ENVIRONMENTAL MANAGEMENT PLAN

Km 7 Leo-Middle FSR
Stuart-Nechako Business Area

Rev 1

April 2021

PREPARED FOR:

Ken Yorston, RFT

BC Timber Sales

Stuart-Nechako Business Area

Ministry of Forests, Lands,
Natural Resource Operations
and Rural Development

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PROFOR
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We make projects take SHAPE

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Revision Record

Rev	Description	Originator	Checker	Approved	Date
R0	DRAFT Environmental Management Plan – Km 7 Leo-Middle FSR	J. White			Sep 2019
R1	DRAFT Environmental Management Plan – Km 7 Leo-Middle FSR	J. White	D. Blagdon	K. Yorkston	Apr 28/21

Limitations of Report

This Environmental Management Plan (EMP) was prepared for the exclusive use of BC Timber Sales, its assignees and representatives, and is intended to outline environmental requirements, best management practices and mitigation measures for the stream crossing replacement at Km 7 on the Leo-Middle Forest Service Road (FSR).

In developing this EMP, Profor Resource Development Inc. (Profor) has relied in good faith on information provided by BC Timber Sales. Profor accepts no responsibility for any deficiency or inaccuracy contained in this report as a result of our reliance on the aforementioned information.

The guidance and findings documented in this report have been prepared for the specific application to this project. This EMP has been developed in a manner consistent with the level of care normally exercised by environmental professionals currently practicing under similar conditions in BC.

The EMP may be revised at the request of BC Timber Sales should new information be discovered in future work from other investigations.

EXECUTIVE SUMMARY

A stream crossing replacement is planned at Km 7 on the Leo-Middle FSR to replace an 800 mm culvert with a single lane, 15.240 m post and pad steel girder bridge. The new bridge will address issues with the poor condition of the existing culvert and the resulting sinkhole that has developed along the road surface.

The crossing site is situated on an unnamed tributary stream of the Middle River. The stream is small and likely only has the ability to provide rearing habitat for fish under certain seasonal water levels. There are no records of fish within the unnamed stream, but fish species found in the Middle River most likely to utilize the site include burbot, chinook salmon, Dolly Varden, lake trout, mountain whitefish, northern pikeminnow, rainbow trout, sculpin, and sockeye salmon.

It is anticipated that there is a low risk to the environment during the crossing replacement if best management practices are followed. The new structure will be installed in the same location as the old crossing structure. Efforts should be focused on completing any work requiring the stream to be isolated in as short of time as possible.

Key considerations for the crossing replacement:

- A DFO request for review will be required for this project, as well as fish salvage permits from the Province and DFO;
- Stream isolation will be required to support removal of the 800 mm culvert and road fill if water is present; and
- The instream timing window is July 15th to August 15th; however, fish are unlikely to utilize the site for spawning so works may be completely outside of this window as long as proper isolation and salvages are completed.

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1 INTRODUCTION

Profor Resource Development Inc. (Profor) was retained by BC Timber Sales of the Ministry of Forest, Lands, Natural Resource Operations and Rural Development (MFLNRORD) to prepare an Environmental Management Plan (EMP) in support of the replacement of an existing 800 mm corrugated steel pipe (CSP) on the Leo-Middle FSR at Km 7, northwest of Fort St. James, BC (Figure 1). There is a small unnamed stream that crosses this location before reaching the Middle River (Watershed Code 182-819600-63300) located approximately 300 m downstream.

The project consists of replacing the existing 800 mm CSP with a 15.240 m long post and pad steel girder bridge. The design drawings are included in Appendix A and site photos in Appendix B. The existing crossing failed and has resulted in a sink hole in the road. The crossing replacement will restore fish passage to the stream as well as road access in support of future forestry activities. This EMP specifically addresses the environmental values of the site, construction considerations and best management practices to implement during the crossing replacement.

2 APPLICABLE LEGISLATION

This section outlines the federal and provincial legislation applicable to the project as well as general best management practices and guidelines to support the project. All work must comply with the conditions of any regulatory agency approvals and permits obtained to proceed with construction activities, as well as Ministry contract requirements.

Applicable environmental protection legislation includes:

- Provincial Water Sustainability Act;
- Federal Fisheries Act;
- Provincial Heritage Conservation Act;
- Federal Migratory Birds Convention Act;
- Federal Species at Risk Act;
- Federal Transportation of Dangerous Goods Act;
- Provincial Spill Reporting Regulation; and
- Provincial Wildlife Act.

A submission to DFO for a project review will be required. As this project will improve fish passage, an authorization from DFO is not anticipated. The agencies may require additional environmental provisions beyond those listed in this EMP be incorporated into the project as a result of their working near water review process. Copies of this EMP and all approvals must be kept on-site for the duration of the project.

If there is sufficient water to sustain fish at the time of construction, a Provincial and DFO Scientific Fish Collection Permit will be required prior to isolating the stream and conducting a fish salvage because of potential presence of both resident and anadromous fish species. Copies of this EMP and all approvals must be kept on-site for the duration of the project.

Additional resources and guides relevant to stream crossing replacement projects and instream works include:

- British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture (MOE 2017);
- Fish-stream Crossing Guidebook (MFLNRO et al. 2012);
- Interim code of practice: End-of-pipe fish protection screens for small water intakes in freshwater (DFO 2020);
- Best Management Practices for Amphibian and Reptile Salvages in British Columbia (MFLNRO 2016);
- Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia (MFLNRO 2013);
- Land Development Guidelines for the Protection of Aquatic Habitat (DFO 1993);
- Manual of Control of Erosion and Shallow Slope Movement (MOTH 1997);
- Projects Near Water — Measures to Protect Fish and Fish Habitat (DFO 2019);
- Omineca Region: Reduced Risk In-stream Work Windows and Measures (MWLAP 2004); and
- Standards and Best Practices for Instream Works: A Users' Guide to Working In and Around Water (MWLAP 2004a, updated 2009).

Leo-Middle River Site Map

Legend

- Site Location
- Roads
- Streams
- Lakes
- Rivers

PROFOR RESOURCE DEVELOPMENT INC.

N

1:10,000

0 250 500
Meters

Map Created by: AP Date Created: 2019-09-05 Data Provided by: Data BC and CanVec Geospatial Data Extraction Project Coor System: NAD 1983 UTM Zone 10N

3 ENVIRONMENTAL DESCRIPTION

The stream was short, measuring just over 1.3km long (based on TRIM mapping) from its mapped origin to where it flows into the Middle River (photos are in Appendix B). The stream measured 0.7 m wide and 0.2 m deep at the time of the site visit (August 26, 2019). The fish habitat was rated as marginal with a minor amount of rearing habitat available for juveniles or fry. There was no spawning or overwintering habitat identified between the crossing and the confluence with the Middle River. Upstream of the culvert, water was pooled over leaf litter, with a small 0.7 m wide channel located above the inlet. The site was well vegetated with a mixed wood forest immediately upstream and downstream of the road followed by willow-dominated vegetation as the stream got closer to the Middle River.

3.1 FISHERIES VALUES

There is no historical fisheries information for this stream. As noted above, it is small and is likely to provide only seasonal rearing or refuge habitat for fish residing in the Middle River. Fish species documented in the Middle River include burbot (*Lota lota*), chinook salmon (*Oncorhynchus tshawytscha*), Dolly Varden (*Salvelinus malma*), lake trout (*S. namaycush*), mountain whitefish (*Prosopium williamsoni*), northern pikeminnow (*Ptychocheilus oregonensis*), rainbow trout (*O. mykiss*), sculpin (*Cottus spp.*), and sockeye salmon (*O. nerka*) (MoE 2021). The Middle River is a low gradient, approximately 35 Km long stretch of water that connects Trembleur Lake to Takla Lake. The Middle River provides important habitat for the Stuart/Takla population of Fraser River sockeye salmon. Two runs of sockeye enter the Fraser in late June/early July and late July/late August. The later run is known to mainly utilize gravel bars in the Middle River and Tachie River for spawning. The system also provides important rearing habitat for millions of sockeye fry. A small population of chinook salmon has also been observed in the Middle River (EDI 1995).

3.2 WILDLIFE VALUES

Based on a search of the BC Species and Ecosystem Explorer (BC Conservation Data Centre 2021) for the Stuart-Nechako Forest District and the habitat values noted on site, there is the potential for blue or red listed species such as Western toad (*Anaxyrus boreas*), Olive-Sided Flycatcher (*Contopus cooperi*), Rusty Blackbird (*Euphagus carolinus*), wolverine (*Gulo gulo*), fisher (*Pekania pennanti*), and grizzly bear (*Ursus arctos*) to be present within the project area. Of those, Western toad, Olive-sided Flycatcher, Rusty Blackbird, and grizzly bear have the highest chance to be found near the stream crossing.

Avoiding clearing during the bird nesting period (described in Section 6.1.2) or completing a nest survey prior to clearing will reduce the risk to bird species. There is a low to moderate potential for Western toads to be in the area. If found during construction, the EM should be notified to determine if any mitigation measures such as an amphibian salvage will be required. Proper site management, particularly of garbage and fuel storage, should minimize the risk of attracting grizzly bears or other animals to the site.

4 POTENTIAL ENVIRONMENTAL IMPACTS

A review of the project was undertaken to identify potential environmental impacts and mitigation measures associated with the stream crossing replacement. The construction activities that are likely to have an impact on environmental values are:

- Site isolation and water management during construction;
- Vegetation clearing;
- Removal of the existing CSP and fill material;
- Placement and activation of the new stream channel under the bridge; and
- Installation of new bridge and rip rap.

These works were then compared to DFO's Measures to Protect Fish and Fish Habitat for determination of impacts to habitat (Table 1). We determined the risk for all pathways to be low to moderate, and mitigable. Overall, the project has potential to produce a net increase in fish habitat, as fish will have improved access to habitat upstream from the crossing.

Table 1: Potential Environmental Impacts

Impact	Risk Assessment	Mitigation
Prevent the death of fish	LOW	Work in the dry, during low water, with the stream isolated and fish salvage performed.
Maintaining riparian vegetation	LOW	Minimize amount of vegetation clearing required to access the site, revegetate as soon as possible after construction is complete.
Carry out works, undertakings and activities on land	LOW	Equipment will work from the bank as much as possible. The new channel will be constructed to mimic natural channel morphology.
Maintain fish passage	LOW	Stream isolation and diversion will be short term. The new bridge will improve fish passage and return the stream channel to its natural state.
Ensure proper sediment control	LOW to MODERATE	Work will be performed in the dry. Erosion and sediment control measures should be implemented until the site is stabilized.
Prevent entry of deleterious substances in water	LOW	Equipment should be clean before entering worksite and monitored for leaks by the onsite EM. Spill kits and containment equipment will be onsite at all times.

5 BEST MANAGEMENT PRACTICES FOR CONSTRUCTION

The following is a list of general best management practices that should be implemented to reduce the potential for harm to the environment during construction works. Measures specific to erosion and sediment control are detailed in Section 7.

- Before any work commences, a pre-work meeting should be held with all personnel to review the EMP and regulatory requirements (if any), ensure all necessary erosion and sediment control supplies are available, and that everyone has an understanding of procedures in case of spills.
- Equipment working on this project must be clean and free of leaks. Equipment found to be leaking will be removed immediately and repaired off-site. It is preferable that machines working near the wetted area of the streams use biodegradable hydraulic fluids. Spill kits must be available on-site.
- Efforts should be made to fall any tree that must be removed away from the channel. If that is not possible, the tree should be lifted out and not dragged to protect undisturbed vegetation and the stream channel. Where possible, root systems should be left intact to provide soil stability.
- Equipment will work from the stream banks as much as possible.
- Rip rap should be clean and free of debris. Rip rap must be non-acid generating or metal leaching. Rip rap must be placed with an excavator using a bucket and thumb. End dumping will not be permitted.
- Any uncured concrete or grout products used for the bridge construction must be isolated a minimum 24 hours to prevent material entering the stream.
- Any pumps used for the stream diversion must be screened in accordance with DFO's *Interim code of practice: End-of-pipe fish protection screens for small water intakes in freshwater* (2020) to prevent the entrapment and impingement of fish.
- If the Contractor encounters contaminated or hazardous material, the Contractor must stop work and contact the Ministry Representative and EM for further direction.
- The construction site will be kept tidy and any garbage removed to appropriate facilities daily to prevent attracting wildlife to the work areas or litter entering the water.
- If the Contractor encounters any archaeological, historical or cultural features or items while conducting work, the Contractor must stop work and notify the Ministry Representative immediately.
- The Contractor shall implement measures to reduce the risk of spreading invasive plants that may be on-site, including arriving on-site with clean equipment, avoiding working in or taking fill/aggregate material from known invasive plant infested areas, and removing soil and plant material from equipment prior to leaving site.

6 CONSTRUCTION CONSIDERATIONS

The following sections provide recommendations to minimize environmental risk during construction.

6.1 TIMING WINDOWS

6.1.1 Instream Timing Window

Based on the potential fish species present, the instream works window for the unnamed stream is July 15th to August 15th (BC MWLAP 2004). As there is no spawning habitat in this stream, work may occur outside that timing window, preferably during low flow conditions.

6.1.2 Migratory Bird Window

Vegetation clearing will be required to replace the crossing. Both sides of the road were surrounded with mature coniferous and deciduous trees that will be removed to provide space for the new bridge crossing. If vegetation clearing is planned within the breeding bird window of May 1 to August 15th, a Qualified Environmental Professional (QEP) should be retained to ensure there are no active nests within or near the work area prior to clearing.

6.2 CONSTRUCTION SEQUENCING

Construction sequencing for the culvert removal and construction of the new stream channel is expected to follow the sequencing below.

- Install stop nets and conduct fish salvage by qualified staff;
- Implement stream isolation;
- Remove the road fill material and the existing culvert;
- Construct the new stream channel to tie into the existing channel and include any requirements outlined in the engineering drawings;
- Allow a small amount of water to be directed over the new channel to “wash” the substrate; pump this water to a vegetated area until the water is flowing clear;
- Return full flow to the channel and remove the stop nets;
- Install the new bridge as per the engineering drawings;
- Seed with an appropriate weed-free seed mix and mulch with straw any disturbed areas; additional erosion and sediment control measures are to be installed as required.

6.3 SITE ACCESS

It is anticipated that the road will remain closed for the duration of the crossing replacement. No temporary access route is planned for the site.

6.4 FISHERIES SALVAGE AND STREAM ISOLATION

In order to remove the existing CSP and install the new bridge, a fisheries salvage may be required prior to isolating the site and diverting the water. If the stream is dry, frozen, or there are insufficient flows to support fish, then a salvage is not required. To complete the salvage, stop nets will be placed upstream and downstream of the work area and any fish will be salvaged under direction of a qualified Environmental Monitor (EM). Salvage methods may include electrofishing, dip-netting and/or minnow trapping.

6.5 STREAM DIVERSION

The type of stream diversion implemented will be up to the successful construction contractor. The contractor may build a diversion channel or dam and pump the water (example drawing in Appendix C) during construction. Alternatively, the contractor may choose to build the bridge over the existing culvert, using it to maintain water flow, and subsequently remove the culvert at the end using one of the methods above to manage the water. Regardless of which method is selected, clean water flow must be maintained downstream at all times and any turbid water must be pumped away from the stream.

6.5.1 Dam and Pump

To isolate the stream using the dam and pump method, locate a suitable place to create a dam upstream and downstream of the work site (example drawing in Appendix C). Sandbags or large grain bags and polysheeting is one option that can be used to build the dams. An excavated sump may be required upstream to ensure suitable depth for the pump intake and help direct flow to this location. The discharge hose should be placed around the worksite away from all potential machine paths. The discharge of the hose should be downstream of the dam but within the wetted perimeter of the stream. Sandbags or other energy dissipating mechanisms may be required to prevent scour and erosion of the stream bed at the hose outlet. As the upstream dam is being constructed, the pump should be started to move flow around the site. If water is turbid at the beginning, the discharge hose should be briefly directed away from the stream until it clears. Once the diversion starts, pumping must continue until the new stream channel is constructed and all instream works completed.

6.5.2 Stream Diversion

Constructing a diversion channel on either side of the crossing site is another feasible option to divert water during the culvert removal. The excavated channel should be wide and deep enough to accommodate the anticipated flows, including precipitation events. The channel should be lined with heavy plastic or a combination of plastic with filter fabric and weighted or staked down to withstand the flows and debris that may move through the diversion. Scour protection may be required at the downstream end of the diversion and the diversion should end where it cannot backwater the active construction area.

6.5.3 Sump

Regardless of the method chosen to isolate the stream, one or more sumps will be needed to manage any sediment-laden water generated within the construction site. A sump on the upstream end could be used to prevent water from entering the excavation area. A sump may also be required downstream, depending on the amount of seepage encountered during excavation.

Turbid water collected in the sumps will need to be discharged from the worksite to a designated disposal site, such as a well vegetated area, that will allow it to settle out before entering back into the stream. The EM should

approve the location for the sumps and discharge locations and monitor the discharge regularly to ensure turbid water is not flowing back to the stream.

6.6 STREAM CHANNEL CONSTRUCTION

General information has been provided in the crossing design (Appendix A) regarding construction of the new channel. The channel should be built to tie into the existing width (0.7 m), depth (0.5 m), gradient (3%), and alignment of the existing stream channel. The new channel should be constructed of a similar substrate size (gravels and fines) as the existing channel. Based on the drawings, the banks will be sloped back with rip rap for scour protection.

Once the new channel is constructed, a small amount of water should be introduced into the channel and pumped to a vegetated area until the water runs clear. This will reduce the initial flush of turbid water typically experienced when passing water over a new channel. After the water has run clear, the stream flow may be moved to the new channel. Stop nets, it used, can be removed once the water is moved to the new channel.

7 EROSION AND SEDIMENT CONTROL MEASURES

Stream crossing replacements have the potential to cause erosion and/or sedimentation to the streams. Mitigation measures will be required for the main crossing site as well as the temporary access road. Examples of typical ESC measures and installation guides are provided in Appendix D.

General measures applicable to this project include:

- Implement sediment and erosion control measures prior to construction and as soon as needed to reduce the potential for negative impacts to the surrounding environment;
- A stockpile of erosion and sediment control materials should be available at all times. This includes but is not limited to silt fencing, filter fabric, sandbags, water pumps, heavy duty plastic or tarps, and straw bales;
- Any sediment-laden water will be directed to a suitable location where sediment can filter out prior to water re-entering the stream;
- Any exposed soil should be seeded with an invasive-free seed mix and mulched with straw as soon as possible to prevent erosion, if possible, considering the time of year. If it is not immediately vegetated, temporary erosion and sediment control measures should be installed until seed can be applied;
- Any stockpiled erodible material should be located on flat stable ground at least 15 m from the stream with appropriate erosion control to prevent sediment being transported to the stream;
- Minimize ground disturbance to only those areas required for construction. Vehicles and equipment will be restricted to designated work areas and prescribed access routes;
- Temporarily delay work if high precipitation levels could result in erosion;

- Track pack fill perpendicular to the fill slope or roughen soils to slow water and promote sites for seed growth; and
- Ensure any erosion and sediment control measures are removed and properly disposed of when no longer required.

8 ENVIRONMENTAL MONITORING

The successful proponent will be required to retain the services of a qualified EM. The EM should be on-site for the following high risk activities:

- Site isolation and fish salvage (if required);
- Removal of existing culvert and fill;
- Channel construction;
- Returning the flow to the new stream channel;
- Installation of ESC measures; and
- Ongoing water quality monitoring.

As part of routine inspections, the EM will check equipment for leaks or spills and monitor the fuel storage and handling practices. The EM may direct erosion and sediment control measures to reduce the risk of sediment entering the water.

The EM should monitor water quality during construction works, particularly during the stream diversion, to ensure water quality objectives are being met. A monitoring site will be established upstream and downstream of the construction site. The frequency of water sampling will be dependent of the activities on-site as well as weather conditions. Sampling can be conducted with a field level accuracy turbidity meter and pH meters (if uncured concrete products are being used). Table 2 summarizes the applicable BC Water Quality objectives for aquatic life (Ministry of Environment 2016).

Table 2: Summary of BC Water Quality Objectives.

Parameter	Maximum Allowable Level
Suspended Solids	Change from background of: • 25 mg/L at any one time for a duration of 24 h in all waters during clear flows or in clear waters • 5 mg/L at any one time for a duration of 30 d in all waters during clear flows or in clear waters • 10 mg/L at any time when background is 25 - 100 mg/L during high flows or in turbid waters • 10% when background is >100 mg/L at any time during high flows or in turbid waters
Turbidity	Change from background of: • 8 NTU at any one time for a duration of 24 h in all waters during clear flows or in clear waters • 2 NTU at any one time for a duration of 30 d in all waters during clear flows or in clear waters • 5 NTU at any time when background is 8 - 50 NTU during high flows or in turbid waters • 10% when background is >50 NTU at any time during high flows or in turbid waters
pH	6.5-8.0 (or the same as receiving waters/background conditions)
Oil and Grease	The surface of the water should be virtually free of petroleum, animal or vegetable oils

The EM should record all activities, including any site-specific ESC measures implemented. An example EM report has been provided in Appendix E.

9 FUEL HANDLING AND SPILL CONTINGENCY

9.1 FUEL HANDLING AND STORAGE

The following is a list of general best management practices associated with refueling and the storage of fuel for construction works to minimize the risk of spills. Fuel management should follow the guidelines outlined in the Province's *A Field Guide to Fuel Handling, Transportation and Storage* (WLAP 2002).

- Fuel or other hydrocarbon containers should not be stored within 30 m of the stream.
- Spill kits should be available at all refuelling areas, and on heavy equipment to allow immediate response to spills. All onsite staff should be trained in refuelling practices, handling requirements, spill kit locations and spill response.
- If possible, all vehicles and machinery will be re-fuelled a minimum 30 m away from the water. Fuel must be properly stored within tidy-tanks or in approved secondary containment facilities as per Transportation of Dangerous Goods requirements.
- Small fuel tanks and containers located within 30 m of the stream must be stored within containment areas or spill trays capable of containing 110% of the volume of the liquid.
- Pumps, generators or other small equipment will be placed on a spill tray when working near water.

9.2 SPILL RESPONSE AND REPORTING

A spill response and reporting procedure should be implemented prior to the commencement of work. An example is provided in Appendix F. Spills should be reported to the MFLRNORD representative and EM as soon as possible. Any spill entering a waterbody must be reported to Emergency Management BC (EMBC) at 1-800-663-3456. Spills of fuels onto land greater than 100 L in volume must also be reported to EMBC.

Small fuel or oil leaks are the most common spills encountered on construction sites of this nature. The EM can help direct any clean-ups. Any contaminated material and surrounding soil as well as any sorbent material used for clean-up must be removed and placed in a designated container for proper disposal.

10 REFERENCES

BC Conservation Data Centre. 2021. BC Species and Ecosystems Explorer. BC Ministry of Environment. Accessed at: http://a100.gov.bc.ca/pub/eswp/ on April 23, 2021.

B.C. Ministry of Environment (MoE). 2017. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife and Agriculture – Summary Report. Water Protection & Sustainability Branch, Ministry of Environment.

BC Ministry of Environment. 2021. Habitat Wizard. Accessed at https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/ecosystems/habitatwizard on April 23, 2021.

B.C. Ministry of Forests, Lands and Natural Resource Operations (MFLNRO). 2013. Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia.

B.C. Ministry of Forests, Lands and Natural Resource Operations (MFLNRO). 2016. Best Management Practices for Amphibian and Reptile Salvages in British Columbia.

B.C. Ministry of Forests, Lands and Natural Resource Operations (MFLNRO), B.C. Ministry of Environment (MoE), and Fisheries and Oceans Canada (DFO). 2012. Fish-stream crossing guidebook. Rev. ed. For. Prac. Invest. Br. Victoria, B.C.

B.C. Ministry of Transportation and Highways (MoTH). 1997. Manual of Control of Erosion and Shallow Slope Movement.

B.C. Ministry of Water, Land and Air Protection (MWLAP). 2002. A Field Guide to Fuel Handling, Transportation and Storage. 3rd Edition.

BC Ministry of Water, Land and Air Protection. 2004. WLAP BMP Series: Region 7 Omineca – Reduced Risk Timing Window for Fish and Wildlife.

EDI Environmental Dynamics Inc. 1995. Salmon resource Analysis for the Fort St. James Land and Resource Management Plan (Fraser River Basin). Accessed at https://a100.gov.bc.ca/pub/acat/documents/r51881/SalmonFSJLRMP_1484333154108_4332706185.pdf

Environment Canada. 2020. Nesting periods for Migratory birds. Accessed at https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods/nesting-periods.html on January 12, 2021.

Fisheries and Oceans (DFO). 1993. Land Development Guidelines for the Protection of Aquatic Habitat. Second edition.

Fisheries and Oceans Canada (DFO). 2020. Interim code of practice: End-of-pipe fish protection screens for small water intakes in freshwater. Department of Fisheries and Oceans, Ottawa, Ontario.

Klohn Crippen Berger Ltd. and SNC-Lavalin Inc. 2016. Site C Clean Energy Project Water Management, Erosion and Sediment Control Plan (rev 1).

Ministry of Environment (MOE). 2004 Standards and Best Practices for Instream Works - General BMPs & Standard Project Considerations, V1.0.

Natural Resources Extension Program (NREP). 2008. Environmental Monitoring for Construction Projects. Nanaimo, BC: Vancouver Island University.

APPENDIX A – ENGINEERED DESIGN DRAWINGS

N

NOT TO SCALE

PROPOSED PERMANENT 15.240m (50') L-100 POST AND PAD STEEL GIRDER BRIDGE WITH MODULAR TIMBER DECK PANELS FOR: 707km ON THE LEO MIDDLE FSR

PREPARED FOR:

BCTS
BC Timber Sales

PREPARED ON:
August 22, 2019

Sheet Number	Sheet Name
1	Cover Sheet
2	Road and Crossing Plan
3	Road/Crossing/Thalweg Profiles
4	Abutment Sections
5	Notes
6	Site Photos

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SHEET 1 OF 6

DWG #: 111-026-004	CURRENT REVISION	
	REVISION DATE	
INTENDED TO BE PRINTED ON 11"X17" PAPER. ANY COPIES OF PDFS MAY NOT BE TO SCALE	REVISION DESC.	

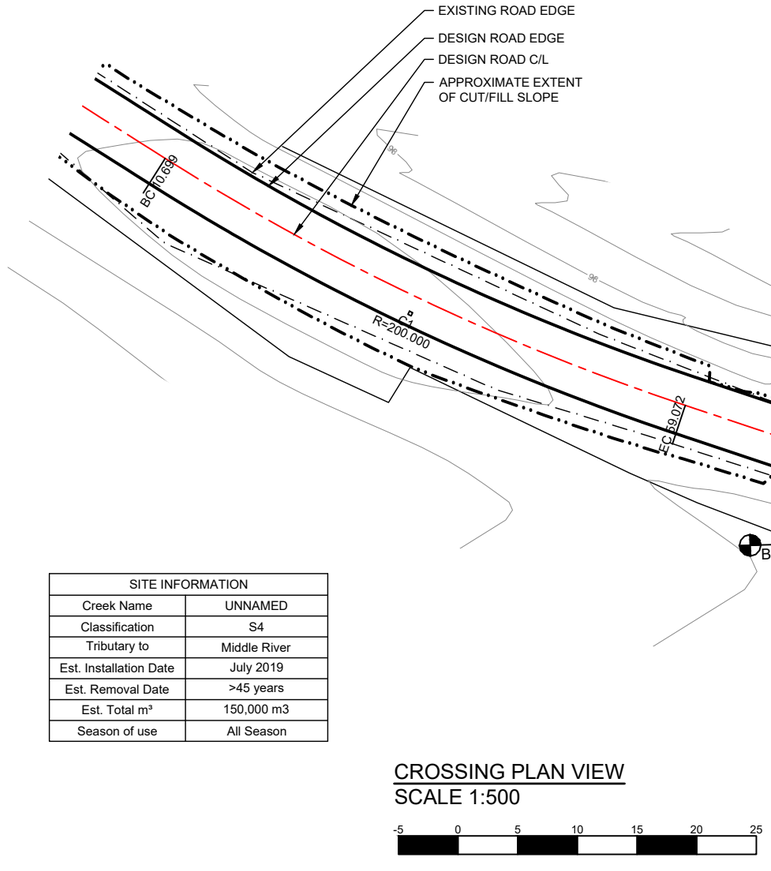
WORKPOINT TABLE		
Point	BENCHMARK	DISTANCE
WP1	BM1	26.580
	BM2	27.301
	BM3	34.780
	BM4	24.552
WP2	BM1	41.220
	BM2	13.652
	BM3	19.987
	BM4	39.070

WORKPOINTS ARE LOCATED UNDERSIDE ENDS OF BRIDGE.

ELEVATIONS SHOWN HAVE AN ARBITRARY DATUM AND SHOULD ONLY BE USED TO ESTABLISH RELATIVE ELEVATION WITHIN THE CROSSING FOR CONSTRUCTION PURPOSES.

REFERENCE TABLE			
Point	Easting (m)	Northing (m)	Elevation (m)
BM1	967.702	1022.011	97.955
BM2	1015.241	1003.809	98.020
BM3	1017.892	987.091	99.929
BM4	963.427	1003.781	99.137
WP1	987.958	1004.801	98.779
WP2	1002.268	999.556	99.161

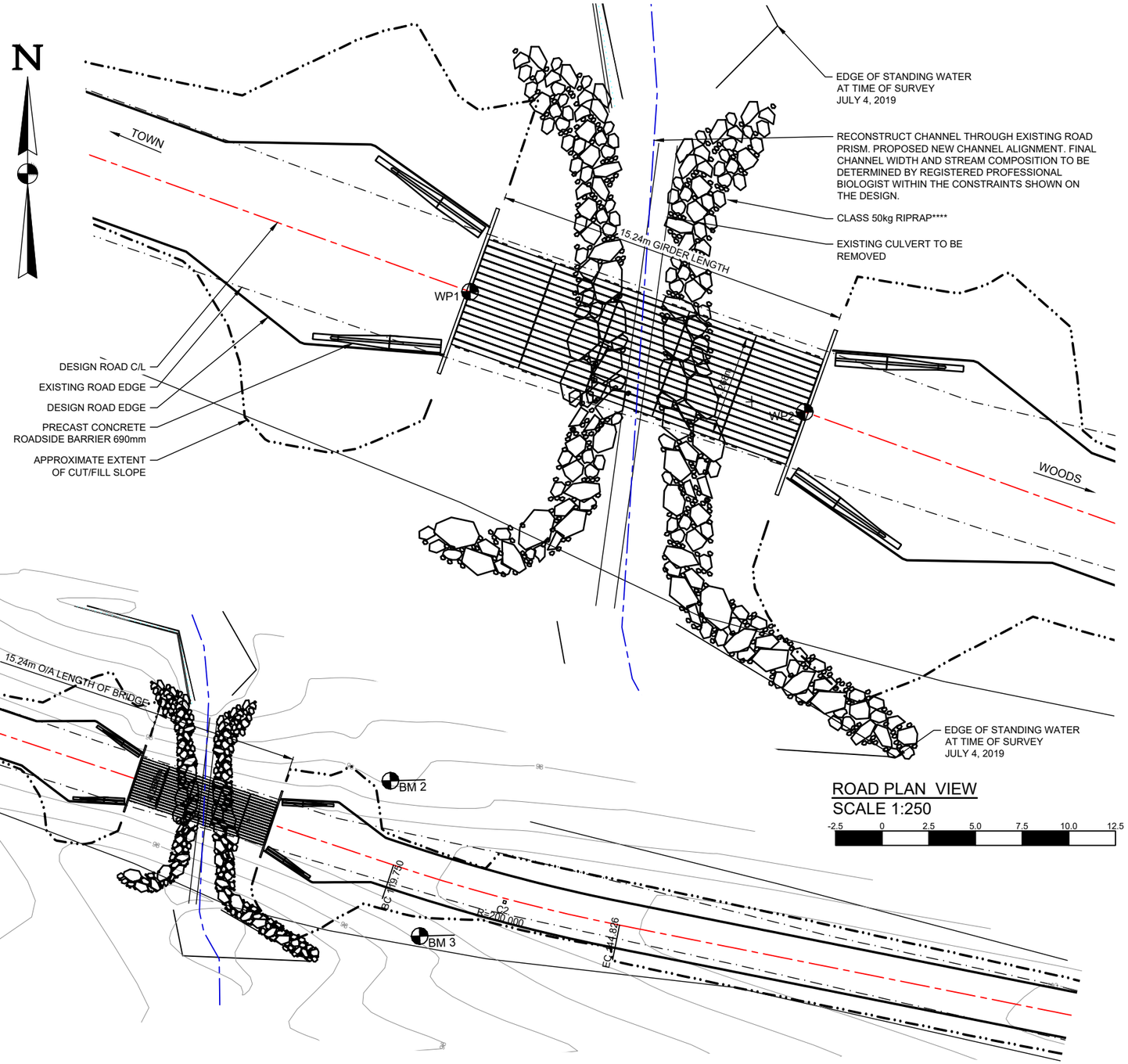
SURVEY CONTROL BASED ON COORDINATES ESTABLISHED LOCALLY. WORKPOINTS ARE AT THE CENTER OF UNDERSIDE OF GIRDER ENDS.



SITE INFORMATION	
Creek Name	UNNAMED
Classification	S4
Tributary to	Middle River
Est. Installation Date	July 2019
Est. Removal Date	>45 years
Est. Total m³	150,000 m3
Season of use	All Season

CROSSING PLAN VIEW
SCALE 1:500

-5 0 5 10 15 20 25



ROAD PLAN VIEW
SCALE 1:250

-2.5 0 2.5 5.0 7.5 10.0 12.5

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BCTS BC Timber Sales

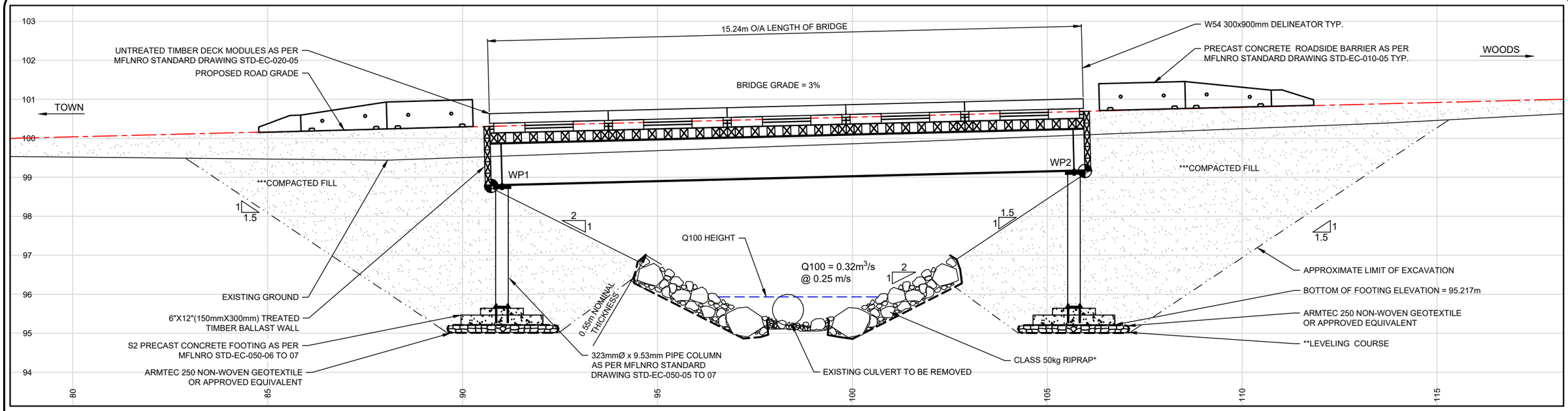
PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — E. D. FOLK # 35587 — Sept 13/2019

PROPOSED PERMANENT 15.240m (50') L-100 POST AND PAD STEEL GIRDER BRIDGE WITH MODULAR TIMBER DECK PANELS FOR: 707km ON THE LEO MIDDLE FSR

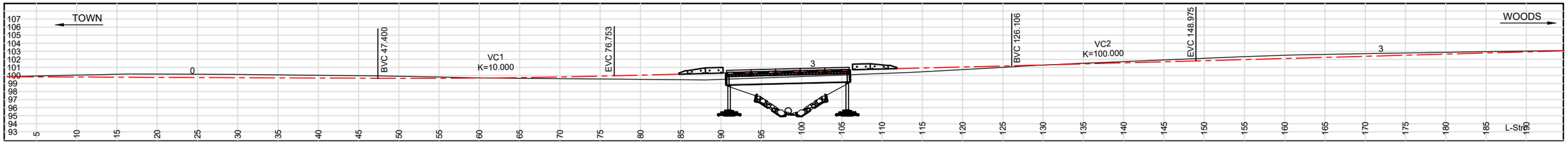
SHEET NAME: ROAD AND CROSSING PLAN VIEW

SCALE: As Indicated	SURVEY CREW: DT, DF
DESIGN BY: Edward Folk, P.Eng, RFT	DATE: August 22, 2019
DRAWN BY: NH	REVISION NUMBER:
REVIEWED BY: Daryl Taylor, P.Eng, RPF	REVISION DATE:
SITE SURVEY: July 4, 2019	DWG #: 111-026-004

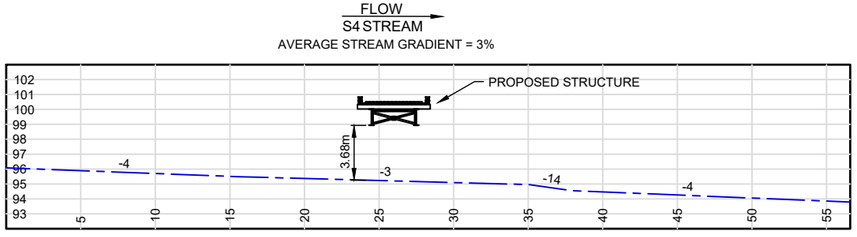
SHEET 2 OF 6



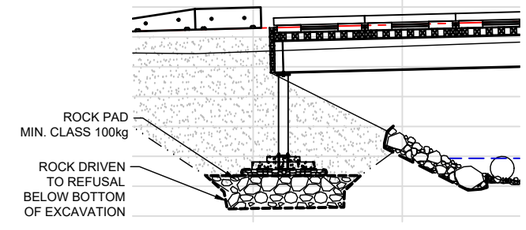
CROSSING PROFILE - PROPOSED STRUCTURE
SCALE 1:100



ROAD PROFILE VIEW WITH PROPOSED STRUCTURE
SCALE 1:500



STREAM THALWEG PROFILE
SCALE 1:400



ALTERNATE FOOTING DETAIL
SCALE 1:200

1. IF FOUNDATION SOILS ARE FOUND UNSUITABLE, MAY HAVE TO DRIVE ROCK TO REFUSAL
2. IF EXCAVATION CANNOT BE DEWATERED UNDER NORMAL OPERATION, BUILD ROCK PAD FOR FOUNDATION PRIOR TO PLACING LEVELLING COURSE

***COMPACTED FILL
IS A WELL DRAINED GRANULAR MATERIAL, TO BE PLACED IN LIFTS OF 0.3m MAXIMUM (MEASURED LOOSE). WATER MAY NEED TO BE ADDED (PRIOR TO COMPACTION AND DURING THE SPREADING OF THE LIFTS) TO THE MATERIAL TO ACHIEVE THE REQUIRED COMPACTION, MULTIPLE PASSES WITH A 1000lb VIBRATING COMPACTOR TO 95% STANDARD PROCTOR OF THE MODIFIED DRY DENSITY (SPMDD)

**LEVELING COURSE
TO BE A WELL DRAINED GRANULAR MATERIAL COMPACTED TO 95% SPMDD AND WRAPPED IN ARMTEC 250 NON-WOVEN GEOTEXTILE OR APPROVED EQUIVALENT.

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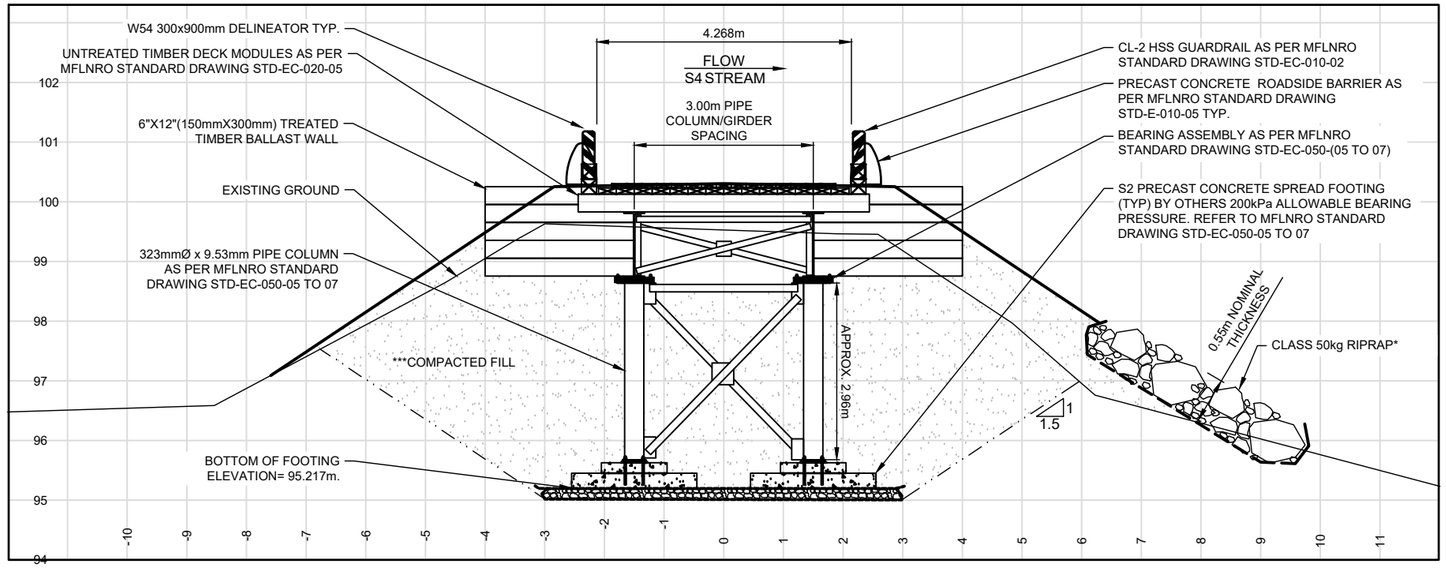
PROPOSED PERMANENT 15.240m (50') L-100 POST AND PAD STEEL GIRDER BRIDGE WITH MODULAR TIMBER DECK PANELS FOR: 707km ON THE LEO MIDDLE FSR

SHEET NAME: ROAD / CROSSING / THALWEG PROFILES

SCALE: As Indicated	SURVEY CREW: DT, DF
DESIGN BY: Edward Folk, P.Eng, RFT	DATE: August 22, 2019
DRAWN BY: NH	REVISION NUMBER:
REVIEWED BY: Daryl Taylor, P.Eng, RPF	REVISION DATE:
SITE SURVEY: July 4, 2019	DWG #: 111-026-004

SHEET 3 OF 6



TOWN ABUTMENT CROSS SECTION
SCALE 1:100

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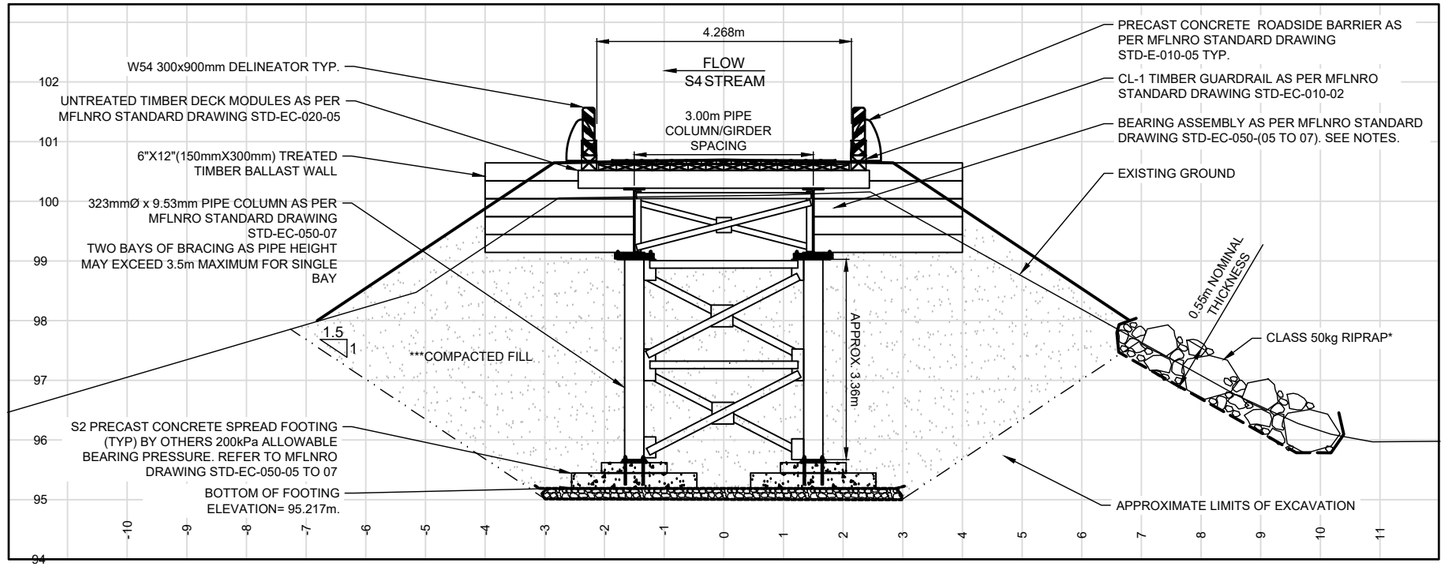

WOODS ABUTMENT CROSS SECTION
SCALE 1:100

-1 0 1 2 3 4 5

*RIPRAP: CLEAN ANGULAR ROCK

CLASS 50kg RIPRAP
ROCK GRADATION
PERCENT SMALLER THAN GIVEN ROCK MASS kg(mm)
15% 5(155)
50% 50(330)
85% 150(475)
NOMINAL THICKNESS OF RIPRAP 550mm

ALL ROCK TO BE PLACED TO MAXIMIZE INTERLOCKING BETWEEN PIECES. ALL ROCK TO BE UNDERLAIN WITH ARMTEC 250 OR APPROVED EQUIVALENT NON-WOVEN GEOTEXTILE.

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BCTS BC Timber Sales

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PROPOSED PERMANENT 15.240m (50') L-100 POST AND PAD STEEL GIRDER BRIDGE WITH MODULAR TIMBER DECK PANELS FOR: 707km ON THE LEO MIDDLE FSR

SHEET NAME: ABUTMENT SECTIONS

SCALE: As Indicated	SURVEY CREW: DT, DF
DESIGN BY: Edward Folk, P.Eng, RFT	DATE: August 22, 2019
DRAWN BY: NH	REVISION NUMBER:
REVIEWED BY: Daryl Taylor, P.Eng, RPF	REVISION DATE:
SITE SURVEY: July 4, 2019	DWG #: 111-026-004

SHEET 4 OF 6

1 - GEOTECHNICAL

FOUNDATION DESIGN REFERENCES THE CANADIAN ENGINEERING FOUNDATION MANUAL. SUBSURFACE INFORMATION HAS BEEN INFERRED FROM SITE OBSERVATIONS OF ROAD CUTS AND ALONG STREAMBANKS AND FROM SHALLOW HAND DUG TEST PITS. NO DETAILED SUBSURFACE INVESTIGATION WAS PERFORMED (LARGE MACHINE DUG TEST PITS OR BORE HOLES). FIELD CONDITIONS MAY VARY FROM THOSE INFERRED. IF, UPON EXCAVATION, FIELD CONDITIONS VARY FROM THOSE INFERRED, THEN CHANGES TO THE FOUNDATION DESIGN OR INSTALLATION MAY BE REQUIRED. SOILS ARE ANTICIPATED TO BE *LOOSE TO COMPACT SILTY* SANDS AND GRAVELS.

2 - HYDROLOGY AND HYDRAULIC ASSESSMENT

HYDRAULIC ANALYSIS BASED ON CURRENT CHANNEL. CONDITIONS COULD VARY OVER TIME

FREE BOARD HEIGHT REQUIREMENT SHOWN REFERS TO UPSTREAM UNDERSIDE OF THE GIRDER OF BRIDGE

THE EXTENT OF THE RIPRAP IS BASED ON AVAILABLE INFORMATION. THE EXTENTS SHOULD BE ADJUSTED IN THE FIELD TO ENSURE ADEQUATE SCOUR PROTECTION IS PROVIDED TO THE BRIDGE SUBSTRUCTURE AND ABUTMENTS.

PEAK FLOW FOR DESIGN PURPOSES WAS DETERMINED BASED ON REVIEW OF CHANNEL CHARACTERISTICS, PREVIOUS HIGH FLOW EVIDENCE, AND REVIEW OF THE RESULTS OF APPLYING SEVERAL PEAK FLOW EMPIRICAL MODELS. THESE EMPIRICAL MODELS EMPLOY ESTIMATES OF TIME OF CONCENTRATION, HYDROMETRIC STATISTICS, WATERSHED CHARACTERISTICS, AND OTHER RELEVANT INFORMATION TO DETERMINE PEAK FLOW. Q100=0.32m³/s @ 0.25m/s LOW LIKELIHOOD OF COARSE WOODY DEBRIS MOVEMENT

3 - BRIDGE DESIGN

CONFORM TO CAN/CSA-S6-36 (MODIFIED) AND THE MINISTRY OF FORESTS AND RANGE, "FOREST SERVICE BRIDGE DESIGN AND CONSTRUCTION MANUAL" 1999.

ALL BRIDGE COMPONENTS SHALL CONFORM TO THE MINISTRY OF FORESTS AND RANGE STANDARD DRAWINGS UNLESS APPROVED BY OWNER.

LOADING: L-100 (90,680 KG G.V.W.) ECCENTRICITY IN ACCORDANCE WITH S6-06.

FATIGUE: DESIGN TO BE COMPLETED IN ACCORDANCE WITH CAN/CSA-S6-06 - 500,000 CYCLES.

GUARD RAIL - CL-1 TIMBER BRIDGE GUARD RAIL AS PER MFLNRO STANDARD DRAWING STD-EC-010-01.

FOR THE PURPOSES OF THIS DESIGN THE TERM PERMANENT REFERS TO DURATION OF THIS INSTALLATION MEANS FORTY-FIVE (45) YEARS OR MORE. DURATION WILL BE DETERMINED IN THE END BY ROUTINE INSPECTIONS.

SUPERSTRUCTURE SUPPLIED BY OTHERS. CONFIRM ALL DIMENSIONS PRIOR TO FIELD LAYOUT. IF SUPERSTRUCTURE USED PREVIOUSLY AT ANOTHER LOCATION IT MUST BE INSPECTED BY A QUALIFIED REGISTERED PROFESSIONAL PRIOR TO USE AT THIS SITE.

CHECK REQUIRED BEARING TO BEARING DISTANCE AND DEPTH OF ACTUAL STRUCTURE PRIOR TO INSTALLATION OF THE FOUNDATION.

4 - CONSTRUCTION NOTES

THE PROFESSIONAL OF RECORD OR THEIR DESIGNATE IS REQUIRED TO INSPECT / CARRY OUT THE FOLLOWING ACTIVITIES PRIOR TO PROVIDING SUBSTANTIAL CONFORMANCE DOCUMENTATION:

-INSPECT FOUNDATION SOILS FOLLOWING EXCAVATION
-INSPECT LAYOUT AND LOCATION OF FOOTINGS
-LAYOUT RIPRAP PLACEMENT
-BACKFILL MATERIAL AND TECHNIQUE
-OTHER SITE INSPECTIONS AT THE DISCRETION OF THE PROFESSIONAL

5 - MATERIALS

ENDFILL MATERIAL - ENDFILL SHALL CONSIST OF WELL GRADED, SELECT, GRANULAR MATERIAL (<75MM), PLACED IN LIFTS OF 300mm MAXIMUM (MEASURED LOOSE), WATER MAY NEED TO BE ADDED (PRIOR TO COMPACTION AND DURING THE SPREADING OF LIFTS) TO THE MATERIAL TO ACHIEVE THE REQUIRED COMPACTION. MULTIPLE PASSES WITH A 1000-LB VIBRATING COMPACTOR, COMPACTED TO 95% STANDARD PROCTOR OF THE MODIFIED DRY DENSITY (SPMDD).

6 - ABUTMENTS

ENSURE ALL WORKS COMPLY WITH MINISTRY OF FORESTS AND RANGE STANDARDS

7 - SAFETY

WHERE EXCAVATION SPECIFICATIONS ON THESE DRAWINGS CONFLICT WITH WORKSAFEBC REGULATIONS, WORKSAFEBC REGULATIONS ARE TO GOVERN

8 - ENVIRONMENT

STREAM REBUILDING TO BE SUPERVISED BY A QUALIFIED REGISTERED ENVIRONMENTAL PROFESSIONAL

ALTERATION TO STREAM BANKS AND IN-STREAM WORK MUST BE SUPERVISED BY QUALIFIED PERSON. SEDIMENT MANAGEMENT TO REDUCE SILTATION IS REQUIRED. IN-STREAM MACHINE CROSSINGS ARE NOT PERMITTED WITHOUT PROPER APPROVAL.

REMOVE THE MINIMUM AMOUNT OF RIPARIAN VEGETATION NECESSARY TO INSTALL A SAFE STRUCTURE. DIRECT SURFACE WATER AWAY FROM WORK SITE. ENSURE MACHINERY IS CLEAN PRIOR TO ENTERING WATERCOURSE. SILT FENCING, GEOTEXTILE CLOTH FABRIC AND A ROLL OF PLASTIC SHOULD BE ON SITE. STOP WORK DURING EXTREME ADVERSE WEATHER CONDITIONS. SEED AND STRAW DISTURBED SLOPES AS SOON AS POSSIBLE.

ENSURE DITCH WATER AND SURFACE RUNOFF FROM THE ROAD DOES NOT FLOW DIRECTLY INTO STREAM. CONSTRUCT SUMPS AS REQUIRED. EXACT LOCATIONS ARE TO BE FIELD DETERMINED UPON CONSTRUCTION.

ON SITE PRESCRIPTIONS MAY HAVE TO BE MODIFIED TO ACCOMMODATE ACTUAL ROAD VERTICAL/HORIZONTAL ALIGNMENT, SLOPE ANGLES ON FILL AND CUT SLOPES, MATERIAL COMPOSITION AND WEATHER.

9 - SITE CONDITIONS

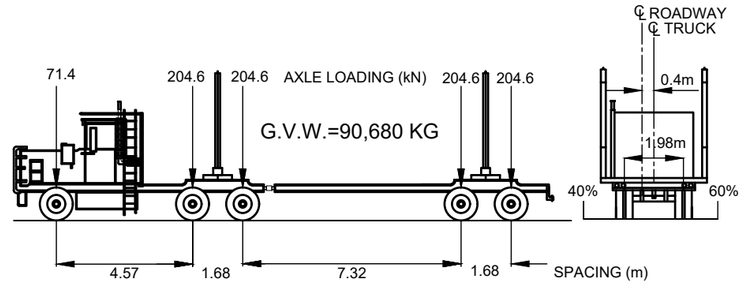
DUE TO THE NATURE OF THE SITE, CONDITIONS MAY VARY FROM THE FIELD INFORMATION GATHERED. ON SITE PRESCRIPTIONS MAY HAVE TO BE MODIFIED TO ACCOMMODATE ACTUAL ROAD HORIZONTAL/VERTICAL ALIGNMENT, SLOPE ANGLES ON FILL AND CUT SLOPES, MATERIAL COMPOSITION AND WEATHER.

ENVIRONMENTAL FISH STREAM NOTES:

1. WORK TO PROCEED IN ACCORDANCE WITH DFO AND BCMOE CONDITIONS NOTED AT THE WEB SITE: http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html THE BCMOE REGIONAL TERMS AND REGIONAL PERIODS OF LEAST RISK TO RESIDENT FISH SPECIES AND FISH REMOVAL/RELOCATION FOR IN-STREAM WORK ALSO APPLY IF THE STREAM HAS FISH PRESENT OR IS CLASSIFIED AS S1 THROUGH S4.
2. A SEDIMENT MANAGEMENT PLAN WITH SPECIFIC MITIGATION MEASURES TO MINIMIZE SILTATION MUST BE ON SITE. MACHINE CROSSINGS MUST BE LIMITED TO 2 UNLESS OTHERWISE INCREASED OR DECREASED BY A QUALIFIED ENVIRONMENTAL PROFESSIONAL (QEP).
3. ALTERATION TO STREAM BANKS AND IN-STREAM WORK SHOULD BE SUPERVISED BY AN ENVIRONMENTAL MONITOR.
4. REMOVE THE MINIMUM AMOUNT OF RIPARIAN VEGETATION NECESSARY TO INSTALL A SAFE STRUCTURE. VEGETATE DISTURBED SLOPES AS SOON AS POSSIBLE.
5. MACHINERY IS TO BE CLEAN AND LEAK FREE WHILE ON SITE. PETROLEUM PRODUCTS MUST BE CAREFULLY MONITORED WITH NO FUELING WITHIN THE RIPARIAN MANAGEMENT AREA.
6. DIRECT SURFACE WATER AWAY FROM WORK SITE DURING CONSTRUCTION. ENSURE DITCH WATER AND SURFACE RUNOFF FROM THE ROAD DOES NOT FLOW DIRECTLY INTO THE STREAM. INSTALL CROSS DRAIN CULVERTS ON THE APPROACHES AND CONSTRUCT SUMPS AS REQUIRED.

ENVIRONMENTAL ROAD AND RUNOFF NOTES:

1. IF POSSIBLE, APPROACHES TO BE CROWNED AND GRAVELED.
2. ENSURE SUMPS ARE INSTALLED IN THE DITCHLINE AN ADEQUATE DISTANCE FROM CREEK.
3. INSTALL SILT FENCE ALONG BASE OF EXPOSED FILL IF WARRANTED. REMOVE SILT FENCE AFTER 1 GROWING SEASON.
4. ALL EXPOSED MINERAL SOILS WITHIN 50m OF CROSSING ARE TO BE GRASS SEEDED AND COVERED WITH STRAW TO PROTECT GROWTH.



BCFS L-100 OFF HIGHWAY LOADING DIAGRAM
SCALE 1:200

**SOIL DENSITY	
VERY LOOSE	EASILY EXCAVATED WITH A SPADE
LOOSE	SOME RESISTANCE TO SPADE
COMPACT	CONSIDERABLE RESISTANCE TO SPADE
DENSE	REQUIRES PICK FOR EXCAVATION
VERY DENSE	HIGH RESISTANCE TO PICK

PARTIAL MATERIALS LIST (EXCLUDING THE BRIDGE SUPER STRUCTURE AND HARDWARE)	
1	ROLL NON-WOVEN GEOTEXTILE: ARMTEC 250 OR EQUIVALENT
5 pcs.	UNTREATED TIMBER DECK MODULES AS PER MFLNRO STANDARD DRAWING STD-EC-020-05
4 pcs.	W-054 SERIES DELINEATORS (2 LEFT, 2 RIGHT)
2 pcs.	W-051 SERIES NARROW STRUCTURE / BRIDGE AHEAD SIGNS
10	6"X12"(150mmX300mm) TREATED TIMBER BALLAST BOARDS
4	323mmØ x 9.53mm PIPE COLUMN, CUT TO LENGTH
4	PRECAST S2 CONCRETE FOOTINGS
12	PRECAST CONCRETE NO-POST BARRIERS

ESTIMATED EARTHWORKS VOLUMES	
1100m^3	CUT MATERIAL (INCLUDES ROAD APPROACHES)
700m^3	GRANULAR FILL MATERIAL (INCLUDES ROAD APPROACHES)
70m^3	APPROXIMATE VOLUME OF CLASS 50KG RIP RAP

NOTE:
THE ABOVE VOLUMES ARE ESTIMATES ONLY AND DO NOT ACCOUNT FOR UNEXPECTED CONDITIONS.

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SHEET NAME: NOTES

SCALE: As Indicated	SURVEY CREW: DT, DF
DESIGN BY: Edward Folk, P.Eng, RFT	DATE: August 22, 2019
DRAWN BY: NH	REVISION NUMBER:
REVIEWED BY: Daryl Taylor, P.Eng, RPF	REVISION DATE:
SITE SURVEY: July 4, 2019	DWG #: 111-026-004

SHEET 5 OF 6

Crossing Approach from Woods

Crossing Approach from Town

Sinkhole in Road

Existing Culvert Inlet

Existing Culvert Outlet

Stream Channel

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PROPOSED PERMANENT 15.240m (50') L-100 POST AND PAD STEEL GIRDER BRIDGE WITH MODULAR TIMBER DECK PANELS FOR: 707km ON THE LEO MIDDLE FSR

SHEET NAME: SITE PHOTOS

SCALE: As Indicated	SURVEY CREW: DT, DF
DESIGN BY: Edward Folk, P.Eng, RFT	DATE: August 22, 2019
DRAWN BY: NH	REVISION NUMBER:
REVIEWED BY: Daryl Taylor, P.Eng, RPF	REVISION DATE:
SITE SURVEY: July 4, 2019	DWG #: 111-026-004

SHEET 6 OF 6

APPENDIX B – SITE PHOTOS

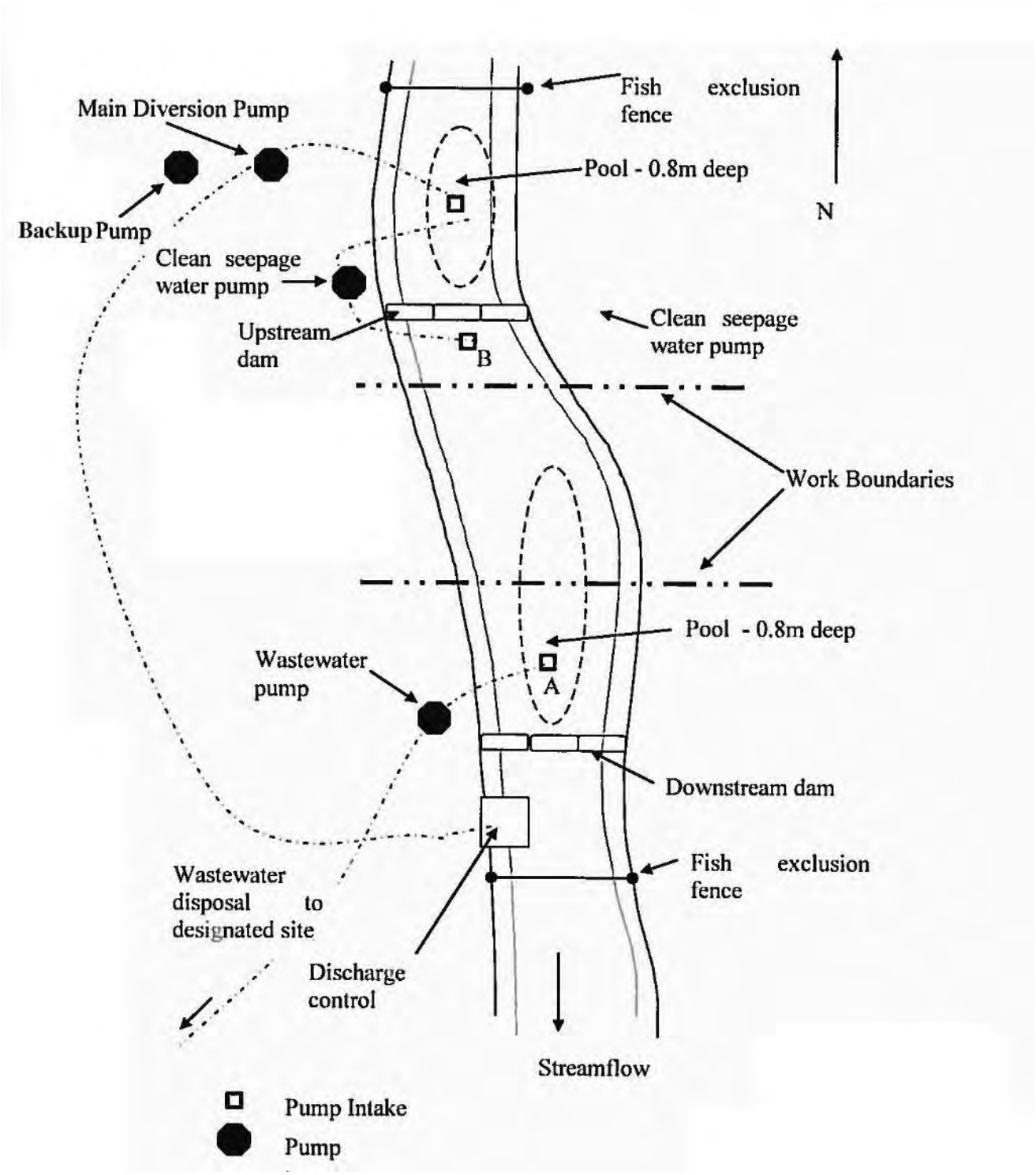
Photo 1. Road washout at Km 7, looking towards the high chain side.

Photo 2. Photo of the culvert outlet.

Photo 3. Photo of the culvert inlet.

Photo 4. Photo looking across the small channel, downstream of the culvert.

APPENDIX C – EXAMPLE SITE ISOLATION DIAGRAM



Example damp and pump set-up (Photo from NREP 2008).

APPENDIX D – EXAMPLE EROSION AND SEDIMENT CONTROL MEASURES

Source: Site C Clean Energy Project Water Management, Erosion and Sediment Control Plan (rev 1) (Klohn Crippen Berger Ltd. and SNC-Lavalin Inc. 2016)

BMP 1	SURFACE GRADING, ROUGHENING & SLOPE TEXTURING	Stripping, Grading and Site Preparation

Description and Purpose

Note: The practices outlined in this BMP are not stand-alone measures; they should be used in conjunction with other erosion and sediment control practices.

- **Stripping & grading to Final Stabilization**
- **Slopes**
- **Stockpiles**

Texturing exposed slopes and stripped/graded areas by roughening the soil surface or installing tracks, grooves, furrows or benches that conform to contours helps interrupt the movement of sheet run-off across exposed areas, reducing effective slope lengths and decreasing potential for sheet and rill erosion. Roughening of exposed soils and tracking/grooving/furrowing perpendicular to the prevailing wind can also significantly reduce the detachment and creep/saltation of soil particles by wind.

Applications and Advantages

- These measures are suitable for all compacted stripped/graded areas and all disturbed areas, especially slopes 3H:1V or steeper (on fresh cut of fill slopes to a maximum gradient of 2H:1V)
- Surface roughening and slope texturing are temporary erosion control measures that need to be used in conjunction with erosion control BMPs. Surface roughening provides some instant erosion protection for exposed soils prior to final stabilization with vegetation or other cover
- Texturing will create pockets to entrap coarse sediment, reducing the sediment yield down-slope.
- Good suitability for freshly cut or filled slopes (at least 8 m in length) with a maximum slope of 2H:1V, with reasonably cohesive soils
- Benching/terracing can be used to reduce the effective length of long slopes (break up slopes)
- Decreasing run-off velocity and surface wind speed decreases erosion potential
- Increases infiltration of run-off into the soil
- Traps and retains seed detached by water and/or wind
- Provides beneficial 'seedling-safe' sites for germination/establishment of seedlings
- Enhances the performance of topsoiling, mulching and hydroseeding

Limitations

- Generally impractical for short slopes with insufficient room for machinery to maneuver
- Generally not suitable for excessively steep slopes and/or non-cohesive soils
- May cause water build-up and sloughing in wet/seepage areas (obtain geotechnical advice)
- These practices provide limited, short-term benefit and work best when used as part of a system of practices/controls
- Grading costs may be increased

Installation

- Do not run heavy equipment on excessively wet soils as this will increase compaction

Surface Roughening/Furrowing

- Always leave exposed soils in a rough-graded condition; do not smooth grade soil
- On large, relatively flat stripped and graded areas, reduce wind erosion potential by furrowing or ripping the soil perpendicular to the prevailing wind direction (using the ripper teeth on a grader is very effective; depth should be 0.15 to 0.30 m). When furrowing sloped areas, ensure that the furrows run perpendicular to the fall of the slope

Surface Tracking (also known as cat-tracking or track-walking)

- Use tracked construction equipment to move up and down the slope, leaving depressions perpendicular to the slope direction. Limit machine-tracking to one or two passes to prevent excessive compaction
- Avoid this practice on excessively wet or clayey soils
- Tracked depressions in the soil will decrease run-off velocities, trap sediment, improve seedling development and increase infiltration of water
- For topsoiling and surface tracking, be sure to immediately seed and mulch roughened areas to obtain optimum seed germination and seedling growth. Establish good soil and seed contact

Inspection and Maintenance

- Inspect a minimum of once every seven (7) days and during or within 24 hours of rapid snowmelt, rainfall events of 12 mm or greater in a 24 hour period, or rainfall on saturated soils
- Areas damaged by rilling or erosion should be re-graded and re-seeded

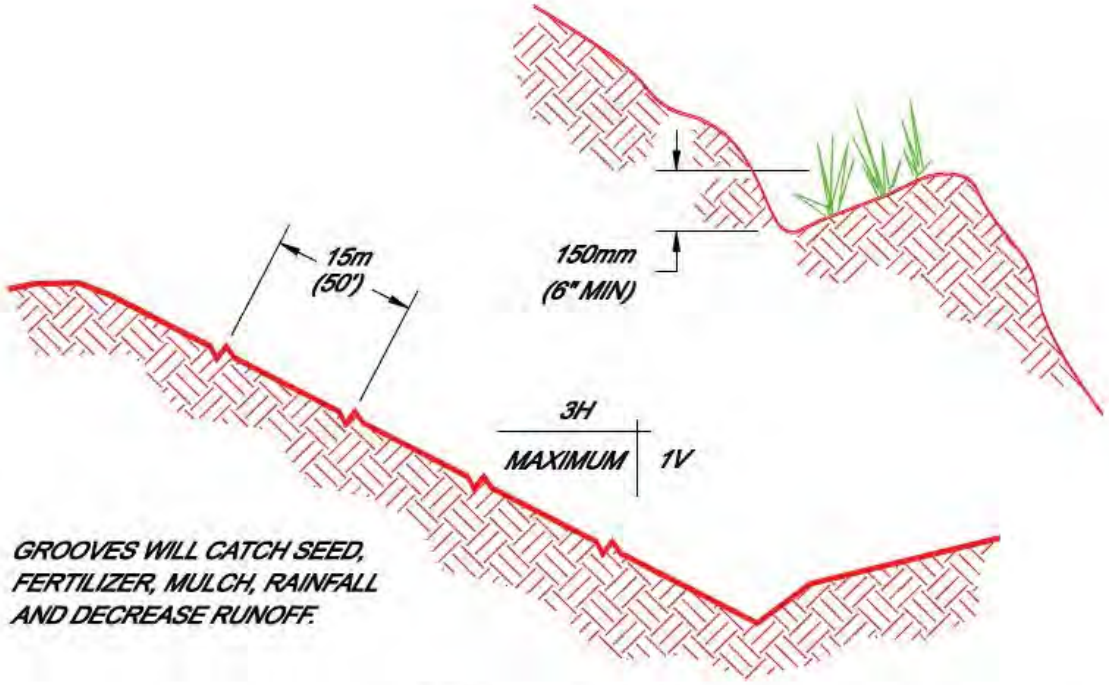
Construction Details

Refer to the following figures:

Surface Roughening

'TRACKING' WITH MACHINERY UP AND DOWN THE SLOPE PROVIDES GROOVES THAT WILL CATCH SEED, RAINFALL AND REDUCE RUNOFF.

TRACKING



GROOVES WILL CATCH SEED, FERTILIZER, MULCH, RAINFALL AND DECREASE RUNOFF.

CONTOUR FURROWS

THE CITY OF CALGARY
WATER SERVICES

Surface Roughening

Erosion & Sediment Control Guidelines 2011

Source: Salix Applied Earthcare - Erosion Draw 5.0

© 1994 JOHN McCULLAH

FILE: srfrough.dgn

BMP 2	SEEDING	Erosion Control

Description and Purpose

The planting or placing of seed on disturbed soil after disturbed areas have been topsoiled or otherwise prepared for seeding. Seeding can provide both temporary and permanent cover and root structure to provide effective erosion control.

- **Temporary or Permanent Measure**
- **Use from Stripping and Grading to Final Site Stabilization**
- **Slopes, Stockpiles (Seeding), Borrow Areas, Landscaping**

Applications and Advantages

- Temporary seeding is used on suitable interim areas that are disturbed and require temporary protection. Temporary seeding is encouraged whenever possible to help reduce erosion on construction sites. Temporary seeding is an important component of "phased" construction activities.
- Common areas for temporary seeding include topsoil stockpiles, rough graded areas, berms and other temporary earthen structures.
- Establishing vegetation cover on exposed soils helps protect soil from erosion by raindrop impact, increases infiltration and reduces run-off. after establishment, temporary seeding can reduce sheet erosion by approximately 90% compared to exposed soil conditions (usda, scs, 1976).
- Temporary seeding can reduce maintenance costs for other site controls (i.e. sediment basin maintenance (clean-out) can be significantly reduced if temporary vegetative cover is established in the contributing drainage area). Temporary vegetation cover is also essential to protecting the integrity of other earthen structures used to control sediment (i.e. diversion and containment berms, compost berms).
- Seeding disturbed areas with a suitable mixture of grasses and forbs provides an inexpensive method of stabilizing soils.

Limitations

- Establishing vegetation cover with temporary seeding can be difficult in northern climates (dry, cool, short growing season). Seasonal planting windows may not coincide with the construction schedule.
- Establishing vegetation cover on steep slopes may require additional - and sometimes expensive - measures such as compost blankets, RECPs or hydromulching.
- Vegetation may require regular maintenance, especially adjacent to roadways.
- Reseeding and amendments may be required where there is poor vegetation establishment.
- Reseeding is not appropriate for areas impacted by construction activities/traffic.

Site Preparation

- For permanent seeding, confirm areas to be seeded will be dormant for one year or more or are at final contour and are ready for permanent seeding.
- Ensure concentrated run-off is being diverted away from all exposed slopes and areas to be seeded.
- Conduct soil tests to determine pH and nutrient content, then determine requirements for suitable soil amendments.
- For soil that is compacted, crusted or hardened, the soil should be loosened (with discing, raking or harrowing) and machine-tracked (refer to BMP…, Surface Roughening). Hydraulic planting generally requires less seedbed preparation (generally suited to slopes steeper than 2H:1V, where seedbed preparation is difficult).
- Seed to soil contact is the key to good germination. Prior to permanent seeding, prepare firm (but not compact) seedbed, 75 - 125 mm deep, with at least 75 - 100 mm topsoil depth (or as otherwise specified). The seedbed should be free of large clods and large stones. The prepared surface should be in reasonably close conformity to the lines, grades and cross sections shown on the grading drawings.

Seeding/Amendments

- Use certified Canada No. 1 seed, free of disease, weed seeds or other foreign materials, and meeting the requirements of the Seeds Act.
- Seed to soil contact is the essential for good germination.
- Apply seed immediately after seedbed preparation while the soil is loose and moist. If the seedbed has been idle long enough for the soil to become compact, the topsoil should be harrowed/loosened.
- Always apply seed before applying mulch.
- Uniformly apply seed at the rates specified in the landscaping or erosion control plan.
-

BMP 3	MULCHING	Erosion Control

Description and Purpose

- **Erosion Control Mulches are a Temporary Measure**
- **Use on Slopes, Stockpiles and Other Exposed Soils from Clearing and Grubbing to Final Stabilization**

Mulching is the application of a protective layer of straw/other suitable material to exposed soil surfaces. Straw mulching and/or hydromulching is also used in conjunction with seeding and hydroseeding of critical areas to provide temporary erosion control and promote the establishment of vegetation. Mulching with straw or fiber mulches is also commonly used as a temporary measure to protect bare or disturbed soil areas that have not been seeded. In addition to absorbing raindrop impact and reducing soil erosion, suitable mulches can also help conserve soil moisture, moderate soil temperature, increase infiltration and protect seeds from predators, run-off and wind.

Mulches can be classified as “dry” (i.e. straw, compost, wood chips, RECPs, rock) and “wet” (i.e. wood fibre and paper slurry applied by hydraulic equipment). Straw mulching consists of placing a uniform layer of straw and binding it onto the soil with suitable devices. Hydraulic mulching typically consists of applying (using hydromulching equipment) a matrix of shredded wood fibre (or other suitable fibre), emulsifying agent and tackifier.

Applications and Advantages

- There are a large variety of mulches available for application on a range of slopes and soil types.
- Mulch application provides a relatively low-cost method of controlling erosion and/or promoting plant growth.
- Mulching is most commonly used to provide temporary stabilization of soil, usually until permanent stabilizing vegetation is established.
- On steep slopes, greater than 2.5H:1V, or where the mulch is susceptible to movement (by wind or water), consider hydraulic mulch application, application of a tackifier on the mulch or mechanical anchoring (i.e. straw crimping).
- To promote vegetation development and provide temporary erosion control, mulches can be applied after seeding (or, in the case of hydroseeding; during seeding). Where mulches are used to compliment vegetation establishment, they should be designed to last as long as it takes to establish effective vegetative cover for erosion control.
- Straw mulch is suitable for application to disturbed areas requiring temporary erosion control. Straw mulch is suitable on slopes where moderate rill erosion may occur. Straw mulch can be used in combination with temporary and/or permanent seeding strategies to enhance plant establishment.

- Hydraulic mulch is suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established, and disturbed areas that will be redisturbed following an extended period of inactivity.

Limitations

- Mulches should be anchored on steep slopes (2.5H:1V or steeper) and/or where they are susceptible to movement by wind/water.
- Punching/crimping of straw may be difficult in sandy soils.
- Certain mulches may be unavailable or too expensive in some areas.
- Cost-effectiveness of mulching large areas can decrease if mulching by hand.
- Long-term erosion control may not occur if the mulch does not provide the required protection time for the establishment of long-term vegetation cover.
- Some mulches (i.e. wood chips, rock cover) may prevent (or slow) vegetation establishment.
- Organic mulches are not suitable for application if delivered in a wet or moldy state.
- Some organic mulches may contain weed seed (i.e. hay) and unwanted plant material.

Implementation

Where feasible/desirable, suitable vegetation should be shredded during clearing activities, providing a local supply of mulch (economical, plus it may provide a reservoir of local seeds).

Site Preparation

- Fine-grade the area of exposed soil.
- Remove large rocks, clods and debris that may prevent contact of the mulch with the soil surface.
- When seeding, follow the guidance in BMP 12 (Seeding).

Mulch Installation

Straw Mulching:

- The length and bulk of cereal straw makes it an excellent mulching product (reduces raindrop impact and moderates soil surface microclimate).
- Straw is weed free, light and readily available in small and large bales.
- Hay should not be used as mulch (contains weed seeds and may attract wildlife).
- For seeded sites, apply 3,500 – 4.500 kg/ha, aiming for 80% cover.
- For unseeded sites, mulch at 4,500 – 6,500 kg/ha, aiming for 90% cover.
- A standard square bale (about 35 kg) covers approx. 90 m^2.
- For this practice to be effective, care should be taken to ensure that straw mulch is in close contact with the soil (rather than just providing cover).
- Straw mulch can be applied by hand or using a straw blower (can blow straw 50 – 80 feet).
- Straw placed on exposed areas and on slopes steeper than 2.5H:1V should be anchored.

BMP 4	SILT FENCE	Sediment Control

Note: Silt fence is a **sediment control practice** (occasionally used as a temporary diversion structure) intended to supplement appropriate upstream run-off and erosion controls.

Definition and Purpose

- **All stages of construction**
- **Perimeter control for stockpiles, slopes and site perimeters**

- Silt fence is a permeable geotextile barrier installed vertically on support posts and entrenched in the ground. Silt fence is installed along contours and in "smile" and "J-hook" patterns designed to detain sediment-laden sheet flow from small, disturbed areas.
- Properly designed, installed sections of silt fence can capture sand and coarse silt-size particles (while silt fence may provide some limited filtering of sediment-laden water, it is most effective at providing temporary detention of sediment-laden run-off, allowing settling of coarse sediment).
- In combination with upstream erosion and run-off controls, silt fence can be an effective way to capture and settle coarse sediment from small areas subject to sheet flow.
- Silt fences generally have a useful life of one up to season (dependent on the amount of maintenancerequired).

Applications and Advantages

- Silt fence is only suitable for detaining sediment-laden flow from locations generating low volume overland sheet flows.
- Silt fence is most effective for trapping larger particle sizes (coarse silt to sand): Finer-size material (fine silt and clay- size) is not detained.
- Silt fence is a suitable practice for the toe of short, exposed cut and fill slopes, as a contour boundary between a construction site and other critical areas such as environmentally sensitive areas and as a stockpile perimeter control.

Limitations

- Improperly applied or installed silt fence can increase erosion.
- Failure to properly plan, install, inspect and maintain silt fence can result in major sediment releases.
- Silt fence is a temporary sediment control practice, requiring a high degree of inspection and maintenance. As a temporary practice, silt fence should be removed when the contributing area is stabilized.
- Silt fence should be considered, wherever possible, as a "last line of defence". There isno substitute for controlling upstream run-off and erosion.
- Long, continuous runs of fence concentrate run-off and commonly lead to failures.
- Do not install silt fence at locations where concentrated run-off occurs or may occur. Silt fences are not designed to withstand high heads of water. Concentrated flows rapidly undercut silt fence or knock it over, a common cause of fence failure and a major cause of off-site sediment releases.
- Silt fence is not effective unless properly sliced or entrenched and compacted into the ground.
- Silt fence should not be designed to impound sediment or water more than 0.5 m high.

- Silt fence does a poor job of controlling clay and fine silt in sediment-laden run-off: Run-off is usually not detained long enough to allow settling of fine soil particles (designers should consider site soils and include appropriate source and detention controls to prevent releases of sediment off- ite). Clays and fine-silts can have extremely deleterious impacts on receiving water-courses and off-site areas.
- Do not place silt fence on a slope. Unless intended as a diversion, long runs of silt fence that do not follow a contour can cause diversion of run-off, resulting in washouts at low spots.

Implementation

- Clean run-off should be diverted away from sediment containment controls such as silt fence.
- Always determine how run-off volume is going to exit. Contributing drainage area (followed by soil type) is the primary consideration when determining silt fence suitability, location and quantity.
- Maximum sedimentation behind the fence should not exceed half the fence height or 0.3 m.
- Silt fences are not to be constructed in areas where flow velocity is expected to exceed 0.03 m/sec.
- Steel posts (minimum 2 kg/m with projections for fastening fence), driven 600 mm into the ground are recommended. Wood posts (100 mm in diameter, with a minimum length of 1.35 m) are an alternative, but may be difficult to drive 600 mm into the ground or may not be reusable.
- Adequate post spacing and proper entrenchment of fence are the two most critical installation requirements.

Location Requirements:

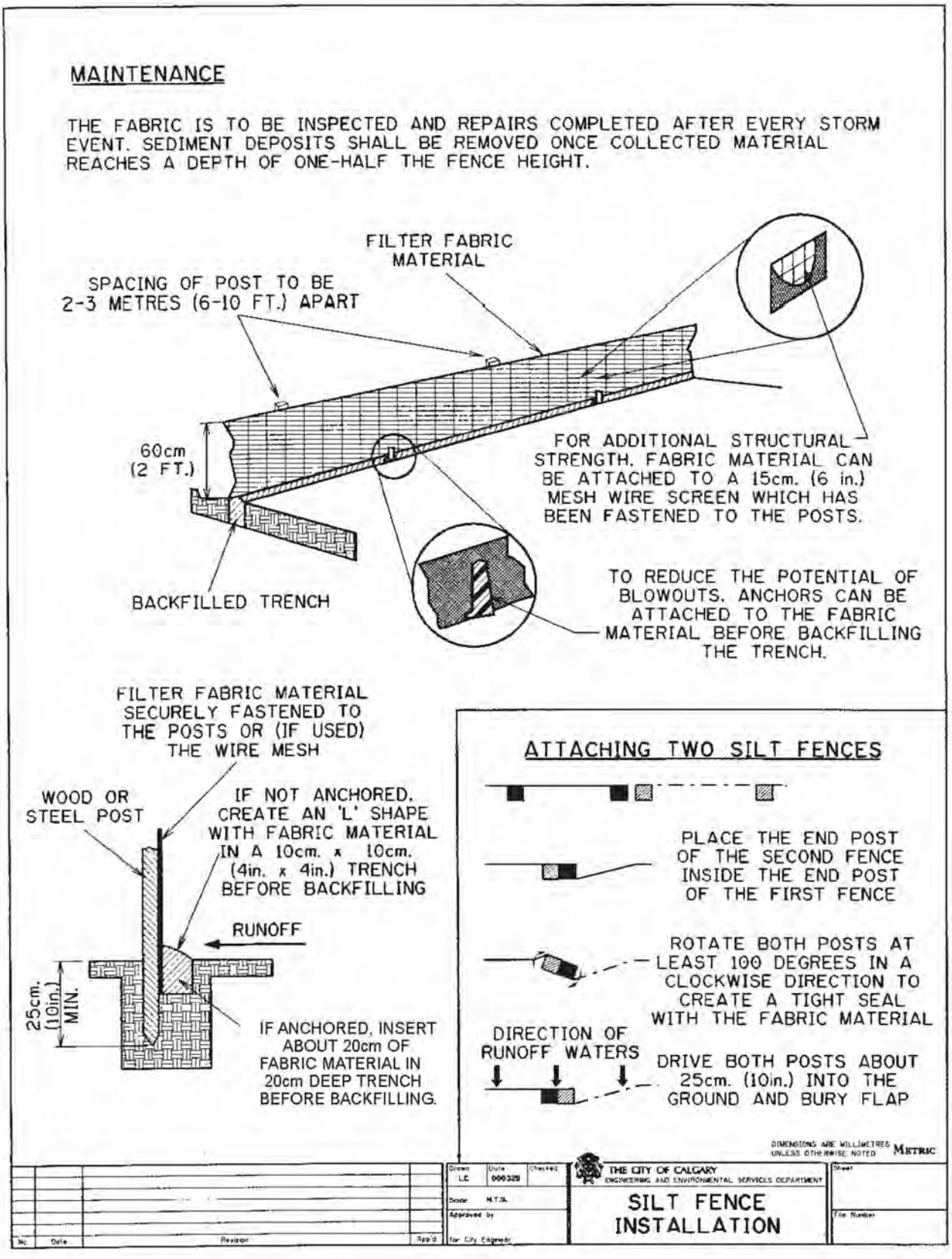
- Contributing drainage area should not exceed 0.1 ha per 30 m of fence.
- The run-off path length above a fence should not exceed 30 m.
- Maximum slope gradient upstream of a fence should not exceed 2H:1V.
- Unless intended as a temporary diversion structure, silt fence should be installed along a contour, with ends of the fence pointed upslope.
- Fence should be installed at least 2 m from the toe of a slope.
- Fence should not be used in drainage swales, except for very low volume swales (flow velocity < 0.03 m/sec) with grades not exceeding 2% and contributing areas not exceeding 0.8 ha.

Installation Requirements:

- Silt fence should be firmly entrenched and anchored into the soil.
- Fence height should not exceed 0.9 m. However, the ponding height of water should not exceed 0.5 m (install stabilized overflow sections on long runs of fence).
- Silt fence should be firmly attached to posts (steel T-posts or 100 mm (4”) diameter wood stakes), driven at least 600 mm into the ground on the downstream side of the fabric.
- Minimize joints by installing fence from a continuous roll. Where joints are required, construct at least a 0.4 m overlap and wrap the end posts together.
- Run-off detention requires storage space behind the fence. Fences constructed on a slope have considerably less retention capacity. Always install the fence at least 2 m from the toe of slopes.
- The maximum length of each run of silt fence should generally not exceed 40 m.

Inspection and Maintenance

- Inspect this sediment control practice a minimum of every seven days and after significant rainstorm/snowmelt events sufficient to cause surface run-off.
- Ensure silt fences are providing the required detention of run-off and sedimentation.
- Except where used as a temporary diversion, ensure silt fence is installed on contour (or in effective “smile” or “J-hook” configurations), with end sections of fence pointed upstream.
- Do not accept long, linear runs of silt fence installed without J-hooks or “smiles”.
- Check all sections of fence for adequate entrenchment by pulling firmly upwards on the fence (fence which moves is not adequately trenched/sliced and compacted).
- Check all sections of fence are firmly secured to posts. Ensure post spacing does not exceed 2 m.
- Ensure stabilized overflows are installed at least every 30 m on long runs of fence. Ponded water should not exceed 0.5 m depth.
- Remove accumulated sediment when it reaches 50% of impoundment height (i.e. 0.25 m).
- Replace damaged fabric and address flow-around and/or undermining problems immediately.
- Silt fence is a temporary sediment control practice: Remove and appropriately dispose of fence as soon as the contributing area is stabilized.



Traditional Trenching Method for Silt Fence Installation

APPENDIX E - EXAMPLE ENVIRONMENTAL MONITORING FORM

Environmental Monitoring Report

Date: _____

Project: _____

Environmental Monitor: _____

Client: _____

SITE CONDITIONS:

Weather: _____

Temperature: _____

Precipitation:_____

Summary of Activities and Instructions:

ESC Measures, notes and comments:

General Comments and Conversations:

Pictures:

APPENDIX F – SPILL RESPONSE PLAN

In the event of a spill, all workers shall immediately take the necessary steps to abate an uncontrolled discharge. The contractor will provide the necessary labor, equipment, materials and absorbents to contain and remove the spill, clean up the affected area, dispose of waste materials at an approved disposal site, as well as restore the area and take precautions against a similar incident occurring. If a spill of fuel, oils, lubricants or other harmful substances occurs, the following procedures will be implemented.

- Ensure Safety
    - Ensure personal/public, electrical and environmental safety.
    - Wear appropriate Personal Protective Equipment (PPE).
    - Never rush in, without understanding the product spilled before taking action.
    - Warn people in immediate vicinity.
    - Ensure that no ignition sources are present**,** if the spill is of a flammable material.
- Stop the Flow (When Possible)
    - Act quickly to reduce the risk of environmental impacts.
    - Close valves, shut off pumps or plug holes/leaks, set containers upright.
    - Stop the flow of the spill at its source.
- Secure the Area
    - Limit access to spill area.
    - Prevent unauthorized entry onto site.
- Contain the Spill
    - Block off and protect direct paths to water.
    - Prevent spilled material from entering the water.
    - Use spill sorbent material to contain spill.
    - If necessary, use a dike or any other method to prevent any discharge off site.
    - Make every effort to minimize contamination.
- Notify / Report
    - Report any spills to the Construction Supervisor and EM immediately.
    - If the spill meets the threshold for reportable levels (table below), EMBC will be contacted within 24 hours
- Clean-Up
    - Technical assistance is available from the EM on clean-up procedures and residue sampling.
    - All equipment and/or material used in clean-up (e.g. used sorbents, oil containment materials etc.) must be disposed of in accordance with BC Ministry of Environment requirements. The EM will assist in compliance with federal and provincial legislation.
    - Accidental spills may produce special wastes (e.g., material with > 3% oil) and contaminated soil. All waste disposal must comply with the BC Hazardous Waste Regulations and the BC Environmental Management Act.

- Waste-contaminated sorbent material may not be disposed of in a landfill without prior approval from MOE and the landfill operator.
- Contaminated soil must be treated and dealt with as required on a site-specific basis and must comply with the requirements of the BC Contaminated Sites Regulations.

REPORTABLE SPILL QUANTITIES

Substance	Quantity to Land	External Reporting
Flammable Gas (propane)	10kg or 10 mins	EMBC
Non-Flammable Gas (CO2)	10kg or 10 mins	EMBC
Flammable Liquids	100 L	EMBC
Corrosive Liquids (battery acid)	5kg or 5 L	EMBC
Environmental Hazards (ie PCBs)	1 kg or 1 L	EMBC
Oil and Waste Oil	Great than or equal 1 L	EMBC
Antifreeze	5L	EMBC
Any Spill to Water	Any amount	EMBC