wire tied to 10 M pins driven 2' into soil at 20' each way.
- 1.7 Utilities
Contractor to verify utility information by independently collecting relevant reference drawings and field verification as required. Work is to be carried out without disturbance to existing utilities.
- 2.0 MATERIALS
Samples and technical specifications for proposed alternative materials may be submitted to the Departmental Representative and Horizon Engineering for technical review. Substitutions are subject to review and approval by the Departmental Representative for contractual implications.
- 2.1 Filter Cloth
Non-woven needle punch Niles 4545, or approved equivalent.
- 2.2 Concrete Modules
Lock+Load precast concrete units (i.e. measuring 813mm by 406mm, complete with 686mm long counterfort) is used as a part of the proposed retaining wall. Half-width panels may be used where necessary. The units shall be installed in accordance with the manufacturer's recommendations.
- 2.3 Geogrids
The geogrid shall possess the design properties as specified in Table: Retaining Wall Design (on G2) or approved equivalent. All geogrid material should be inspected upon reaching the jobsite to ensure proper material strengths as specified in the project documents. Contractor to confirm the direction of primary strand prior to cutting. A product certification should be supplied with each shipment to verify that the delivered product conforms to the supplier's published values.
- 2.4 Engineered Fill
Backfill material shall be composed of inert, clean, tough, durable, mineral particles capable of withstanding the effects of handling, spreading, and compaction without excessive degradation or production of deleterious fines. The particles shall be uniform in quality and free from organic materials and deleterious matter. Suitable material would be well graded with less than 5% passing the US #200 sieve and 100% passing a 75mm sieve. The material used as Engineered Fill shall possess an internal friction angle of 38° when measured by direct shear test as per ASTM D3080. At least one direct shear test is required for each source of Engineered Fill material. Fill supplier to provide documentation confirming that supplied material is same as that tested per ASTM D3080. All granular backfill should be placed in 200mm [8"] thick lifts and compacted to 100% of its Standard Proctor Maximum Dry Density. To avoid excessive wall face movement, compacting equipment should be operated parallel to the wall face and compaction should start at the face and be worked away from the walls. Only light-weight hand operated equipment is permitted within 1m (increase to 2m where H>3m) of the wall facing.

Selection and testing of backfill is the responsibility of the contractor. Prior to mobilizing the site, backfill test results should be provided to Horizon Engineering for review and approval, as records of compliance with the backfill requirements. Any structure built using material that does not meet all backfill requirements will not perform as intended and will not be approved by Horizon Engineering.

The following backfill requirements, notes, and procedures apply to construction completed above freezing temperatures and structures not submerged in water.

1. The engineered fill for the MSE wall must be a free draining, granular material, free from organic matter, ice, and other deleterious material.
2. The engineered fill must be tested and comply with all of the following electrochemical limits:
 - pH: 5 - 10 (AASHTO T289-91)
 - Resistivity: <3000 ohm-cm (AASHTO T288-91)
 - Chlorides: <100 ppm (AASHTO T291-91)
 - Sulphates: <200 ppm (AASHTO T290-91)
 - Organic content: <1.0% (AASHTO T267-86)

- 2.5 Drain Rock (Clear Crushed Gravel)
Crushed rock, passing a 25mm [1"] screen and retained on 19mm [3/4"] screen.
- 2.6 Sandbags
Burlap or poly bags are to be filled with clean sand to at least half, and no more than two thirds, of their total capacity. Each placed bag should be tamped and flattened.
- 3.0 INSTALLATION PROCEDURES
Workers shall be provided with appropriate safety gear. Contractor to carry out a minimum daily site reconnaissance around excavation and perimeter and report any deterioration to the Contractor's Geotechnical Engineer immediately. All work to be done per VWorkSafeBC.
- 3.1 Excavation
Prior to excavation, the Contractor shall:
 - Consult with the relevant authorities for appropriate methods of locating utilities. Determine the locations of all structures and underground services that may be affected by the work.
 - Notify the Contractor's Geotechnical Engineer and the Utilities Companies 48 hours before commencing the excavation.
 - The contractor shall excavate to the lines and grades shown on the construction drawings. Excavation slopes may be constructed in stages (i.e. max 4m long segments) at 1.0 Horizontal to 1.0 Vertical, subject to review by the Contractor's Geotechnical Engineer. The exposed excavation slopes should be covered by 6-mil polyethylene sheeting and securely staked to the ground during periods of wet weather. This sheeting must be removed prior to placing any backfill.
- 3.2 Segmental Wall Installation
The drawings include one typical section of the proposed retaining wall complete with design requirements such as backfill type, geogrid length and facing angle, etc. Excavate any unsuitable material within the retaining wall footprint. The excavation depth to be minimum of a half height of the Lock + Load panel height and allowance for the leveling course. Subgrade material to be approved by the Contractor's Geotechnical Engineer and the Departmental Representative. Minimum 150mm thick leveling pad consists of 19mm (3/4") clear crushed gravel to be placed to provide a flat surface for facing units. Wall facing units to be placed as indicated on the section drawings. The facing units should be placed to provide a 6° batter angle, in accordance with the manufacturer's recommendations (see Table: Retaining Wall Design for minimum embedment depth). All granular fill should be placed in suitable lifts (e.g. 200mm or less) and compacted to 100% of its Standard Proctor Maximum Dry Density. Field density tests are required to measure the compaction of the granular fill. Test results should be forwarded to Horizon Engineering Inc. A 300mm

wide drainage layer of 19mm (3/4 inch) clear crushed rock, or equivalent as approved by the Contractor's Geotechnical Engineer, should be provided immediately behind the wall facing as shown on the section drawing. Only light-weight compaction equipment such as hand-operated 1000lb vibrating plate compactors should be used to compact the fill (or asphalt) within 1m (increase to 2m where H>3m) from the back of the wall facing. To avoid excessive wall face movement, compaction equipment should be operated parallel to the wall face and compaction should start at the face and work away from the walls. The correct orientation (strength direction) of the geogrid shall be verified by the contractor prior to cutting.

- 3.3 Site Drainage
The Contractor is responsible for construction and maintenance of works, site drainage, and erosion/sediment control during construction. That may include but is not limited to installation of berms and swales. Appropriately collect and divert any site water via pumping or gravity flow.
At the end of each day's operation and prior to rainfall events, the area at and adjacent to the site shall be graded to direct run-off away from excavation slopes and new fill zones.
- 3.3.1 Control of Surface Water
Adjacent perimeter surface flow to be directed away from excavation slopes and new fill zones. Interior surface flows to be directed to suitable sediment removal system prior to discharge to the approved location.
- 3.3.2 Control of Groundwater
Suitable measures shall be taken, where necessary, to control groundwater flow at the excavation face during excavation. These shall include the installation of materials such as burlap and filter cloth and pea or bird's eye gravel to permit drainage without loss of soil, and where necessary, replacement of eroded soil with suitable backfill material.
- 3.4 Foundation Subgrade
The Contractor's Geotechnical Engineer shall review and approve foundation subgrade for the retaining wall including via test pits within the clearing area but outside of the wall footprint and reinforced fill zone. Any loose, disturbed, organic or otherwise unsuitable material shall be removed from the surface of the subgrade and the subgrade shall be compacted using a ride-on roller compactor.
- 4.0 QUALITY CONTROL AND TESTING
- 4.1 Backfilling
Field density testing to be carried out by a qualified testing agency over the full fill depth during backfill placement. In addition, the Contractor's Geotechnical Engineer should review the backfilling with respect to material type and placement procedures and to ensure density testing is representative.
- 4.2 Field Reviews
The Contractor shall arrange for a technical representative from the wall system manufacturer to be on site at 25%, 50%, 75% and 100% completion, at a minimum, of wall construction to ensure correct installation procedures.

NOTES:

- All dimensions are in meters (unless noted otherwise).
- Please refer to sheet G5 for surface water management details.
- Sectional excavation & construction may be required.
- Installation of Lock+Load facing elements, geogrids and filter fabric to be completed in accordance with manufacturer's specifications.
- The Contractor's Geotechnical Engineer shall confirm that global stability parameters and frost susceptibility of subgrade is consistent with the design analyses.
- Contractor to confirm the offsets and depths of all underground utilities, including but not limited to Telus ducts (indicated by BC One Call to be generally present in the existing road alignment) prior to commencing construction. The Departmental Representative should be contacted should any utilities be in conflict with proposed design.
- Refer to contractual drawings for proposed road details.

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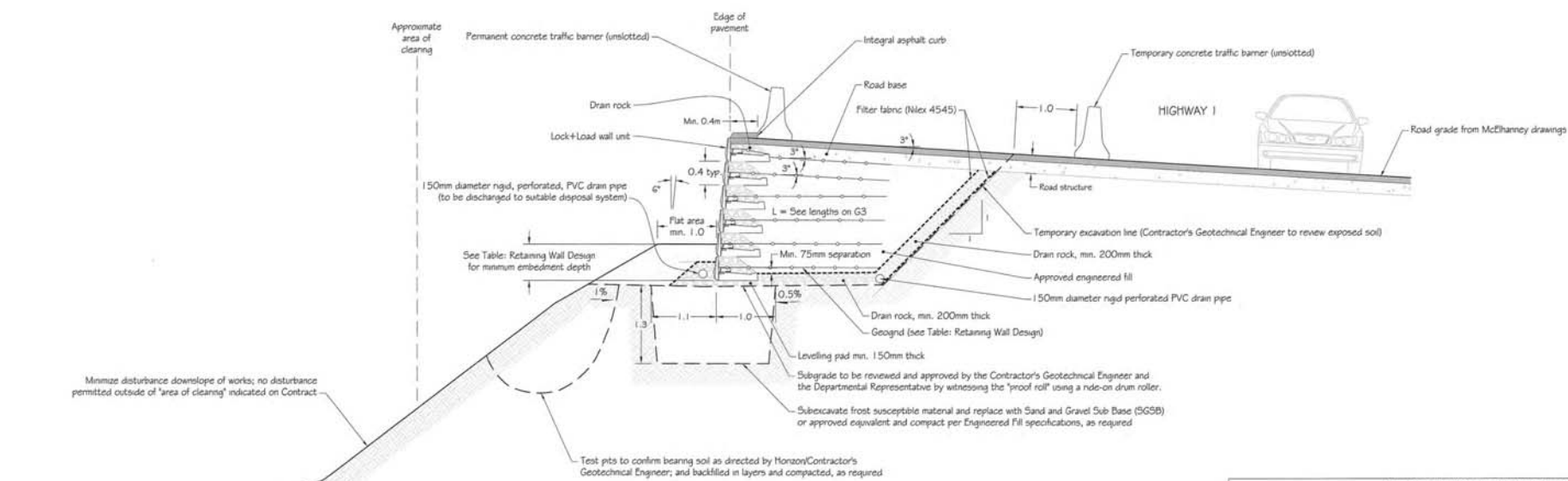
AE Concrete
19060 54th Avenue
Surrey, BC

Illecillewaet Curve Safety Improvements
PHASE 1A RETAINING WALLS
Rogers Pass, Glacier National Park, BC

SITE LOCATION PLAN & SPECIFICATIONS

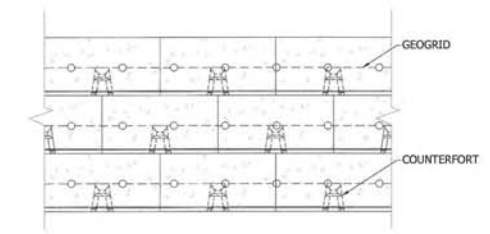
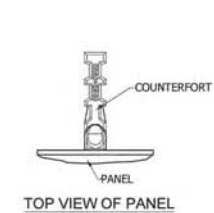
PROFESSIONAL
ENGINEER
B.C. REG. NO. 11174
E. SAVAGE
JUNIOR
ENGINEER

SCALE: NTS
DATE: MAR/2018
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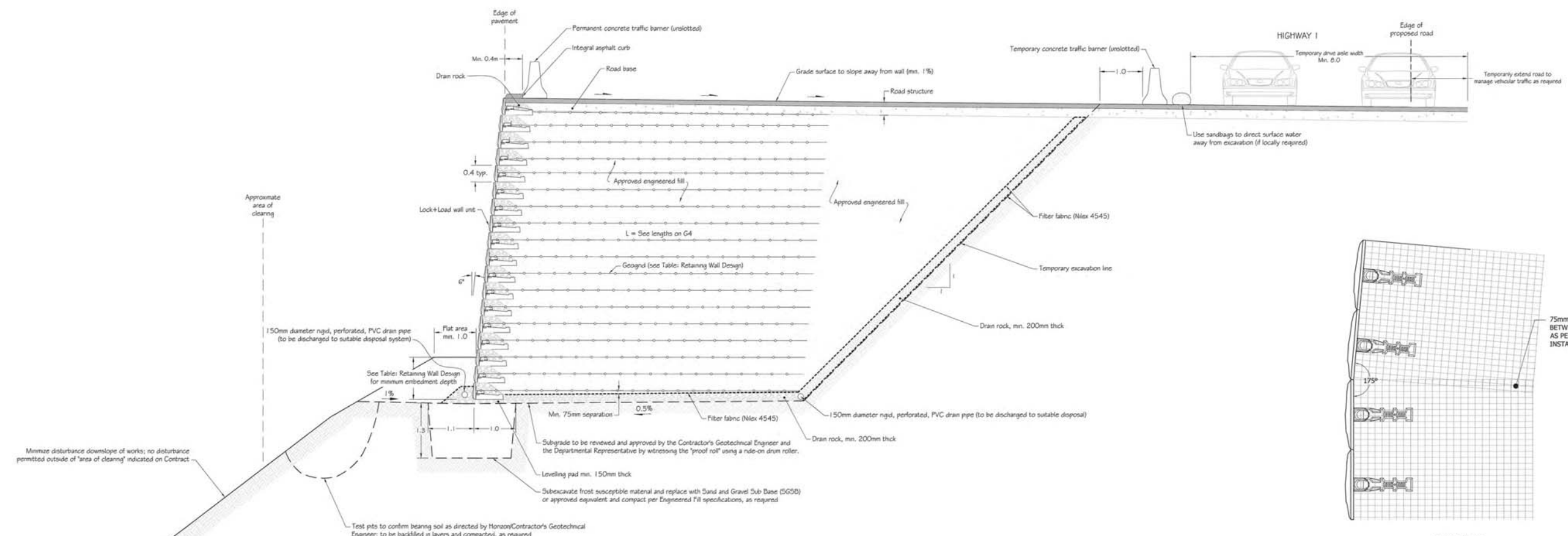


TYPICAL SECTION - KM27.1 RETAINING WALL DESIGN
Scale: NTS

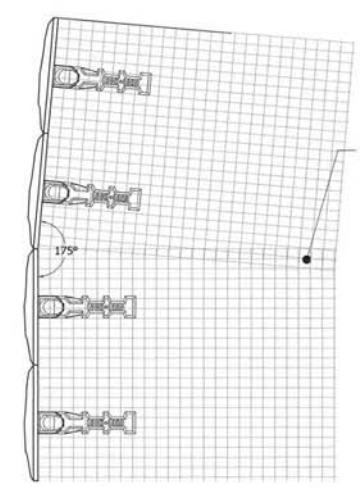
Table: Retaining Wall Design				
Wall	Max Wall Height H (m)	Min Geogrid Length L (m)	Min Embedment Depth D (m) per Golder Associates geotechnical report	Geogrid Type (or approved equivalent)
Km 27.1	2.4	See G3	0.6	Mirafi 5XT
Km 28.0	7.3	See G4	See G4	See G4



STAGGERED TYPICAL ELEVATION DETAIL
Scale: NTS



TYPICAL SECTION - KM28.0 RETAINING WALL DESIGN
Scale: NTS



PLAN VIEW
OUTSIDE CORNER GEOGRID DETAIL
Scale: NTS

- NOTES:**
- All dimensions are in meters (unless noted otherwise).
 - Please refer to sheet G5 for surface water management details.
 - Sectional excavation & construction may be required.
 - Installation of Lock+Load facing elements, geogrids and filter fabric to be completed in accordance with manufacturer's specifications.
 - The Contractor's Geotechnical Engineer shall confirm that global stability parameters and frost susceptibility of subgrade is consistent with the design analyses.
 - Contractor to confirm the offsets and depths of all underground utilities, including but not limited to Telus ducts (indicated by BC One Call to be generally present in the existing road alignment) prior to commencing construction. The Departmental Representative should be contacted should any utilities be in conflict with proposed design.
 - Refer to contractual drawings for proposed road details.

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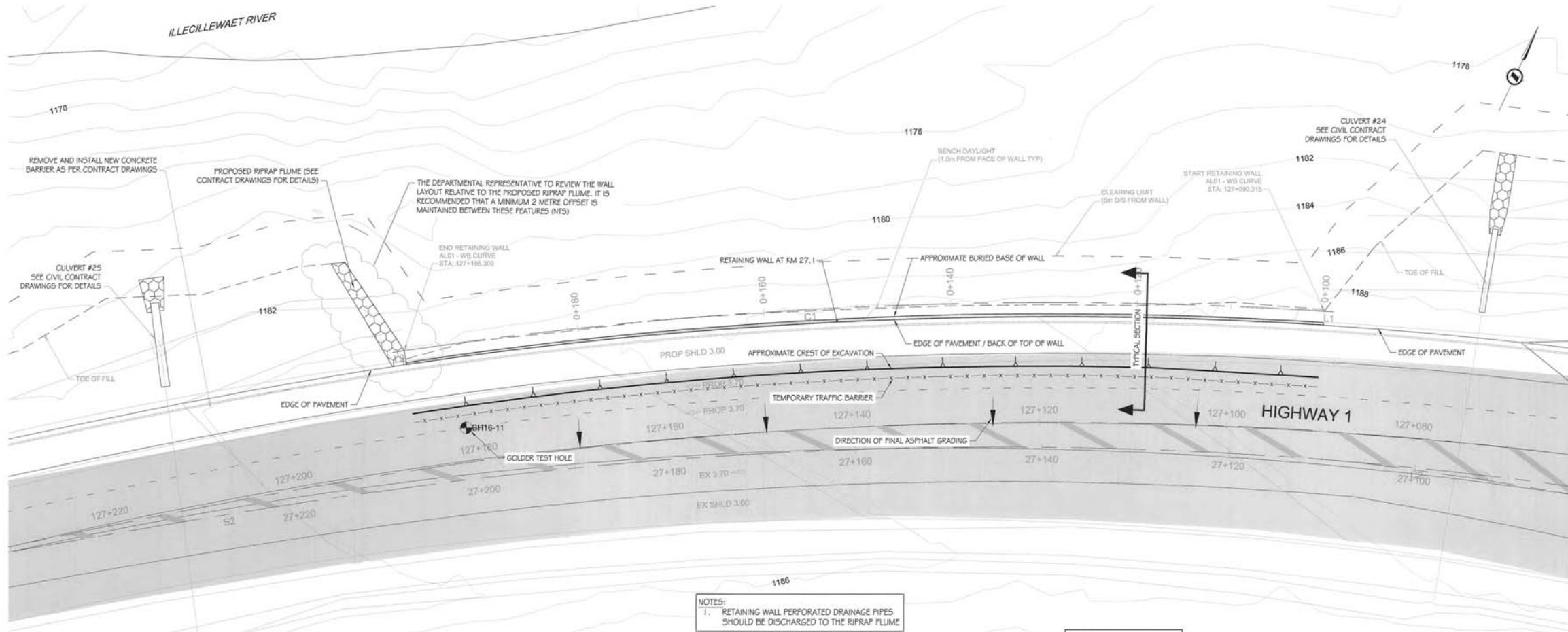
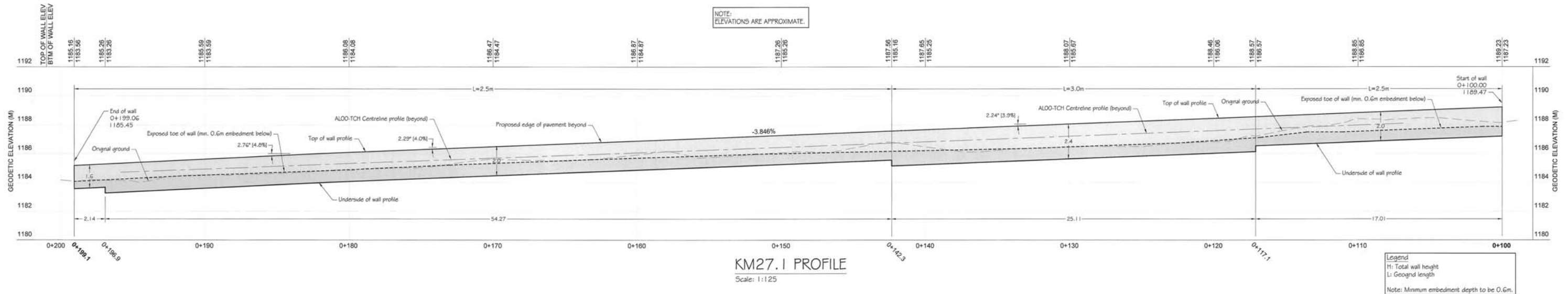
Illecillewaet Curve Safety Improvements
PHASE 1A RETAINING WALLS
Rogers Pass, Glacier National Park, BC

KM27.1 & KM28.0 RETAINING WALLS
TYPICAL SECTIONS & DETAILS

PROFESSIONAL ENGINEER
E. SAVAGE
BC REG. # 117-4140

DESIGNED BY NTS
CHECKED BY CT
DATE MAR/2018

G2
OF 5
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- NOTES:
- All dimensions are in meters (unless noted otherwise).
 - Please refer to sheet G5 for surface water management details.
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Illecillewaet Curve Safety Improvements
PHASE 1A RETAINING WALLS
Rogers Pass, Glacier National Park, BC

KM27.1 WALL
Site Plan & Elevation

PROFESSIONAL
K. SAVAGE
P. ENG'G
B.C. REG. NO. 12345

SCALE: NTS
DATE: MAR/2018
DRAWN: CT
CHECKED: KS
DESIGNED: AF
SHEET: G3
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FILE NUMBER: 117-4140

