

February 21, 2018

Gilles Lussier
Highway Engineering Services, Parks Canada Agency
301B West 3rd Street
Revelstoke, B.C. V0E 2S0

Email: gilles.lussier@pc.gc.ca

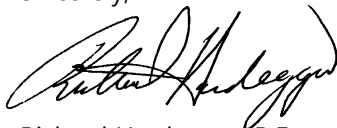
**Re: Basic Impact Analysis for Culvert Replacement - Radium Hot Springs Overflow Parking Lot,
Hwy 93S KM 100.6, Highway 93S Kootenay National Park**

Dear Mr. Lussier:

Barr Engineering and Environmental Science Canada Ltd. (Barr) is pleased to submit the attached Basic Impact Analysis report for the replacement of the culvert passing under the Radium Hot Springs overflow parking lot (KM 100.6).

If you have questions or would like more information, please contact our project manager, Paul Fraser (403-592-8321, pfraser@barr.com), or me (952-832-2629, rhardegger@barr.com).

Sincerely,

A handwritten signature in black ink, appearing to read "Richard Hardegger". The signature is fluid and cursive, with the first name being more prominent.

Richard Hardegger, P.Eng.
Vice President/ Principal in Charge

Enclosure

Basic Impact Assessment for Culvert Replacement - Radium Hot Springs Overflow Parking Lot at Hwy 93S km 100.6



Prepared for
Parks Canada Agency

February 2018

Executive Summary

Sinclair Creek Culvert Replacement

Highway 93S is a major transportation corridor joining Banff National Park (BNP) and Kootenay National Park (KNP). The highway is the most direct route from BNP to Radium Hot Springs, which is a major tourist attraction. Recent upgrades in the Radium Hot Springs area include highway improvements and parking lot expansions, and replacement of the culvert at km 100.6 is proposed here. The culvert carries Sinclair Creek below Highway 93S and Parks visitor parking lots, and is currently perched preventing fish from accessing habitat between the culvert and waterfall downstream. Works to replace the existing corrugated steel plate culvert include topsoil and vegetation removal, asphalt concrete pavement (ACP) removal and milling, excavation, channel diversion, culvert removal and disposal, culvert installation, headwall installation at outlet and inlet, associated channel habitat work, backfill and granular backfill over new culvert, paving parking lot area of impacted are, topsoil and vegetation replacement, road curb replacement, paint marking and replacement of road signage.

The following BIA is based on construction plans issued for 60% review and the analysis of impacts to valued components may change with altered construction plans.

Key Mitigations Notice

The following mitigations are highlighted for their potential to significantly affect project planning. **This list does not replace the comprehensive mitigation requirements and details provided in Section 8 of this BIA.**

Requirement/ Mitigation	Description	Page
QEP-certified Environmental Protection Plan (EPP)	Due from the contractor 10-15 days before start of construction; includes Erosion and Sedimentation Control (ESC) Management Plan, a Spill Response Plan (SRP), an Emergency Response Plan, and a Fire Prevention Plan; needs Lake Louise Yoho Kootenay (LLYK) Field Unit (FU) approval.	23
Bio-degradable hydraulic fluids	To minimize contamination, and at the discretion of the Environmental Surveillance Officer (ESO) and Departmental Representative, biodegradable hydraulic fluids may be required for machinery working within drainages, wetlands, watercourses and water bodies.	25
Water Management Plan	The contractor will prepare a detailed water management plan regarding the temporary diversion of Sinclair Creek during Project activities. It will be written under the guidance of a Qualified Aquatic Environmental Specialist (QAES) or a Qualified Environmental Professional (QEP), and must be reviewed and approved by the LLYK FU before Project activities begin.	26
Fish Salvage	A fish salvage will be completed by a QEP (such as a Professional Biologist) prior to diverting flow and proper equipment such as screens will be used to prevent fish from entering pumps and diversionary flow structures. Results of the fish salvage will be forwarded to the LLYK ESO and will include species, sex, age, weight, and fork length	26

Whirling Disease Prevention	With the discovery of whirling disease in summer of 2016 in BNP, Parks Canada has implemented decontamination procedures for Permitted Users conducting water-related activities (Parks Canada 2016b)	27
Migratory Bird Timing Window	Removal of vegetation used by birds (either migratory or non-migratory) will be conducted prior to the Zone A3 nesting period April 14 to August 19, Environment and Climate Change Canada 2017), wherever possible	30
Traffic Management Plan for Bighorn Sheep	The traffic management plan will include strategies and contingencies for the presence of bighorn sheep on or near the Project area and the adjacent highway.	30
Northern Rubber Boa	A Qualified Environmental Professional (QEP) will conducted a preconstruction survey before ground disturbance activities occur. Potential rubber boa habitat (rock outcrops, rock piles, rock bluffs, or talus slopes) will be surveyed for snake presence.	30

Basic Impact Assessment for Culvert Replacement - Radium Hot Springs Overflow Parking Lot at Hwy 93S km 100.6

February 2018

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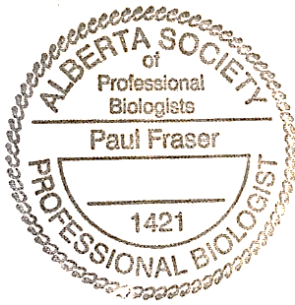
Certifications



Paul Fraser, Senior Ecologist
P. Biol.

February 21, 2018

Date



Acronyms

Acronym	Description
ACP	Asphalt Concrete Pavement
AOA	Archaeological Overview Assessment
ASRD	Alberta Sustainable Resource Development
Barr	Barr Engineering and Environmental Science Canada Ltd.
BC	British Columbia
BC CDC	BC Conservation Data Centre
BC MOE	British Columbia Ministry of Environment
BIA	Basic Impact Analysis
BNP	Banff National Park
BMPs	<i>Parks Canada National Best Management Practices for Roadway, Highway, Parkway and Related Infrastructure</i> (Parks Canada, 2015a)
CCME	Canadian Council of Ministers of the Environment
CIP	Cast-In-Place
COSEWIC	Committee on the Status of Endangered Wildlife
CSP	Corrugated Steel Plate
DFO	Fisheries and Oceans Canada
EPP	Environmental Protection Plan
ESC	Erosion and Sedimentation Control
ESO	Environmental Surveillance Officer
FU	Field Unit
KNP	Kootenay National Park
LLYK	Lake Louise Yoho Kootenay
MBCA	<i>Migratory Birds Convention Act</i>
NTU	Nephelometric Turbidity Unit
PCA	Parks Canada Agency
PECG	Palmer Environmental Consulting Group
QAES	Qualified Aquatic Environmental Specialist
QEP	Qualified Environmental Professional
RAP	Restricted Activity Permit
SARA	the Canadian <i>Species at Risk Act</i>
SDS	Safety Data Sheets
SRP	Spill Response Plan
TMP	Traffic Management Plan
WGB	Well-Graded Base
VC	Valued Component

1.0 Project Title and Location

Basic Impact Assessment for Culvert Replacement –
Radium Hot Springs Overflow Parking Lot at Hwy 93S km 100.6

2.0 Proponent Information

Parks Canada Agency (PCA)

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3.0 Proposed Dates

Planned commencement: 2018-07-01

Planned completion: 2018-10-31

4.0 Internal Project File

5.0 Project Description

This Project description (**Appendix 1**) outlines the proposed culvert replacement at km 100.6 along Highway 93S.

5.1 Project objective

The primary objective of this project is to replace the existing 180 m long corrugated steel plate (CSP) culvert that runs underneath the Radium Hot Springs overflow parking lot (new location of the South Park Gates) and is parallel to Highway 93S at km 100.6. The general scope of work will be to excavate and install a new culvert similar to the current culvert alignment, remove and dispose of existing culvert and associated road and parking lot works for culvert work. See attached map for location (**Appendix 2**).

Short extension/truncations to the aforementioned limits may be proposed due to Project circumstances and may include targeted repairs to roadway, signs, curb, parking lot and concrete barriers in accordance with the Parks Canada National BMPs for Roadway, Highway, Parkway and Related Infrastructure (Parks Canada 2015a).

5.2 Project rationale

Highway 93S is an essential component of the transportation network that provides both a scenic route for tourists and cyclists through Kootenay region, and is vital for commercial transport into southern BC. The existing culvert was installed in the early 1960's with the latest inspection report identifying damage including deformation, cracking and corrosion of the culvert and damage to both inlet and outlet headwalls. Culvert replacement and roadside improvement will improve Parks assets and safety for users at this location.

5.3 Project location

Primary location

British Columbia, Highway 93S at km 100.6, Radium Hot Springs overflow parking (new site of Proposed South Gate Kiosks).

Footprint size

The footprint of impacted area is primarily within the Highway 93S right-of-way, existing day use parking lot and Sinclair Creek to accommodate the new culvert alignment. The size of the footprint is about 11,000 m², which includes the Radium Hot Springs overflow parking lot, and 50 m on either side of the culvert along Highway 93S for traffic accommodation and the existing water channel.

Offsite location

Pit 16 and/or Hector will be used as staging areas subject to approval. No other offsite locations have been identified at this time.

Footprint for offsite pits will be confined to the existing disturbed footprint at these locations.

5.4 Project phases and activities

Site preparation/access activities

Minimal site preparation for associated work will be required. The Radium Hot Springs overflow parking lot will be used for laydown area. Any other work will be part of the construction operation.

Dimensions of structures, size of excavation, area of disturbance, fill requirements

The existing culvert is 180 m long CSP arch section of 3.5 m span and 2.3 m rise. It is expected this structure will be removed and disposed of. From the previous inspection, this culvert has been identified as a potential fish habitat (Parks Canada 2006).

Preliminary designs propose a new rectangular precast concrete box culvert with 3.5 m span and 2.9 m rise (outer dimension), about 170 m long. The culvert design is to be fish bearing.

Diversion pipes will be used to temporarily accommodate the flow of the Sinclair Creek through the Project area. The pipe sizes will be specified by the contractor, and will accommodate flow from the 1:10 year storm (**Appendix 3**).

The excavation footprint is approximately 3,000 m² for culvert installation and removal. Construction limits extending within the parking lot and approximately 50 m from inlet and outlet of the culvert along Highway 93S for traffic accommodation.

It is expected some activities (e.g. rip-rap/rock modification for the energy dissipation pool, the installation and removal of temporary diversion flows, potential scaffolding for headwall renovations) will take place within the channel to accommodate the new culvert. At this time, the extents of limits upstream and downstream of the channel are not definite and will depend on the Contractor's work plan. Anticipated impact to the channel will be in the range of 10 m – 15 m at the outlet, and 15 m – 20 m at the inlet. Minimizing impact to the stream will be of utmost importance during the time of construction and the Environmental Protection Plan (EPP) will be reviewed to ensure low impact to the surrounding area.

Fill will be required to backfill the proposed culvert.

Road structure replacement will require granular fill and asphalt concrete pavement. All fill is expected to come from outside the Park. Fill brought in from outside the Park will require proof that it is weed free. This may be in the form of a certification or approval by the Environmental Surveillance Officer (ESO) of the fill source.

Construction activities, methods, materials to be used

Activities for culvert replacement include: topsoil and vegetation removal (~200m² at the inlet and ~225m² at the outlet - Figure 5-1 and Figure 5-2), asphalt concrete pavement (ACP) removal and milling, excavation, channel diversion, culvert removal and disposal, culvert installation, headwall installation at

outlet and inlet, associated channel habitat work, backfill and granular backfill over new culvert, paving parking lot area of impacted area, topsoil and vegetation replacement, road curb replacement, paint marking, and replacement of any road signage removed. Topsoil will be stored separately and if more topsoil is required in replacement it will require proof of being weed free (certification). Seed mix will be supplied by PCA (DeLong 2016).

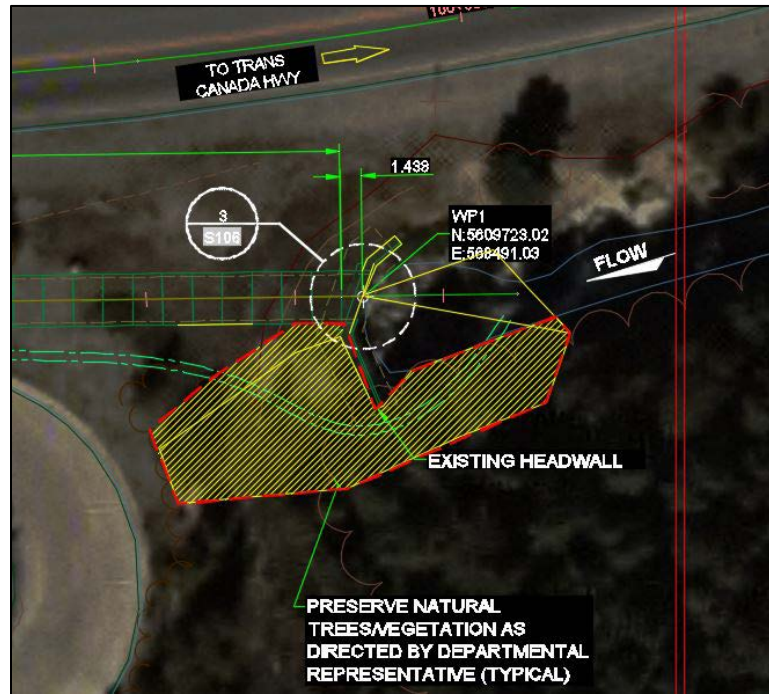


Figure 5-1: Vegetation area to be cleared (inlet)

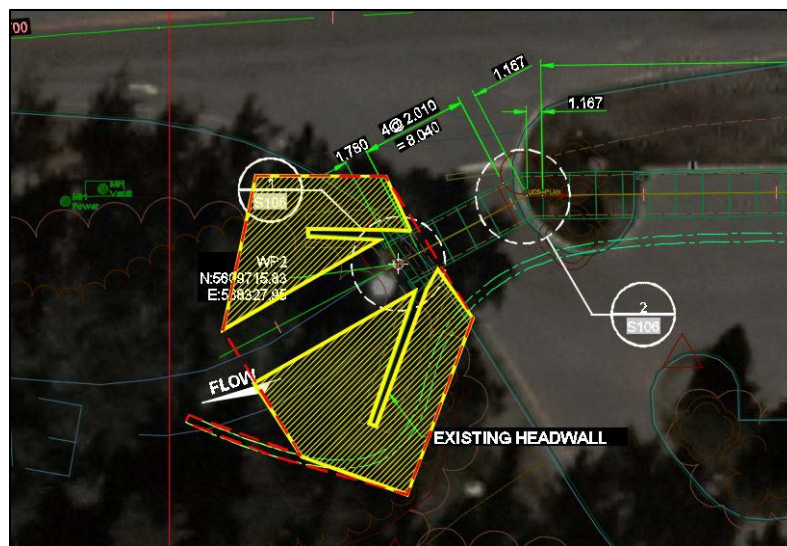


Figure 5-2: Vegetation area to be cleared (outlet)

Materials used are precast concrete, concrete for headwalls and curb and gutter, granular base material, asphalt aggregate and bituminous materials for ACP production, catch basins, fuel for equipment and vehicles. Dump trucks, paver, loaders, excavator, milling machine, packers and small vehicles will be used.

Changes to utilities, capacity or demand, new lines

Existing utilities currently under and surrounding the parking lot near the culvert. Utilities will be relocated with the removal of existing culvert as required. At this time relocation or reinstallation, options have not been identified. Existing underground utilities include telephone line, electrical and storm line.

Associated project work (e.g. paving, vegetation removal, excavation, etc.)

Associated work along Highway 93S and within the parking lot includes culvert removal and installation, vegetation removal at existing and proposed culvert inlet and outlet headwalls, channel work, catch basin installation, parking lot paving, line painting and curb replacements.

Toxic or hazardous materials (e.g. cast in place concrete, chemicals, fuels, paints, solvents, explosives)

Bituminous materials (ACP), cast in place concrete. Non-toxic water based traffic paint. Fuel for construction equipment and vehicles. Biodegradable hydraulic fluids may be an option as a means to minimize contaminating surface and groundwater at the Project site.

Operational requirements (materials, maintenance procedures, monitoring, waster & wastewater management requirements)

Materials, monitoring and waste disposal will be in accordance with contract specifications. Before commencement of construction, the contractor will prepare an EPP, prepared and certified by a Qualified Environmental Professional (QEP) (i.e. Professional Biologist or Professional Agrologist) and in accordance with Parks Canada Environmental Procedures. The EPP must be approved by the Lake Louise Yoho Kootenay (LLYK) field unit (FU).

Site modifications, structure removals, site reclamation activities

Site modifications will include new culvert and headwalls, associated works for channel streambed, existing culvert and headwalls to be removed.

Plans and drawings

See attached (**Appendix 3**).

5.5 Detailed construction methodology

Project activities over the construction program will include the following aspects:

- Review and approval all submittals (EPP, Traffic Management Plan [TMP], schedule, Safety, Restricted Activity Permits [RAPs], etc.)
- Pre-construction Meeting.
- Survey, layout and staging preparation.

- Traffic Accommodation and detour works.
- Stripping and asphalt removal where required.
- Temporary roadway support (lock blocks, retaining wall, shoring) if required (not anticipated).
- Excavation for temporary creek diversion & removal of existing culvert.
- Removal of stonework and stone facing from existing headwalls.
- Saw-cut exiting headwalls for installation of the concrete box section.
- Placement of bedding material for culverts with 25mm Well-Graded Base (WGB) material.
- Supply and installation of Precast Concrete Box culvert sections and seals.
- Installation of reinforcement dowels on headwalls and placement of Cast-In-Place (CIP) pigmented concrete with form liner to create rock facing on headwalls.
- Placement and compaction of Granular backfill around culverts with 50 mm WGB material as shown on the drawings.
- Placement and compaction of common backfill around the culvert.
- Placement of Riprap where required and as shown on the drawings.
- Diversion of water through the new bridge culvert.
- Seeding and clean up at inlet / outlet locations.
- Reinstatement of the parking lot to the satisfaction of PCA.

5.6 Summary of Project phases and activities

Table 5-1: Summary of Project in relation to Project phases and activities

Project Phases	Associated Activities	Project Site Specifics
Construction / Site Preparation	Supply and storage of materials	To be determined in and approved by ESO
	Demolition	Limited demolition of existing roadway structure
	Disposal of waste	Construction, trade, hazardous waste, fuel and domestic waste materials to be removed from the National Parks
	Use of machinery	For asphaltic surfacing, excavation, clearing, backfilling, grading and hauling
	Transport of materials / equipment	Transport of construction materials to site (asphaltic surfacing material, construction equipment) and removal of construction wastes
	Use of chemicals	Paint, which will be applied only to the new asphaltic surface. Bituminous materials and fuel for construction equipment and vehicles
	Traffic control	Traffic controllers and signs will be present on the roadway during construction activities
Operation/Decommissioning	Waste disposal	Construction, trade, hazardous waste and domestic waste materials to be removed from the National Parks
	Use of chemicals	Construction, trade, hazardous waste and domestic waste materials to be removed from the National Parks
	Vehicle traffic	General public, visitors and commercial vehicles

6.0 Valued Components Likely to Be Affected

Using the Effects Identification Matrix (**Appendix 4**), the following potential interactions between the Project and the surrounding environment were identified. These Valued Components (VCs) are those likely to be affected by Project activities or outcomes, and can be classified as either natural or cultural.

Barr conducted desktop searches for background information pertaining to components that may potentially be directly or indirectly affected by the Project and associated activities. The following provides a list of sources searched:

- Federal Contaminated Sites Inventory (Government of Canada 2017)
- Parks Canada Agency Biotics Web Explorer (Parks Canada 2017a) (**Appendix 5**)
- Species at Risk Public Registry (Government of Canada 2002) (**Appendix 6**)
- BC Ministry of Environment iMap (BC MOE 2017)
- Field studies conducted in the area (Barr 2017)
- LLYK provided data (Parks Canada 2014)
- Species Recovery Planning KNP – 2015 (**Appendix 7**)
- National Historic Sites (Parks Canada 2017c)

Table 6-1 summarizes identified VC's and the rationale for their selection.

Table 6-1: Valued components in the Project area and rationale for selection

Valued Component (VC)	Rationale for Selection
Air Quality and Noise	Potential effects on air quality and noise levels
Soil and Landform	Potential effects on soil and land formations surrounding Sinclair Creek
Water	Project activities have the potential to impact surface water, groundwater and watercourse crossings
Fish and Fish Habitat	<ul style="list-style-type: none"> • Regulatory requirements; potential to cause serious harm to fish as defined under the federal <i>Fisheries Act</i> (i.e. death of fish or permanent alteration or destruction of fish habitat) • Potential effects on fish populations • Potential to spread whirling disease
Flora	<ul style="list-style-type: none"> • Potential impact on SARA-listed species • Invasive species management
Fauna	<ul style="list-style-type: none"> • Potential impact on SARA-listed species • Potential impact on migratory birds and contravention of <i>Migratory Birds Convention Act</i>
Heritage Resources	Potential impacts on both known and yet-to-be discovered archaeological resources
Visitor Experience	Potential effects on visitors' experience

6.1 Natural resources

6.1.1 Air quality and noise

Kootenay National Park (KNP) historically has a high air quality index, and Project activities have the potential to locally impact this valued component, primarily due to dust generation. The Park also has low noise levels, with the primary source being traffic along Highway 93S. Project activities will temporarily produce typical noise levels associated with heavy machinery and construction. The localized disturbance to both air quality and noise requires that this VC be carried forward in this assessment.

6.1.2 Soil and landforms

The Project area lies wholly within the Montane Spruce biogeoclimatic zone and Daer ecosection of the Montane ecoregion. The Montane Spruce biogeoclimatic zone is commonly characterized by eutric brunisols, orthic gray luvisols or brunisolic luvisols in wet areas, or humo-ferric podzols and dystic brunisols in wet areas, overlying loamy to clayey morainal deposits (Meidinger and Pojar 1991). The DR5 (Daer 5) ecoregion is comprised of medium and fine calcareous textured till and variably textured calcareous ice contact stratified drift. Overlying soil is an orthic eutric brunisol with a lower layer of eluviated eutric brunisol and orthic gray luvisol (Achuff *et al* 1984).

Since Project activities have the potential to impact the soils and landforms, particularly in areas with earthworks and watercourse channels, this VC will be carried forward in this assessment.

6.1.3 Water

6.1.3.1 Surface Water

The culvert at km 100.6 conducts Sinclair Creek beneath Highway 93S and the Radium Hot Springs overflow parking lot, where it drains into the Columbia River approximately 6km downstream. Water flow is fast due to constricted area through the culvert and there is little substrate (primarily cobbles) within the structure.

6.1.3.2 Groundwater

There are no groundwater wells within 300 m of the Project area registered with the BC Water Well Information Database (BC MOE 2017). This VC does not require further specific evaluation but will be carried forward in the general water VC.

6.1.4 Fish and fish habitat

Sinclair Creek is a permanently flowing water body, with a cobble / boulder substrate indicating high flow rates. The culvert outlet is perched approximately 150 cm, resulting in an 8m wide by 2m deep plunge pool. The perch is a barrier to fish passage upstream of the culvert. Some fish habitat is located within 100m upstream of the culvert inlet. Sheltered, slow moving water areas are found along the creek margins, with 6% gradient.

A desktop review of the BC Fisheries Information Summary System and Habitat Wizard (BC MOE 2017) identified 6 species of fish known to occur within Sinclair Creek:

- Bull trout (*Salvelinus confluentus*) – Blue Listed
- Brook trout (*Salvelinus fontinalis*) - Exotic
- Kokanee salmon (*Oncorhynchus nerka*) - Yellow
- Mountain whitefish (*Prosopium williamsoni*) - Yellow
- slimy sculpin (*Cottus cognatus*) - Yellow
- prickly sculpin (*Cottus asper*) - Yellow

In the 6 km reach where the culvert is located, brook trout are the only species known to occur (Shelley Humphries, PCA, personal communication, December 19, 2017). Fisheries assessments conducted along Sinclair Creek in 2016 (PECG 2016) and 2017 (Barr 2017) identified the area around the culvert at km 100.6 as fish bearing habitat, although no electrofishing was conducted to confirm species presence or absence.

A self-assessment was completed ascertaining that the Project was not expected to cause serious harm to fish or fish habitat as defined by the *Fisheries Act*, after mitigation measures are applied (PECG 2017). Details of the rationale for Self-Assessment and Pathways of Effects are provided in (**Appendix 8**).

Due to historical fish presence and moderate quality fish habitat in Sinclair Creek, this VC will be carried forward in this assessment.

6.1.5 Flora

The Daer 5 ecosection is dominated by white spruce (*Picea glauca*), douglas fir (*Pseudotsuga menziesii*), feather moss (*Hylocomium splendens*), and buffaloberry (*Shepherdia canadensis*) (Achuff *et al.* 1984).

A list of vegetation elements of management concern (VEMCs) for the Project area was compiled from:

- The Parks Canada Biotics Web Explorer (Parks Canada 2017a)
- The Multi-species Action Plan for Kootenay National Park (Parks Canada 2017b)
- The Canada *Species at Risk Act* (SARA, Government of Canada 2002)
- The BC Conservation Data Centre (BC CDC) Habitat Wizard (BC CDC 2017)
- The BC CDC Species Ecosystems Explorer (BC CDC 2017)

SARA-listed species

One SARA listed species was listed in Kootenay National Park:

Whitebark pine (*Pinus albicaulis*) is typically found in cold, windy, high elevation or high latitude sites and as a result, many stands are geographically isolated. It is a stress-tolerant pine and its hardiness allows it to grow where other conifer species cannot. Whitebark pine is ecologically very significant in maintaining snow pack and regulating runoff, initiating succession after fire or other disturbance events, and providing seeds that are a high-energy food source for many wildlife species (COSEWIC 2010). No individuals were noted within the Project area during the 2017 vegetation assessment (Barr 2017). This VC does not require further specific evaluation; however, Project activities will follow appropriate PCA BMPs

(e.g. clause 7.6) to minimize potential for impact to rare plants (Parks Canada 2015a). This will be in addition to mitigation measures outlined in Section 8 of this BIA. If vegetation clearing footprints change, this species can be surveyed for outside of the early and late season rare vegetation timing windows as it is identifiable year round.

Other species of interest

Limber pine (*Pinus flexilis*) was noted near km 100 (11N 568072 5609769), approximately 500 m from the Project area during 2017 vegetation surveys (Barr 2017). Another individual was noted in a 2015 survey as well, near km 101 (11N 568076 5609763) (TTEBA 2015). This species is not currently protected under SARA but is categorized as “Endangered” by the Committee on the Status of Endangered Wildlife (COSEWIC).

Invasive species

Six noxious weeds were recorded during the early and late season vegetation surveys conducted in 2017 (Barr 2017):

- Creeping thistle (*Cirsium arvense*)
- Oxeye daisy (*Leucanthemum vulgare*)
- Spotted knapweed (*Centaurea stoebe*)
- Field sow thistle (*Sonchus arvense*)
- Meadow buttercup (*Ranunculus acris*)
- Common mullein (*Verbascum thapsus*)

Oxeye daisy, spotted knapweed and common mullein are also listed within the Project area on the Parks Canada Invasive Species Occurrence Database (Parks Canada 2015b).

The flora VC including invasive vegetation species will be carried forward in the assessment.

6.1.6 Fauna

A list of wildlife species listed under SARA that are known to occur within KNP was compiled by querying the following data sources:

- Parks Canada Agency Biotics Web Explorer (Parks Canada 2017a) (**Appendix 5**)
- Species at Risk Public Registry (Government of Canada 2002) (**Appendix 6**)
- The Multi-species Action Plan for KNP (Parks Canada 2017b);
- The BC Conservation Data Centre (BC CDC) Habitat Wizard (BC CDC 2017)
- The BC CDC Species Ecosystems Explorer (BC CDC 2018)
- Recovery planning species lists for KNP as developed by LLYK field unit (**Appendix 7**).

The Daer 5 ecosite is suitable habitat for the SARA listed olive-sided flycatcher and BC-listed bighorn sheep (Achuff *et al* 1984). Species identified as having ranges overlapping the Project area are listed in Table 6-2, and species with low, moderate or high potential to be found within the Project area are bolded.

Table 6-2: Federally and provincially listed wildlife species with potential occurrence within the Project area

Species	SARA ¹	COSEWIC ²	Potential for occurrence within Project footprint
Mammals			
American badger (<i>Taxidea taxus jeffersoni</i>)	Endangered	Endangered	Nil – suitable soil for digging and prey (ground squirrels and marmots) limited. No impact anticipated from the project
Little brown myotis (<i>Myotis lucifugus</i>)	Endangered Schedule 1	Endangered	Low – roosting habitat (>25 cm dbh trees) lacking. However, there has been recorded presence within the vicinity of the Project area (Marla Bojarski, pers. comm. February 16, 2018)
Birds			
Bank Swallow (<i>Riparia riparia</i>)	Threatened	Threatened	Nil – preferred nesting habitat (sand/silt riverbanks, aggregate pits, road cuts, and stock piles of soil) is absent. No impact anticipated from the Project
Barn swallow (<i>Hirundo rustica</i>)	Threatened	Threatened	Moderate – preferred nesting habitat (artificial structures, buildings, bridges, road culverts) in footprint
Common nighthawk (<i>Chordeiles minor</i>)	Threatened	Threatened	Low – preferred nesting habitat present along roadside but highly disturbed
Olive-sided flycatcher (<i>Contopus cooperi</i>)	Threatened	Threatened	Moderate – nesting habitat adjacent to Project footprint
Short-eared owl (<i>Asio flammeus</i>)	Special Concern	Special Concern	Low – preferred nesting habitat present along roadside but highly disturbed
Western grebe (<i>Aechmophorus occidentalis</i>)	Threatened	Special Concern	Nil – accidental/non-regular visitor, preferred nesting habitat (still water bodies with sufficient emergent vegetation) is lacking. No impact anticipated from the Project
Amphibians			
Western toad (<i>Anaxyrus boreas</i>)	Special Concern	Special Concern	Nil – no breeding habitat observed during Barr's 2017 surveys (Barr 2017a)
Reptiles			
Northern rubber boa (<i>Charina bottae</i>)	Special Concern	Special Concern	Moderate – recorded occurrences at Radium Hot Springs; suitable habitat exists – humid mountainous and dry lowland areas with rock outcrops, rock piles, rock bluffs, or talus slopes (COSEWIC 2016)

¹SARA - Species at Risk Act (Government of Canada 2002)

²COSEWIC - Committee on the Status of Endangered Wildlife in Canada (Government of Canada 2018)

SARA-listed species

American badger. The SARA-listed *Taxidea taxus jeffersonii* subspecies range extends into British Columbia including KNP (COSEWIC 2012a). Habitat requirements are not well understood; however, friable soil suitable for badgers to burrow in appears to be a key element. Open habitats, whether natural (e.g. forest clearings, alpine areas) or human-made are generally used. Suitable habitat in British Columbia is limited and fragmented. No burrows of badgers, or their prey (ground squirrels or marmots) were

observed within the Project footprint during a biophysical assessment conducted on 24 August 2017 (Barr 2017). This species is not expected in the Project footprint.

Little brown myotis are more abundant in older mixedwood forests and forage over still water, rivers and gaps along forest edges (COSEWIC 2013a). Maternity colonies are commonly in warm sites in buildings and other structures, but also infrequently in hollow trees. Bats generally use trees during the same time of year as migratory birds. Proponents abiding by the prohibitions of the *Migratory Birds Convention Act* (MBCA), 1994, and its regulations, (i.e. not disturbing vegetation during the migratory breeding bird season - (Zone A4: April 21 to August 19, Environment and Climate Change Canada 2017) would comply with the SARA prohibitions regarding destruction of a bat residence (Parks Canada 2016a). Though roosting habitat (>25 cm dbh trees) is lacking within the Project area, this species will be carried forward in the assessment since LLYK FU indicated known presence within Sinclair watershed and echolocation data has been recorded in the vicinity of the Project (Radium Hot Springs, Olive Lake, West gate, McKay compound and Redstreak) (Marla Bojarski, LLYK FU, pers. comm. February 16, 2018).

Bank swallow breed in a wide variety of natural and artificial sites with vertical banks such as riverbanks, aggregate pits, road cuts, and stock piles of soil (sand-silt substrates preferred for excavating nest burrows) (COSEWIC 2013b). This species is not expected in the Project footprint.

Barn swallow nest in and on artificial structures, including barns and other outbuildings, garages, houses, bridges and road culverts (COSEWIC 2011). Several buildings near the Project footprint may provide suitable nesting habitat for this species; therefore, it will be carried forward in the effects analysis.

Common nighthawk prefer nesting habitat on gravel substrates in logged or slash-burned areas, and open forests (COSEWIC 2007a). Disturbance caused by constant traffic along Highway 93S and the parking lots near the Project area limits presence in the area. This species is not expected in the Project paving footprint, however, because there is potential, though low, for the species to occur and there are records of nests in the Redstreak area (Marla Bojarski, pers. comm. February 16, 2018), it will be carried forward in the effects analysis.

Olive-sided flycatcher preferred nesting habitat is semi-open coniferous and mixedwood forests along edges and openings near water or wetlands (COSEWIC 2007b). Tall prominent trees and snags are common features of all nesting habitats, which is present within the Project footprint. Vegetation clearing will take place outside of MBCA nesting window (Zone A4: April 21 to August 19, Environment and Climate Change Canada 2017) to avoid disturbance. The presence of suitable nesting habitat in the Project area requires that this species be carried forward in the effects analysis.

Short-eared owl breed in unforested Arctic areas, coastal marshes, and interior grasslands, where voles and other small rodents proliferate. Preferred nesting sites are dense grasslands with areas of small willows (COSEWIC 2008). In British Columbia, breeding usually occurs at elevations below 1,000 m (Cannings 2015). Potential for occurrence within the Project area is low because the area is highly disturbed lacking large patches of dense grass habitat.

Western grebe nest on marshes and lakes with stands of emergent vegetation, stable water levels, extensive areas of open water, and sufficient populations of prey fish (COSEWIC 2014). This species is not expected in the Project footprint due to lack of habitat.

Western toad breed in wetlands including shallow, sandy margins of ponds, streams, rivers, geothermal springs, roadside ditches and beaver ponds. This species overwinters by hibernating below the frost line in squirrel middens, natural crevices, root channels, cavities under spruce trees and abandoned beaver lodges. Hibernation sites are mainly communal and can be located within ~2 km of breeding sites (which adults show high fidelity for) (COSEWIC 2012b). Western toads were not found during surveys in 2017 and suitable amphibian breeding/rearing habitat was not present (Barr 2017). This species will not be carried forward in the effects analysis; however, Project activities will follow appropriate PCA BMPs (e.g. clauses 7.3, 7.8, 9.2, 9.3, 13.2, and 13.6 of Parks Canada 2015a) to minimize potential for impact to wildlife and wildlife habitat.

Northern rubber boa snakes occupy a variety of habitats including streambanks, thickets, grasslands, and montane forests. They require rocky outcrops and abundant coarse woody debris to hide from predators and thermoregulate. Mostly active at night, they spend about 25% of their time above ground (under cover), and the remaining 75% underground in abandoned rodent burrows and rock crevices (COSEWIC 2016). The population of importance to this project is located at Radium Hot Springs and the adjacent area. There are few scattered observations of northern rubber boas from the Iron Gates tunnel down to the final canyon near the west park gate (St.Clair and Dibb 2001).

Other Wildlife

Bighorn sheep are common throughout Sinclair Canyon, as the area is within their critical winter habitat. (Demarchi *et al* 2000). Herds and individuals are regularly seen along Highway 93S near Radium Hot Springs and the species should be expected to be present within the Project area. Therefore, it will be carried forward in this analysis.

6.2 Cultural Resources

A screening of the proposed Project area against the PCA database of archeological and cultural resource sites (Government of Canada 2012), the National Historic Sites of Canada (Parks Canada 2017c), and the Archaeological Overview Assessment (AOA) by Jessica Hill, Terrestrial Archaeology, IACHD, Parks Canada (Hill 2017). The AOA noted the west end of Sinclair Canyon as having a rich concentration of pre-contact archaeological sites and identified Site # 423T (a pre-contact campsite) located approximately 150 m NE of the Project site whose polygon falls within 100 m of the Project footprint. No further CRM review is required for this Project.

6.3 Visitor Experience

Anticipated negative effects to visitor experience will likely be associated with noise disturbance during construction, and occasional temporary traffic delays and difficulty accessing some roadside turnoffs

during construction. Minor and temporary traffic delays may be needed to accommodate equipment mobilization or demobilization during the project staging and construction phases. Anticipated positive effects include improvements to visitor perception of KNP, as the new culvert will provide better integration between the natural landscape and highway infrastructure. This VC will be carried forward in the assessment.

7.0 Effects Analysis

Effects analysis considers the possible interactions between the Project infrastructure components and activities and the Valued Components (VCs), within the identified spatial boundaries. Project interactions may be direct or indirect and may cause a positive or negative impact. Potential effects of the Project on the key indicators are determined by comparing the existing conditions to those that are expected to result from the introduction of the Project. The effects identification matrices in **Appendix 4** were used to identify possible VC interactions with Project activities, and **Tables 7-1** and **7-2** below detail how each of the VCs are anticipated to be affected during the various Project phases. Note that these effects do not consider the adoption of planned mitigation measures identified in Section 8, which will largely control/minimize the possible effects identified in these tables.

Table 7-1: Possible effects on Valued Components during preparation/construction

Valued Components		Possible Effects
Air Quality and Noise	General	Excavation, grading, backfilling, use of machinery, transportation of materials and equipment may result in increased noise, dust and vehicle emissions above baseline.
Soil and Landforms	General	Excavation, grading, backfilling, rock and soil cuts, clearing and/or grubbing of vegetation and cut and fill activities may result in negative changes to slope stability and increase susceptibility to erosive forces.
		Accidental spills or leaks during transportation, construction, or installation may adversely affect soils.
		Stripping of the existing soils during construction and installation may negatively affect vegetation communities.
		Excavations have the potential to uncover previously contaminated materials, which will need to be remediated accordingly.
Water (surface/ground)	General	Accidental spills or leaks during construction and installation may adversely affect surface and ground water.
		Fuels and materials stored at temporary staging areas have the potential to leak and leach into groundwater.
		Stripping, handling, or storing of soils may create sedimentation, which may be released into watercourses downstream, potentially changing the characteristics of the watercourse (i.e. water quality, flow patterns, sediment deposition)
	Water Diversion	If the stream flow exceeds the maximum design flow for diversionary pipes, ponding may occur at the inlet with the potential for flooding of the surrounding area.
Fish and Fish Habitat	General	Construction operations have the potential to involve heavy machinery within or adjacent to Sinclair creek and its riparian zone, and fish spawning habitats. This may have temporary effects on fish and fish habitat related to erosion and sedimentation.
		Aquatic habitat (i.e. the riparian zone) may be destroyed or harmfully altered.
		Improper cleaning of machinery may spread Whirling disease into uninfected wetlands and tributaries within the Vermilion River watershed.

Valued Components		Possible Effects
		Stripping, handling, or storing of soils may create increased sedimentation into Sinclair Creek, creating harm for fish and fish habitat.
Flora	General	As-yet undiscovered rare plant species may be cut during vegetation clearing activities.
		Invasive vegetation species may be introduced/spread in the Project area or KNP.
Fauna	General	Accidental fuel or oil spills from construction equipment may negatively affect wildlife and habitat quality through contamination of vegetation or water sources used by wildlife.
		Noise from construction operations and habitat disturbance may cause temporary avoidance behaviors from wildlife, which would otherwise occupy the land adjacent to roads or use Sinclair Creek or the Vermilion River.
		Dust generated during construction activity may affect nearby aquatic habitats when dust settles.
		Garbage and food waste generated by construction activities may attract wildlife and lead to human-wildlife encounters.
	Bank swallow; Barn swallow; Common nighthawk; Olive-sided flycatcher; Short-eared owl	Clearing of trees, shrubs, and vegetation could result in destruction of nests and nesting habitat.
		Operation of machinery, equipment, human presence, and noise may result in temporary avoidance of habitat.
	Little brown myotis	Clearing of trees could result in destruction of bat roosts and maternity sites.
	Bighorn sheep	Increased human presence in the area may condition wildlife to become more human tolerant.
		Increased traffic and congestion may cause additional vehicle-wildlife incidents
	Northern rubber boa	Excavation, grading, backfilling, use of machinery, transportation of materials and equipment may result in habitat loss.
Cultural Resources	General	Unidentified cultural resource areas near the Project area may be discovered and disturbed during construction.
Visitor Experience	General	Construction operations (i.e. machinery use, excavation, temporary storage of materials on site) may disrupt regular visitor traffic and may result in delays for park visitors.
		Dust, smells, and noise from construction may result in short-term nuisance to park visitors.

Table 7-2: Possible effects on VCs during operation/maintenance

Valued Components	Possible Effects
Air Quality and Noise	No change from baseline expected.
Soil and Landforms	There is potential for increased soil erosion in cleared and regraded roadside ditches until vegetation has re-established
Water - surface/ground	Until slopes are fully stabilized and vegetation has established, increased erosion and sedimentation into ditches and/or surface water may occur.
	Improved natural drainage through embedded culvert design.
Fish and Fish Habitat	Until vegetation has re-established, there is potential for increased soil erosion and sedimentation into ditches and Sinclair Creek increasing the risk of deleterious effects on fish habitat.
	Improved access through the culvert will expand current habitat extent
Flora	Potential for invasive species to colonize the disturbed footprint and outcompete native species.
Fauna	None
Visitor Experience	Anticipated long term improvement to visitor experience due to more natural landscape with new culvert design.

8.0 Mitigations

All relevant mitigation measures outlined in the Parks Canada National Best Management Practices for Roadway, Highway, Parkway and Related Infrastructure (BMPs; Parks Canada 2015a) will be followed. These allow an identified suite of well-understood project activities to proceed such that there will not be resulting significant adverse environmental effects. The BMPs are applicable when the project activities are routine and repetitive with well-understood and predictable effects.

8.1 General mitigation measures

Additional specific mitigation measures to be followed during the removal of the existing culvert and construction of a new culvert at km 100.6 on highway 93S are numbered and divided into categories below. If these mitigations conflict with the PCA Highways BMPs, the most rigorous with regard to environmental stewardship shall be followed.

1. Before initiation of construction (at least 10 days prior to start of construction), the contractor will prepare an Environmental Protection Plan (EPP) and have it certified by a Qualified Environmental Professional (QEP), such as Professional Biologist or Professional Agrologist, and in accordance with Parks Canada Environmental Procedures. Prior to work beginning, the EPP must also be approved by the LLYK FU. The EPP will include, but not be limited to:
 - Details on how the work limits will be marked and procedures to keep operations within the clearing boundaries to minimize damage to vegetation and soil.
 - An overall site Erosion and Sedimentation Control (ESC) Management Plan which outlines areas where erosion and sedimentation are likely to occur and the means by which the Contractor proposes to control these issues. In addition, a localised ESC plan which directs specific mitigation for working in close proximity to Sinclair Creek may be required during construction at the discretion of the Departmental Representative, or the Environmental Surveillance Officer (ESO). The ESC management plan will also include methods and mitigations to ensure the long term stability of the slope within the construction footprint.
 - A Spill Response Plan (SRP) that details the containment and storage, handling, use and disposal of empty containers, surplus fuels, or other hydrocarbon products to the satisfaction of the Departmental Representative and the LLYK FU (i.e. ESO) and in accordance with all applicable federal and provincial legislation. The SRP will include a list of products and materials to be used or brought on site that are considered or defined as hazardous or toxic to the environment. Such products may include, but are not limited to, fuels and lubricants. The Safety Data Sheets (SDS) for all chemicals used will be made available on-site. Appropriately sized and stocked spill kits will be on site capable of handling 110% of the largest potential spill. All contractor's staff will be made aware of their location(s) on site and will be trained on spill response procedures.
 - An Emergency Response Plan that outlines procedures to follow in the case of an emergency (e.g. wildlife encounter, equipment malfunction/failure or fire). A written record

of the wildlife sighting must be submitted to the Parks Canada ESO within 24 hours of the sighting.

- A Fire Prevention Plan that describes the fire prevention equipment (e.g. fire extinguishers) and procedures on-site in the event of a fire. Should a fire occur, the Parks Dispatch and the Fire Duty Officer will be notified immediately.
2. All Contractor personnel working on site will be required to attend an on-site environmental briefing conducted by the LLYK ESO. The first briefing will occur at the start of construction and will be provided at later dates as new personnel arrive on site.
 3. Equipment fueling will only take place at an impermeable roadside area away from watercourses, or at staging areas with spill catchment countermeasures in place. Refueling and servicing of vehicles and equipment will only take place at least 30 m from the stable top of any banks, and in an area that drains away from any watercourse.
 4. Tanks, hoses and connections will be inspected prior to use. Hose connections will be wrapped and secured with absorbent pads during fuel/oil transfers. Hoses, valves and equipment are to be kept in a containment area whenever possible. Hose length and the number of connections shall be minimized, and dripless connections will be used if possible. Gravity-fed systems are not permitted within the Parks, so manual or electric pump delivery systems shall be used.
 5. Fuels, gases, or other deleterious substances will be contained within the appropriate and approved containers. Secondary containment large enough to hold 110% of the volume of the containers will be used and will not be stored on-site. Fuels, gases, or other deleterious substances will be transported according to the federal Transportation of Dangerous Goods Regulations.
 6. Prior to use on the Project sites and daily during use, equipment, propane storage and fuel lines will be inspected for leaks and structural integrity, and inspections will be recorded. Detected leaks will be addressed immediately. All equipment stored overnight in staging areas will be stored on tarps with appropriate containment and with drip trays and/or pans under fuel tanks, if required.
 7. Spills (e.g. hydraulic fluids) will be responded to immediately according to the Contractor's SRP. In the event of fluid spills or leaks exceeding 5 L, or any spill quantity in or near water, the Spill Response Plan will be followed, including immediate containment, cleanup/mitigation, and immediate reporting to Parks Dispatch and the ESO. Absorbent materials used in the clean-up or soils contaminated by the spill will be disposed of in the appropriate facilities and transported in accordance with the federal Transportation of Dangerous Goods Regulations. All spills, regardless of size or location will be reported to the ESO.
 8. Hazardous or toxic products (fuels, lubricants, etc.) will be stored no closer than 100 m from any drainage, wetland, watercourse, and water body (clause 2.18 of Parks Canada 2015a). This will prevent/minimize deleterious materials from entering drainages, wetlands, watercourses and water bodies that would result in damage to aquatic and riparian habitat.

9. To minimize contamination, and at the discretion of the ESO and Departmental Representative, biodegradable hydraulic fluids may be required for machinery working within drainages, wetlands, watercourses and water bodies.
10. A Standard Operating Procedure will be strictly adhered to in storage and application of patching and sealing compounds, tar, asphalt, traffic paint, and chemical surface sealants and none of these will be disposed of within the National Parks.
11. No garbage or debris will be left on site. Garbage and/or food attractants will be kept inside vehicles, or in bear-safe garbage bins if they can be arranged for the site, and not kept out in the open, to minimize the risk of wildlife encounters.

8.2 Air quality and noise

12. Dust generated by Project activities, both on Project site and highway 93S in general, will be controlled as necessary by watering down surfaces and ongoing cleanup/maintenance. Dust-generating activities will be minimized as much as possible during windy periods.
13. No oils, rubber, or tires will be burned on site. All such material will be hauled off-site and disposed of appropriately.
14. Stationary emission sources such as portable diesel generators, compressors, etc. will only be used when necessary.
15. No equipment (motor vehicle or construction equipment) motor will idle when not in use, unless required under extenuating circumstances, and carpooling will be encouraged to reduce air emissions and noise pollution.
16. All equipment, vehicles and stationary emission sources will be well maintained and used at optimal loads for minimal noise and air emissions.
17. Asphalt plant operation will comply with federal and provincial operating permit requirements and applicable environmental and pollution control regulations, as well as plant operational plan and possible work hour or noise restrictions.
18. Project activities will be planned and scheduled for dry weather whenever possible.

8.3 Soil and landforms

19. Construction and equipment travel will be minimized during periods of heavy precipitation and excavation activities halted during heavy rainfall events (50 mm or more in 1 hour; Environment Canada 2015).
20. Contingency plans for isolating worksites during high precipitation, high wind and runoff events will be identified in the EPP.
21. The area of exposed soil at any given time will be minimized by using techniques such as phased construction activities, retaining vegetation as much as possible, and, following construction works completion, stabilizing the exposed soils as soon as possible using temporary measures (e.g. mulch, erosion sediment control blankets, vegetation restoration, plastic sheeting, planting

long-term vegetation, etc.). Broadcast seeding will take place within 30m of watercourse to prevent entry into water.

22. Disturbance of the existing soils and landforms (stream bank and similar) to be minimized while constructing the temporary water detour structures.
23. Topsoil will be salvaged and stored separately at all excavation sites for reclamation purposes and whenever possible stripping done under dry conditions only. All salvaged topsoil will be covered (i.e. tarped) to prevent nutrient loss, and erosion from wind and rain, and to prevent weeds from becoming established on topsoil stockpiles.

8.4 Water (surface and ground)

24. The ESC Management Plan that was included with the EPP will be implemented by the construction Contractor since the work will be undertaken in proximity to and within Sinclair Creek. All components will be regularly maintained to guarantee effectiveness. The regular inspection must generate a physical report that will include all active components and their condition for review to the ESO weekly.
25. Project activities will be planned for dry weather to allow easier control of contaminated runoff and sediment. However, if scheduled activity requires working in wet conditions, the area of work will be isolated and appropriate sediment controls installed to prevent the release of sediment-laden water or other deleterious substances into surface waters.
26. If on-site water will be used as a water source for construction purposes, the contractor will obtain the necessary withdrawal permit and put in place proper intake screening procedures to prevent fish impingement and entrainment.
27. The contractor will prepare a detailed water management plan regarding the temporary diversion of Sinclair Creek during Project activities. It will be written under the guidance of a Qualified Aquatic Environmental Specialist (QAES), and must be reviewed and approved by the LLYK FU before Project activities begin.

8.5 Fish and fish habitat

Impacts to fisheries resources will be avoided or mitigated through application of BMPs for working in close proximity to water. PCA Highways BMP clauses 2.7 to 2.24 (Parks Canada 2015a) for preventing transportation of sediment and deleterious substances into water bodies will be followed in addition to the mitigation measures outlined below. Work within 30 m from a water body will adhere to avoidance and mitigation measures as identified by Fisheries and Oceans Canada (DFO) (DFO 2016) and specific *Fisheries Act* criteria so that all activities near water do not interfere with fish habitat.

28. A fish salvage will be completed by a QEP (such as a Professional Biologist) prior to diverting flow and proper equipment such as screens will be used to prevent fish from entering pumps and diversionary flow structures. Results of the fish salvage will be forwarded to the LLYK ESO and will include species, sex, age, weight, and fork length

29. Disturbance to natural materials and vegetation that contribute to fish habitat or stream channel stability will be minimized. If vegetation that contributes to fish habitat needs to be removed, a restoration plan that meets PCA requirements for re-vegetation will be compiled subject to LLYK FU review and approval.
30. Shorelines and banks that might be disturbed by the works will be stabilized immediately and if the original gradient of channel banks cannot be restored, a stable gradient will be restored.
31. If replacement rock reinforcement/armouring is required to stabilize eroding or exposed areas, appropriately-sized, clean rock will be used. Such rock will be installed at a similar slope to maintain a uniform bank/shoreline and natural shoreline alignment.

Key fish species

Note: Though the Project area is located in the Kootenay Region of BC, Aquatic Specialist Shelley Humphries (LLYK Field Unit) indicated that Alberta's "East Slopes 1" timing windows fit more closely with the timing that have been found even at lower elevations in Kootenay and Yoho (Humphries, personal communication, January 20, 2016).

32. Particular care will be taken to prevent increased sediment deposition into Sinclair Creek during October 1 to April 15 which is the sensitive spawning and early developmental period for brook trout (ASRD 2009) which have the potential to occur within the Project area.
33. At spawning and early developmental periods:
 - In clear flow, the turbidity level should not increase more than 2 Nephelometric Turbidity Units (NTUs) from background levels for a long term exposure (e.g. 1 month) or increase more than 8 NTUs from background levels for short term exposure (e.g. 1 day).
 - In high flow or turbid waters, the turbidity levels should not increase more than 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs. Turbidity levels should not increase more than 10% of background levels when background is >80 NTUs (CCME 2002).

If, due to construction schedules there is suspected sediment deposition, turbidity levels will be monitored by a QEP to be certain that exceedances do not go beyond the allowable levels indicated above. Monitoring requirements in regard to these NTU limits are to be addressed in the ESC that is included with the EPP.

Whirling disease prevention

With the discovery of whirling disease in summer of 2016 in BNP, Parks Canada has implemented decontamination procedures for Permitted Users conducting water-related activities (Parks Canada 2016b). For all contractors permitted to conduct work instream, working in wet or muddy riparian areas or soils that are seasonally wetted, or pumping or moving of surface water, the following prescribed decontamination protocols are required to be adhered to:

34. **PREVENTION:** Do not allow equipment to enter a watercourse or wet riparian area, or to pump or transport water, unless the equipment has been properly decontaminated **before AND after** use in different waterbodies. The current extent of Whirling Disease in Alberta is not known, so your equipment may already be contaminated or may become contaminated during use. Never move equipment between water bodies without applying the following decontamination protocols
35. **PRE-CLEAN:** When you leave a work area **remove all mud**. The most resistant life stage is the myxospore and these spores settle into the mud. By washing off all mud (in an area where the rinse water will not re-enter the watercourse, a storm water system, or sanitary sewer system) you can reduce the chances of spreading this disease.
36. **HOT WASH or DISINFECT:** At an appropriate facility, where wastewater will not re-enter a watercourse (either through storm water or sanitary water treatment), wash or disinfect your equipment as follows:
- i. **HOT WASH** – use a low pressure hot water wash system (e.g. Hotsy) to apply very hot water (90°C) across all equipment surfaces for at least 10 minutes. Appropriate PPE is required to prevent injury when using water at these temperatures. For smaller items or in remote locations - boiling at 90°C for 10 minutes will also destroy the spores. **OR**
 - ii. **DISINFECT** – For equipment that cannot withstand these temperatures, (e.g. glued fabrics such as inflatable watercraft, aqua-dams, Gore-Tex, etc.) use regular water to remove residual mud and destroy the TAM stage. However, extra diligence must be taken, in disinfecting this equipment in order to destroy the spore stage. All equipment must be soaked, for at least 10 minutes, in an appropriate concentration of disinfectant. Disposal of rinse water containing disinfectant may go into sanitary sewers (spores should be chemically destroyed) provided quantities are diluted enough not to impact your local wastewater treatment plant by killing bacteria. Contact your WWTP for approval if disposing of more than 45 gallons in any given day.
37. **DRY:** Allow all equipment to dry thoroughly (fully dry + 24 hours) before being used in each new waterbody. Drying is **ONLY** effective if every surface is completely dry. Again, this is why removal of **ALL** mud is so important, as it aids effective drying. Note - Freezing, for 7 or more days, will also kill spores and TAMs provided temperatures remain below -20°C.

Proof of decontamination will be required prior to commencement of instream works.

Decontamination will include all Personal Protective Equipment (boots, gloves, etc.), nets, and heavy equipment. Proof may be supplied in the form of photos or other means which provide documentation.

8.6 Flora

Although the pre-construction rare plant field surveys in 2017 (Barr 2017) did not identify vegetative species of management concern within the Project footprint, the following mitigations are necessary to avoid Project interaction with undiscovered rare plants:

38. Brushing and clearing will only be completed within the Project area. Clearing of vegetation requires a Restricted Activity Permit from the LLYK FU.
39. To minimize disturbance of vegetation, all equipment will be stored either on the road or on previously disturbed or hardened surfaces.
40. Efforts will be made to minimize the amount of vegetation cleared or disturbed. The area to be cleared will be visibly delineated to avoid unnecessary vegetation removal. Such area will be clearly marked with highly visible materials such as flagging tape to inform equipment operators of the area they are to work in. Equipment operators will make sure no mechanical damage is caused to trees and other vegetation outside the designated clearing area.
41. Prior to accessing KNP, contractors will make sure that construction equipment is clean to prevent introduction of invasive species, noxious weeds and soils from off-site.
42. To minimize migration of invasive species from the Project site:
 - Prior to entry onto new segments of the Project area, all equipment that came into contact with soil at previous segments (i.e. clearing, grading, decompaction, or restoration equipment) must be cleaned (blow down/scrape down), and approved by the LLYK FU, where possible and appropriate.
 - Construction staff and others will be required to scrape mud off their boots and brush seeds and dirt from their clothing before leaving the Project site.
43. Disturbance to vegetation by heavy equipment and other construction-phase-related activities (including lay-down sites, temporary work sites, and material stock pile sites) will be restored as quickly as possible by planting grass seed or hydroseeding (using seed mixtures approved by the LLYK ESO).
44. All vegetation debris will be removed from the Park. No other debris management options (piling and burning, mulching, etc.) have been approved for this project; a change in method of removing debris will require approval from the ESO on a site-by-site basis and will follow Banff/LLYK Woody/Vegetation Debris Management Guidelines (draft).

8.7 Fauna

General wildlife

45. Construction vehicles shall yield to wildlife.
46. Food and food waste will be securely stored to avoid access by animals. Daily off-site disposal of food wastes and other wildlife attractants are mandatory.
47. Contractor lunches will be stored and eaten inside vehicles or site trailers to minimize wildlife attractants.
48. Feeding, harassment, or destruction of wildlife is strictly prohibited. Wildlife encountered within or near the Project area will be allowed to passively disperse without harassment.

49. The EPP will be developed to include protocols for addressing wildlife encounters. The Contractor is required to carry satellite phones or cell phones for use in reporting large carnivore sightings or incidents and other emergencies to Park Dispatch. Park Dispatch Non-Emergency Line at 403-762-1473 will be notified immediately if a human-wildlife encounter occurs with a bear, wolf, cougar, wolverine, or wildlife species of management concern. A written record of the wildlife sighting must be submitted to the Parks Canada ESO within 24 hours of the sighting.
50. The EPP will include a plan to minimize wildlife disturbance, including the time of work, and potentially stopping all activities while potentially dangerous and/or sensitive wildlife is in the immediate vicinity.
51. If individuals, active nests, roosts, or dens of species protected by SARA or the *Migratory Birds Convention Act* (MBCA; Government of Canada, 1994) are identified, the contractor will stop work and immediately consult with the LLYK FU to determine appropriate mitigation measures.

Birds

52. Removal of vegetation used by birds (either migratory or non-migratory) will be conducted prior to the Zone A3 nesting period April 14 to August 19, Environment and Climate Change Canada 2017), wherever possible. Where removal of vegetation is scheduled to occur within the restricted activity period, pre-clearance nest surveys will be conducted by a contracted QEP with an appropriate level of experience identifying birds and conducting nest sweeps. The number of surveys recommended is one in typical roadside areas or other open habitats or two (2-3 days apart) in forested areas. Vegetation clearing can commence immediately once an area has been surveyed for nests. If clearing is not initiated within 7 days from the completion of a nest sweep, then another sweep will be required. Should active nests be detected during surveys, whether on vegetation or existing structural components that need to be removed, consultation will occur with LLYK FU staff to determine the appropriate course of action, which may include species-specific setback distances until nestlings have fledged.

Bighorn sheep

53. The traffic management plan (TMP) will include strategies and contingencies for the presence of bighorn sheep on or near the Project area and the adjacent highway.
54. Encounters with wildlife during construction will be managed as per the contractor's EPP, and will be consistent with direction from Parks Canada.

Northern rubber boa

55. A QEP will conduct a preconstruction survey before ground disturbance activities occur. The survey will assess the Project area for potential snake presence including small rodent holes, rocky slopes that may be disturbed and large diameter rotted logs that need to be moved. Pre-construction surveys will follow inventory methods for snakes (RIC 1998, St. Clair 1999).

8.8 Cultural resources

56. Contractors will be informed of the nature and location of culturally significant sites by Parks Canada Cultural Resource Management (CRM) personnel prior to construction activities commencing.
57. Work will be conducted outside areas of known historical or cultural significance (such as Site # 423T) and there will be no trespass over such areas.
58. If workers accidentally find significant isolated cultural resources while they are working, work will cease in the immediate area. The project manager, a Parks Canada Terrestrial Archaeology representative archaeologist, and/or a cultural resource advisor will be contacted to discuss protective actions that might be needed (i.e. photo documentation, geo-referencing, substantial mitigation, etc.). Significant isolated historic items may include but are not limited to: historic cabin foundations or dumps, concentrations of turn-of-the-century bottles or cans, structural features related to early railroad construction (i.e. railway debris, metal, railway spikes), or pre-contact resources such as concentrations of butchered animal bone, hearths, stone features, or archeological artifacts.

8.9 Visitors experience

59. The LLYK FU will be kept apprised of timelines, work periods and construction activities so that their staff (e.g. visitor centre and media) can provide information to the public to prevent additional safety risks for recreational users in proximity to the Project site during construction. A TMP will be prepared and submitted to the LLYK FU, which addresses effects on traffic from the Project.
60. Work will be restricted to daylight hours between 7am and 7pm, 7 days a week. These timings will be confirmed with the LLYK Field Unit prior to commencing construction.
61. The contractor will post road signage (e.g. trucks turning, reduced speed) to improve public safety. All signage will be in French and English.
62. Aesthetically displeasing visual impacts of the work site and staging areas will be reduced by minimizing clearing of vegetation to the extent possible (i.e. only what is necessary to maintain stable slopes and a safe work environment).
63. During construction and operation periods, the contractor will follow the contractor's specific requirements for lane closure and delay, including closing the highway and/or recreational areas when required for public safety.

9.0 Other considerations

Check all that apply. Briefly describe what was done, how the results were incorporated into the BIA and/or outline plans for what is needed.

- ☐ Public/stakeholder engagement
- ☐ Aboriginal engagement or consultation
- ☐ SARA Notification

If PCA has notified a responsible Minister under S.79 of SARA, indicate here and include a brief description. SARA notification will occur when a project on Parks Canada-administered lands has the potential to adversely affect a listed species at risk (and its critical habitat) *beyond* our lands:

- for effects to terrestrial species off our lands, the regional representative from Environment Canada is the responsible Minister for notification
- for effects to aquatic species off our lands, the regional representative from Fisheries and Oceans Canada is the responsible Minister for notification

By following identified mitigation measures provided in this BIA, SARA notification is not required. Consultations with Shelley Humphries, Aquatics Specialist at the LLYK FU confirmed that the limit of westslope cutthroat trout distribution is between Vermilion Crossing and Numa Falls (Humphries 2016) hence no potential for occurrence within the Project area.

10.0 Significance of residual adverse effects

After following identified mitigation measures, there will be no significant residual adverse effects.

11.0 Experts consulted

Department/Agency/Institution: Highway Engineering Services – Parks Canada	Date of Request: multiple requests
Expert's Name & Contact Information: Trevor Kinley, 250-347-6634, trevor.kinley@pc.gc.ca	Environmental Assessment Scientist
Expertise Requested: species list and bird nesting guide	
Response: data was provided	
Department/Agency/Institution: LLYK Field Unit - Parks Canada	Date of Request: multiple requests
Expert's Name & Contact Information: Shelley Humphries, 250-343-6108, shelley.humphries@pc.gc.ca	Title: Aquatics Specialist, LLYK Field Unit

Expertise Requested: Fish species occurrences	
Response: Fish and fish habitat data in Vermilion River provided	
Department/Agency/Institution: AECOM	Date of Request: multiple requests
Expert's Name & Contact Information: Kenn Leonhardt, kenn.leonhardt@aecom.com Direct: (403) 254-3383 Mobile: (403) 771 8877	Title: Project coordinator
Expertise Requested: Construction design details	
Response: Construction design drawings provided and additional details by phone and email conversations	
Department/Agency/Institution: Palmer Environmental Consulting Group	Date of Request: multiple requests
Expert's Name & Contact Information: Irene Mencke, irene@pecg.ca	Title: Environmental Biologist
Expertise Requested: Fisheries habitat assessment	
Response: Site visit conducted and report submitted.	

12.0 Attachments

1. Project Description
2. Mapbook
3. Construction Drawings
4. Effects Identification Matrix
5. BIOTCS results
6. SARA Results
7. Species Recovery Planning – KNP
8. Rationale for Self-Assessment and Pathway of Effects

13.0 Author

Prepared by: Barr Engineering and Environmental Science Canada Ltd.	Date: February 21, 2018
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14.0 Surveillance

The construction contractor will coordinate with the LLYK FU to make sure the appropriate oversight is on hand during construction. If necessary, as identified in the mitigation measures, work in-stream or adjacent to watercourses will be monitored by a QEP or QAES, including fish salvage from areas that are isolated for in-stream work.

15.0 Follow-up monitoring

Follow-up monitoring is:

- ☐ not required
- ☐ required by legislation or policy (e.g. under the Species at Risk Act, Fisheries Act or the Parks Canada Cultural Resource Management Policy)
- ☐ required to evaluate effectiveness of mitigation measures and/or assess restoration success

16.0 Recommendation and approval

Taking into account implementation of mitigation measures outlined in the analysis, the Project is:

- ☐ not likely to cause significant adverse environmental effects.
- ☐ likely to cause significant adverse environmental effects.

Reviewed by: PCA EIA Specialist (name & position):	
EIA Specialist Comments:	
Recommended by: Functional manager of the project (name):	Date:
Approved by: Name & position (Field Unit Superintendent, Director of Waterway)	
Signature:	Date:

17.0 National impact assessment tracking system

- ☐ Project registered in tracking system: <http://collaboration/sites/ea/SitePages/ImpactAssessmentTrackingSystem.aspx>
- ☐ Not yet registered (*CEAA 2012 requires PCA submit a report to Parliament annually. EIAs must be entered in the tracking system **by the end of April** to enable reporting.*)

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Appendix 1

Project Description



Project Title: Rehabilitation of Highway 93S – Culvert Replacement – Radium Hot Spring Overflow Parking Lot KM 100.6

Project Contact(s):

Proponent: Parks Canada Agency	Brett McPhedran Highway Engineer, Western Highway Engineering Services	Phone: 1-250-200-0057 (Mobile) Email: brett.mcphedran@pc.gc.ca
Engineering Consultant: AECOM Canada Ltd.	Kenn Leonhardt AECOM Project Coordinator	Phone: 1-403-254-3383 (Direct) 1-403-771-8877 (Mobile) Email: kenn.leonhardt@aecom.com
Environmental Consultant: Barr Engineering and Environmental Science Canada Ltd.	Paul Fraser, Senior Ecologist	Phone: 403-592-8321 Email: pfraser@barr.com

Date of Request: January 2018

Proposed Project Start: Summer 2018 (tentative)

PROJECT DESCRIPTION

Project objective:

The primary objective of this Project is to replace the existing 180 m long CSP culvert that runs underneath the Radium Hot Spring overflow parking lot (new location of the South Park Gates) and is parallel to Highway 93S at km 100.6. The general scope of work will be to excavate and install a new culvert similar to the current culvert alignment, remove and dispose of existing culvert and associated road and parking lot works for culvert work. See attached Map for location.

Short extension/truncations to the aforementioned limits may be proposed due to project circumstances and may include targeted repairs to roadway, signs, curb, parking lot and concrete barriers in accordance with the Parks Canada National BMPs for Roadway, Highway, Parkway, and Related Infrastructure (Parks Canada 2015a).

Project rationale:

Highway 93S is an essential component of the transportation network that provides both a scenic route for tourists, cyclists through Kootenay region, and is vital for commercial transport into Southern BC. The existing culvert was installed in the early 1960's with the latest inspection report identifying damage including deformation, cracking, and corrosion of the culvert and damage to both inlet and outlet headwalls. Culvert replacement and roadside improvement will improve Parks assets and safety for users at this location.

Project location:

Primary Location: British Columbia, Highway 93S at km 100.6, Radium Hot Spring Overflow Parking (new site of



Proposed South Gate Kiosks).

Footprint size: The footprint of impacted area is primarily within the Highway 93S right-of-way, existing day use parking lot and Sinclair Creek to accommodate the new culvert alignment. The size of the footprint is about 11 000 m² that includes the Radium Hot Springs overflow parking lot and 50 m either side of the culvert along Highway 93S for traffic accommodation and existing water channel.

Off-site Location(s): Pit 16 and/or Hector will be used as staging areas subject to approval. No other offsite locations have been identified at this time.

Footprint for offsite pits will be confined to the existing disturbed footprint at these locations.

Project phases and activities:

Site preparation/access activities:

Minimal site preparation for associated work will be required. The Radium Hot Springs overflow parking lot will be used for laydown area. Any other work will be part of the construction operation.

Dimensions of structures, size of excavation, area of disturbance, fill requirements

The existing culvert is 180 m long corrugated steel plate arch section of 3.5 m span and 2.3 m rise. It is expected this structure will be removed and disposed of. From the previous inspection, this culvert has been identified as a potential fish habitat.

Preliminary designs propose a new rectangular precast concrete box culvert with 3.5 m span and 2.9 m rise (outer dimensions), about 170 m long. The culvert design is to be fish bearing.

The excavation footprint is approximately 3 000 m² for culvert installation and removal. Construction limits extending within the parking lot and approximately 50 m from inlet and outlet of the culvert along Highway 93S for traffic accommodation.

It is expected some activities (e.g. rip-rap/rock modifications for the energy dissipation pool, the installation and removal of temporary diversion flows, potential scaffolding for headwall renovations) will take place within the channel to accommodate the new culvert. At this time the extents of limits upstream and downstream of the channel are not definite and will depend on the Contractor's work plan. Anticipated impact to the channel will be in the range of 10m-15m at the outlet, and 15m-20m at the inlet. Minimizing impact to the stream will be of utmost importance during the time of construction and the EPP will be reviewed to ensure low impact to the surrounding area.

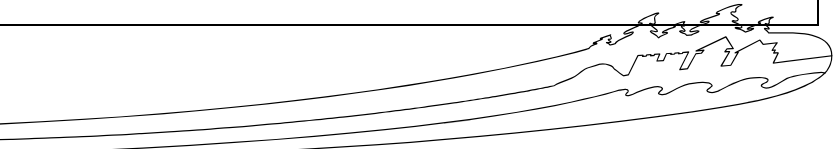
Fill will be required to backfill the proposed culvert.

Road structure replacement will require granular fill and asphalt concrete pavement. All fill is expected to come from outside the park. Fill brought in from outside the park will require proof that it is weed free. This may be in the form of a certification or an approval by the Environmental Surveillance Officer (ESO) of the fill source.

Construction activities, methods, materials, equipment to be used

Activities for culvert replacement include topsoil and vegetation removal, asphalt concrete pavement (ACP) removal and milling, excavation, channel diversion, culvert removal and disposal, culvert installation, headwall installation at outlet and inlet, associated channel habitat work, backfill and granular backfill over new culvert, paving parking lot area of impacted area, topsoil and vegetation replacement, road curb replacement, paint marking, and replacement of any road signage. Topsoil will be stored separately and if more topsoil is required in replacement it will require proof of being weed free (certification). Seed mix will be supplied by PCA (DeLong 2016).

Materials used are precast concrete, concrete for headwalls and curb and gutter, granular base material, asphalt aggregate and bituminous materials for ACP production, catch basins, fuel for equipment and vehicles. Dump trucks, paver, loaders, excavator, milling machine, packers and small vehicles will be used.





Changes to utilities, capacity or demand, new lines (i.e., water, electric, natural gas, wastewater)

Existing utilities currently under and surrounding the parking lot near the culvert. Utilities will be relocated with the removal of existing culvert as required. At this time relocation or reinstallation, options have not been identified. Existing underground utilities include telephone line, electrical and storm line.

Associated project work (e.g., paving, vegetation removal, excavation, etc.)

Associated work along Highway 93S and within the parking lot include, culvert removal and installation, vegetation removal at existing and proposed culvert inlet and outlet headwalls, channel work, catch basin installation parking lot paving, line painting and curb replacements.

Toxic or hazardous materials (e.g., cast in place concrete, chemicals, fuels, paints, solvents, explosives)

Bituminous materials (AC), cast in place concrete. Non-toxic water-based traffic paint. Fuel for construction equipment and vehicles.

Operational requirements: (materials, maintenance procedures, monitoring, waste & wastewater management requirements)

Materials, monitoring and waste disposal will be in accordance with Contract Specifications. Before commencement of construction, the contractor will prepare an Environmental Protection Plan (EPP) prepared and certified by a Qualified Environmental Professional (QEP) (i.e. Professional Biologist or Professional Agrologist) and in accordance with Parks Canada Environmental Procedures. The EPP must be approved by the LLYK Field Unit.

Site modifications, structure removals, site reclamation activities

Site modifications will include new culvert and headwalls, associated works for channel streambed, existing culvert and headwalls to be removed.

Plans & drawings attached.

Preliminary figures are attached.

Project Environment:

Other facilities that may be affected:

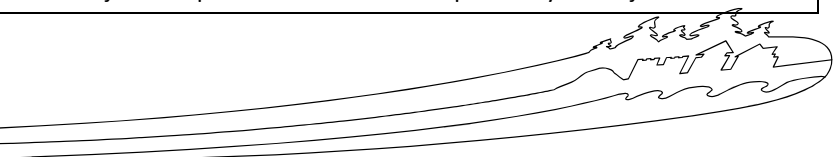
There will be temporary traffic disruptions along the Highway during the construction period. The contractor will develop a traffic management plan to address any traffic impacts.

Site history (previous use, contamination, buried tanks, lines, cables):

The Project site is located along Highway 93S in Kootenay National Park at km 100.6 within the road right of way. A screen of the Project corridor against the Federal Contaminated Sites Inventory (Government of Canada 2016) did not identify any contaminated sites within the Project footprint. However, there is potential for releases from historical undocumented motor vehicle incidents within the Project corridor. If any contaminated sites are discovered or brought to our attention by LLYK staff or contractors, all mitigations necessary to avoid or limit interaction with those sites as directed by LLYK staff will be followed. A line and utility locate will be conducted prior to the commencement of construction to check for exact location of buried utility lines within the Project corridor.

Known cultural resources (e.g., buildings, engineering works, landscapes and landscape features, historical and archaeological objects):

An Archaeological Overview Assessment (AOA) by Jessica Hill, Terrestrial Archaeology, IACHD, Parks Canada, noted the west end of Sinclair Canyon as having a rich concentration of pre-contact archaeological sites (Hill 2017). The AOA identified Site # 423T (a pre-contact campsite) located approximately 150 m NE of the Project site whose polygon falls within 100 m of the Project footprint. Due to the close proximity of Project activities to





the polygon for this site, the AOA recommends that care and attention be taken during construction – minimizing ground disturbance as much as practical, and being aware of the possibility of uncovering unknown artifacts or features associated with cultural sites and sensitive areas. The Accidental Finds Protocol (see below) should be adhered to throughout the Project (Hill 2017). No additional cultural sites were identified from a screen of the Project site against the PCA database of archeological and cultural resource sites (Government of Canada 2012) and the National Historic Sites of Canada (Parks Canada 2016a).

Accidental Finds Protocol

In the event of encountering yet-to-be discovered archaeological or cultural resources during Project activities, work will stop immediately and the PCA Project manager notified. The work area in relation to the findings should be photo documented and geo-referenced. The Project manager should then contact PCA's Terrestrial Archaeology office for advice and assessment of significance that will, in turn, determine what will be required to mitigate the chance find. Significant resources that could be considered grounds for work stoppage include, but are not limited to, human remains, unique or diagnostic artifacts, and/or artifacts directly associated with known sites and/or unidentified sites in the area.

Distance to the nearest water body, water crossings, shoreline work:

The main water body at the Project location is Sinclair Creek whose culvert is being replaced. Since this is an instream work, Project activities will be undertaken with strict adherence to clauses 2.7, 2.8, 2.15-2.23 of the PCA Highways BMPs (Parks Canada 2015a). Mitigation measures will include proper erosion and sediment control measures as well as measures to prevent migration of deleterious substances into the creek. Shoreline re-vegetation and stabilization will be implemented if necessary.

Impacts to fish habitat:

Fish habitat assessments conducted by Palmer Environmental and Barr in August/September 2016 (PECG 2016) and in September 2017 (Barr 2017) identified Sinclair Creek as a fish habitat. The proposed Project site is dominated by fast flowing, boulder and cobble cascade habitat. Though the creek lacks deep pool habitat for approximately 100 m upstream and downstream of the culvert (excluding the outlet plunge pool), it contains some sheltered, slow-water areas along the stream margins. Additionally, a PCA crossings database (Parks Canada 2006) identified this culvert location as likely fish-bearing and within reach known to support brook trout (Shelley Humphries, pers. comm. 2016). These field observations were augmented by a screening of the Project corridor against the Fish Inventory Data Base Queries (Government of BC 2015) which did not identify any additional fish species within the Project area. All construction works will be carried out with strict adherence to PCA Highways BMP clauses 2.7, 2.8, 2.15-2.23 for preventing transportation of sediment and deleterious substances into water bodies. This will minimize any impacts to fish and fish habitat that may result from sediment and deleterious substance transport from the Project works. In-channel work will be completed in-the-dry through the implementation of a diversion system. A fish salvage will be carried out prior to setting up the diversion system to collect fish that may be stranded when the existing culvert and areas around the inlet and outlet are dewatered. Results of the fish salvage will be provided to LLYK. The general time period or 'window' in which changes in and about the stream would cause the least risk of impact to brook trout is June 1 through August 31 (BC MOE 2009) hence the proposed Project schedule overlap with the Restricted Activity window for this fish species. A self-assessment was completed ascertaining that the Project is not expected to cause serious harm to fish or fish habitat as defined by the *Fisheries Act*, after mitigation measures are applied. The following is a rationale for Self-Assessment:

- The proposed works will follow appropriate mitigation measures and best management practices, such that harm to fish and fish habitat will be avoided or mitigated
- The new culvert is designed based on fish passage requirements, and will allow access for fish to upstream habitat, thereby potentially increasing the range and productivity of fish residing in Sinclair Creek downstream of the culvert
- The new culvert design includes fish baffles, which reduce water velocities and increase depth through a culvert, and provide areas for fish to rest and seek refuge as they migrate through the culvert, thereby



improving fish passage

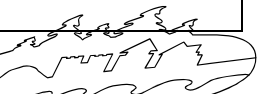
- An energy dissipation pool at the culvert outlet is designed to reduce erosion potential and improve fish passage into the culvert:
 - Rip-rap (for 1:200 year flood protection) will line the base of the pool and will extend up at a 2:1 slope from the bottom of the energy dissipation pool up to the invert elevation of the culvert, and downstream to the top of a weir at the pool outlet
 - The top of the most downstream fish baffle in the culvert will be at the same elevation as the downstream control (i.e. weir) of the energy dissipation pool
 - The culvert outlet perch will be eliminated
- Permanent habitat alteration will be limited to rip rap placement at the culvert inlet and outlet (the existing inlet and outlet headwalls will be retained). The rip rap (class 2) will be keyed into the channel bed, and provides scour protection for 1:200 year flood. The rip rap placement for scour control will improve channel stability and help prevent formation of a perch at the culvert outlet.

Details of the rationale for Self-Assessment are provided in the 'Sinclair Creek Culvert Replacement on Highway 93S, Kootenay National Park - Rationale for self-assessment under the *Fisheries Act*' submitted together with this Project Description.

In addition to any mitigation and avoidance measures employed to protect fish and fish habitat, Parks Canada's measures to prevent the spread of whirling disease will also be followed. These are the decontamination procedures for Permitted Users conducting water-related activities (Parks Canada 2016b).

For all contractors permitted to conduct work instream, working in wet or muddy riparian areas or soils that are seasonally wetted, or pumping or moving of surface water, the following prescribed decontamination protocols are required to be adhered to:

1. **PREVENTION:** Do not allow equipment to enter a watercourse or wet riparian area, or to pump or transport water unless the equipment has been properly decontaminated **before AND after** use in different water bodies. The current extent of Whirling Disease in Alberta is not known, so your equipment may already be contaminated or may become contaminated during use. Never move equipment between water bodies without applying the following decontamination protocols.
2. **PRE-CLEAN:** When you leave a work area, **remove all mud**. The most resistant life stage is the myxospore and these spores settle into the mud. By washing off all mud (in an area where the rinse water will not re-enter the watercourse, a stormwater system, or sanitary sewer system) you can reduce the chances of spreading this disease.
3. **HOT WASH or DISINFECT:** At an appropriate facility, where wastewater will not re-enter a watercourse (either through stormwater or sanitary water treatment), wash or disinfect your equipment as follows:
 - a. **HOT WASH** – use a low-pressure hot water wash system (e.g., Hotsy) to apply very hot water (90°C) across all equipment surfaces for at least 10 minutes. Appropriate PPE is required to prevent injury when using water at these temperatures. For smaller items or in remote locations - boiling at 90°C for 10 minutes will also destroy the spores. **OR**
 - b. **DISINFECT** – For equipment that cannot withstand these temperatures, (e.g., glued fabrics such as inflatable watercraft, aqua-dams, Gore-Tex, etc.) use regular water to remove any residual mud and destroy the TAM stage. However, extra diligence must be taken, in disinfecting this equipment in order to destroy the spore stage. All equipment must be soaked, for at least 10 minutes, in an appropriate concentration of disinfectant. Disposal of rinse water containing disinfectant may go into sanitary sewers (spores should be chemically destroyed) provided quantities are diluted enough not to impact your local wastewater treatment plant by killing bacteria. Contact your WWTP for approval if disposing of more than 45 gallons in any given day.





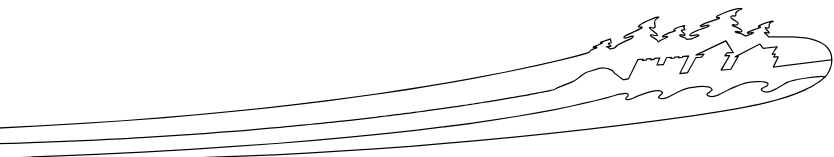
4. **DRY:** Allow all equipment to dry thoroughly (fully dry + 24 hours) before being used in each new waterbody. Drying is **ONLY** effective if every surface is completely dry. Again, this is why removal of **ALL** mud is so important, as it aids effective drying. Note - Freezing, for 7 or more days, will also kill spores and TAMs provided temperatures remain below -20°C.

Proof of decontamination will be required prior to commencement of instream works. Decontamination will include all Personal Protective Equipment (boots, gloves, etc.), nets, and heavy equipment. Proof may be supplied in the form of photos or other means which provide documentation.

Species at risk, critical habitat, and residence of individuals (if any):

The following is a list of protected (SARA and/or COSEWIC-listed) species at risk which have a regular occurrence within Kootenay NP (Parks Canada 2017a) hence there is potential for presence within the Project area. This list was compiled by querying the PCA's Biotic Web Explorer, PCA's Multi-species Action Plan for KNP (Parks Canada 2017b), BC Ministry of Environment Species Ecosystems Explorer (BC MOE 2015a), BC Conservation Data Centre Mapping Service (BC CDC 2008a), BC CDC Habitat Wizard, (BC CDC 2008b) and BC CDC iMAPBC, (BC CDC 2013).

Species	SARA ¹ Listing	COSEWIC ² Listing	BC ³ Listing	Potential for Presence in Project	BMP Mitigation
Mammals					
American badger (<i>Taxidea taxus</i>)	Endangered Schedule 1	Endangered	Red	Nil – suitable soil for digging and prey (ground squirrels and marmots) limited. No impact anticipated from the project	BMP 2.3, 7.9
Bighorn sheep (<i>Ovis Canadensis</i>)*	No Status	No Status	Blue	High – Project area has a high concentration of this species - Suitable grazing habitat	BMP 2.3, 2.4, 2.5, 7.9 plus fencing of culvert trenches
Little brown Myotis (<i>Myotis lucifugus</i>)	Endangered Schedule 1	Endangered	Yellow	Nil – roosting habitat (>25 cm dbh trees) lacking	BMPs 7.1-7.2, 7.4, 7.6, 7.8, 9.1
Birds					
Barn swallow (<i>Hirundo rustica</i>)	Threatened Schedule 1	Threatened	Blue	Moderate – preferred nesting habitat (artificial structures, buildings, bridges, road culverts) in footprint	BMPs 7.1-7.2, 7.4, 7.6, 7.8, 9.1
Bank swallow (<i>Riparia riparia</i>)	Threatened Schedule 1	Threatened	Yellow	Low - preferred nesting habitat (sand/silt riverbanks, aggregate pits, road cuts, and stock piles of soil) is absent. No impact anticipated from the Project	BMPs 7.1-7.2, 7.4, 7.6, 7.8, 9.1





Common nighthawk (<i>Chordeiles minor</i>)	Threatened Schedule 1	Threatened	Yellow	Low – preferred nesting habitat present along roadside but highly disturbed.	BMPs 7.1-7.2, 7.4, 7.6, 7.8, 9.1
Short-eared owl (<i>Asio flammeus</i>)	Special Concern Schedule 1	Special Concern	Blue	Low – preferred nesting habitat present along roadside but highly disturbed	BMPs 7.1-7.2, 7.4, 7.6, 7.8, 9.1
Olive-sided flycatcher (<i>Contopus cooperi</i>)	Threatened Schedule 1	Threatened	Blue	Moderate – nesting habitat adjacent to Project footprint	BMPs 7.1-7.2, 7.4, 7.6, 7.8, 9.1
Western grebe (<i>Aechmophorus occidentalis</i>)	Threatened Schedule 1	Special Concern	Red	Nil – accidental/non-regular visitor, preferred nesting habitat (still water bodies with sufficient emergent vegetation) is lacking. No impact anticipated from the Project	BMPs 7.1-7.2, 7.4, 7.6, 7.8, 9.1
Amphibians					
Western toad (<i>Anaxyrus boreas</i>)	Special Concern Schedule 1	Special Concern	Blue	Nil – no breeding/rearing habitat. No impact anticipated from the Project	BMPs 7.3, 7.6, 7.8, 9.3
Reptiles					
Northern rubber boa (<i>Charina bottae</i>)	Special Concern Schedule 1	Special Concern	Yellow	Moderate – recorded occurrences at Radium Hot Springs; suitable habitat exists – humid mountainous and dry lowland areas with rock outcrops, rock piles, rock bluffs, or talus slopes (COSEWIC 2016)	BMPs 9.2
Vascular Plants					
Whitebark pine (<i>Pinus albicaulis</i>)	Special Concern Schedule 1	Special Concern	Blue	Nil – Low habitat potential and no occurrences noted during pre-construction surveys by Barr (2017)	BMPs 7.4-7.6

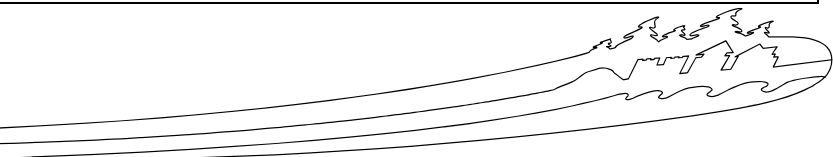
*Though not federally listed, this species is commonly present at the Project site and on top of the Iron Gates Tunnel hence presenting a high risk of interaction with Project activities

¹ SARA - Species at Risk Act (Government of Canada 2002)

² COSEWIC - Committee on the Status of Endangered Wildlife in Canada (Government of Canada 2015)

³ British Columbia Red = extirpated, endangered, threatened; Blue = special concern; yellow = least risk (BC CDC 2017)

Field surveys and wildlife habitat assessments by Barr in July 2017 noted potential suitable habitat for breeding birds immediately adjacent to the culvert (Barr 2017). Project activities will follow appropriate wildlife control and safety measures as well as the specific PCA Highways BMPs outlined in the table above to minimize the potential for impact to wildlife and wildlife habitat. Since the proposed Project schedule is within the migratory





bird nesting breeding window (Zone A3: April 14 to August 19, Environment and Climate Change Canada 2017), a qualified professional biologist/ecologist will ascertain species presence/ absence and timing particular to the work site and any occupied bird nests, eggs, or nests of species protected under the *Migratory Bird Convention Act* (MBCA) or the *National Parks Act* before vegetation clearing commences.

A rare plant habitat assessment by TetraTech EBA (2015) noted moderate potential for encountering Vegetation Elements of Management Concern within the Project corridor. However, a rare plant survey by Barr in July and August 2017 did not identify any SARA-listed rare plant species or potential for rare plant habitat within the Project footprint (Barr 2017). Nonetheless, limber pine (*Pinus flexilis*) (listed by COSEWIC as endangered) was observed during the surveys near KM 101 (11 U 568072E 5609769N). This is about 300 m west of the Project area on the opposite side of the highway so will not be affected by Project activities.

Rubber boas are often associated with rock outcrops, rock piles, rock bluffs and talus slopes (BC MOE 2015b, COSEWIC 2016). However, they are cryptic, crepuscular or nocturnal in nature, and not readily observed. No surveys were conducted.

Site photos or map attached:

Map attached.

Red flags/ issues:

Oxeye daisy (*Leucanthemum vulgare*), creeping thistle (*Cirsium arvense*), spotted knapweed (*Centaurea stoebe*), meadow buttercup (*Ranunculus acris*), common mullein (*Verbascum thapsus*) and field sow thistle (*Sonchus arvense*) were noted within the Project corridor during weeds survey by Barr in September 2016 (Barr 2016) and vegetation surveys in July – August 2017 (Barr 2017). An earlier survey by Parks Canada (Parks Canada 2015b) also identified knapweed (*Centaurea* spp) within the project footprint. Clauses 2.10 and 7.18 of the PCA Highways BMPs for the control of invasive species will be followed to avoid translocation of seeds and vegetation fragments. Construction equipment will be cleaned prior to moving to any new construction site.

Project timing: July to October, 2018

Proposed Project Start: Summer 2018 (tentative)

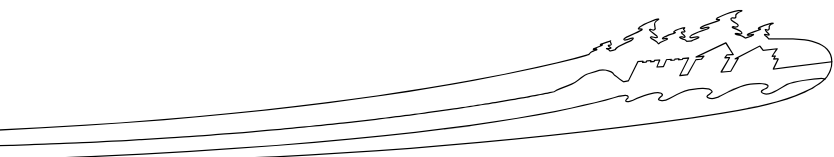
Additional details (as required):

Potential for project to affect use of lands or resources by aboriginal persons (as relevant):

None.

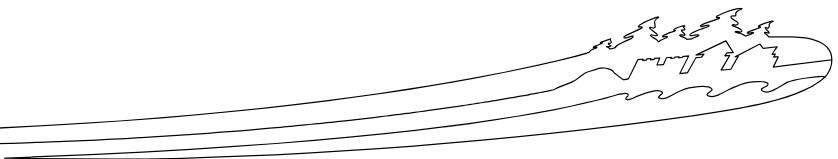
Other jurisdictions or departments involved in project development, review & approval (as relevant):

None.



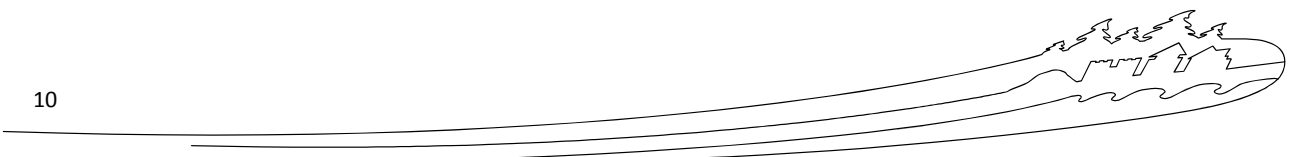
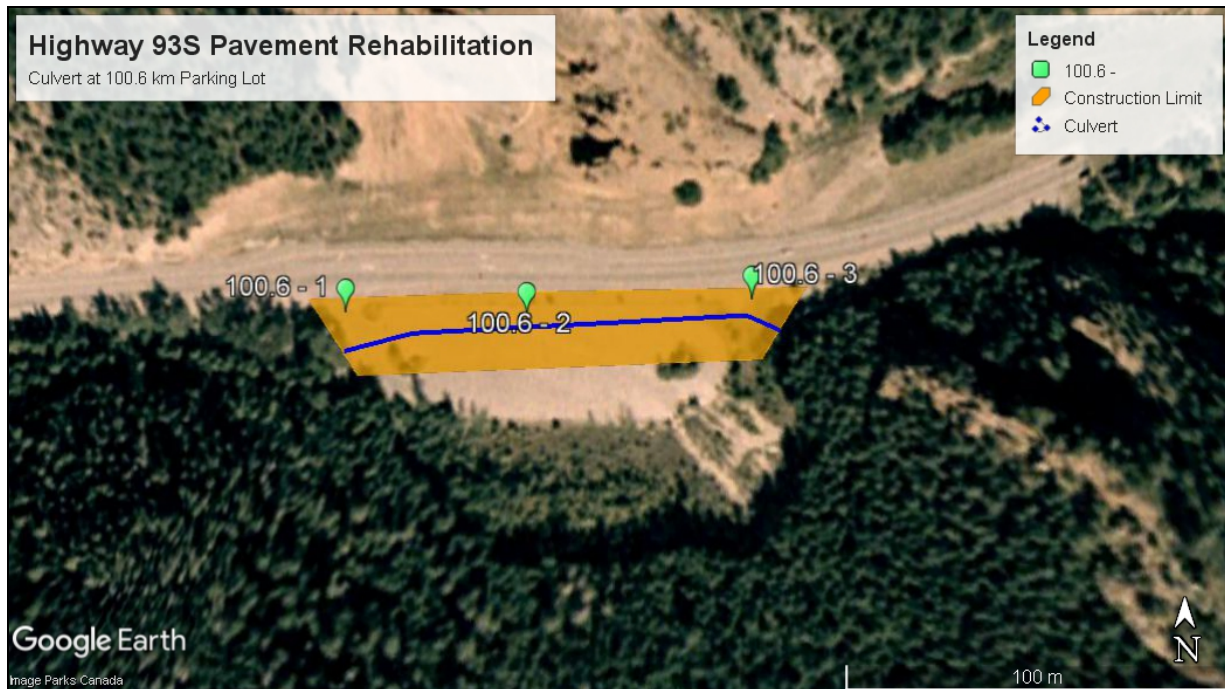


Project Phases and Activities Table				
	Phases	Examples of Associated Activities	Y / N	Details
Project Components	Construction / Site Preparation	Supply and storage of materials	Y	To be determined in and approved by ESO.
		Burning	N	
		Clearing	N	
		Demolition	Y	Limited demolition of existing roadway structure.
		Disposal of waste	Y	Construction, trade, hazardous waste, fuel and domestic waste materials to be removed from the National Parks.
		Blasting/ Drilling	N	
		Dredging	N	
		Drainage	N	
		Excavation	N	
		Grading	N	
		Backfilling	N	
		Use of machinery	Y	For asphaltic surfacing, excavation, clearing, backfilling, grading and hauling.
		Transport of materials/ equipment	Y	Transport of construction materials to site (asphaltic surfacing material, construction equipment) and removal of construction wastes.
		Building of fire breaks	N	
		Use of Chemicals	Y	Paint, which will be applied only to the new asphaltic surface. Bituminous materials and fuel for construction equipment and vehicles.
		Set up of temporary facilities	N	
		Traffic control	Y	Traffic controllers and signs will be present on the roadway during construction activities.
		Other...		
	Operation/Implementation Decommissioning	Waste disposal	Y	Construction, trade, hazardous waste and domestic waste materials to be removed from the National Parks.
		Wastewater disposal	N	
		Maintenance	N	
		Use	N	
		Use/Removal of temp. facil.	N	
		Use of Chemicals	Y	Paint, which will be applied only to the existing asphalt surface.
		Active fire stage	N	
		Clean-up of prescribed burn	N	
		Planting	N	
		Culling	N	
		Vehicle Traffic	Y	General public, visitors and commercial vehicles.
		Other...		





Project Location:



**References:**

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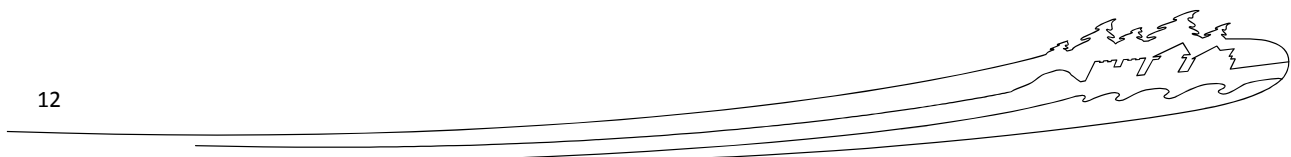
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Appendix 2

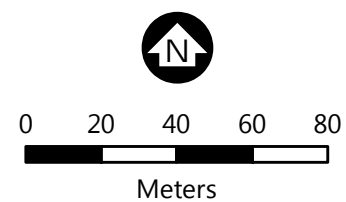
Mapbook

Barr Footer: ArcGIS 10.4, 2018-01-19 10:20 File: I:\Client\Parks_Canada\Work_Orders\Highway_93\Maps\Reports\Radium_Hot_Spring_Culvert_Replacement.km100.6.mxd User: MRQ



Imagery Provided by McElhanney

- | | | | |
|---|--------------------------|---|--|
| + | 100-meter Stationing | ▲ | Vegetation Survey - Barr, July and August 2017 |
| ▲ | Archaeological Feature | — | Vegetation Survey - Barr, July and August 2017 |
| Fish Habitat Assessment - Barr, August - September 2016 | | | |
| ⊗ | Fish Habitat Present | | |
| ⊗ | Fish Habitat Not Present | | |



Culvert Replacement
Radium Hot Spring Overflow Parking Lot
Sinclair Creek
km 100.6
Highway 93 South

Appendix 3

Construction Drawings



for / pour



Parks Canada
Agency

L'Agence Parcs
Canada

HIGHWAY 93 SOUTH
BANFF – WINDERMERE HIGHWAY
CULVERT REPLACEMENT
SINCLAIR CREEK (KM 100.6)

KOOTENAY NATIONAL PARK, BRITISH COLUMBIA

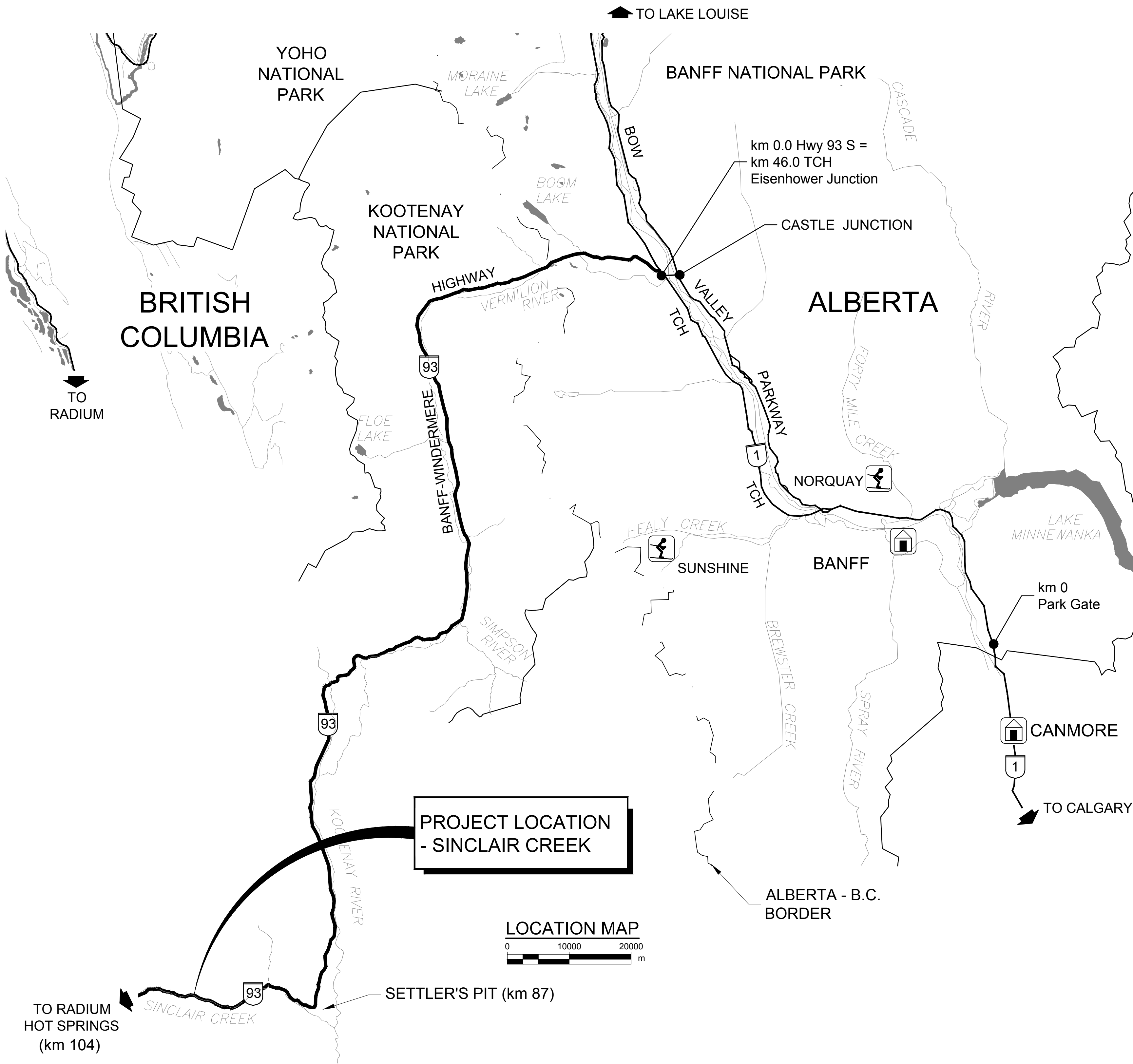
ISSUED FOR 90% REVIEW

NOT FOR CONSTRUCTION

PROJECT NO. 1079-01

JAN 2018

00-C6-S000



DRAWING INDEX	
Sheet Number	Sheet Title
S000	COVER SHEET
S100	LOCATION MAP & GENERAL NOTES
S101	EXISTING CULVERT LAYOUT AND DEMOLITION PLAN
S102	DEMOLITION DETAILS EXISTING END TREATMENT
S103	NEW CULVERT LAYOUT
S104	CULVERT BACKFILL DETAILS
S105	PRECAST CULVERT DETAILS
S106	CULVERT DETAILS
S107	CULVERT INLET DETAILS
S108	CULVERT OUTLET DETAILS
S109	CULVERT END TREATMENT
S110	HANDRAIL DETAILS AT CULVERT OUTLET HEADWALL
S111	INLET & OUTLET RIPRAP DETAILS

SEQUENCE OF OPERATIONS

- DETERMINATIONS OF EQUIPMENT FREE ZONES AND LIMITS OF WORK, DFO REQUIREMENTS AND DRAINAGE COLLECTION AREAS TO BE ESTABLISHED.
- INSTALLATION OF GEOTEXTILES FILTERS, BARRIERS AND SEDIMENT TRAPS ALONG WORK AREAS.
- CONTRACTOR TO SUBMIT AN ENVIRONMENTAL PROTECTION PLAN (EPP) AND PLAN FOR CHANNEL EXCAVATION AND DIVERSION FOR DEPARTMENTAL REPRESENTATIVE'S APPROVAL. SEE SHEETS S103 AND S104 FOR THE TENTATIVE LOCATION OF THE CHANNEL DIVERSION PIPES AND EXTENT OF CAHNNEL EXCAVATION.
- CONTRACTOR TO SUBMIT TRAFFIC ACCOMMODATION PLAN AND INSTALL TEMPORARY BARRIERS AND FENCES AS REQUIRED TO CREATE A SAFE WORKING AREA.
- REMOVAL OF EXISTING CULVERT, PORTION OF HEAD WALLS AND FILL MATERIAL TO BE COMPLETED IN THE DRY. WORKING FROM THE DOWNSTREAM END BACK. SUMPS AND FILTERS SHALL BE KEPT AHEAD OF THE WORK TO INTERCEPT AND TRAP DRAINAGE SILT. DEWATERING THE SOIL IN ADVANCE OF THE EXCAVATION MAY BE NECESSARY FOR EXCAVATION STABILITY AND SEEPAGE CONTROL.
- INSTALL NEW CULVERT IN THE DRY IN COMPLIANCE WITH ENVIRONMENTAL ASSESSMENT RESTRICTIONS. ALL REMOVED ACP FROM THE PARKING LOT TO BE EITHER HAULED AND DISPOSED OUTSIDE OF PARK OR AT SETTLERS PIT (km 87) AT CONTRACTOR'S EXPENSE.
- COMPLETE REROUTING CHANNEL FLOW INTO NEW CULVERT. SEDIMENT TRAPS AND BARRIERS TO BE PLACED TO CAPTURE SILT AND DELETERIOUS MATERIALS TO DIRECT FLOW INTO NEW CULVERT.
- CONTRACTOR TO MINIMIZE DISTURBANCE TO ALL NATURAL FEATURES AT BOTH UPSTREAM AND DOWNSTREAM OF THE CHANNEL.

GENERAL NOTES

- ALL DIMENSIONS SHOWN ON SHEETS S101 & S103 ARE IN METRES. ALL OTHER SHEETS ARE DIMENSIONED IN MILLIMETERS.
- ALL DIMENSIONS AND DETAILS SHOWN ON THESE DRAWINGS PERTINENT TO NEW CONSTRUCTION AND EXISTING STRUCTURES SHALL BE VERIFIED IN THE FIELD BY THE CONTRACTOR BEFORE STARTING CONSTRUCTION.
- CULVERT FLOWS MUST BE MAINTAINED THROUGHOUT THE PROJECT. WATER NEEDS TO BE CONTROLLED WITH COFFERDAMS, PUMPS, AND PIPING AS APPROPRIATE. ENSURE THAT ALL ENVIRONMENTAL REQUIREMENTS ARE MET.
- DESIGN SPECIFICATION: CAN/CSA S6-14
- DESIGN LOADS:
 - SELFWEIGHT OF THE PRECAST BOX UNITS
 - VERTICAL EARTH PRESSURE DUE TO FILL HEIGHT (MAX FILL HEIGHT ABOVE THE BOX SECTION= 3.0M)
 - LATERAL EARTH PRESSURE FROM BACKFILL ON THE SIDES OF THE BOX UNITS
 - COMPACTION SURCHARGE: 12 KPa
 - LIVE LOAD: BCL 625 TRUCKS PLUS DYNAMIC LOAD ALLOWANCE (AS PER CLAUSE 3.8.4.5 OF S6-14). THE PRESSURE DISTRIBUTION ON THE BOX UNITS DUT TO LIVE LOAD SHALL BE AS PER CLAUSE 7.8.5.3.3 OF S6-14.
 - EARTHQUAKE LOADS AS PER CLAUSE 7.8.4.4 OF S6-14.
- FACTORED SOIL BEARING CAPACITY AT CULVERT INSTALLATION ELEVATION IS 150 kPa (ULS).
- THE CONTRACTOR SHALL DESIGN THE CONCRETE CULVERT WITH LIFE EXPECTANCY OF 75 YEARS AND SUBMIT THE DESIGN DRAWINGS DULY SIGNED AND STAMPED BY THE PROFESSIONAL ENGINEER REGISTERED OR LICENSED TO PRACTICE IN THE PROVINCE OF BRITISH COLUMBIA TO PARKS CANADA AGENCY FOR APPROVAL BEFORE ANY WORK IS STARTED.

MATERIALS AND FABRICATION

- ALL CAST-IN-PLACE AND PRECAST CONCRETE UNITS SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 45 MPa AT 28 DAYS WITH MINIMUM AIR CONTENT OF 6%.
- ALL REINFORCING BARS AND BARS NOTED AS DOWELS SHALL BE DEFORMED REINFORCEMENT CONFORMING TO CAN/CSA G30.18-09 (2014), GRADE 400 UNLESS NOTED OTHERWISE.
- WELDED WIRE REINFORCEMENT (WWR) SHALL BE MADE OF DEFORMED WIRES AND CONFORM TO ASTM A1064/A1064M.
- MINIMUM CLEAR CONCRETE COVER TO REINFORCING STEEL SHALL BE AS FOLLOWS:

• PRECAST CONCRETE UNITS	40 mm
• CAST-IN-PLACE CONCRETE EXPOSED TO EARTH	70 mm
• CONCRETE CAST DIRECTLY AGAINST EARTH	100 mm
- ALL LAPS FOR REINFORCING STEEL FOR SPLICES SHALL BE AS FOLLOWS:

BAR SIZE	LAP LENGTH (mm)
10M	400
15M	600
20M	700
25M	1100
- A REINFORCING STEEL SCHEDULE, AND PLAN SHOWING LAYOUT OF THE PRECAST UNITS SHALL BE PREPARED BY THE CONTRACTOR AND SUBMITTED TO THE DEPARTMENT FOR REVIEW AND APPROVAL.
- THE PRECAST UNITS SHALL CONFORM TO THE FABRICATION REQUIREMENTS OF ASTM C1433M-16B.
- JOINTS FOR PRECAST UNITS SHALL BE TONGUE AND GROOVE TYPE CONFORMING TO THE REQUIREMENTS OF SECTION 9 OF ASTM C1433M-16B.

INSTALLATION AND BACKFILLING

- PRECAST CONCRETE BOX CULVERT SECTIONS SHALL BE ERECTED AND LAID IN PLACE AS PER MANUFACTURER'S SPECIFICATIONS AND RECOMMENDATIONS. SECTIONS SHALL BE LAID WITH THE GROOVE END OF EACH SECTION UP-GRADE. PLACEMENT OF THE BOX SECTIONS SHALL START AT THE DOWNSTREAM END AND PROCEED UPSTREAM.
- THE JOINT OPENINGS BETWEEN ADJACENT PRECAST SECTIONS SHALL NOT EXCEED 20 mm. THE SECTIONS SHALL BE DRAWN TOGETHER WITH A MINIMUM OF FOUR MECHANICAL CONNECTORS PER JOINT. AFTER INSTALLATION, CONNECTORS SHALL BE REMOVED.
- THE JOINTS SHALL BE SEALED WITH CONTINUOUS FLEXIBLE WATER TIGHT BUTYL RUBBER SEALANT CONFORMING TO THE REQUIREMENTS OF ASTM C990-09. ALL JOINTS SHALL BE TRIMMED CLEAN ON THE INSIDE AFTER SEALING.
- A 600 mm WIDE FILTER FABRIC SHALL BE PLACED AROUND THE TOP AND SIDES OF EACH PRECAST UNIT CENTERED OVER THE JOINT.
- LIFTING HOLES SHALL BE FILLED WITH CONCRETE PLUGS OR WITH AN APPROVED NON-SHRINKABLE GROUT.
- DOWEL REINFORCING BARS TO BE INSTALLED WITH A MINIMUM EMBEDMENT OF 150 mm INTO EXISTING CONCRETE HEAD WALLS AND PRECAST END UNIT. THE SPACING OF THE DOWELS SHALL BE AS SHOWN ON SHEETS S107 AND S108.
- CONTRACTOR IS FULLY RESPONSIBLE FOR ADEQUATE PROTECTION OF ALL UTILITIES, SERVICES, STRUCTURES, ETC., DURING CONSTRUCTION OPERATIONS.
- EXCAVATION SHALL BE DONE TO LINES AND GRADES SHOWN ON THE DRAWINGS TO ALLOW FOR PLACEMENT AND COMPACTION OF ALL BEDDING AND BACKFILL MATERIALS. ADDITIONAL SUB-CUT MAY BE REQUIRED FOR THE REMOVAL AND REPLACEMENT OF THE SOFT MATERIALS ENCOUNTERED DIRECTLY BELOW THE CULVERT FOUNDATION WITH COMPACTED GRANULAR FILL AS PER THE DIRECTION OF THE GEOTECHNICAL ENGINEER. PLEASE REFER TO GEOTECHNICAL REPORT TITLED "GEOTECHNICAL INVESTIGATION FOR TWO CULVERT REPLACEMENTS (KILOMETRES 95.6 AND 100.6) ALONG HIGHWAY 93S IN KOOTENAY NATIONAL PARK, BC" FOR PREPARATION OF SUBGRADE AND ADDITIONAL SUBCUT.
- STRUCTURAL BACKFILL SHALL CONSIST OF APPROVED GRANULAR MATERIAL. BACKFILL MATERIAL SHALL BE PLACED AND COMPACTED IN AN UNFROZEN CONDITION. MEET THE SPECIFIED GRADATION, CONTAIN NO ROCKS EXCEEDING 50 mm IN DIAMETER AND SHALL BE FREE OF LARGE OR FROZEN LUMPS, WOOD, OR OTHER UNSUITABLE MATERIAL. BACKFILLING IS NOT ALLOWED ON FROZEN SUBSTRATE OR WHEN AIR TEMPERATURE IS BELOW 0°C.
- THE STRUCTURAL FILLS SHALL BE PLACED IN MAXIMUM LIFTS OF 150 mm AND COMPACTED TO A 98% OF STANDARD PROCTOR DENSITY AT 2% OPTIMUM MOISTURE CONTENT.
- BACKFILL SHALL BE PLACED IN SIMULTANEOUS EQUAL LIFTS ON BOTH SIDES OF CULVERT.
- TOP OF BACKFILL ELEVATION SHALL BE WITHIN 150 mm ON BOTH SIDES OF CULVERT AT ALL TIMES.
- CONTRACTOR SHALL SUBMIT SURFACE DRAINAGE SCHEME (DITCHING, SUMPS AND PUMPS) FOR MANAGING SURFACE RUNOFF AND DRAINAGE DURING CONSTRUCTION TO THE DEPARTMENTAL REPRESENTATIVE FOR REVIEW AND APPROVAL AT LEAST TWO WEEKS PRIOR TO COMMENCEMENT OF CONSTRUCTION WORK.
- PRE-APPROVED GRANULAR MATERIALS SHALL MEET THE BC MOTI GRADATION SPECIFICATIONS FOR CRUSHED BASE COURSE AGGREGATES.
- GEOTEXTILE FILTER FABRIC SHOWN SHALL MEET THE FOLLOWING REQUIREMENTS:

WOVEN GEOTEXTILE FILTER FABRIC SPECIFICATIONS AND PHYSICAL PROPERTIES		NON-WOVEN GEOTEXTILE FILTER FABRIC SPECIFICATIONS AND PHYSICAL PROPERTIES	
GRAB STRENGTH	1275 N	CLASS 250	
ELONGATION (FAILURE)	15%	GRAB STRENGTH	900 N
PUNCTURE STRENGTH	275 N	ELONGATION (FAILURE)	50%
TRAPEZOIDAL TEAR	475 N	PUNCTURE STRENGTH	550 N
MINIMUM FABRIC LAP TO BE 1000mm		TRAPEZOIDAL TEAR	350 N
		MINIMUM FABRIC LAP TO BE 1000mm	

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No.	Date	Description	Drawn by Dessiné par	Approved Approuvé

Revision / Revision

A
B

Detail number
Sheet number
A Numéro de détail
B Numéro de la feuille

Linear dimensions
in millimetres
Dimensions linéaires
en millimètres

Consultant's Name
Nom de l'expert-conseil

AECOM



Parks Canada
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Gestion des biens
Région de l'Ouest et
du Nord

Canada

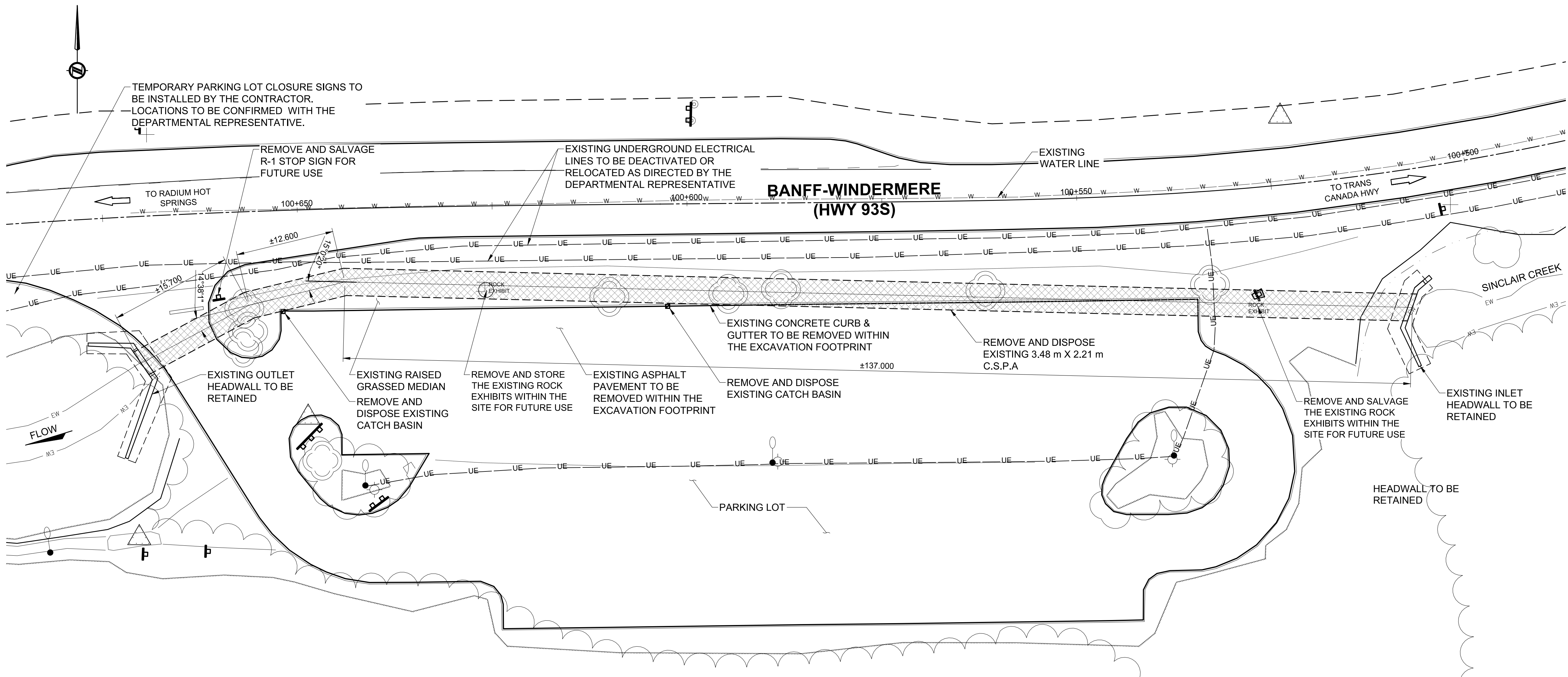
Project title/Titre du projet

**HIGHWAY 93 SOUTH
BANFF – WINDERMERE HWY
CULVERT REPLACEMENT
SINCLAIR CREEK (KM 100.6)**

Drawing title/Titre du dessin

LOCATION MAP & GENERAL NOTES

Surveyed by/Arpenté par SA	Drawn by/Dessiné par ES	Date 2018-01-29
Designed by/Conçeut par SM	Reviewed by/Revisé par BS	Scale/Echelle AS SHOWN
Client Acceptance/Acceptation du client		Approved by/Approuvé par
Date		Date
Project No./Nº du projet 1079-01	Asset No./Nº du bien -	Sheet No./ Nºde la feuille S100
Drawing Set No./Nº de série du dessin 60547362-C6		



PLAN
Scale 1:300

LEGEND:

 DENOTES DEMOLITION AREA

DEMOLITION NOTES

1. SEE SEQUENCE OF OPERATIONS NOTES ON DWG S-100 FOR REQUIREMENTS OF HANDLING EXISTING STREAM FLOW DURING DEMOLITION.
2. GEOMETRY AND LAYOUT OF THE EXISTING HEADWALLS, WINGWALLS, FOOTINGS AND STEEL PIPE ARCH CULVERT ARE BASED ON INFORMATION OBTAINED FROM EXISTING DESIGN INFORMATION. THE ACCURACY OF THIS INFORMATION HAS NOT BEEN VERIFIED. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO FIELD CONFIRM ALL NECESSARY DIMENSIONS SUCH THAT THE WORK CAN BE CONSTRUCTED AS SHOWN ON THESE DRAWINGS. THE CONTRACTOR SHALL INFORM THE DEPARTMENT OF ANY DISCREPANCIES IDENTIFIED FROM THAT INFORMATION SHOWN IN THIS DRAWING.
3. CONTRACTOR SHALL COORDINATE WITH THE UTILITY OWNERS FOR DEACTIVATION AND RELOCATION (IF REQUIRED) OF THE EXISTING UTILITIES BEFORE COMMENCEMENT OF ANY DEMOLITION OR EXCAVATION WORK.
4. THE PORTIONS OF THE HEADWALLS SHALL BE REMOVED USING SAWCUT AS SHOWN ON SHEET S102. ALL RAILING, STONE FACING, STONE WORK ON THE WALLS SHALL BE REMOVED WITHOUT ANY DAMAGE TO THE EXISTING WALLS. ANY DETERIORATED CONCRETE SHALL BE REMOVED TO THE SOUND CONCRETE USING HAND TOOLS.
5. ALL MATERIALS RESULTING FROM DEMOLITION AND REMOVAL OF THE EXISTING STEEL PIPE ARCH CULVERT SHALL BE HAULED AND DISPOSED OUTSIDE OF PARK AT CONTRACTOR'S EXPENSE.

EQUIPMENT PERMITTED FOR CONCRETE DEMOLITION

1. JACKHAMMERS AND CHIPPING HAMMERS HEAVIER THAN NOMINAL 15kg SHALL NOT BE USED TO REMOVE CONCRETE.
2. ONCE THE REINFORCING STEEL IS REACHED, JACKHAMMER OR MECHANICAL CHIPPING TOOLS SHALL NOT BE OPERATED AT AN ANGLE IN EXCESS OF 45 DEGREES MEASURED FROM THE SURFACE OF THE CONCRETE.
3. MECHANICAL SCABBLERS OF 8 Nm (6 ft-lb) IMPACT, GRINDERS OR SHOTBLASTING, CAPABLE OF REMOVING THE CONCRETE AND PRODUCING AN ANGULAR FINISHED SURFACE.
4. CONCRETE CUTTING SAWS CAPABLE OF SAWING TO THE DEPTHS INDICATED ON THE DRAWINGS.
5. HAND TOOLS SUCH AS HAMMERS AND CHISELS.

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Linear dimensions
in millimetres
Dimensions linéaires
en millimètres

Consultant's Name
Nom de l'expert-conseil

AECOM



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Gestion des biens
Région de l'Ouest et
du Nord

Canada

Project title/Titre du projet

**HIGHWAY 93 SOUTH
BANFF – WINDERMERE HWY
CULVERT REPLACEMENT
SINCLAIR CREEK (KM 100.6)**

Drawing title/Titre du dessin

**EXISTING CULVERT LAYOUT
AND DEMOLITION PLAN**

Surveyed by/Arpenté par SA	Drawn by/Dessiné par ES	Date 2018-01-29
Designed by/Conçeut par SM	Reviewed by/Revisé par BS	Scale/Echelle AS SHOWN
Client Acceptance/Acceptation du client		Approved by/Approuvé par
Date		Date
Project No./Nº du projet 1079-01	Asset No./Nº du bien -	Sheet No./ Nº de la feuille S101
Drawing Set No./Nº de série du dessin 60547362-C6		

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Detail number
Sheet number

A Numéro de détail
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Linear dimensions
in millimetres

Dimensions linéaires
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Consultant's Name
Nom de l'expert-conseil

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Parks Canada
Asset Management
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Region

Parcs Canada
Gestion des biens
Région de l'Ouest et
du Nord

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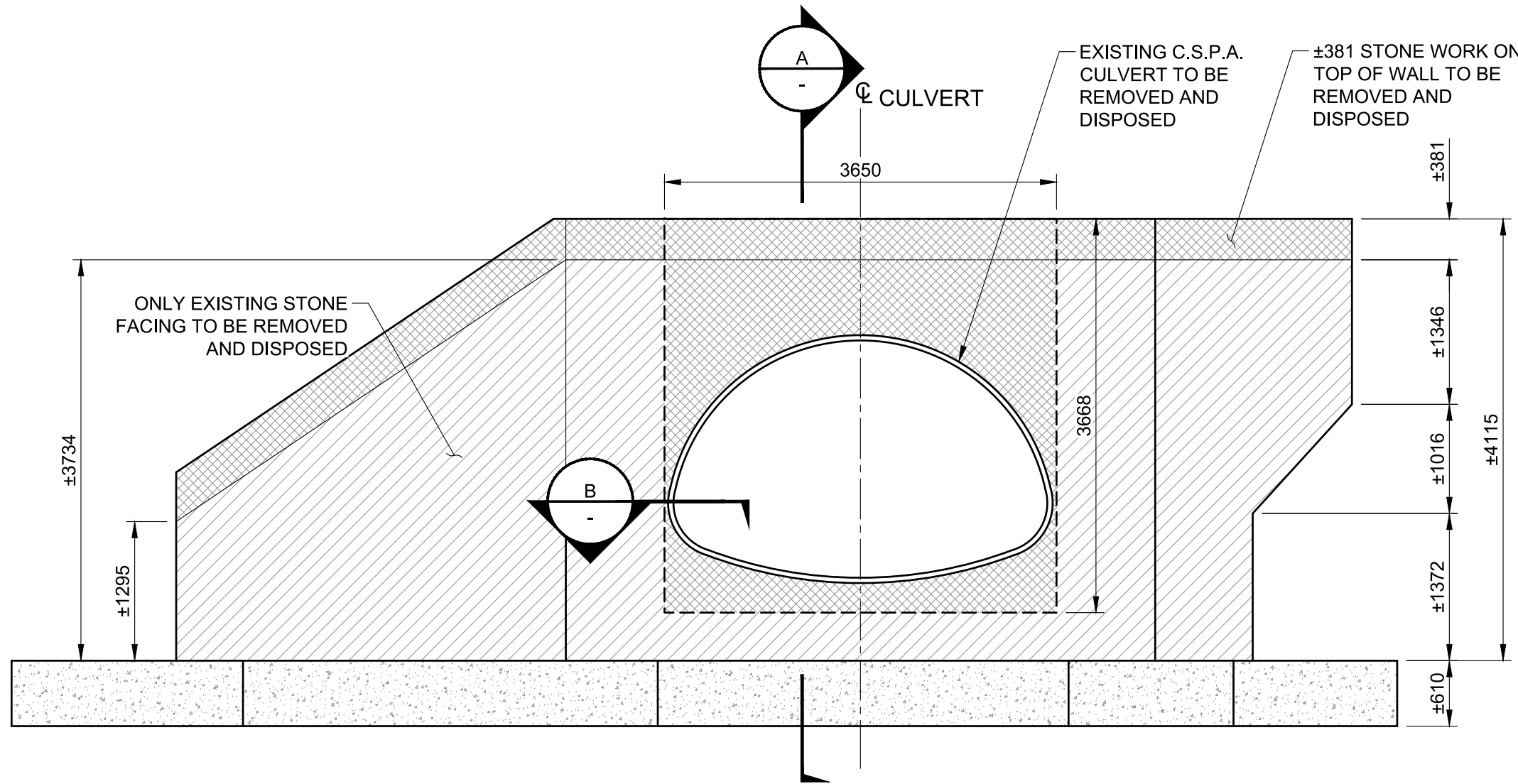
Project title/Titre du projet

**HIGHWAY 93 SOUTH
BANFF – WINDERMERE HWY
CULVERT REPLACEMENT
SINCLAIR CREEK (KM 100.6)**

Drawing title/Titre du dessin

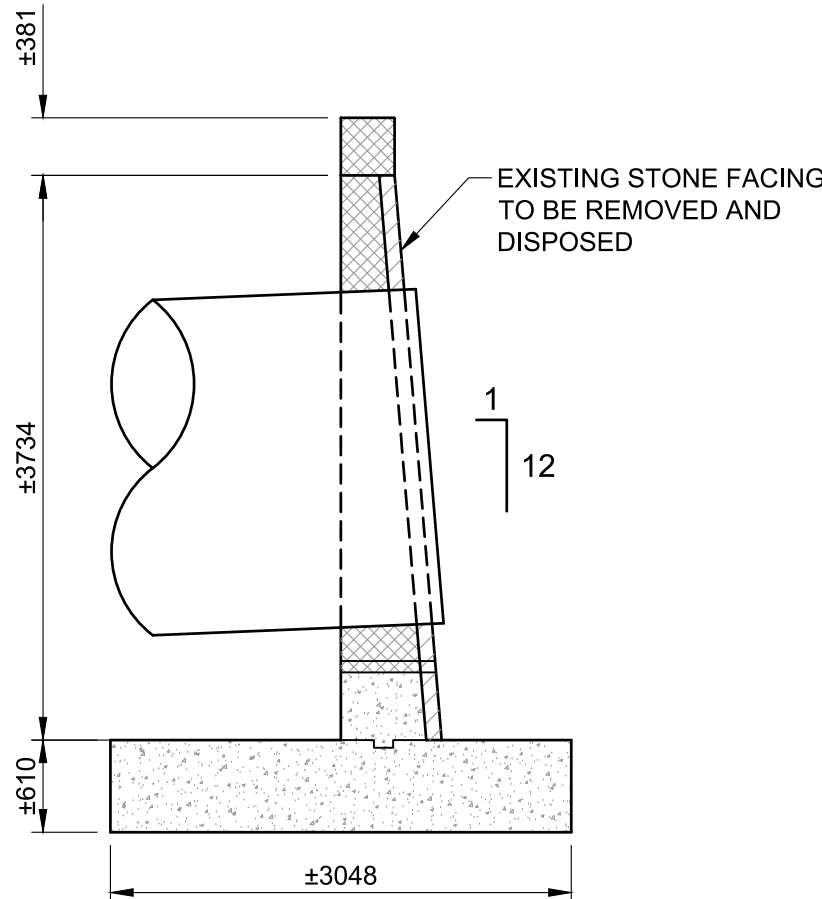
**DEMOLITION DETAILS
EXISTING END TREATMENT**

Surveyed by/Arpenté par SA	Drawn by/Dessiné par ES	Date 2018-01-29
Designed by/Concept par SM	Reviewed by/Revisé par BS	Scale/Echelle AS SHOWN
Client Acceptance/Acceptation du client		Approved by/Approuvé par
Date		Date
Project No./Nº du projet 1079-01	Asset No./Nº du bien -	Sheet No./ Nº de la feuille
Drawing Set No./Nº de série du dessin 60547362-C6		S102



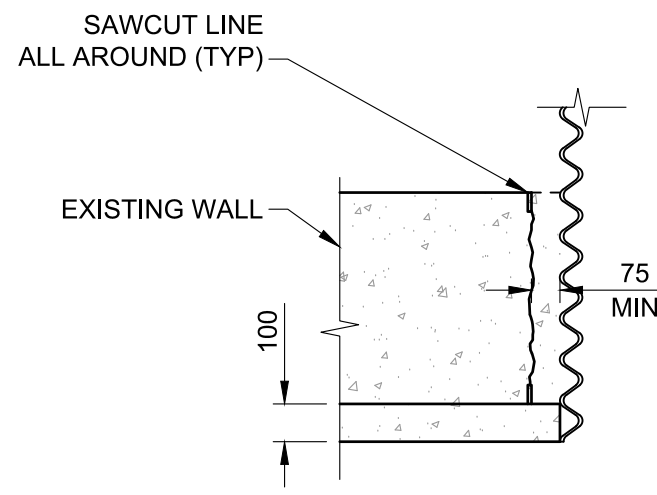
INLET - ELEVATION

Scale 1:50



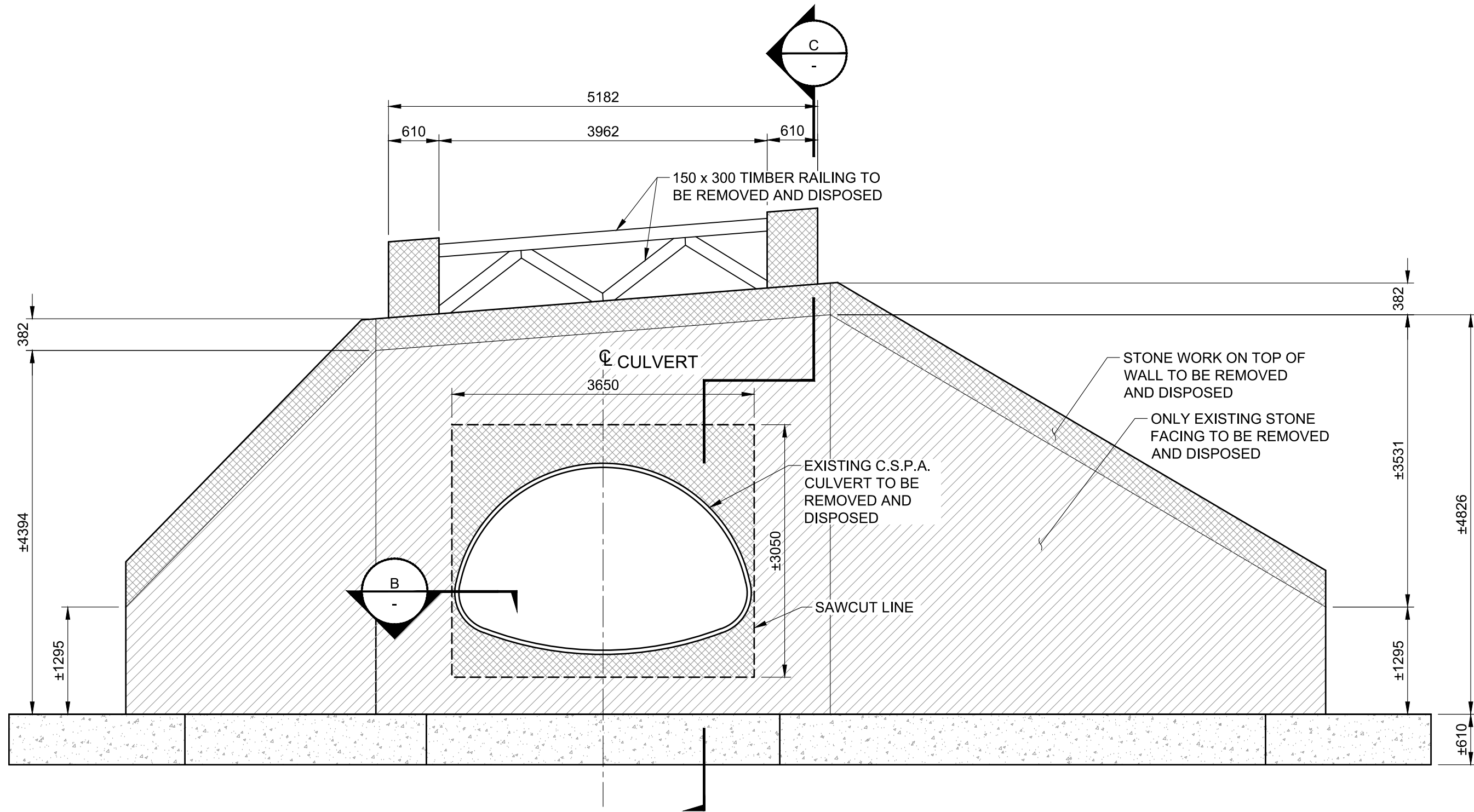
A SECTION

Scale 1:50



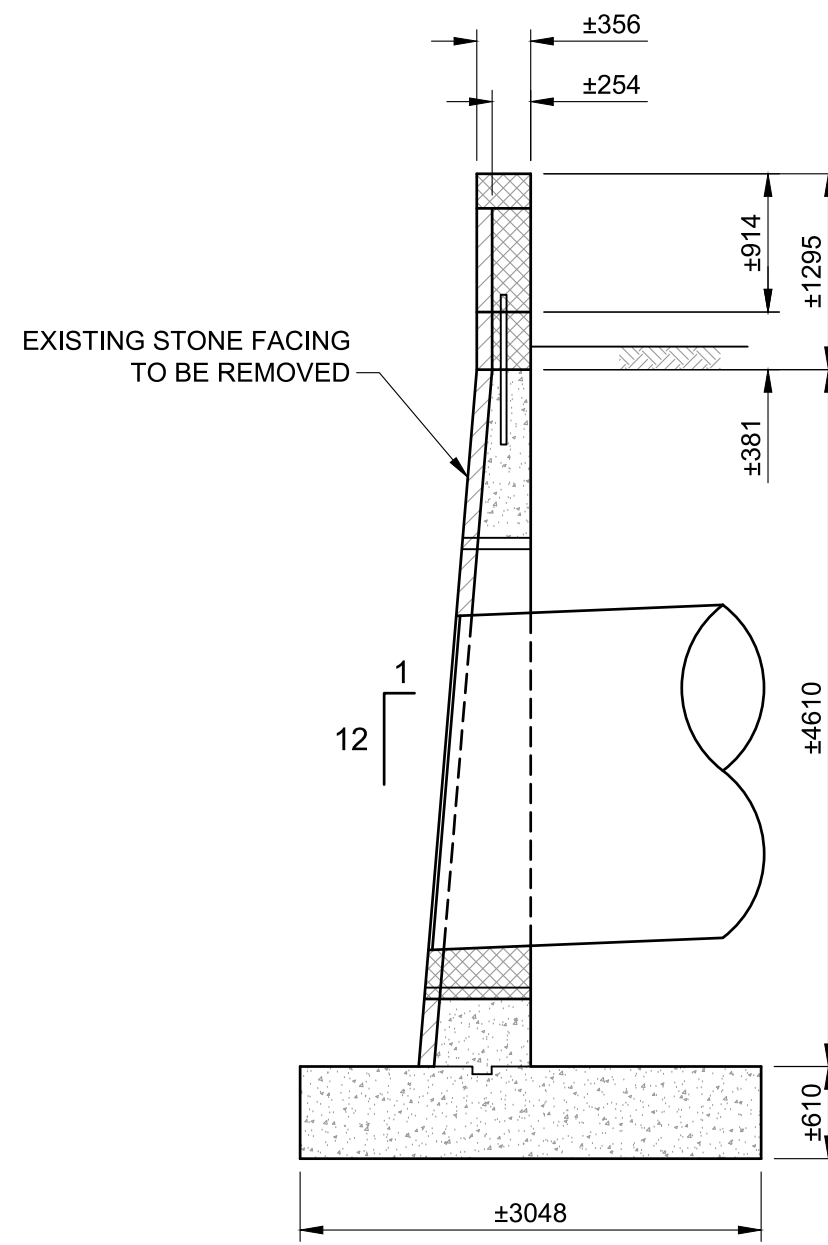
B SECTION

Scale 1:20



OUTLET - ELEVATION

Scale 1:50

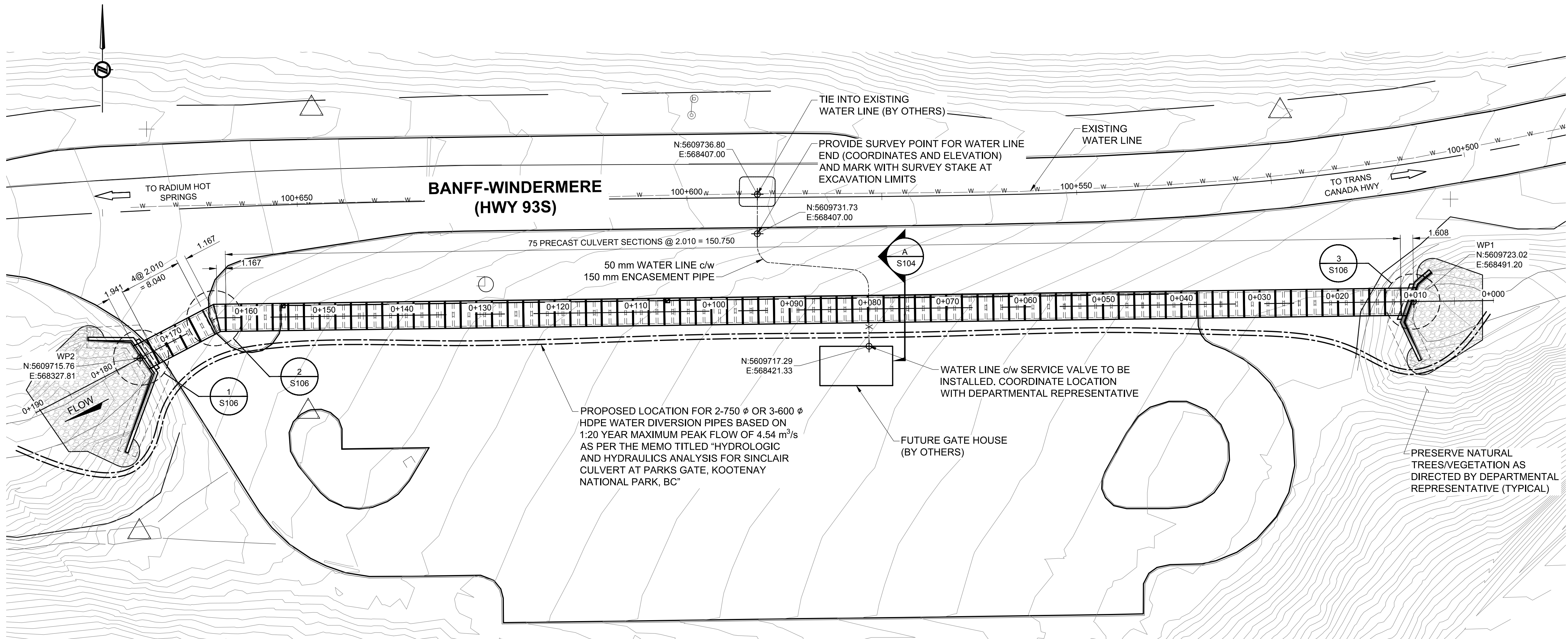


C SECTION

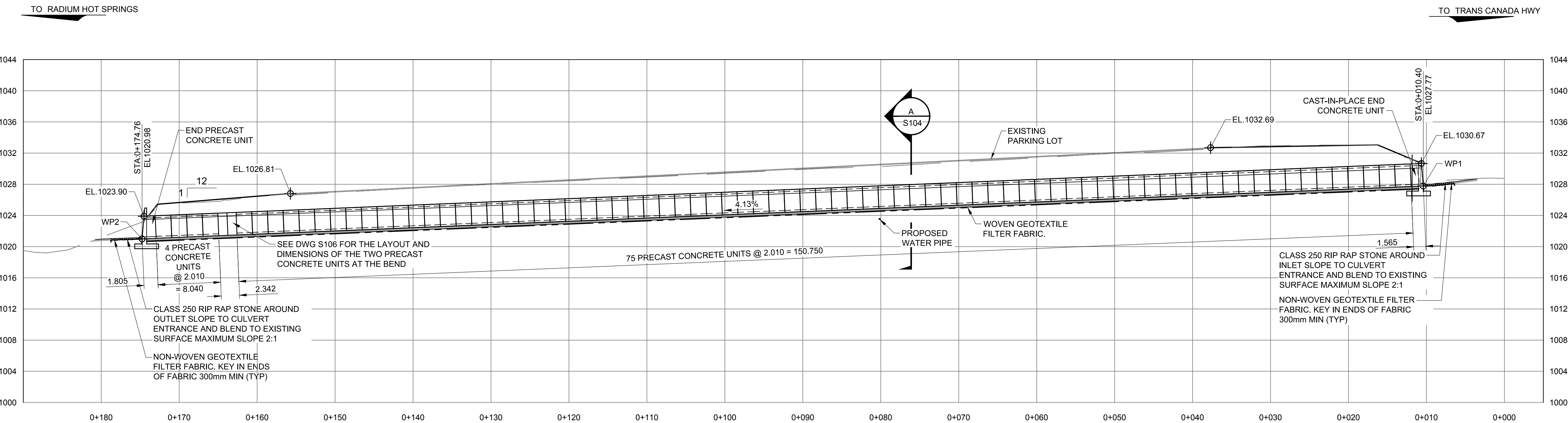
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LEGEND:

- DENOTES EXISTING CONCRETE AREA
- DENOTES DEMOLITION AREA
- DENOTES FACING DEMOLITION AREA



PLAN
Scale 1:300



ELEVATION
Scale 1:300

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Revision / Revision

A	Detail number	A Numéro de détail
B	Sheet number	B Numéro de la feuille

Linear dimensions in millimetres	Dimensions linéaires en millimètres
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Consultant's Name
Nom de l'expert-conseil

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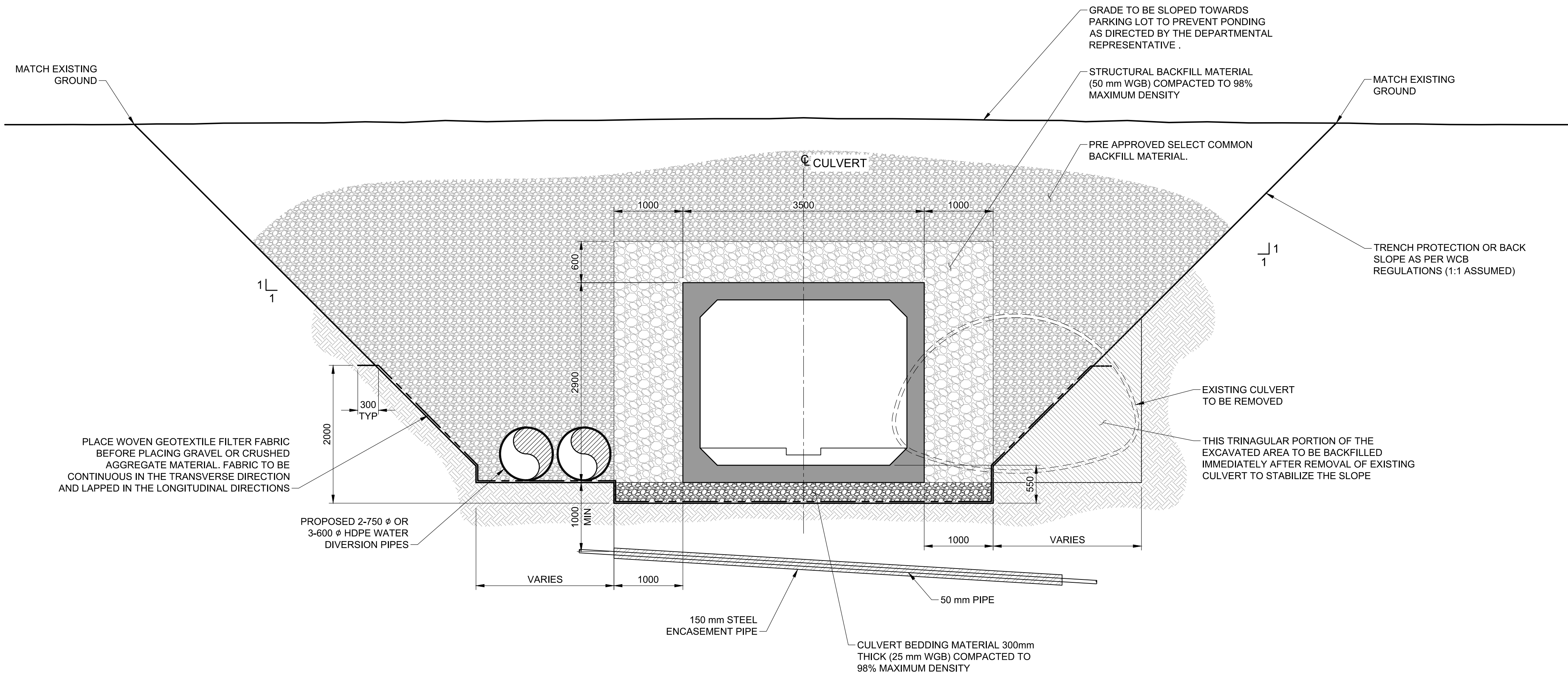
Parcs Canada
Gestion des biens
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Canada

Project title/Titre du projet
**HIGHWAY 93 SOUTH
BANFF - WINDERMERE HWY
CULVERT REPLACEMENT
SINCLAIR CREEK (KM 100.6)**

Drawing title/Titre du dessin
NEW CULVERT LAYOUT

Surveyed by/Arpenté par SA	Drawn by/Dessiné par ES	Date 2018-01-29
Designed by/Conçut par SM	Reviewed by/Revisé par BS	Scale/Echelle AS SHOWN
Client Acceptance/Acceptation du client		Approved by/Approuvé par
Project No./Nº du projet 1079-01		Asset No./Nº du bien -
Drawing Set No./Nº de série du dessin 60547362-C6		Sheet No./ Nº de la feuille S103



A | BACKFILL SECTION
S103 | Scale 1:40

GENERAL NOTE

- FOR CULVERT INSTALLATION, BACKFILLING AND COMPACTION REQUIREMENTS REFER TO SHEET S100.

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<div><div>A</div><div>B</div></div>	Detail number Sheet number	A Numéro de détail B Numéro de la feuille
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Linear dimensions in millimetres	Dimensions linéaires en millimètres
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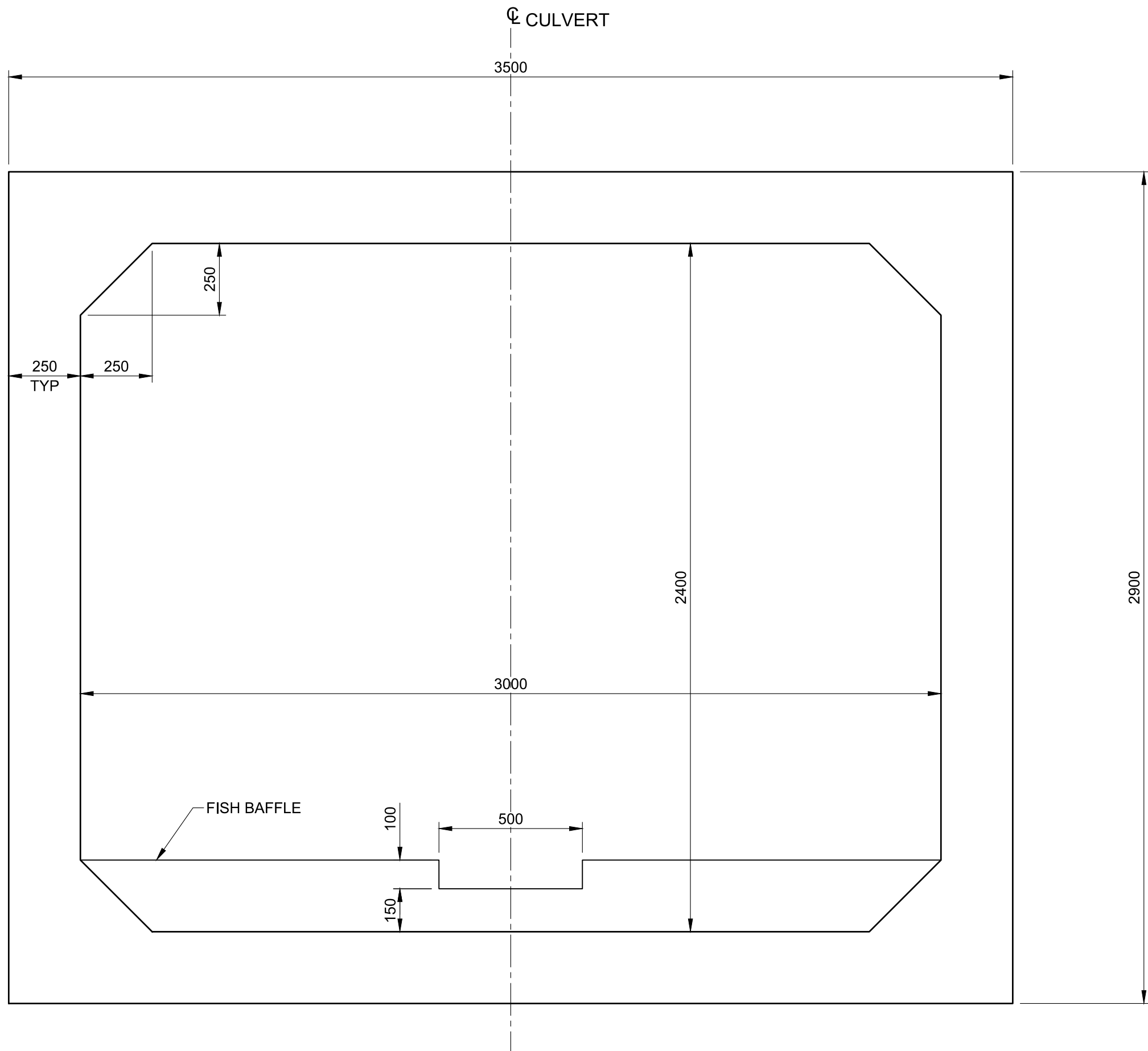
Canada

Project title/Titre du projet
**HIGHWAY 93 SOUTH
BANFF – WINDERMERE HWY
CULVERT REPLACEMENT
SINCLAIR CREEK (KM 100.6)**

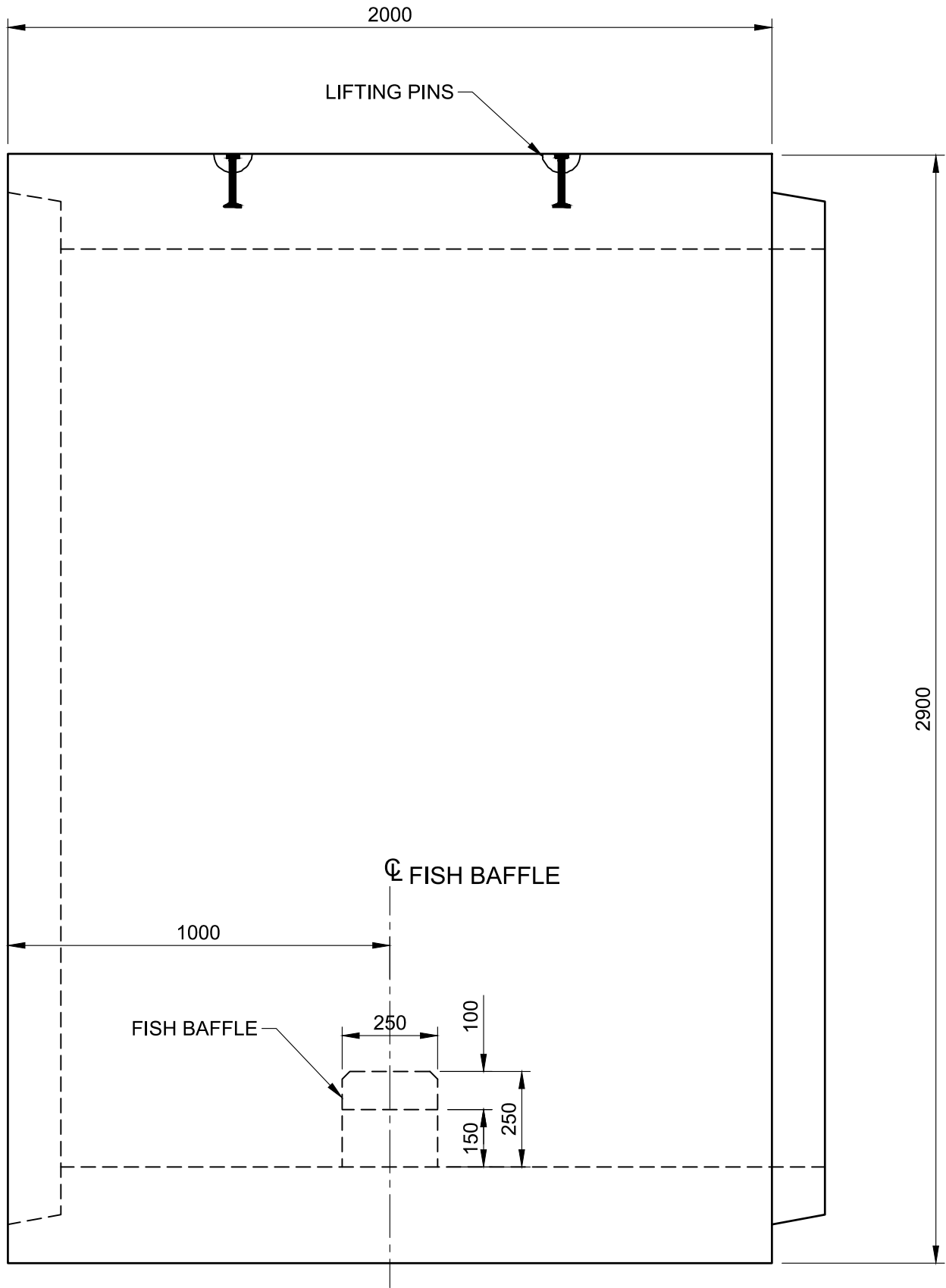
Drawing title/Titre du dessin
CULVERT BACKFILL DETAILS

Surveyed by/Arpenté par SA	Drawn by/Dessiné par ES	Date 2018-01-29
Designed by/Concept par SM	Reviewed by/Revisé par BS	Scale/Echelle AS SHOWN
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Date		Date

Project No./Nº du projet 1079-01	Asset No./Nº du bien -	Sheet No./ Nº de la feuille S104
Drawing Set No./Nº de série du dessin 60547362-C6		



PRECAST CULVERT - TYPICAL SECTION
Scale 1:15



PRECAST CULVERT - TYPICAL ELEVATION
Scale 1:15

GENERAL NOTES

1. FOR CONCRETE AND REINFORCING STEEL NOTES REFER TO SHEET S100.
2. FOR MATERIALS AND FABRICATION SEE NOTES ON SHEET S100.
3. CONTRACTOR MAY PROPOSE A DIFFERENT SEGMENT LENGTH FOR THE PRECAST BOX SECTIONS AND SUBMIT THE REVISED CULVERT LAYOUT FOR APPROVAL FROM DEPARTMENTAL REPRESENTATIVE.
4. THE SPACING OF FISH BAFFLE SHALL NOT EXCEED 2000 mm BETWEEN ADJACENT PRECAST BOX SECTIONS AS PER THE MEMO TITLED "FISH PASSAGE DESIGN FOR SINCLAIR CULVERT AT PARKS GATE, KOOTENAY NATIONAL PARK, BC".

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Dimensions linéaires
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Project title/Titre du projet

**HIGHWAY 93 SOUTH
BANFF – WINDERMERE HWY
CULVERT REPLACEMENT
SINCLAIR CREEK (KM 100.6)**

Drawing title/Titre du dessin

PRECAST CULVERT DETAILS

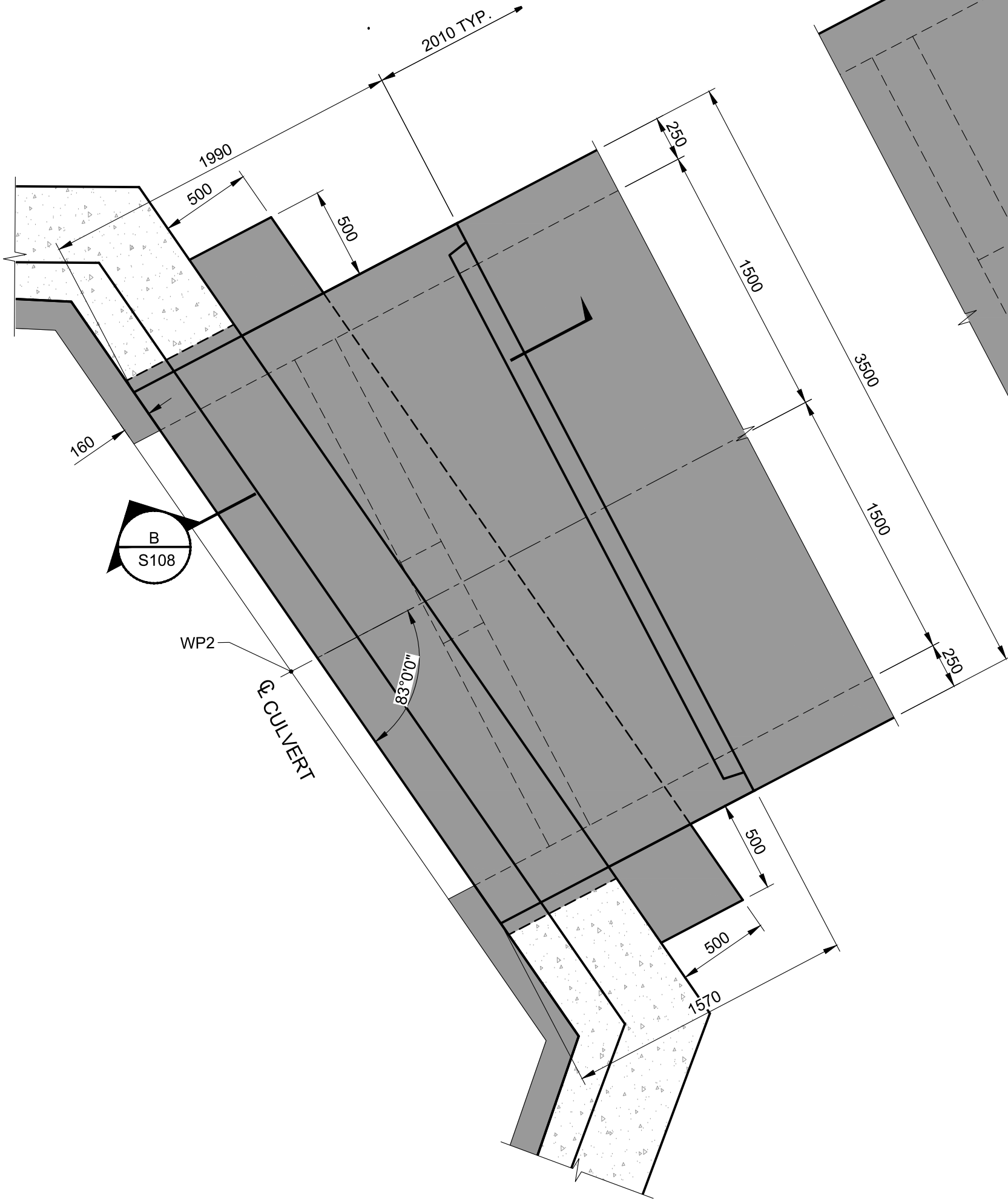
Surveyed by/Arpenté par SA	Drawn by/Dessiné par ES	Date 2018-01-29
Designed by/Concept par SM	Reviewed by/Revisé par BS	Scale/Echelle AS SHOWN
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Project No./Nº du projet 1079-01	Asset No./Nº du bien -	Sheet No./ Nº de la feuille S105
Drawing Set No./Nº de série du dessin 60547362-C6		

LEGEND:

- DENOTES NEW CONSTRUCTION
CONCRETE AREA
- DENOTES EXISTING CONCRETE AREA

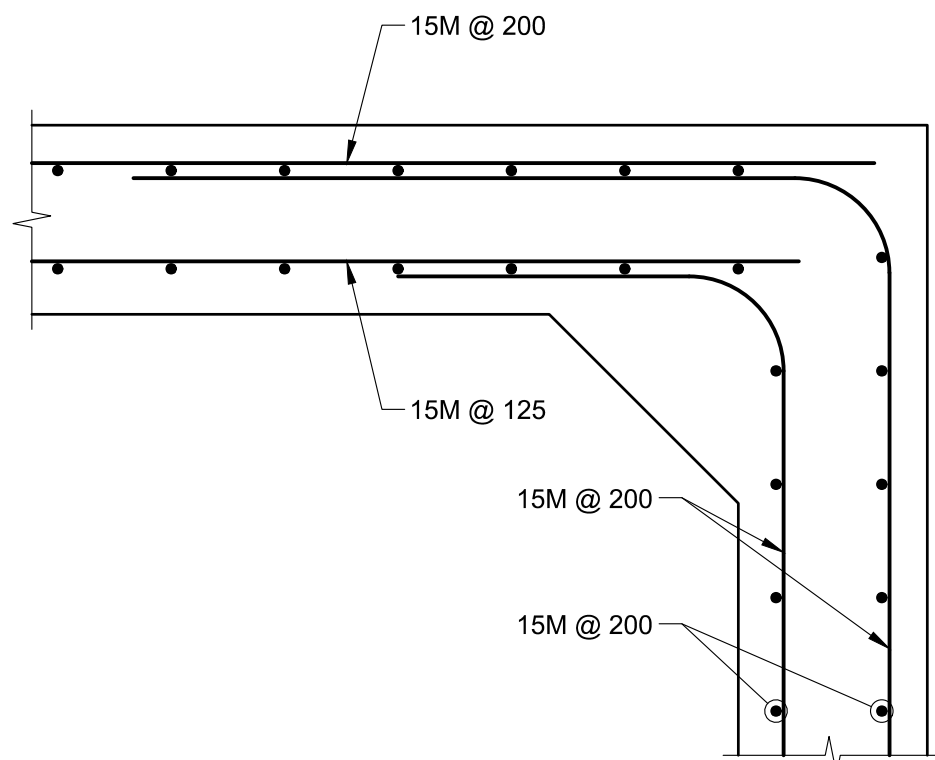
GENERAL NOTES

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- FOR MATERIALS AND FABRICATION REFER TO NOTES SHEET S100.
- CONTRACTOR MAY PROPOSE A PRECAST CONCRETE END SECTION AT INLET END INSTEAD OF A CAST-IN-PLACE SECTION. THE PRECAST SECTION WILL BE ACCEPTABLE AS LONG IT CAN BE PLACED FLUSH WITH THE FRONT FACE OF THE HEADWALL.

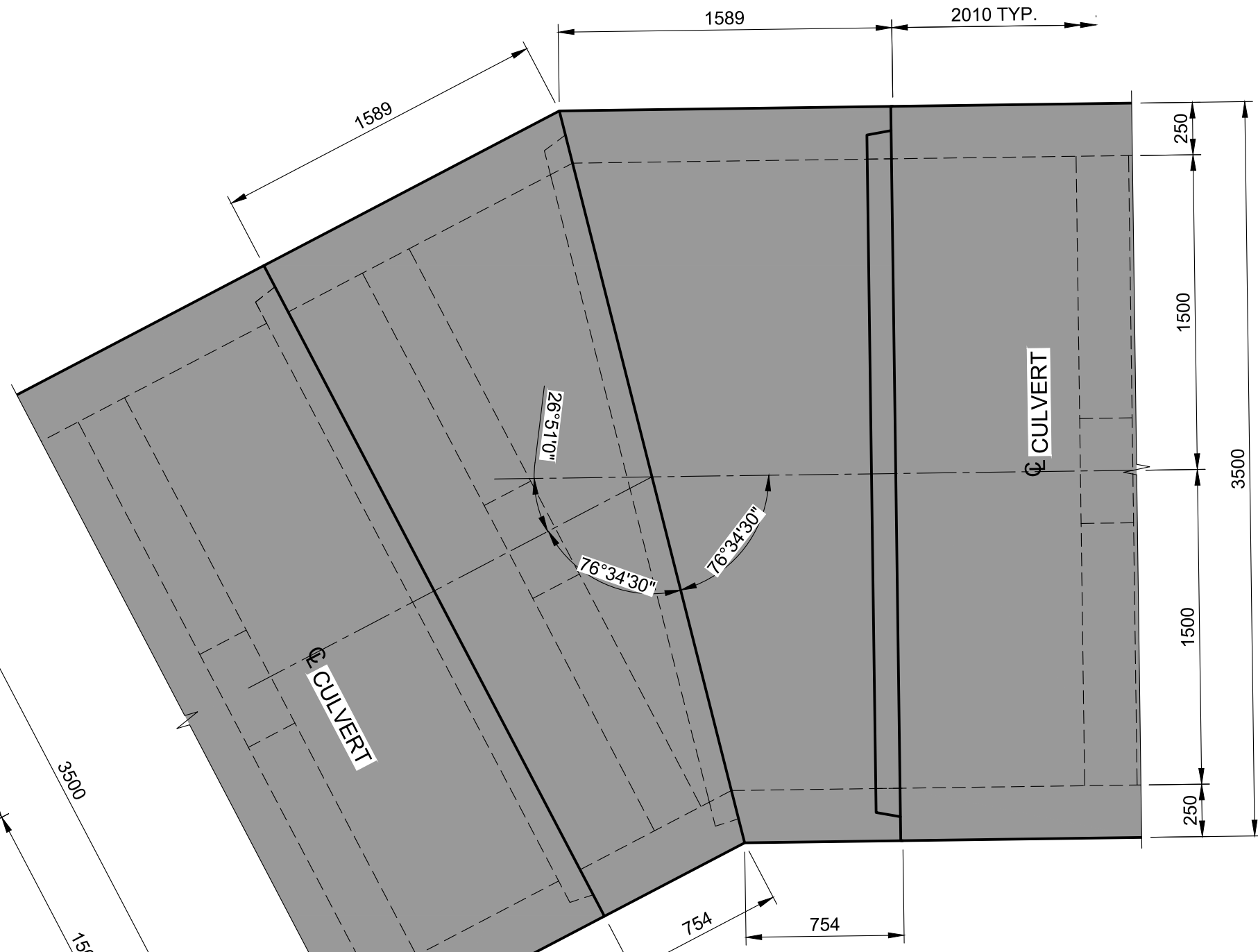


OUTLET END

1 | DETAIL
S103 Scale 1:25

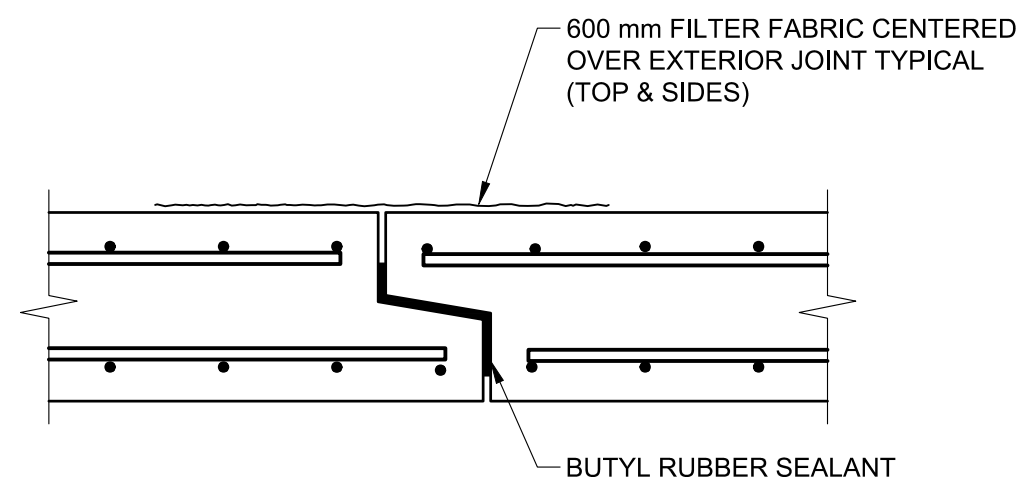


4 | DETAIL
Scale 1:10

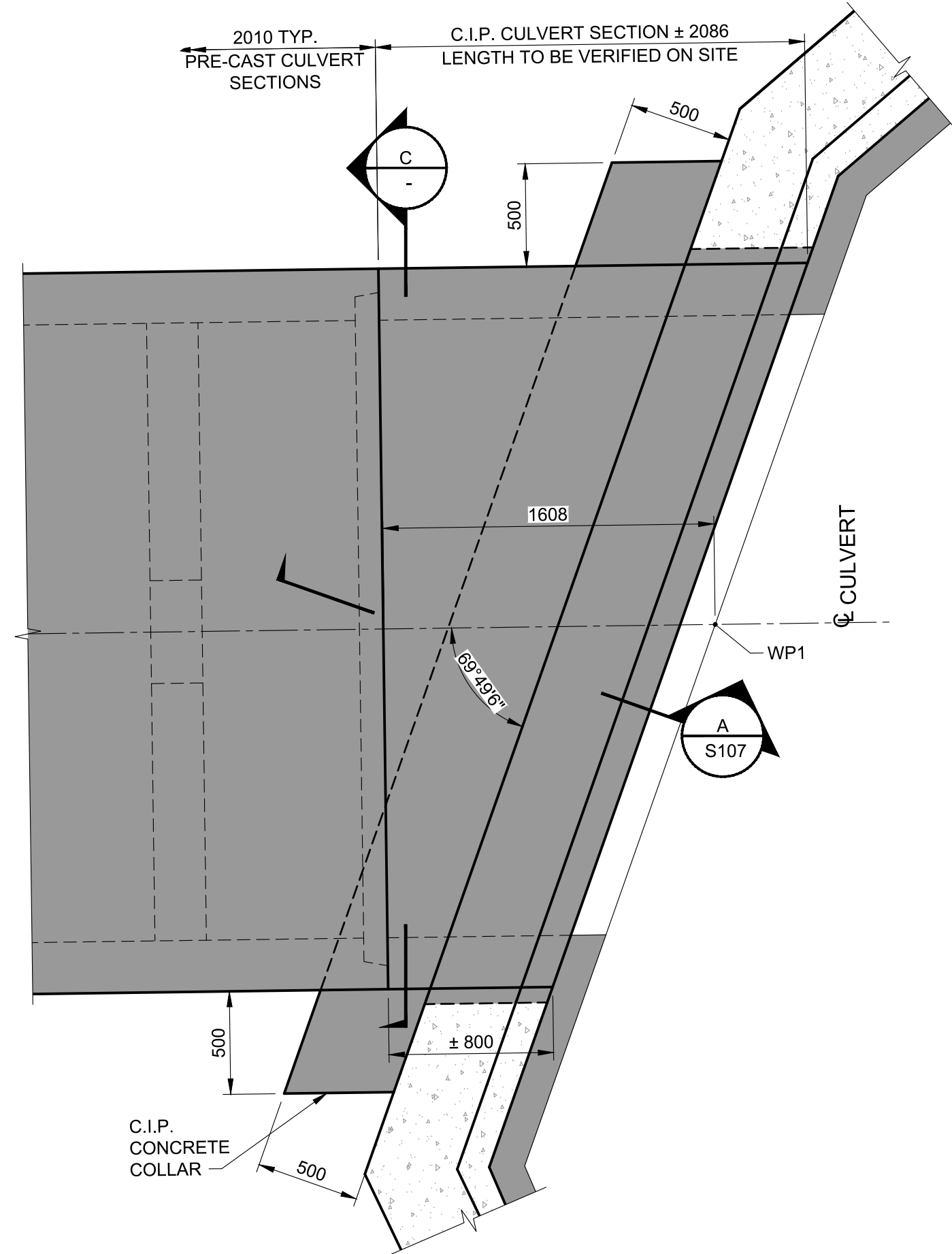


AT BEND LOCATION

2 | DETAIL
S103 Scale 1:25

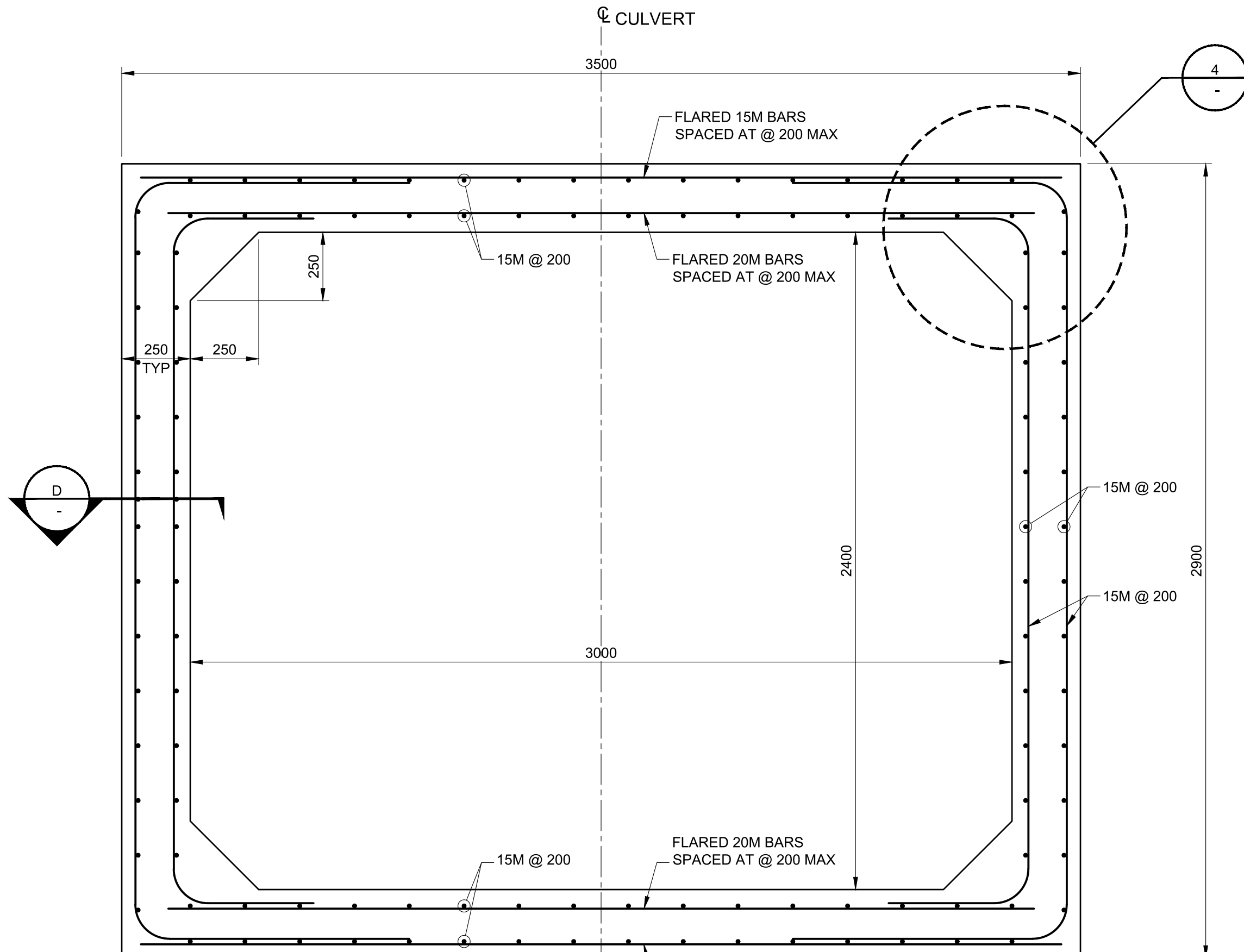


D | SECTION
Scale 1:10



C.I.P. INLET END

3 | DETAIL
S103 Scale 1:25



C | CULVERT - C.I.P. SECTION AT INLET

Scale 1:15

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Linear dimensions in millimetres	Dimensions linéaires en millimètres
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Consultant's Name
Nom de l'expert-conseil

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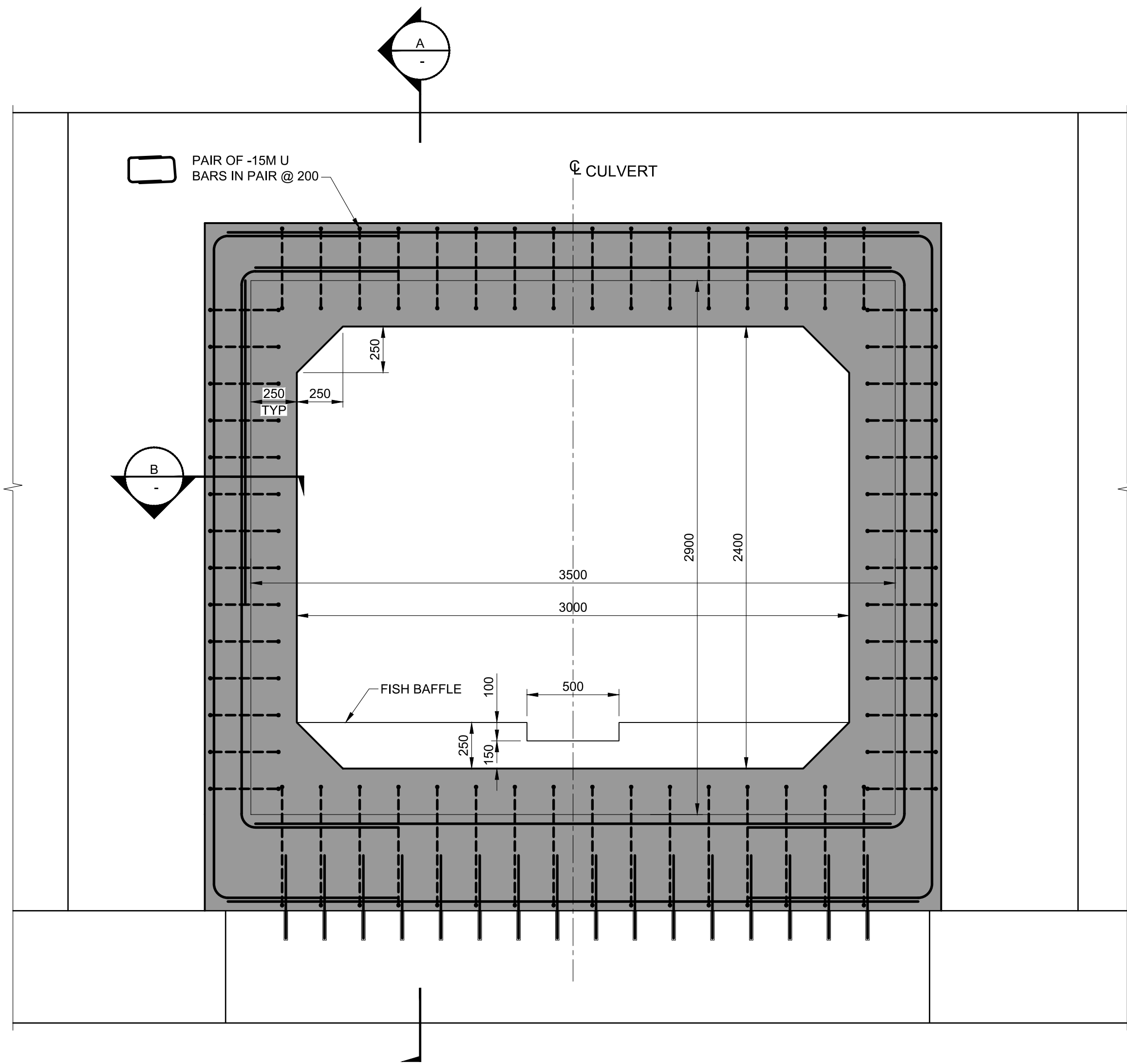
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Canada

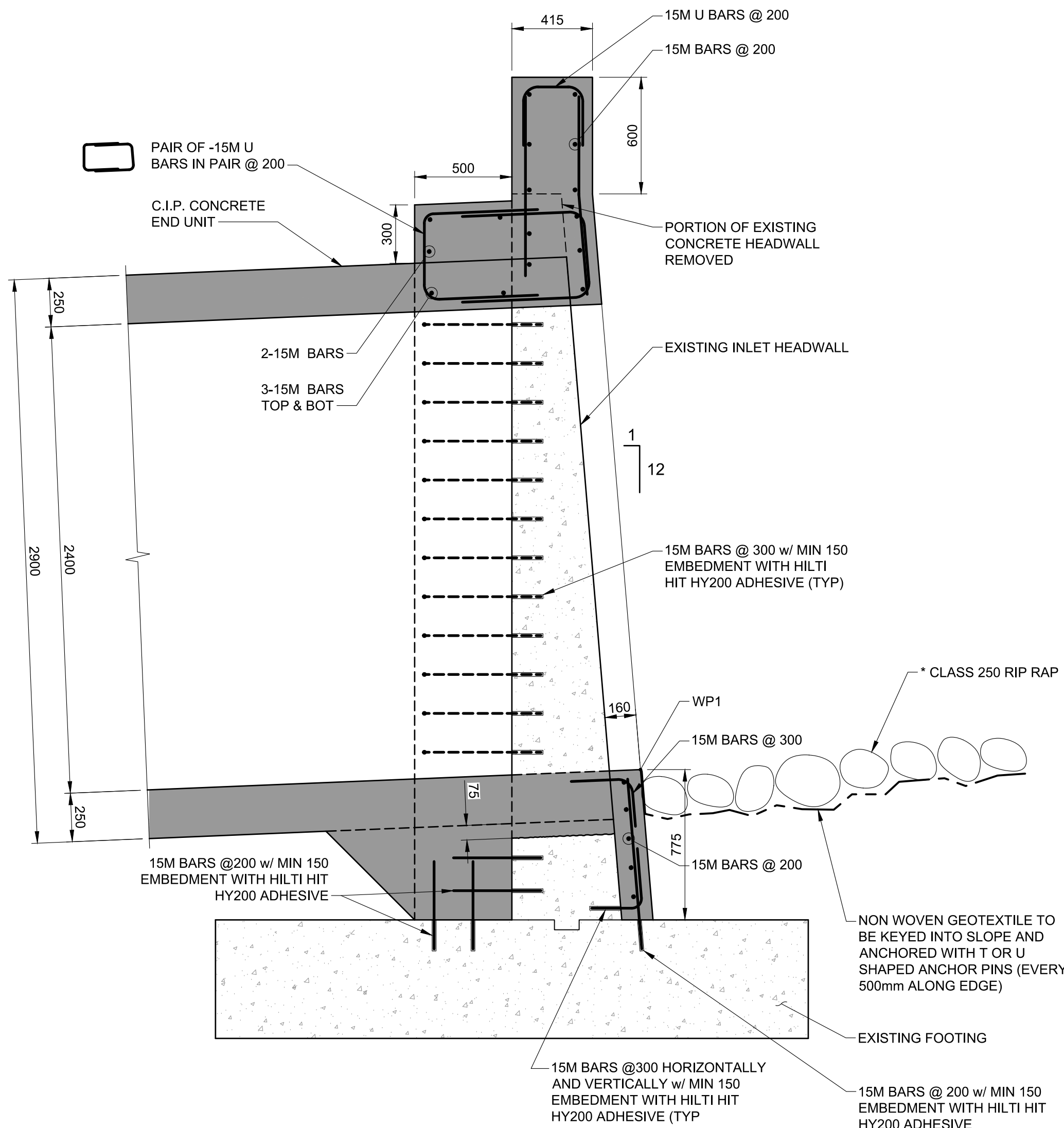
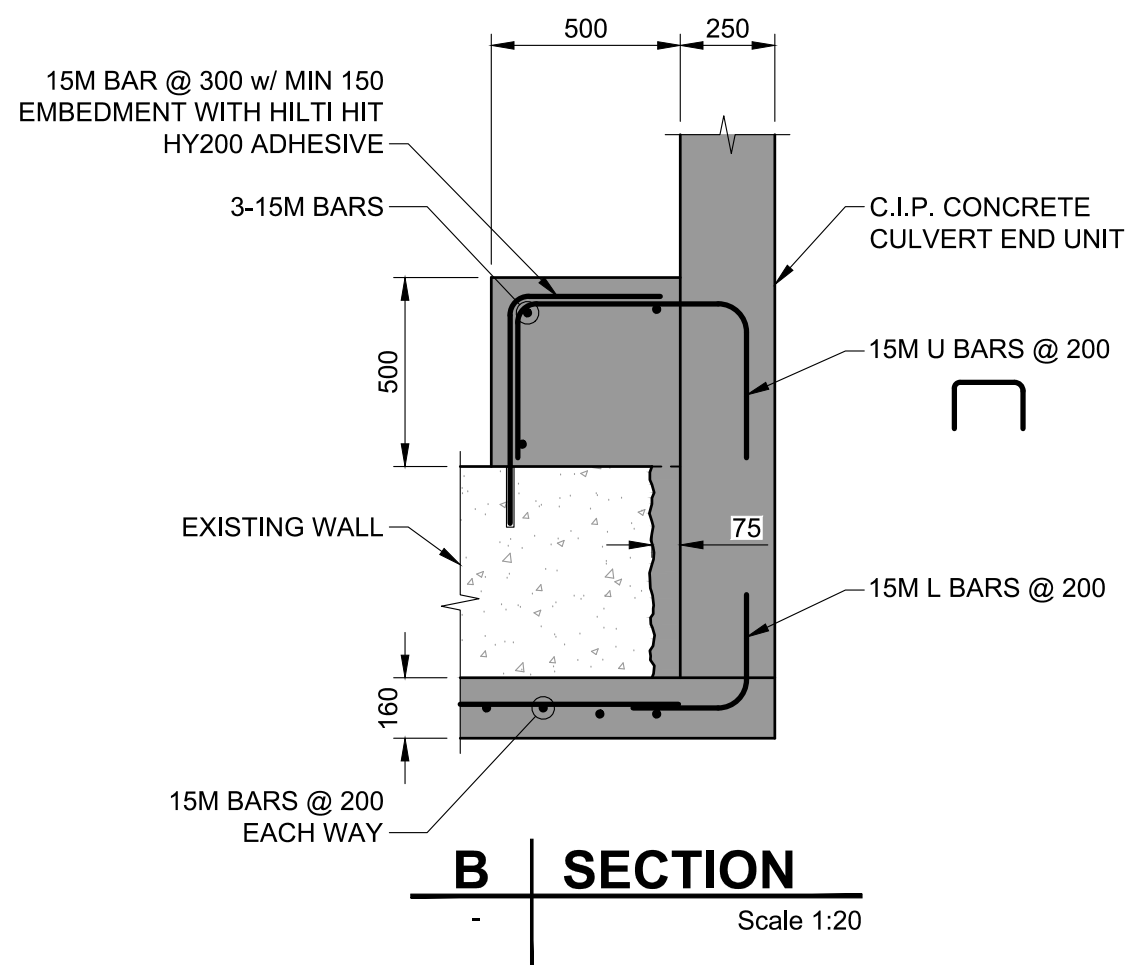
Project title/Titre du projet
HIGHWAY 93 SOUTH
BANFF – WINDERMERE HWY
CULVERT REPLACEMENT
SINCLAIR CREEK (KM 100.6)

CULVERT DETAILS

Surveyed by/Arpenté par SA	Drawn by/Dessiné par ES	Date 2018-01-29
Designed by/Conçeut par SM	Reviewed by/Revisé par BS	Scale/Echelle AS SHOWN
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Project No./Nº du projet 1079-01	Asset No./Nº du bien -	Sheet No./ Nº de la feuille S106
Drawing Set No./Nº de série du dessin 60547362-C6		



C.I.P. CONCRETE INLET DETAILS
(LOOKING FROM BACKSIDE OF THE HEADWALL) Scale 1:20



A SECTION
S106 Scale 1:20

NOTE

- * FOR RIPRAP NOTES REFER TO SHEET S111

CULVERT END TREATMENT NOTES

1. CONTRACTOR SHALL INSTALL THE REINFORCING DOWEL BARS USING HILTI HIT-HY 200 SYSTEM AT THE LOCATIONS SHOWN ON SHEETS ##### & #####.
2. CONTRACTOR SHALL USE APPROPRIATE SIZE OF DRILL BITS AS PER THE MANUFACTURER'S RECOMMENDATION FOR THE SIZES OF REBARS SHOWN ON THE DRAWINGS. CARE SHOULD BE TAKEN NOT TO DAMAGE TO ANY EXISTING REINFORCING.
3. THE CONCRETE SURFACES SHALL BE DRY AND THE HOLES SHALL BE CLEANED THOROUGHLY USING COMPRESSED AIR AS PER MANUFACTURER'S RECOMMENDATION PRIOR TO INSTALLATION OF THE DOWELS. ALSO, THE CONCRETE TEMPERATURE SHALL BE WITHIN THE MANUFACTURER'S SPECIFIED TEMPERATURE RANGE DURING DOWEL INSTALLATION.
4. ANY VOIDS UNDERNEATH THE FOOTING SHALL BE FILLED WITH FILLCRETE.
5. THE REINFORCING BARS FOR THE WALLS SHALL BE INSTALLED AS SHOWN ON SHEETS ##### & #####.
6. CONTRACTOR SHALL USE CONCRETE FORMLINER AND CONCRETE PIGMENTS IN THE CONCRETE MIX TO CREATE A STONE FACING FOR THE WALLS RESEMBLING TO EXISTING STONE FACING OR APPROVED EQUIVALENT.

LEGEND:

- DENOTES NEW CONSTRUCTION CONCRETE AREA
- DENOTES EXISTING CONCRETE AREA

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No.	Date	Description	Drawn by Dessiné par	Approved Approuvé

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A
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Detail number
Sheet number
A Numéro de détail
B Numéro de la feuille

Linear dimensions
in millimetres
Dimensions linéaires
en millimètres

Consultant's Name
Nom de l'expert-conseil

AECOM



Parks Canada
Asset Management
Western and
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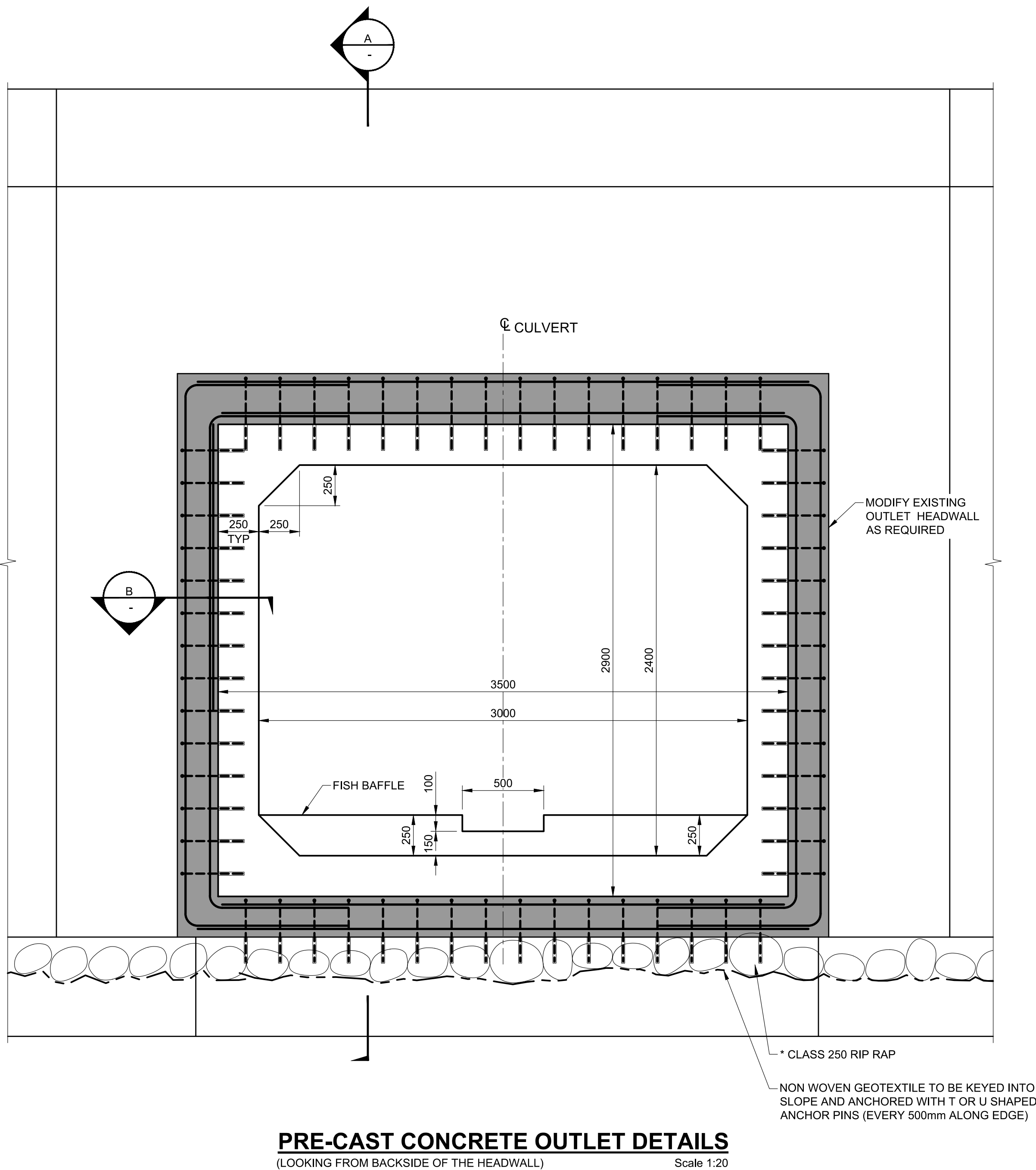
Project title/Titre du projet

**HIGHWAY 93 SOUTH
BANFF – WINDERMERE HWY
CULVERT REPLACEMENT
SINCLAIR CREEK (KM 100.6)**

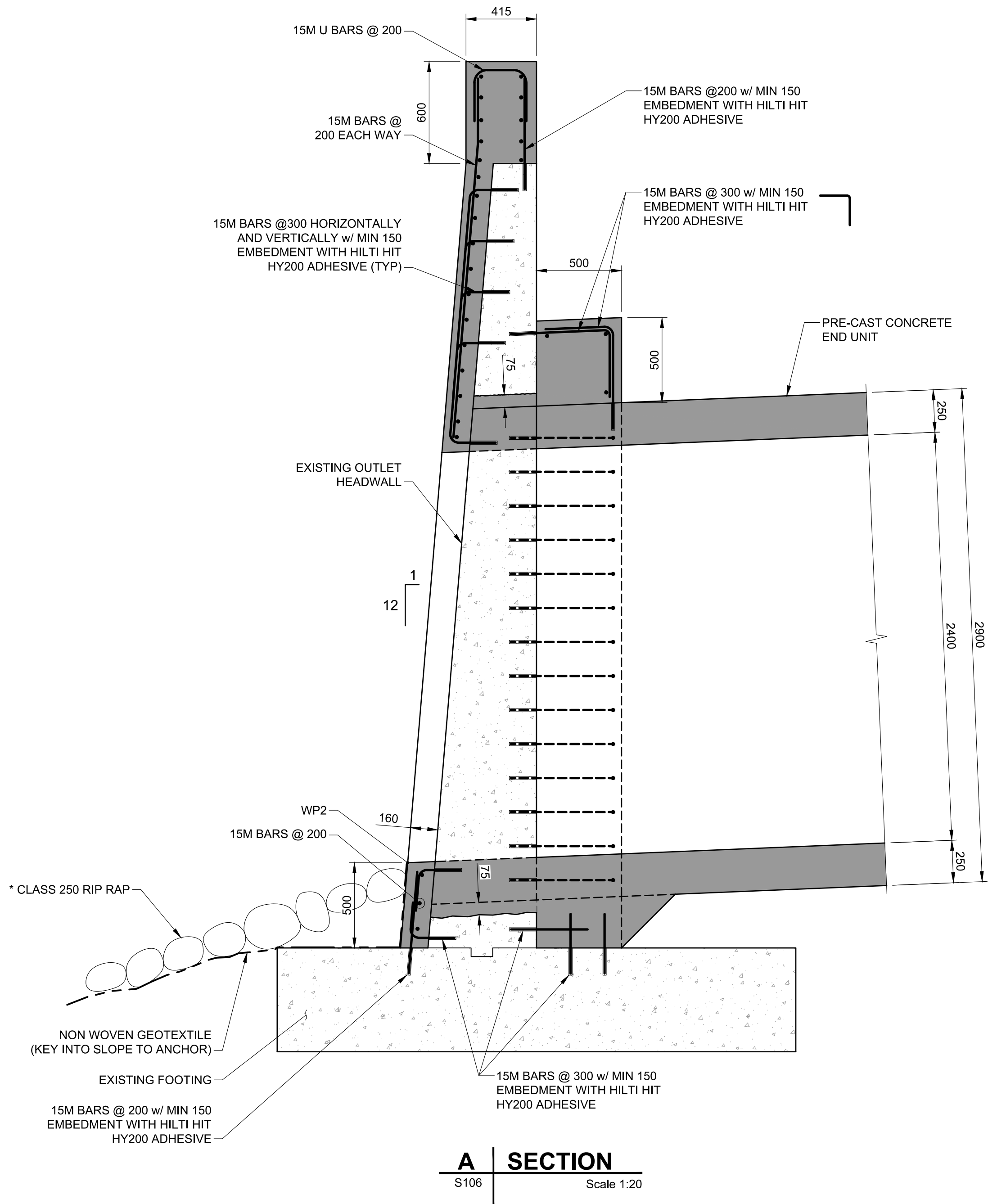
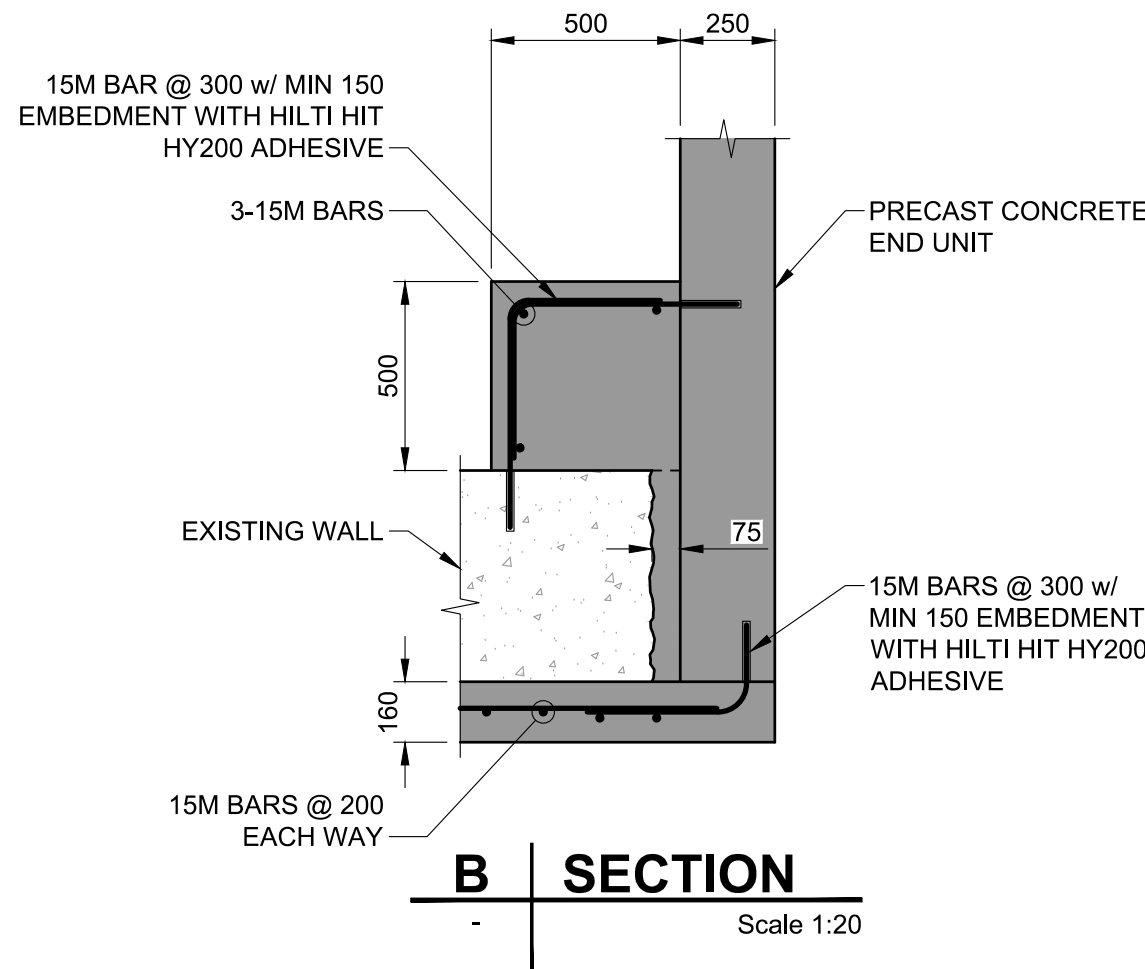
Drawing title/Titre du dessin

CULVERT INLET DETAILS

Surveyed by/Arpenté par SA	Drawn by/Dessiné par ES	Date 2018-01-29
Designed by/Conçait par SM	Reviewed by/Revisé par BS	Scale/Echelle AS SHOWN
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Date		Date
Project No./Nº du projet 1079-01	Asset No./Nº du bien -	Sheet No./ Nº de la feuille
Drawing Set No./Nº de série du dessin 60547362-C6		S107



PRE-CAST CONCRETE OUTLET DETAILS
(LOOKING FROM BACKSIDE OF THE HEADWALL) Scale 1:20



A SECTION
S106 Scale 1:20

NOTE

- * FOR RIPRAP NOTES REFER TO SHEET S111

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Detail number
Sheet number
A Numéro de détail
B Numéro de la feuille

Linear dimensions
in millimetres
Dimensions linéaires
en millimètres

Consultant's Name
Nom de l'expert-conseil

AECOM



Parks Canada
Asset Management
Western and
Northern
Region

Parcs Canada
Gestion des biens
Région de l'Ouest et
du Nord

Canada

Project title/Titre du projet

**HIGHWAY 93 SOUTH
BANFF – WINDERMERE HWY
CULVERT REPLACEMENT
SINCLAIR CREEK (KM 100.6)**

Drawing title/Titre du dessin

CULVERT OUTLET DETAILS

Surveyed by/Arpenté par SA	Drawn by/Dessiné par ES	Date 2018-01-29
Designed by/Concept par SM	Reviewed by/Revisé par BS	Scale/Echelle AS SHOWN
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	Detail number	A Numéro de detail
	Sheet number	B Numéro de la feuille

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Consultant's Name Nom de l'expert-conseil	
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	Parks Canada	Parcs Canada
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	Northern	du Nord
	Region	

Canada

Project title/Titre du projet

HIGHWAY 93 SOUTH
BANFF – WINDERMERE HWY
CULVERT REPLACEMENT
SINCLAIR CREEK (KM 100.6)

Drawing title/Titre du dessin

Surveyed by/Arpenté par SA	Drawn by/Dessiné par ES	Date 2018-01-29
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Drawing Set No./N° de série du dessin	S109
60547362-C6	



 DENOTES NEW CONSTRUCTION
CONCRETE AREA

 DENOTES EXISTING CONCRETE AREA

1. REFER TO SHEETS S107 & S108 FOR LOCATIONS AND DETAILS OF DOWELS REINFORCING BARS FOR CONNECTING NEW CONCRETE TO EXISTING CONCRETE HEADWALL.

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 Sheet number B Numéro de la feuille

Linear dimensions in millimetres	Dimensions linéaires en millimètres
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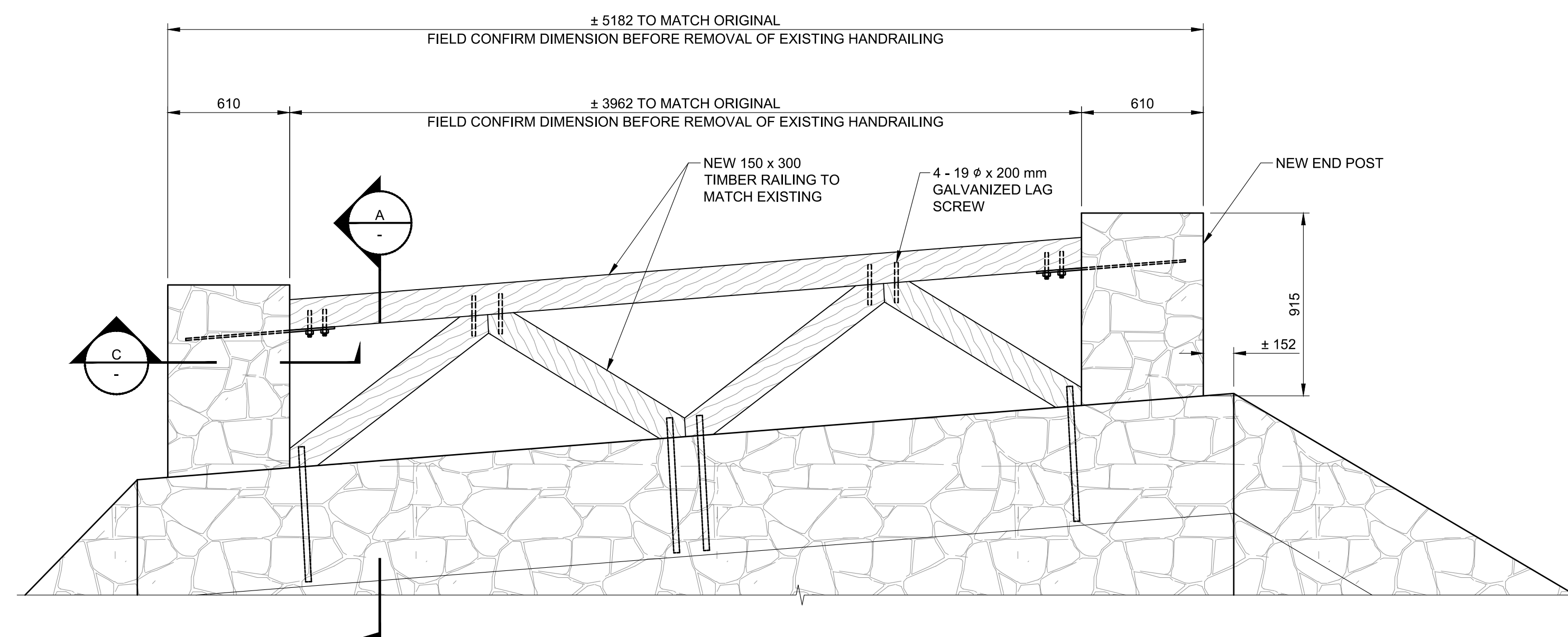
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HIGHWAY 93 SOUTH
BANFF – WINDERMERE HWY
CULVERT REPLACEMENT
SINCLAIR CREEK (KM 100.6)

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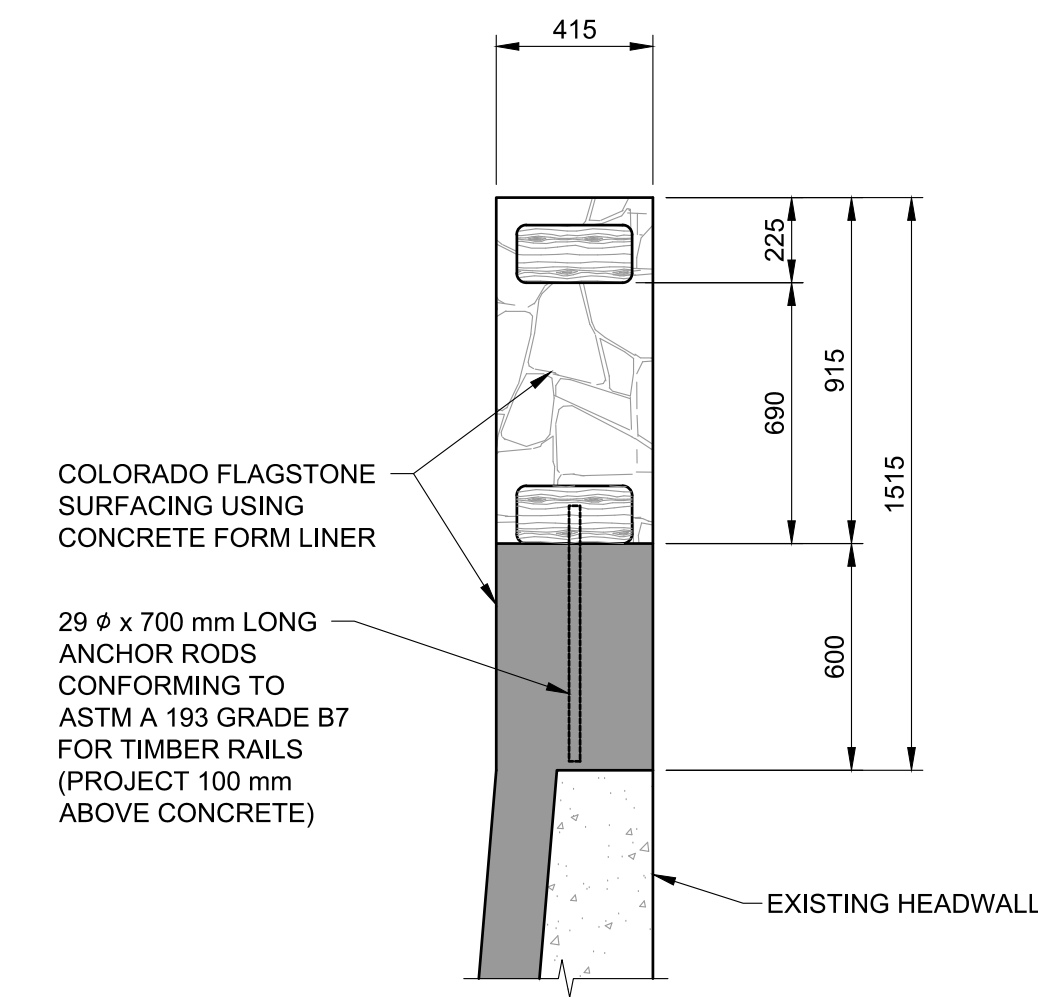
HANDRAIL DETAILS AT CULVERT OUTLET HEADWALL

Surveyed by/Arpenté par SA	Drawn by/Dessiné par ES	Date 2018-01-29
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Drawing Set No./N° de série du dessin 60547362-C6		

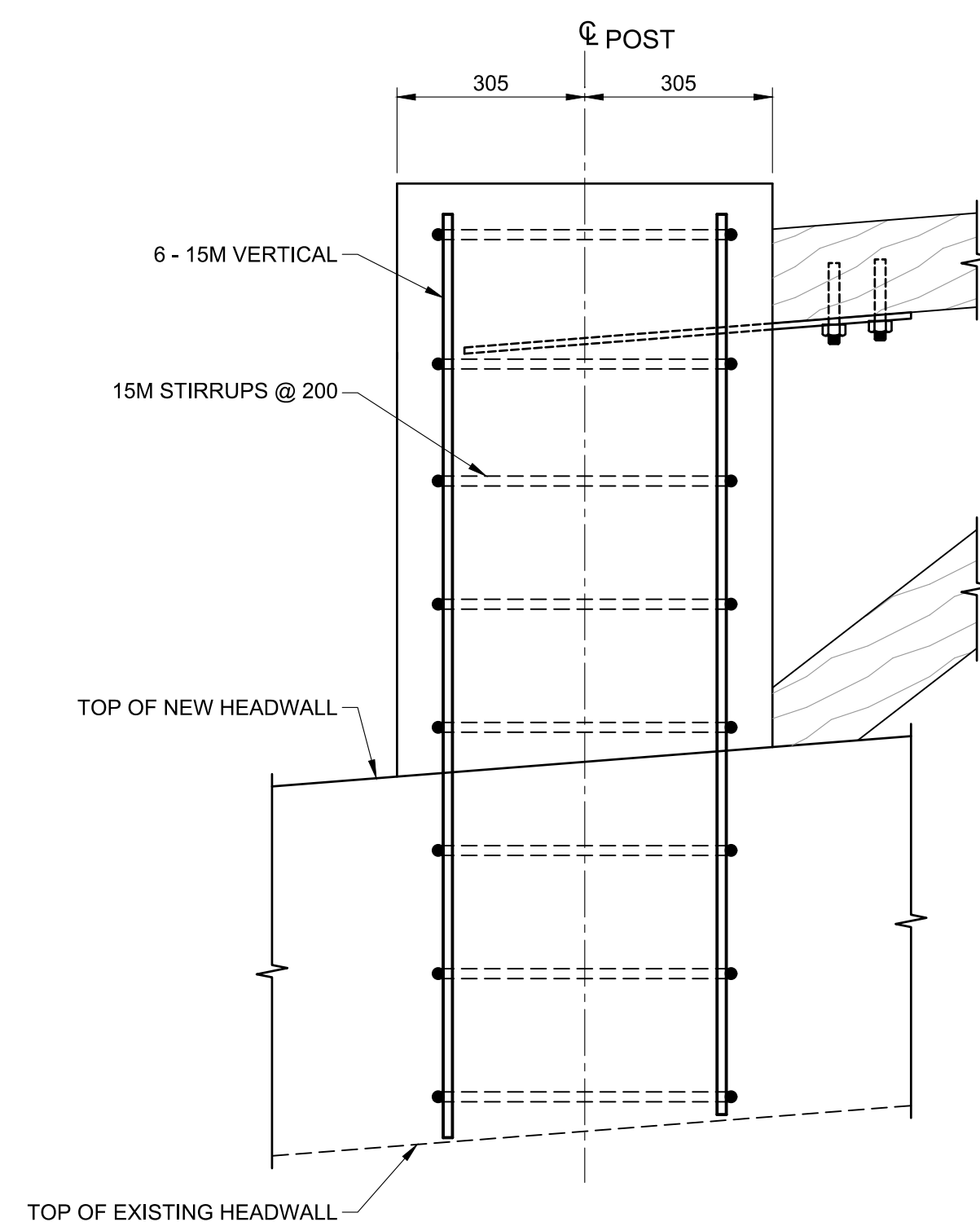


OUTLET - RAILING DETAIL

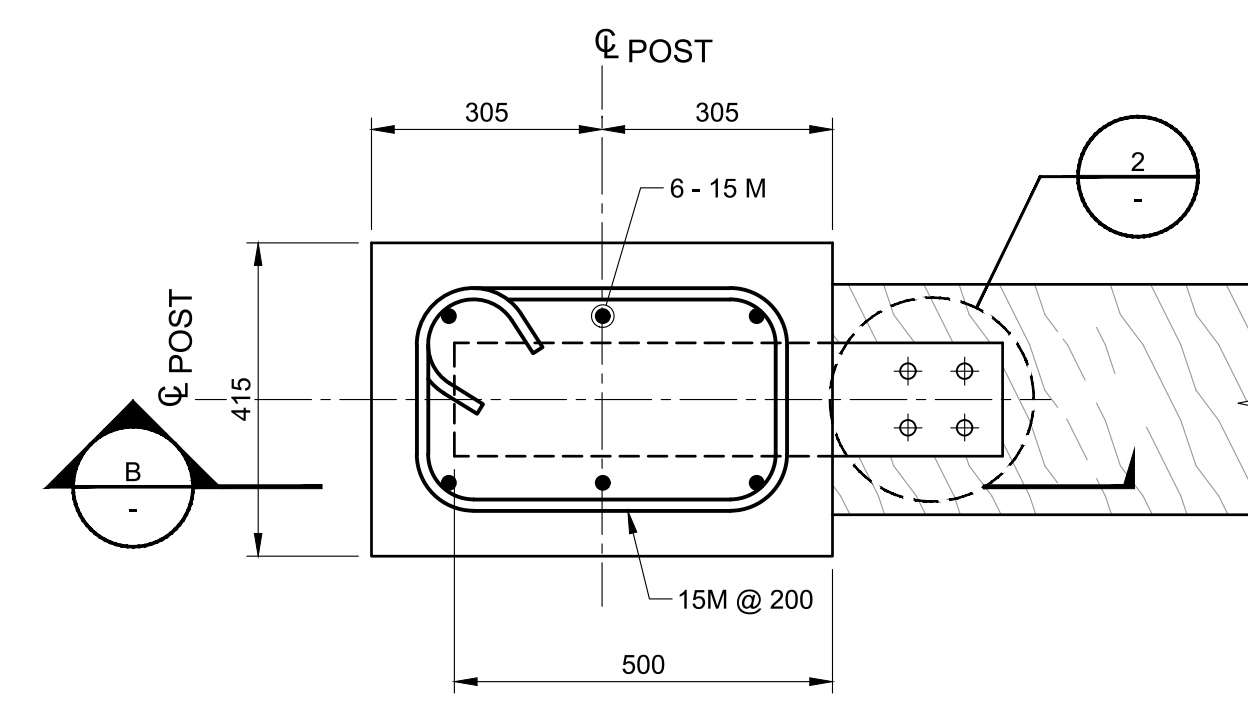
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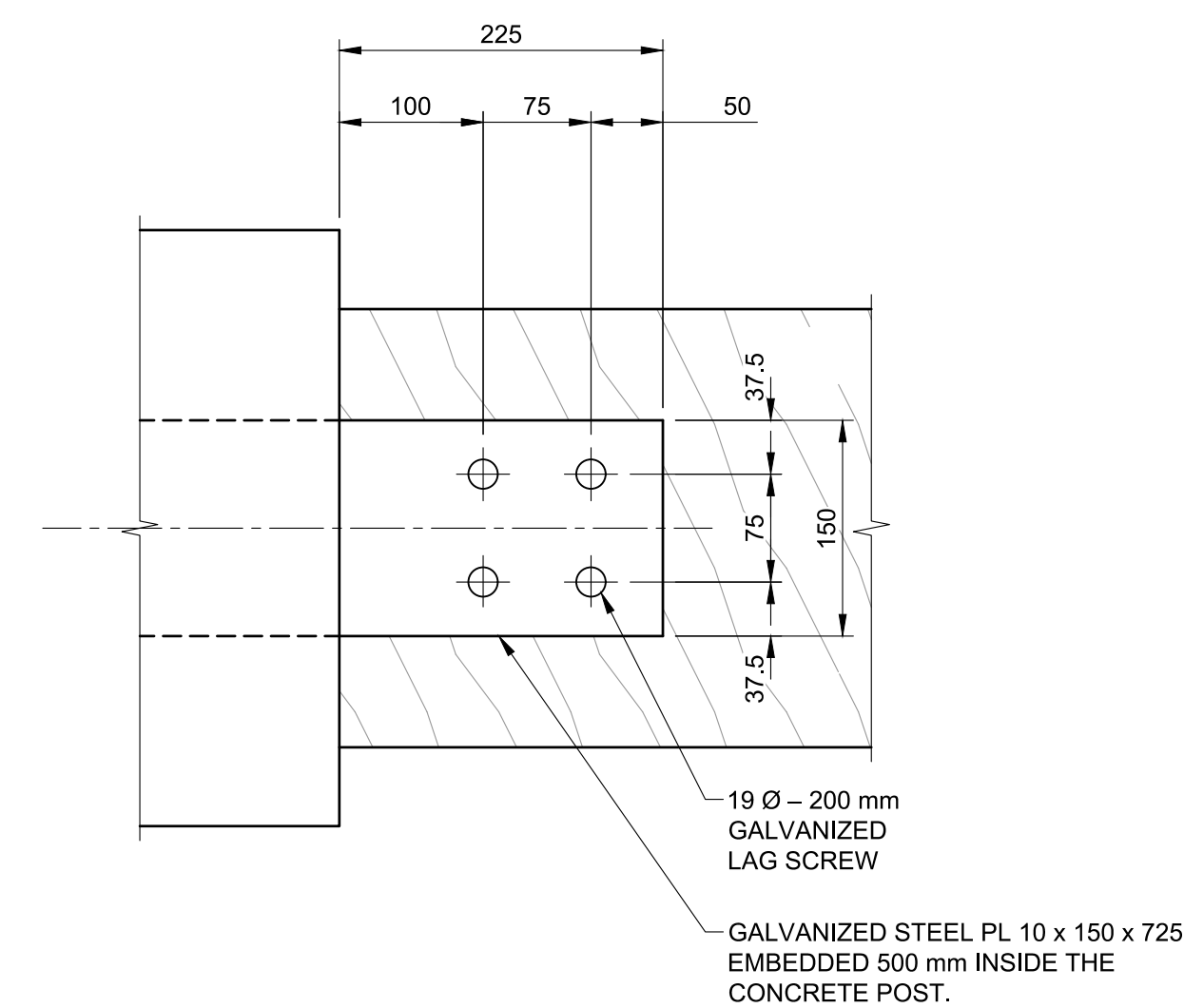
A	SECTION
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B | **SECTION**



C SECTION



2	DETAIL
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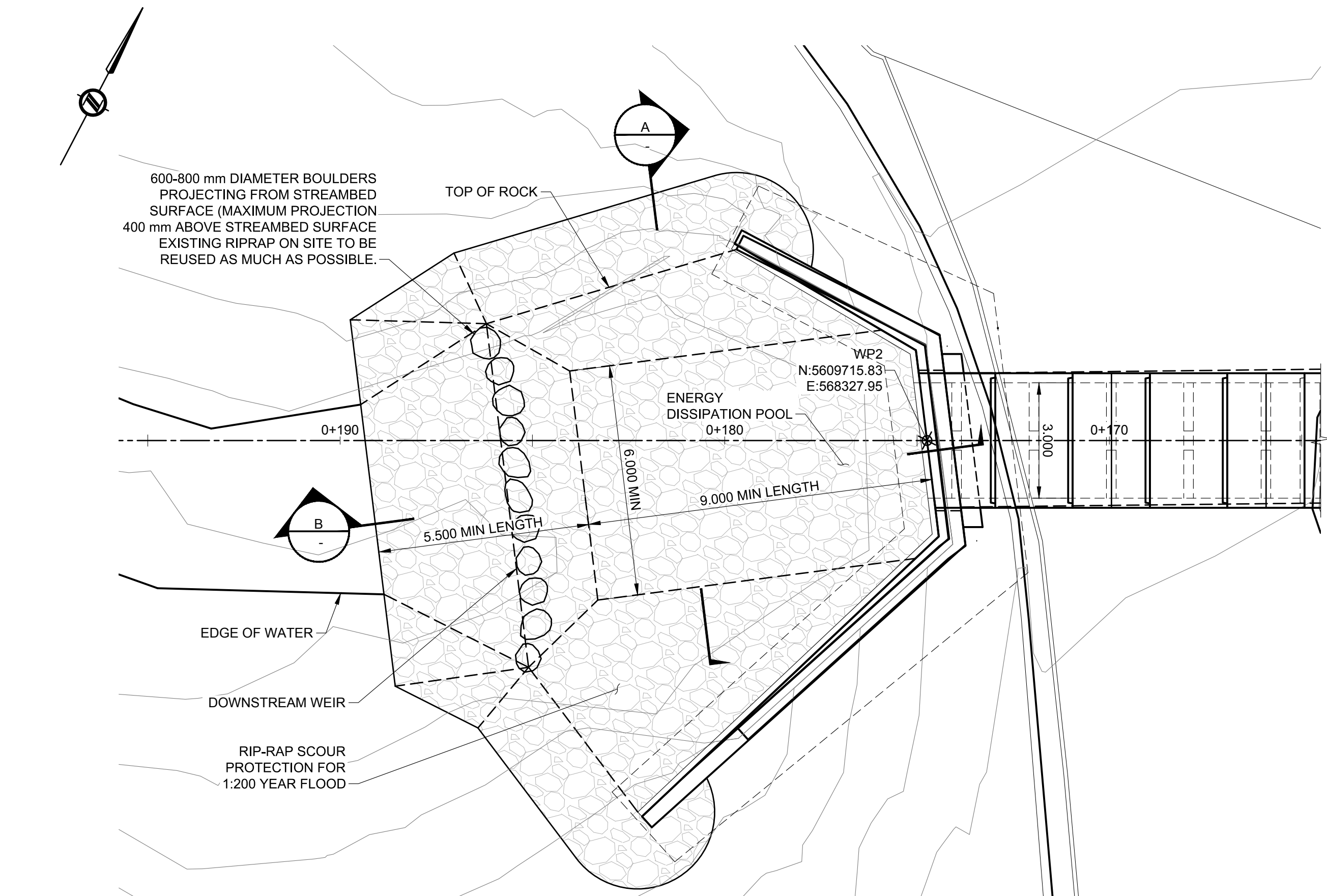
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CULVERT REPLACEMENT
SINCLAIR CREEK (KM 100.6)**

Drawing title/Titre du dessin

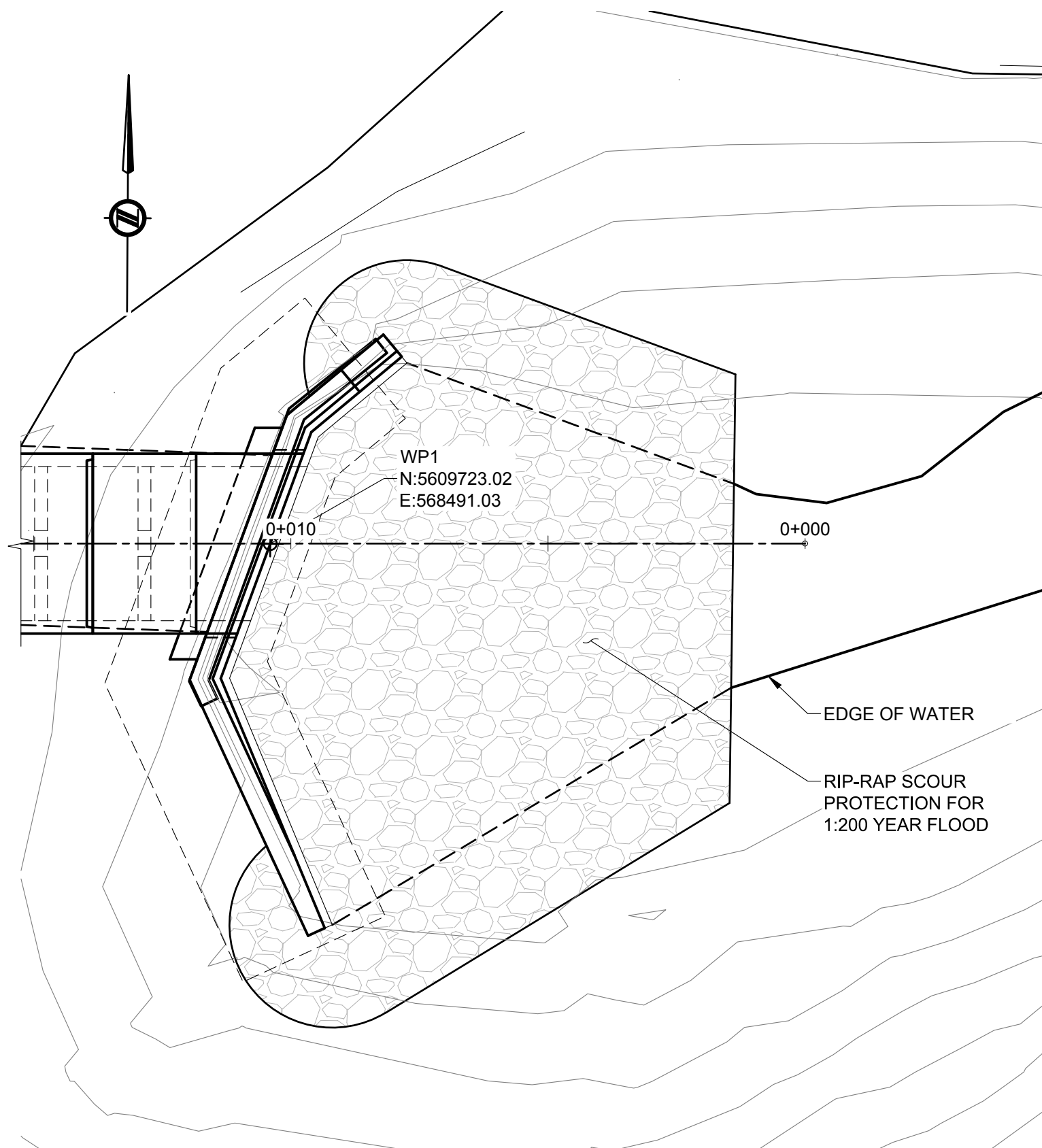
INLET & OUTLET RIPRAP DETAILS

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Designed by/Concept par SM	Reviewed by/Revisé par BS	Scale/Echelle AS SHOWN
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Drawing Set No./Nº de série du dessin 60547362-C6		S111



OUTLET PLAN

Scale 1:100



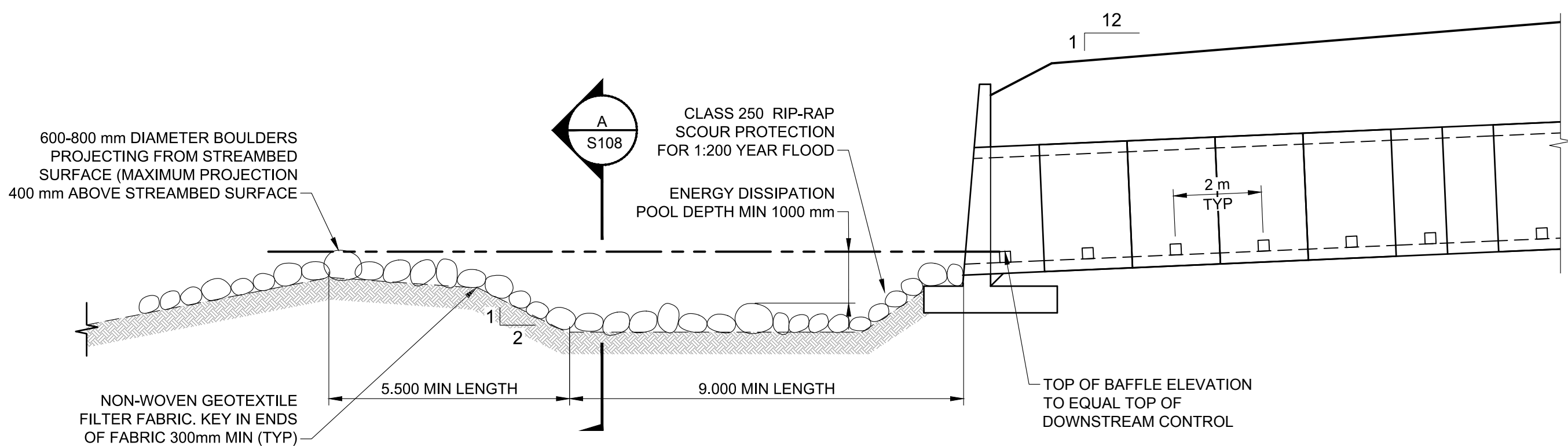
INLET PLAN

Scale 1:100

GENERAL NOTES

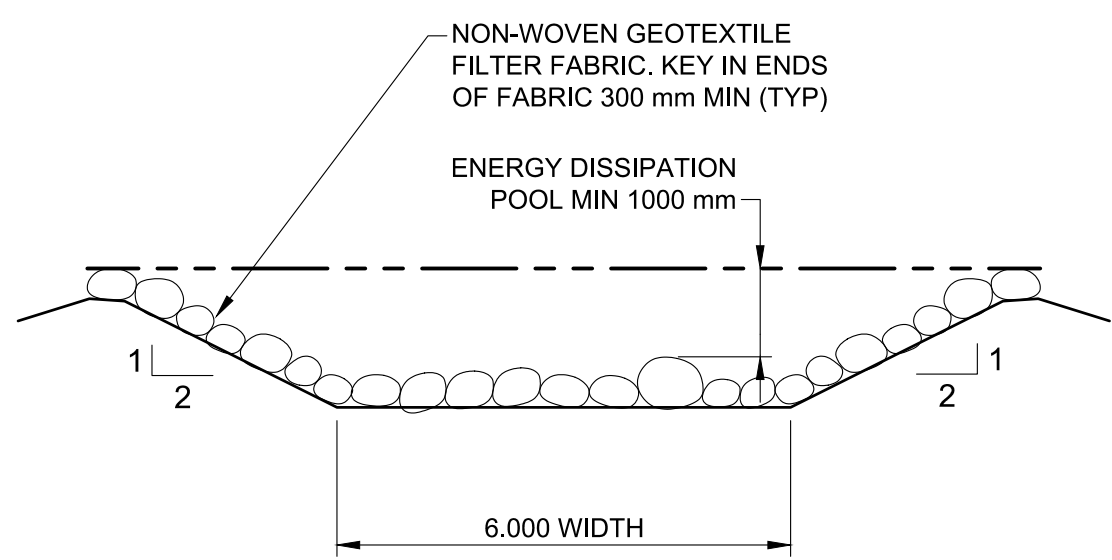
- FOR THE ENERGY DISSIPATION POOL HEAVY ROCK RIPRAP SHALL COVER THE AREA SHOWN ON THIS DRAWING.
- CLASS 250 RIPRAP TO BE PLACED TO THE ELEVATIONS SHOWN ON THIS DRAWINGS AND SHALL BE PLACED TO A MINIMUM THICKNESS OF 800 mm OVER AN AREA OF APPROXIMATELY 150 m² FOR OUTLET AND 75 m² FOR THE INLET, TOTAL = 225 m².
- EXISTING RIPRAP AT CULVERT INLET AND OUTLET TO BE REUSED WHERE FEASIBLE.
- PLACE NON-WOVEN GEOTEXTILE FILTER FABRIC UNDER ALL HEAVY ROCK RIPRAP.
- GEOTEXTILE FILTER FABRIC SHOWN SHALL MEET THE FOLLOWING REQUIREMENTS:

NON-WOVEN GEOTEXTILE FILTER FABRIC SPECIFICATIONS AND PHYSICAL PROPERTIES	
	CLASS 250
GRAB STRENGTH	900 N
ELONGATION (FAILURE)	50%
PUNCTURE STRENGTH	550 N
TRAPEZOIDAL TEAR	350 N
MINIMUM FABRIC LAP TO BE 100mm	



B SECTION

Scale 1:100



A SECTION

Scale 1:100

To	Basir Saleh, Siddhwartha Mandal	Page	1 of 54
CC	Fadi Shahin, Gordon Geoffrey		
Subject	Hydrologic and Hydraulics Analysis for Sinclair Culvert at Parks Gate, Kootenay National Park, BC		
From	Jagadish Kayastha		
Date	January 29, 2018	Project Number	60547362

1. Introduction

Parks Canada Agency (PCA) is planning to rehabilitate or replace the existing Sinclair culvert using a suitable culvert option with a sufficient hydraulic capacity for the 1:200 year design flow. PCA retained AECOM Canada Ltd. (AECOM) to assess the different crossing options and provide preliminary recommendations for a suitable option to replace the existing culvert.

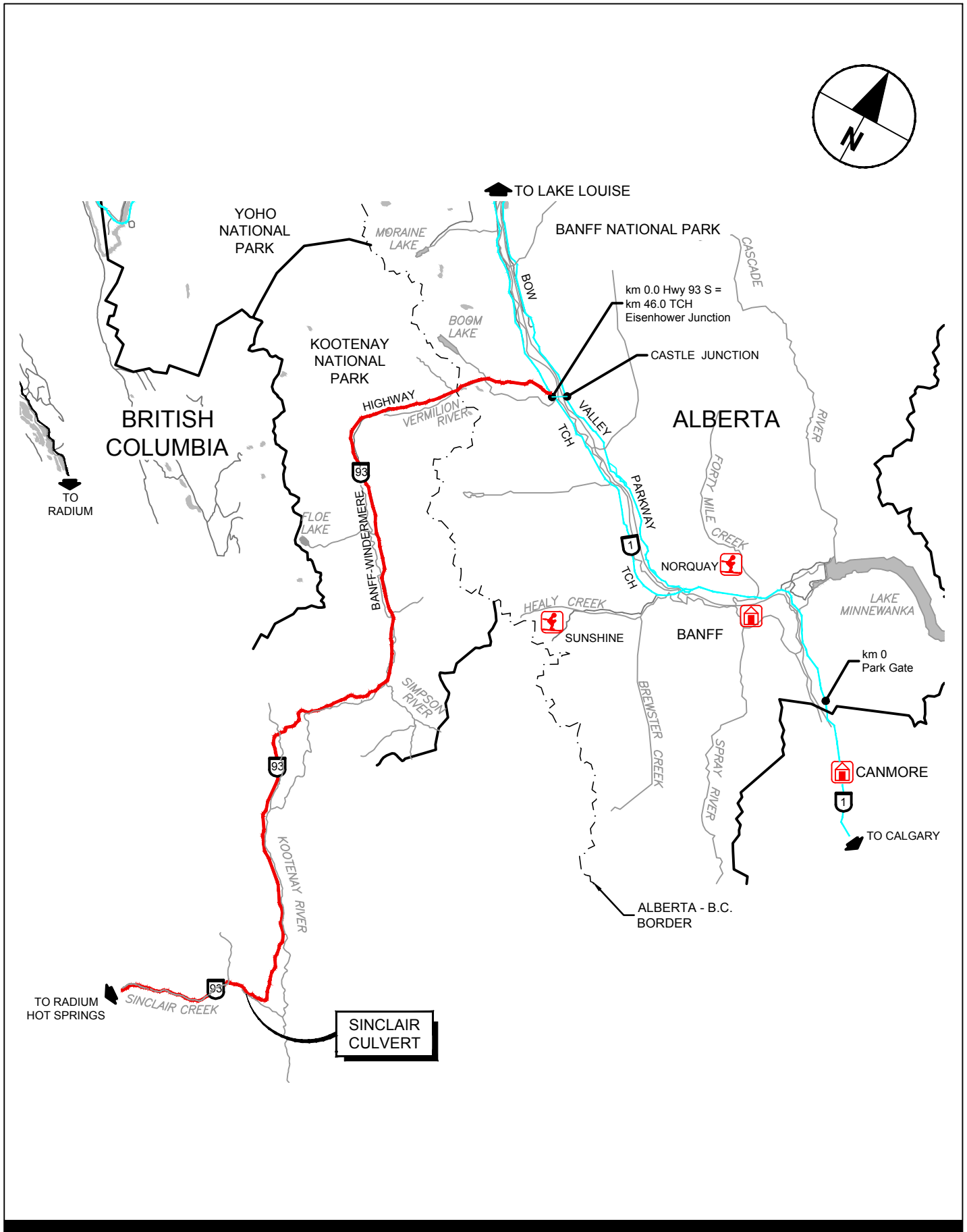
Sinclair Culvert is located at the Parks Gate (latitude 50° 38' 07.16:N and longitude 116° 01' 57.49"W) across Kootenay HWY 93S at the unnamed creek, is 102.03 km south of the Intersection of HWY 93S and the Trans-Canada Highway as shown in **Figure 1**.

The existing culvert is a corrugated structural plate pipe arch section of 3840 mm span and 2210 mm rise with a longitudinal slope of 4.13%. The culvert was built in 1962. Based on the existing inspection reports dated October 02, 2006; October 03, 2012 and October 13, 2016 the culvert is in poor condition with through corrosion and distorted ribs in the culvert and multiple sections with cracked bolt seams. The culvert site location and the creek catchment are shown on **Figures 1 and 2**.

Hydrologic and hydraulic analysis (H&H) is required for assessment of the existing culvert and designing new culvert crossing options. The H&H analysis and this technical memo have been prepared to be consistent with guidelines for the collection and analysis of fish and fish habitat data for the purpose of designing fish bearing culvert in British Columbia.

The primary purpose of this memo is to estimate the hydrologic information and related hydraulics data for the existing and proposed culvert options. The 1:200 year return period flow was used to design structures to withstand appropriate levels of flooding during both construction and operations.

The hydrology study is specifically intended to support the assessment of the existing culvert and design of new culvert crossing options. The scope of this memo is consistent with the intended use of the results. The hydrology presented below is for the culvert inlet location.



LOCATION PLAN

AECOM

Figure: 1

2. Hydrologic Analysis

2.1 Catchment

The watercourse in question is an unnamed creek which originates at a highpoint approximately 9.5 km northeast of the Sinclair culvert location. The watercourse flows southwest along the southeast side of Highway 93 and crosses to the parking lot area about 1.0 km east of the Radium Hot Springs.

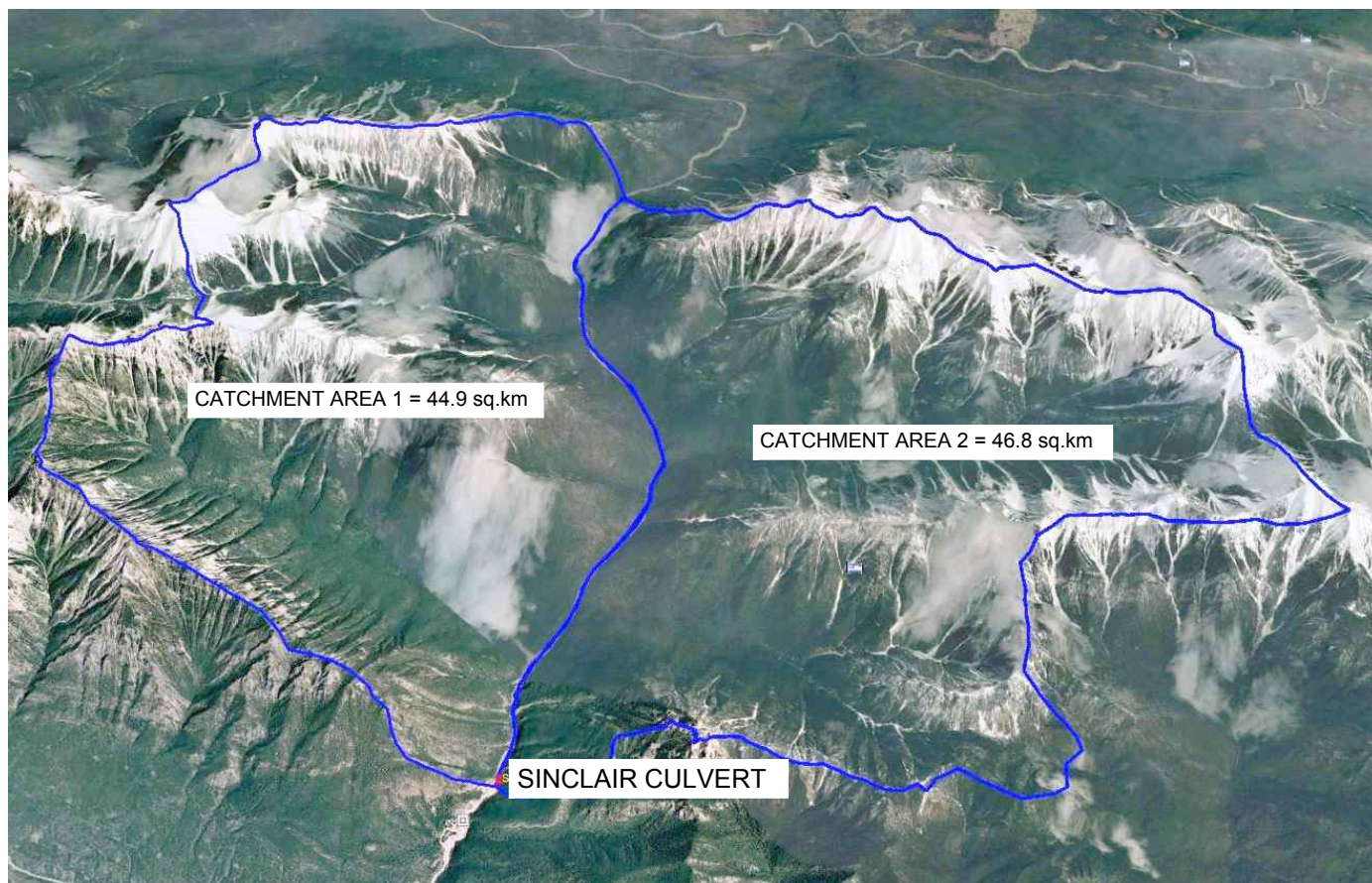
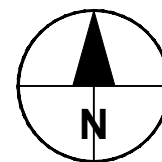
There is no flow record available for the unnamed creek at the culvert location. A regional reference gauging stations in the vicinity of the site with a longer period of record was selected for derivation of long-term discharge characteristics based on a regional analysis with the gauging stations data in the vicinity of the site.

Catchment delineation for the culvert inlet location was done using Google Earth as shown in **Figure 2**. This delineation was verified by a site visit conducted on July 14, 2017.

Catchment Area 1, located on the north side of HWY 93 has a drainage area of 44.9 km². Runoff from this catchment is captured by roadside ditches and then conveyed to the creek via the existing culverts crossing HWY 93.

Catchment Area 2, located on the south side of HWY 93 has a drainage area of 46.8 km². Runoff from this catchment drains directly to the unnamed creek.

The total drainage area contributing flow to the unnamed creek draining through the Sinclair culvert consists of Catchment Areas 1 and 2, totals 91.7 km².



Last saved by: ZHANGD1(2017-11-28) Last Plotted: 2017-11-28
Filename: P:\60547362\900-CAD\GIS\910-CAD\25-SKETCHES\CW 01 SINCLAIR CREEK CULVERT KM102.03 HWT 93S 60547362-FIG-01-CWF02.DWG

**SINCLAIR CULVERT (REDWALL/PARKS GATE)
CATCHMENT AREAS**

AECOM

2.2 Regional Analysis

There is no representative reference hydrometric station with a catchment area similar to the project catchment in the vicinity of the site. Gauging stations in the project area either show a large catchment area or very small catchment area as shown in **Table 2.1**

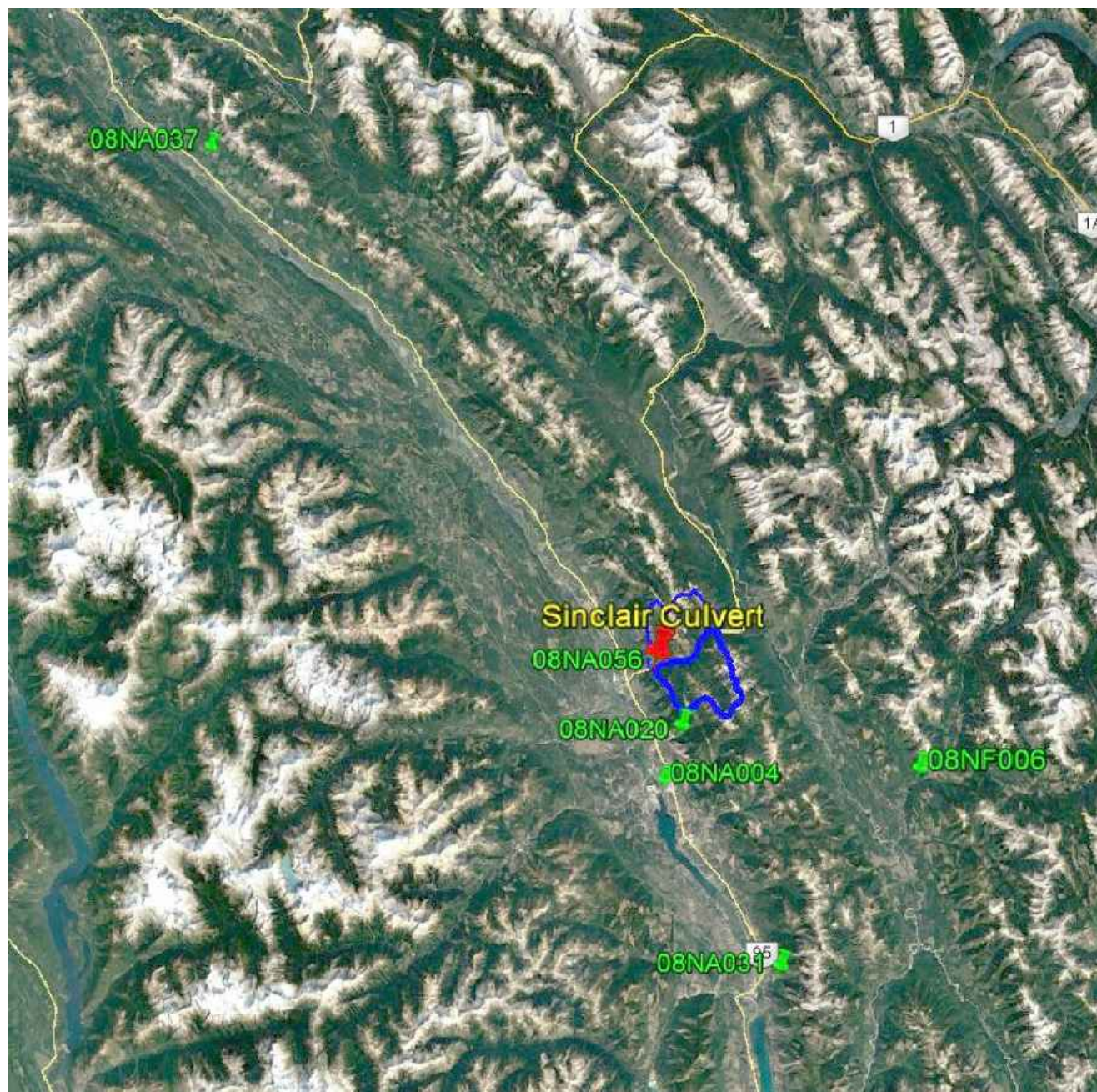
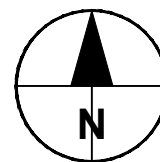
Therefore, a regional analysis was performed using flow data obtained from the regional WSC gauging stations. The 1:200 year flow data derived from the annual maximum flows for the gauging stations was used in the regional analysis.

Table 2.1
Regional Water Survey of Canada Referenced Hydrometric Stations

Station No.	Station Name	Area (km ²)	Period of Record	Years of Record	Locations
08NA004	Columbia River at Athalmer	1,340.0	1912 – 1984	73	50°30'56" N 116°01'08" W
08NA020	Stoddart Creek near Athalmer	21.2	19438 – 1982	45	50°34'06" N 115°59'29" W
08NA037	Carbonate Creek near McMurdo	8.03	1924 – 1998	74	51°08'35" N 116°44'23" W
08NA056	Gulch Creek near Radium Junction	4.4	1964 – 1974	11	50°35'13" N 116°02'00" W
08NF002	Kootenay River at Canal Flats	5,390.0	1939 - 1995	57	50°08'52" N 115°47'57" W
08NF006	Palliser River in Lot SL49	653.0	1973 – 1995	23	50°31'31" N 115°37'09" W

Figure 3 shows a Google image with nearby WSC gauging station locations in the vicinity of Sinclair culvert.

Annual maximum stream flows derived from the surrounding gauging stations were analyzed to obtain the 1:200 year flows using HYFRAN frequency analysis software. A regional analysis curves using the 1:200 year flows versus the catchment areas for the gauging stations is shown in **Figure 4**. The 1:200 year estimated flow for the culvert site corresponding to 91.7km² catchment areas is estimated at 13.5 m³/s and 40.0 m³/s from the regional analysis as illustrated in curves A and B, respectively. The spread in the 1:200 year flows varies a lot as shown in **Table 2-2**.



SINCLAIR CULVERT (REDWALL/PARKS GATE)
 WSC GAUGING STATIONS



Figure: 3

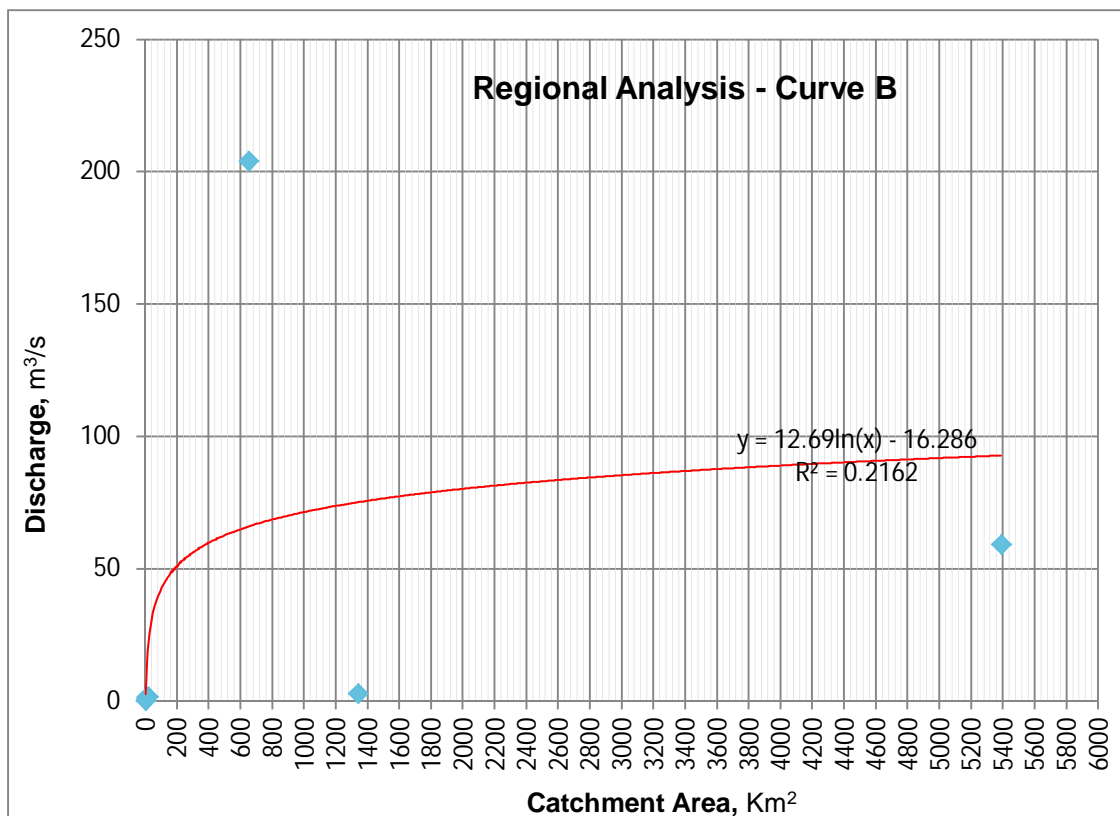
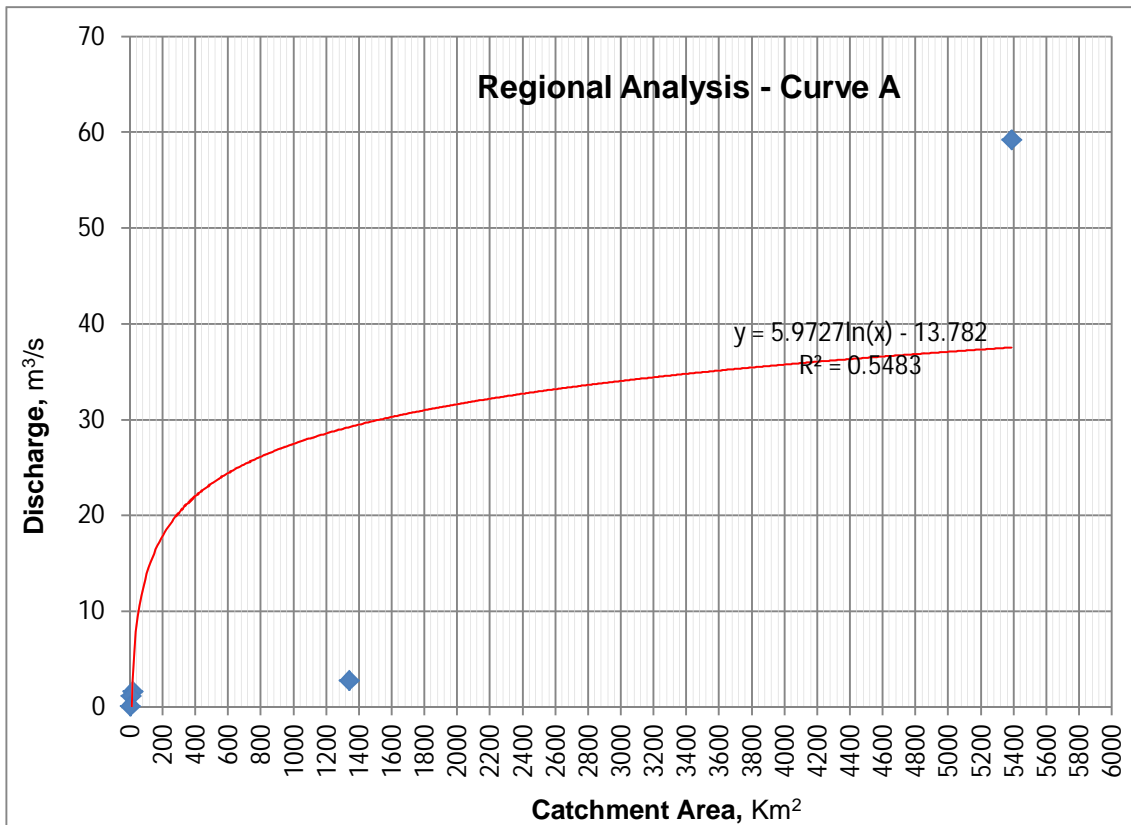


Figure 4: Regional Analysis Curves for the 1:200 Year Event

2.3 Extreme Flows

Peak flows are most likely to occur in response to snowmelt during the spring freshet. The magnitude of the peak flow depends on the extent of the snowpack and antecedent temperature conditions. For example, a cool spring could prolong the snowpack, which in turn could produce significant flooding if warming occurs quickly.

Peak flows for ungauged watersheds may be estimated using various methods depending on the size of the watershed and availability, quality, quantity, and proximity of hydrometric data. Available methods include the rational formula, unit hydrograph model, regional analysis, and transferred flood frequency analysis.

Regional hydrometric data are available in the vicinity of the site. However, these stations do not represent the project site hydrology in terms of catchment size and its characteristics. Thus a regional analysis was used for the current study. The 1:200 year flood frequencies were estimated for all the regional stations using the HYFRAN software (INRS, 2013).

Results of the flood frequency analysis for the referenced stations and the culvert inlet are summarized in **Table 2.2**. The 1:200 year return period flow at culvert location was estimated as 13.5 m³/s by using the regional analysis curve corresponding to the culvert catchment area of 91.7 km². The curve A fit excludes gauging station 08NF006 which showed the 1:200 year discharge of 204 m³/s for 653 km² drainage area. If this gauging station were included in the curve fit (Figure 4 Curve B), the 1:200 year design flow would have been approximately 40.0 m³/s. Unit rate flow varies from 0.002 m³/s/Km² to 0.317 m³/s/Km². Therefore, the 1:200 year design discharge was chosen matching the existing culvert capacity of 14.0 m³/s, which is slightly less than the estimated flow of 13.5 m³/s.

Table 2.2 1:100 and 1:200 Year Flood Frequency Estimates

WSC Gauging Stations	1:100 Year Flow)	1:200 Year Flow)	Drainage Areas	1:200 year Unit Rate
	(m ³ /s)	(m ³ /s)		(m ³ /s/Km ²)
08NA004	2.75	2.8	1340	0.002
08NA020	1.45	1.63	21.2	0.077
08NA037	1.09	1.2	8.03	0.149
08NA056	0.103	0.118	4.4	0.026
08NF002	54.7	59.2	5390	0.011
08NF006	184	204	653	0.312

2.4 Diversion Flows during Construction

In general, historical flooding in the Sinclair culvert location was observed during the months of May and June based on flooding records and the cause of the flooding was due to a combination of snow melt and rainfall. Therefore, construction period from July to October would be the most appropriate time for replacing the existing culvert to avoid potential flooding during construction season. Water Survey Canada gauging station 08NA020 was considered to check the recorded daily flows for July to October and there is 1815 number of daily flow records for 1938 to 1982. Figure 4-a shows recorded daily flow for the gauging station 08NA020 and equivalent synthetic flows at culvert inlet location. Daily equivalent flows at culvert inlet were obtained using multiplying factor of 4.325 to the

gauging station flows based on catchment pro-rate basis of the culvert location and the gauging station catchment areas and the maximum peak flow at culvert inlet location during July to October was estimated at 1.544 m³/s based on recorded flows.

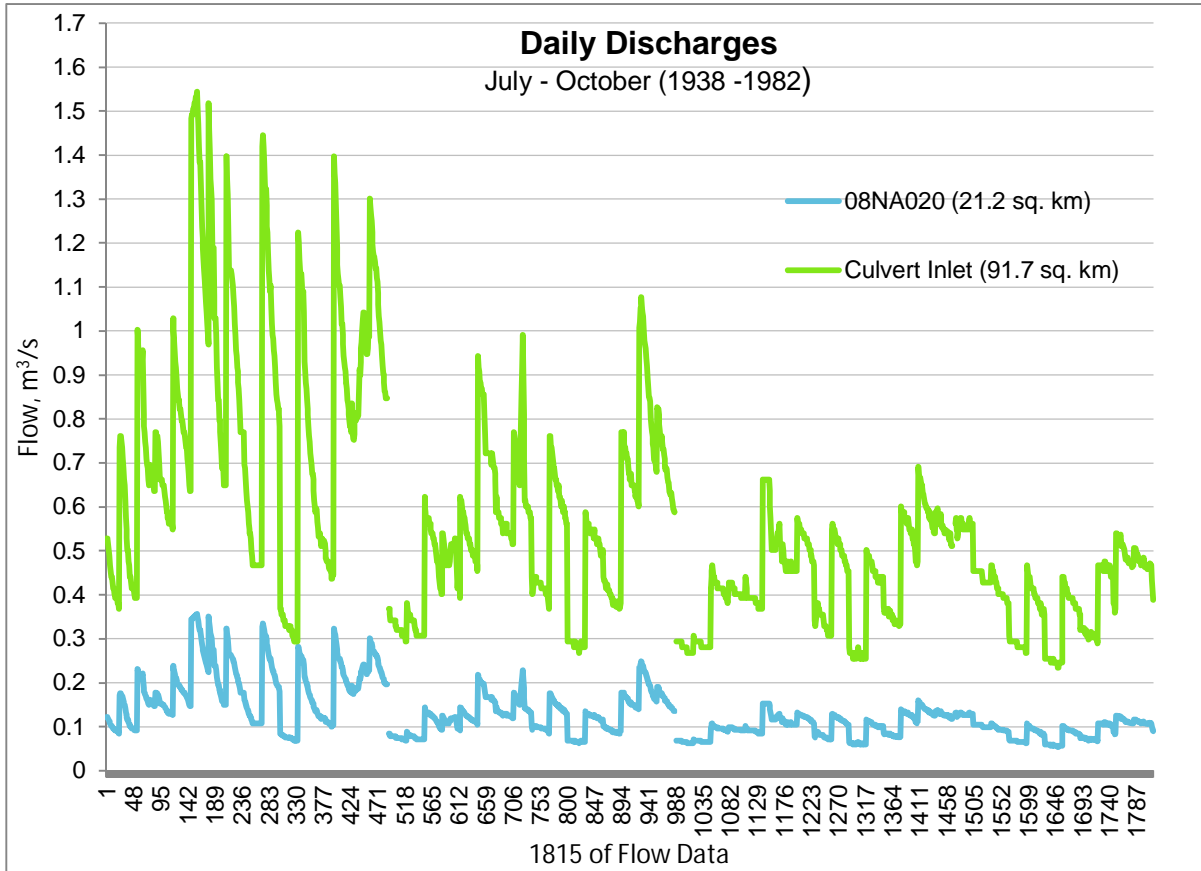


Figure 4-a: Daily Flows at Gauging Station 08NA020 and Culvert Inlet Location

Table 2-3 shows a different return period flows obtained from a frequency analysis for the chosen gauging station 08NA020 and pro-rated return period flows for the culvert location using a multiplier of 4.32 based on catchment area ratios.

Table 2.3: Return Period Flows for Construction Period

Return Period	Gauging Station #08NA020	Culvert Inlet Location
	(m ³ /s)	(m ³ /s)
1	0.010	0.043
2	0.453	1.957
5	0.720	3.11
10	0.893	3.858
20	1.050	4.536

It is recommended to use a double barrel of 750 mm HDPE pipes or three number of 600 HDPE pipes with a longitudinal slope of 4.13%, which provides total hydraulic capacity of 5.344 m³/s and 4.8 m³/s respectively at free flow condition for the 1:20 year peak flow. Thus, it is recommended to use either a double barrel 750 mm or three (3) 600 mm diameter HDPE pipes for flow diversion during construction season.

3. Hydraulic Analysis

3.1 Culvert Alignments

A 165.29 m long existing pipe arch culvert made of steel structural plate of 3480 mm span and 2210 mm rise is sloped at 4.13%. The existing culvert pipe bends at two locations at 137.178 m distance from the culvert inlet, the second is at additional 12.628 m distance further on as shown in **Figure 5**. The existing layout plan is named as Alignment 1.

Figure 6 shows a new Alignment 2 which is similar to alignment 1. This option was proposed with two HDPE diversion pipes meant to be used during construction. There is only one bend proposed for alignment 2 at 143.184 m distance from the inlet. The following structural options were proposed for alignments 1 and 2.

Hydraulic capacity of the culvert was assessed using HY-8 culvert analysis software (version 7.5). This software was prepared by the USA Department of Transportation, Federal Highway Administration (FHA). The culvert does not include any fish passage provision and there is 1.0 m vertical drop at the downstream outlet. The 1:200 year design flow of 14.0 m³/s was used to predict an upstream headwater elevation and other hydraulics characteristics. **Figure 7** shows the existing culvert section with a slip liner plate section.

Hydraulic capacity of the existing corrugated structural pipe arch culvert was checked for the design flow using HY-8 analysis. Based on culvert analysis results from HY-8, the existing culvert can handle the 1:200 year maximum flow of 14.0 m³/s without overtopping the road surface. Head water elevation was estimated at 1029.78 m. **Figure 8** shows the rating curve for the existing condition. **Figure 9** illustrates the HGL profile obtained from HY-8 analysis. The existing HY-8 culvert report is attached in Appendix A.

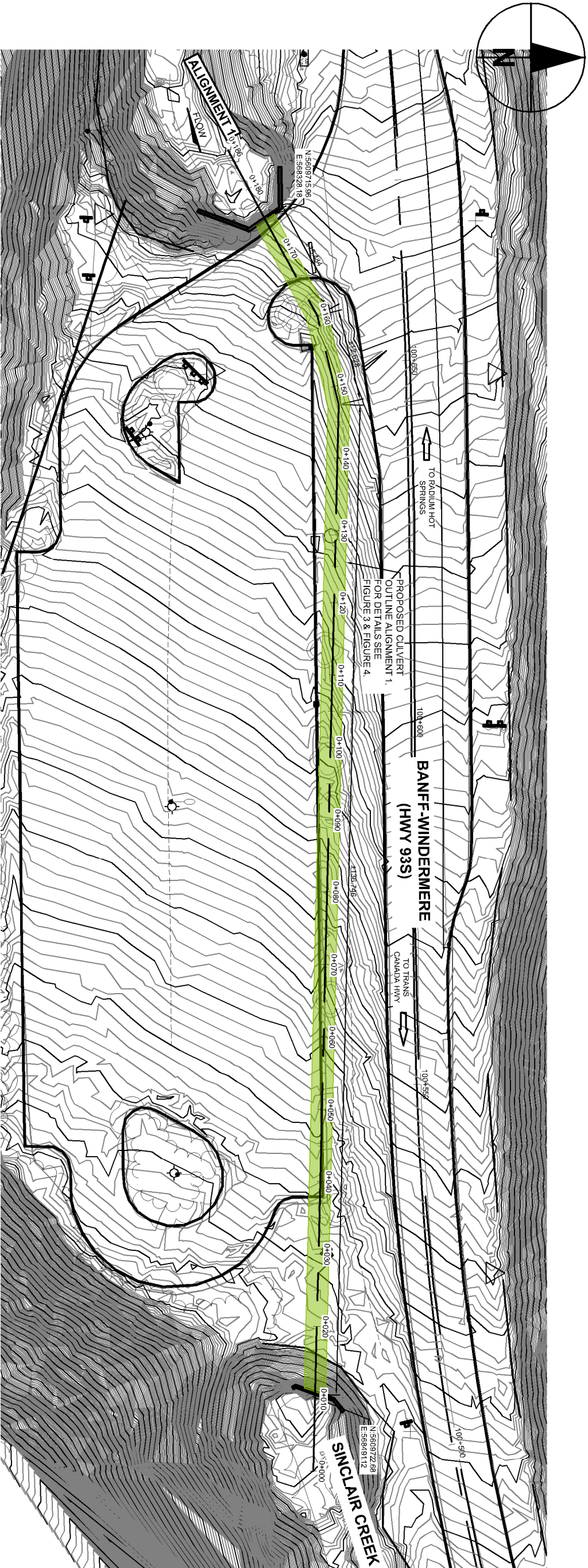
3.2 Culvert Option Considerations

The existing culvert is large enough to handle the estimated 1:200 year design flow of 14.0 m³/s. However, the culvert inspection report reveals that the culvert needs to be replaced in the near future because of its deformed bolts and corrosion of steel plates at many locations. Therefore, three different structural section options have been analysed to check the hydraulic capacity in reference to the 1:200 year design discharge.

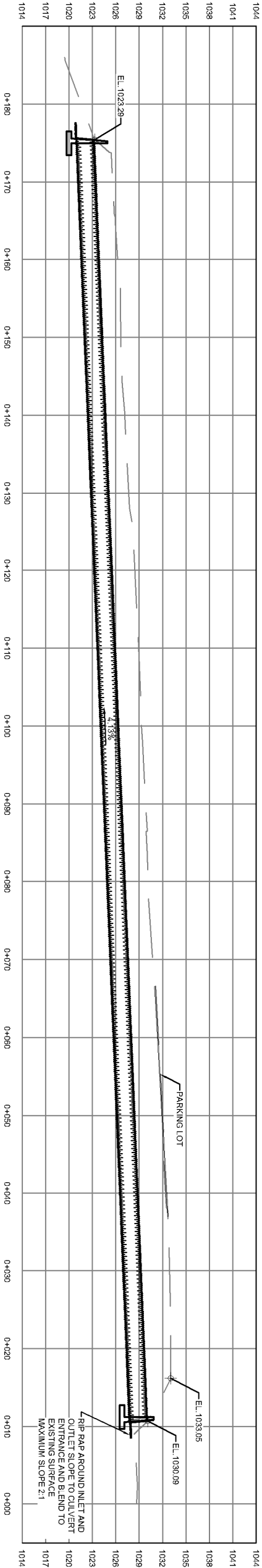
3.2.1 Structural Options

No change in the existing culvert alignment was proposed for a structural option 1 rehabilitation task. The following list three options that have been reviewed in this report:

- Structural Option 1: slip line the existing culver with a 3097 mm span by 1990 mm rise slip liner steel plate section in conjunction along Alignment 1. Refer to **Figure 7** for the structural section;
- Structural Option 2: replace the existing culver with a 3000 mm span by 2400 mm rise concrete box section as shown in **Figure 10**; and
- Structural Option 3: replace the existing culvert with a 3960 mm span by 2060 mm rise corrugated structural plate steel arch section as shown in **Figure 11**.

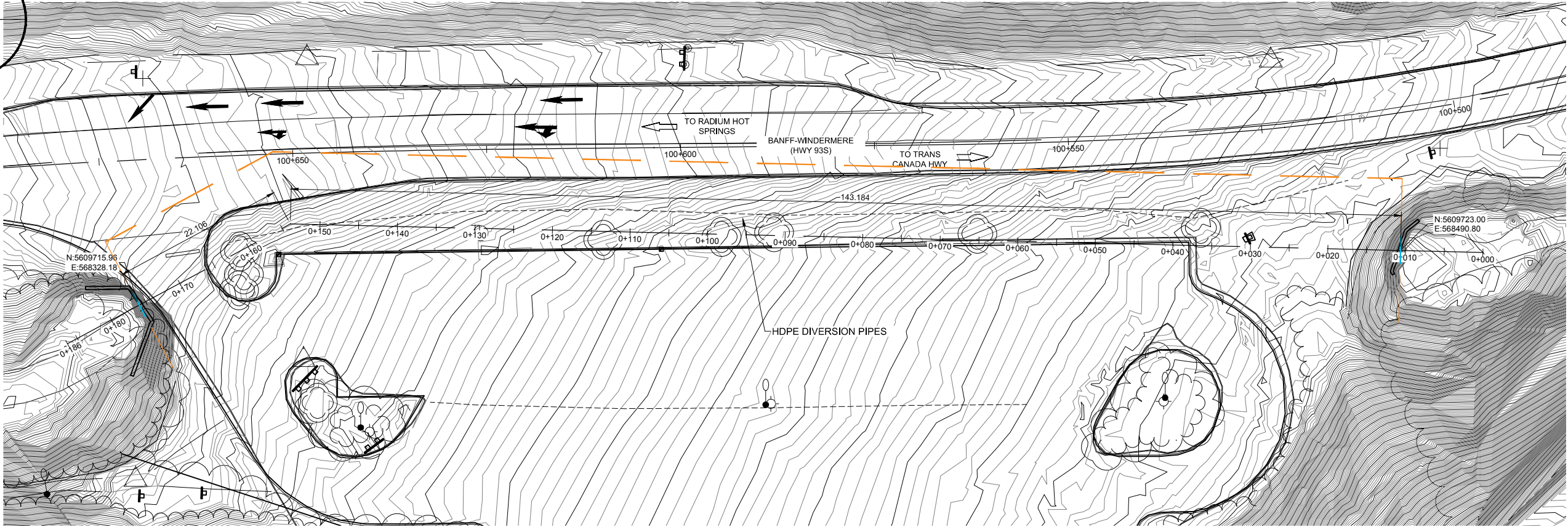
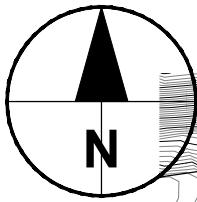


PLAN
Scale 1:300

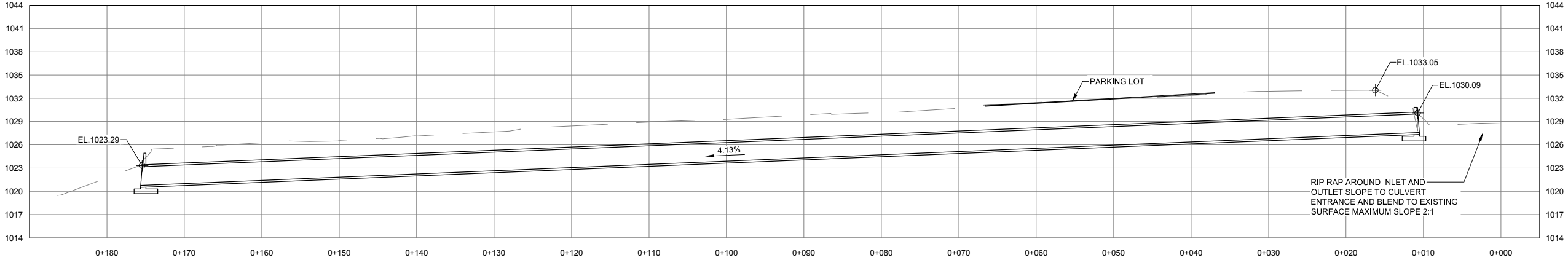


LONGITUDINAL SECTION - ALIGNMENT 1
Scale 1:300

Issue Status: DRAFT



PLAN
Scale 1:300



ELEVATION
Scale 1:300

Issue Status: DRAFT

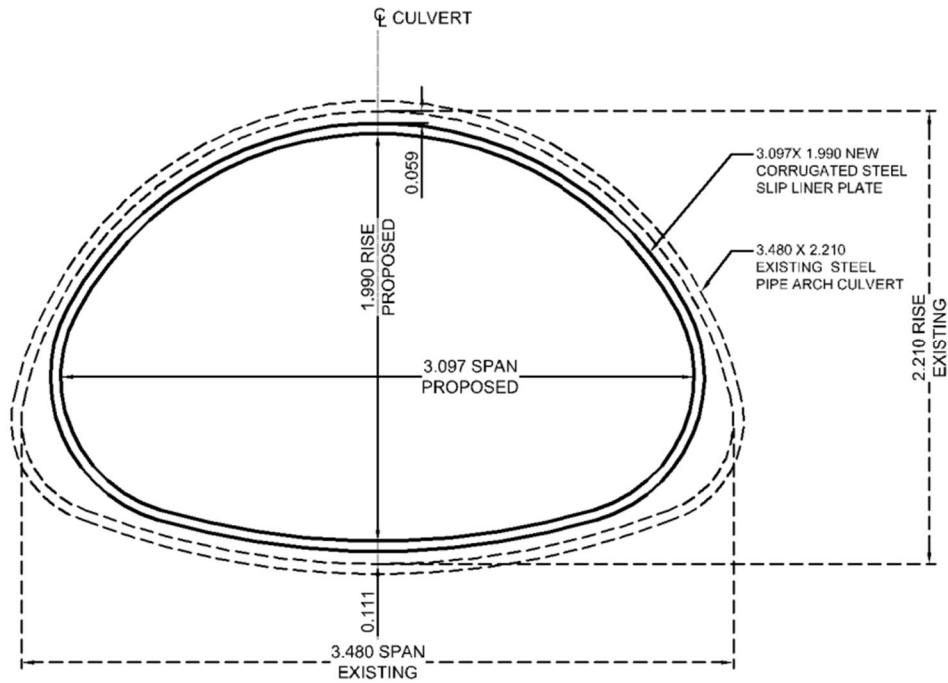


Figure 7: Existing and Option 1 Culvert Section

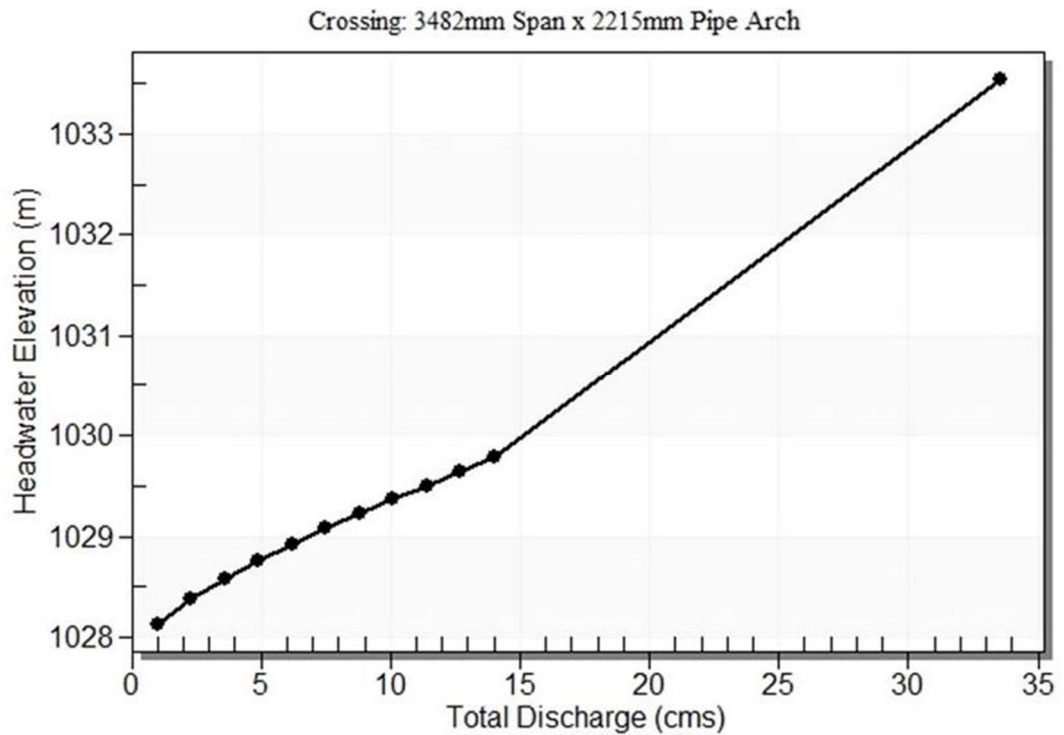


Figure 8: Existing Culvert Rating Curve

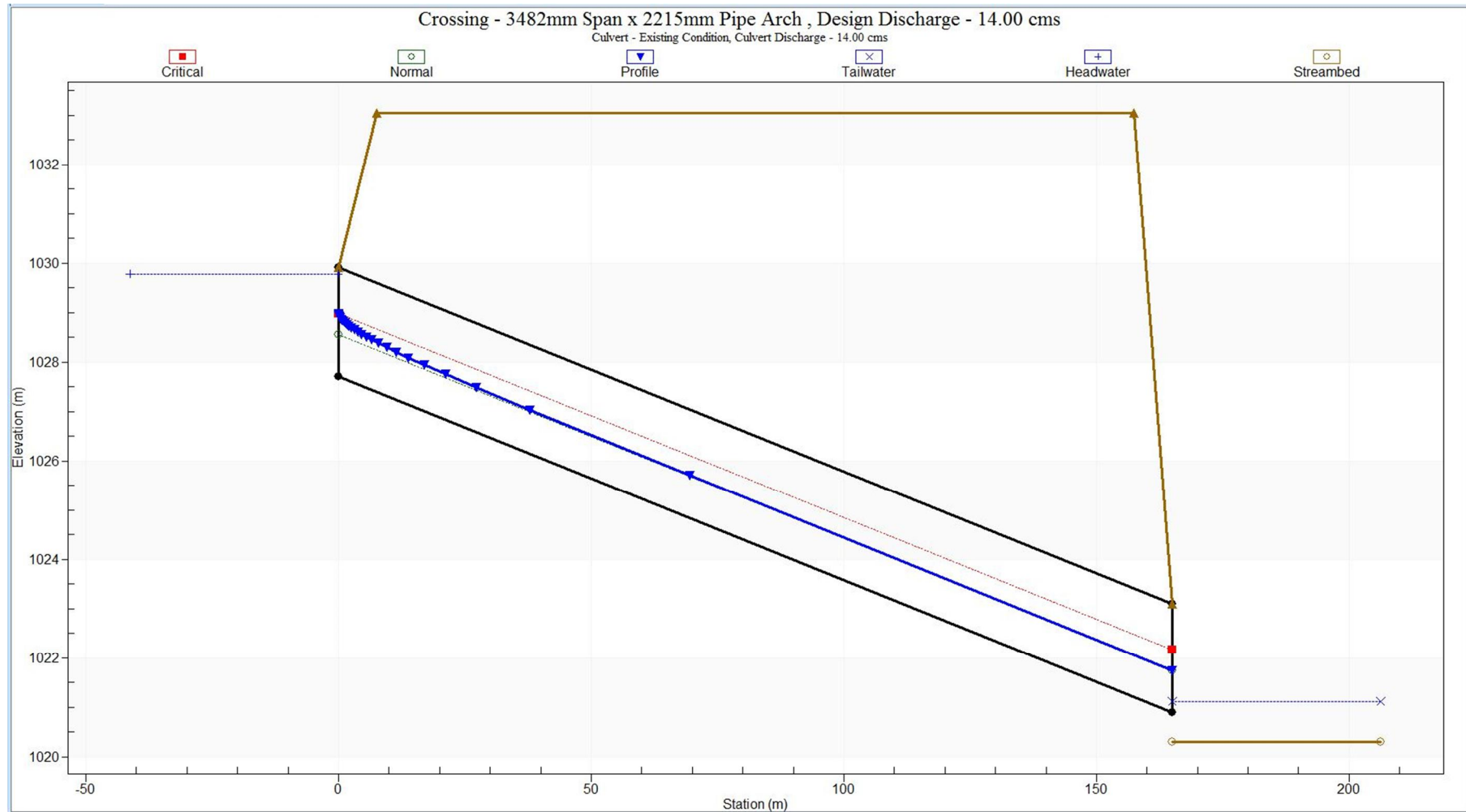


Figure 9: HGL Profile for the Existing Culvert

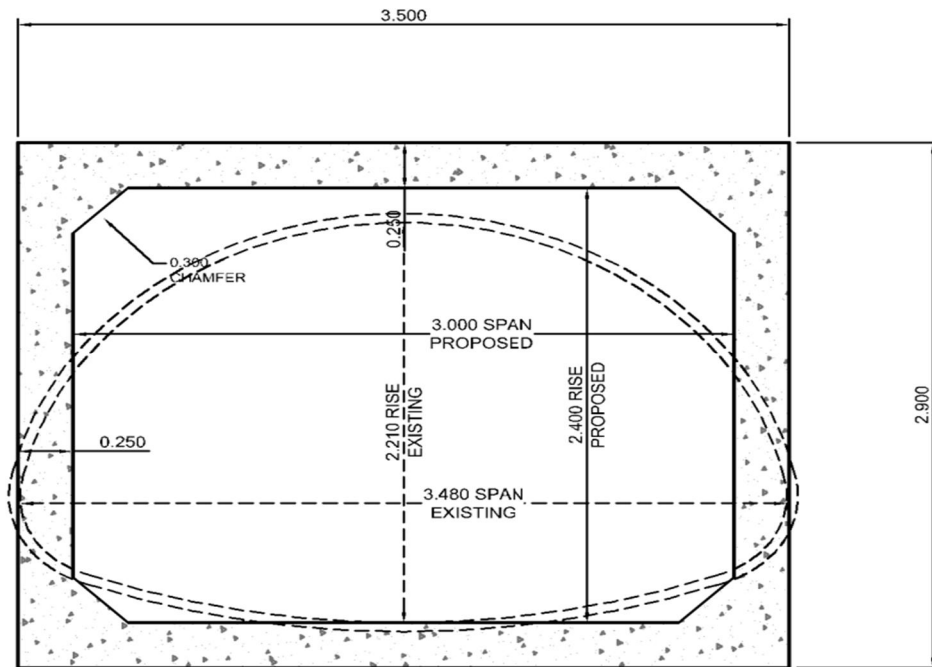


Figure 10: Option 2 Culvert Section

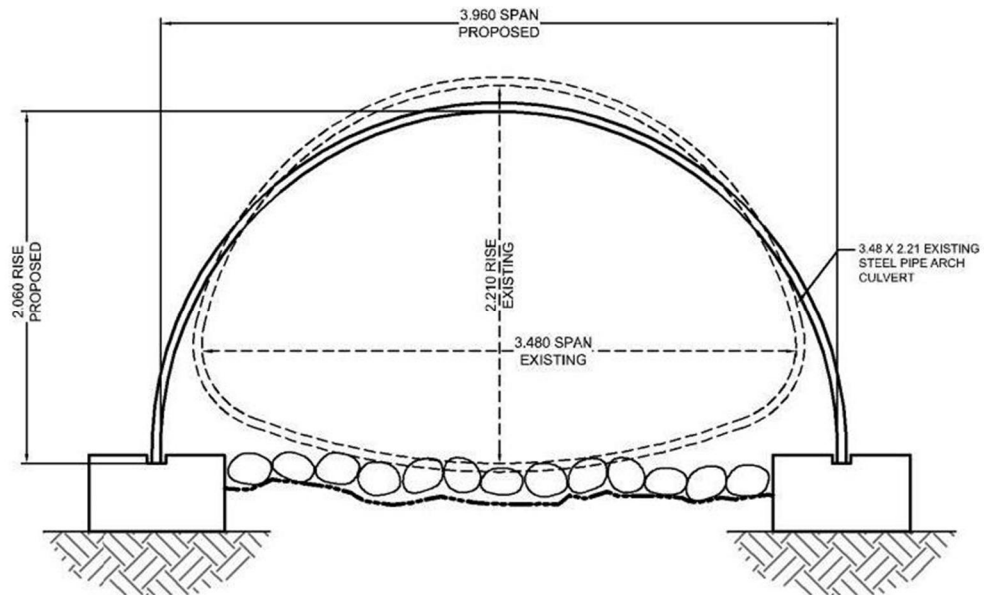


Figure 11: Option 3 Culvert Section of Steel Arch

Figures 12 through 14 illustrate HGL profiles for options 1 to 3, respectively. Results are based on the 1:200 year design flow of $14.0 \text{ m}^3/\text{s}$ obtained from HY-8 culvert analysis as presented in Appendix B. **Figures 15 through 17** illustrate rating curves for options 1 to 3, respectively.

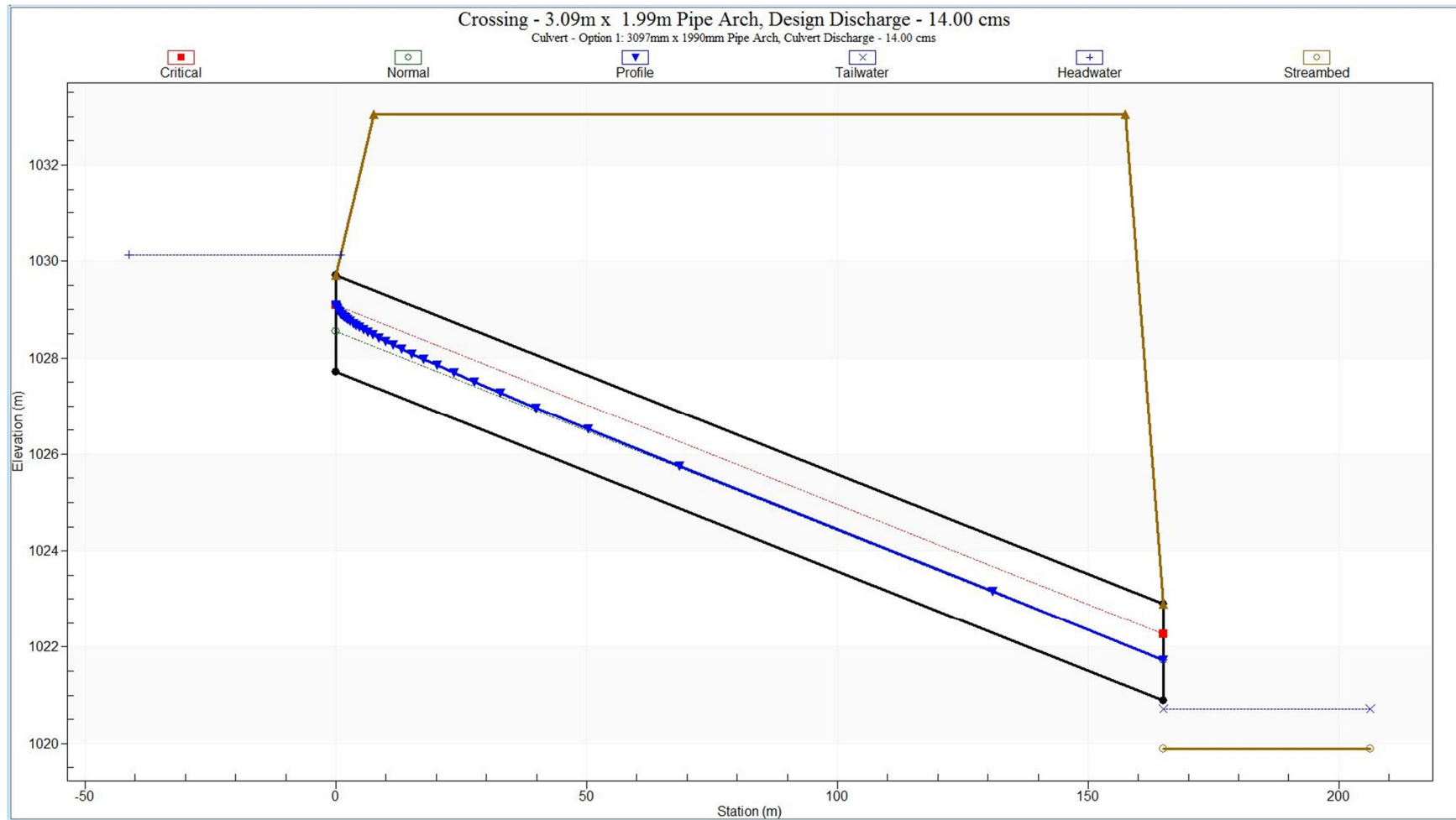


Figure 12: HGL Profile for Option 1 Culvert Section

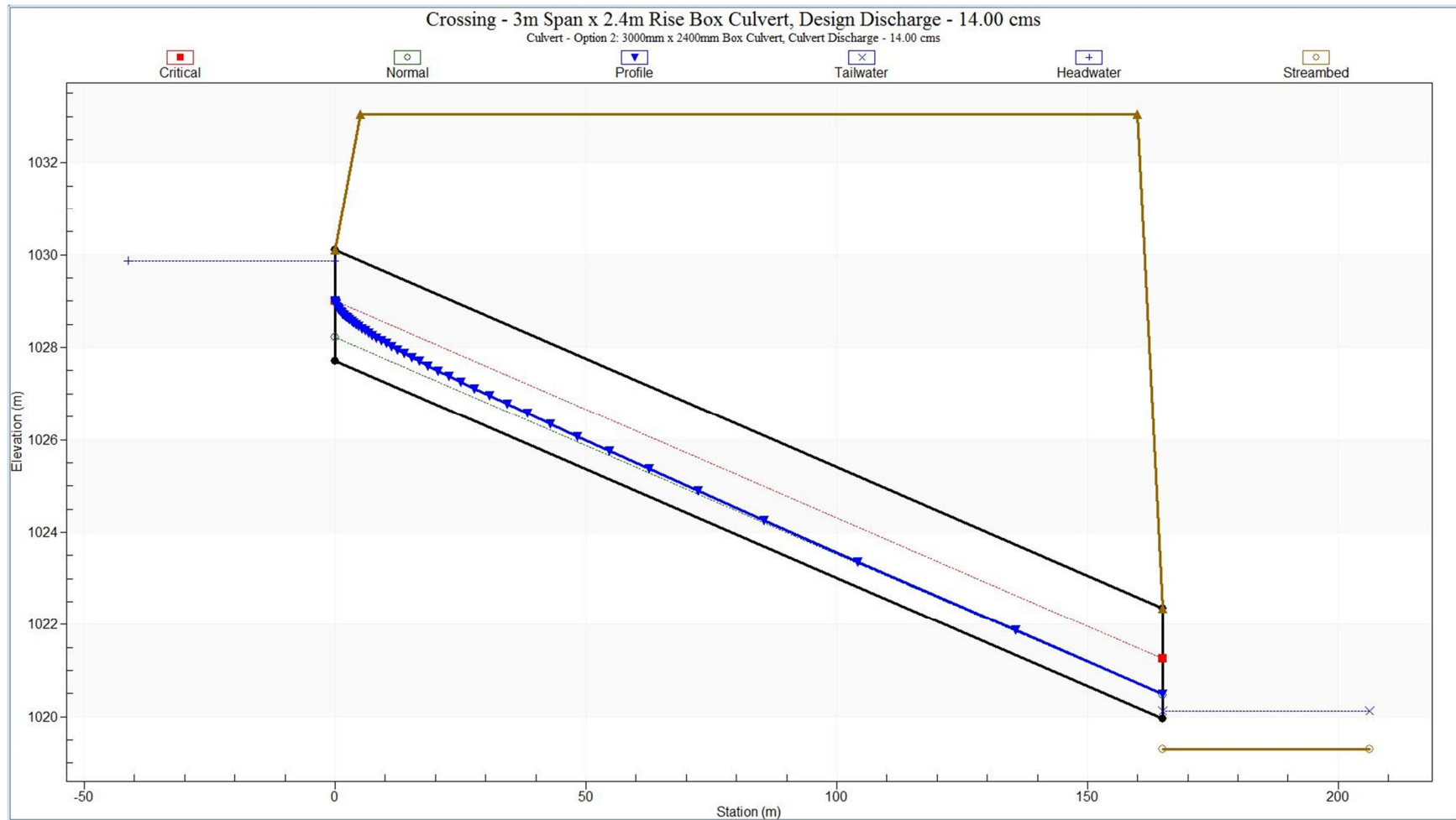


Figure 13: HGL Profile for Option 2 Culvert Section

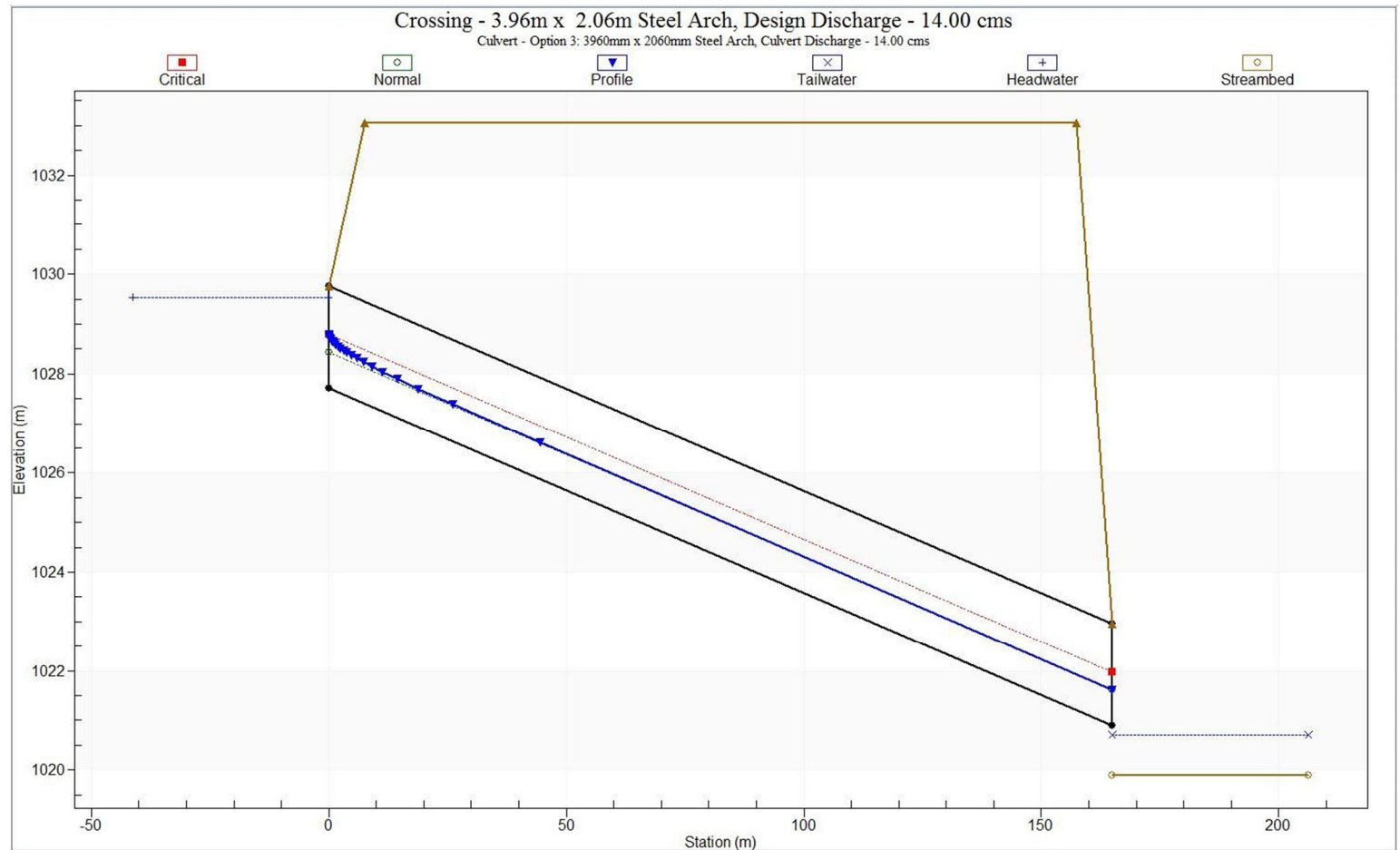


Figure 14: HGL Profile for Option 3 Culvert Section

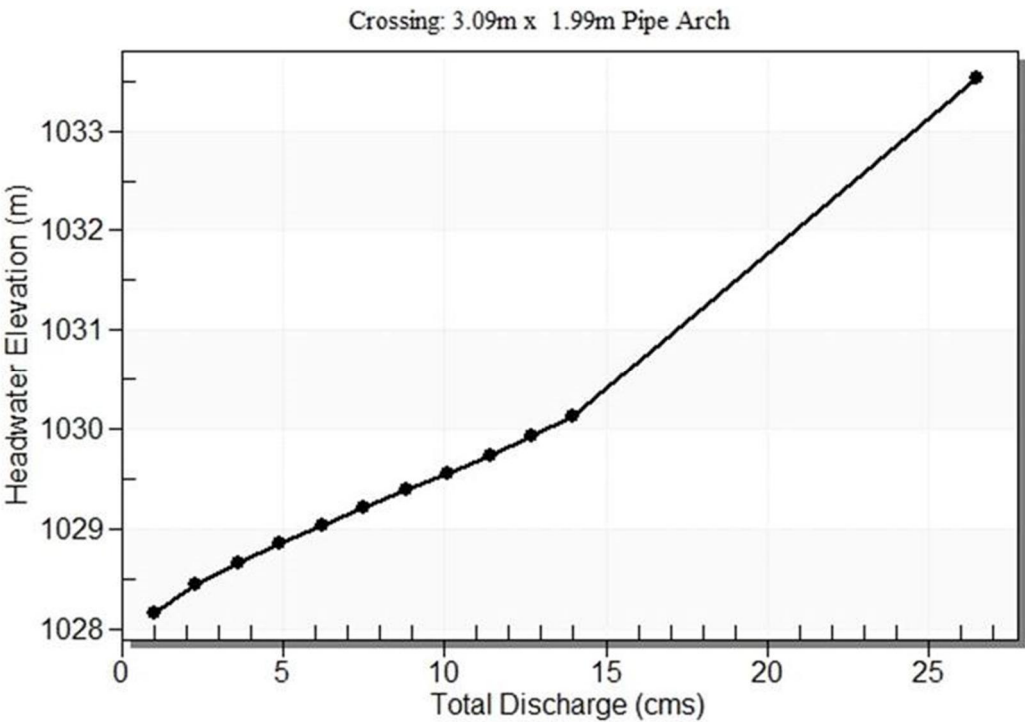


Figure 15: Option 1 Culvert Rating Curve

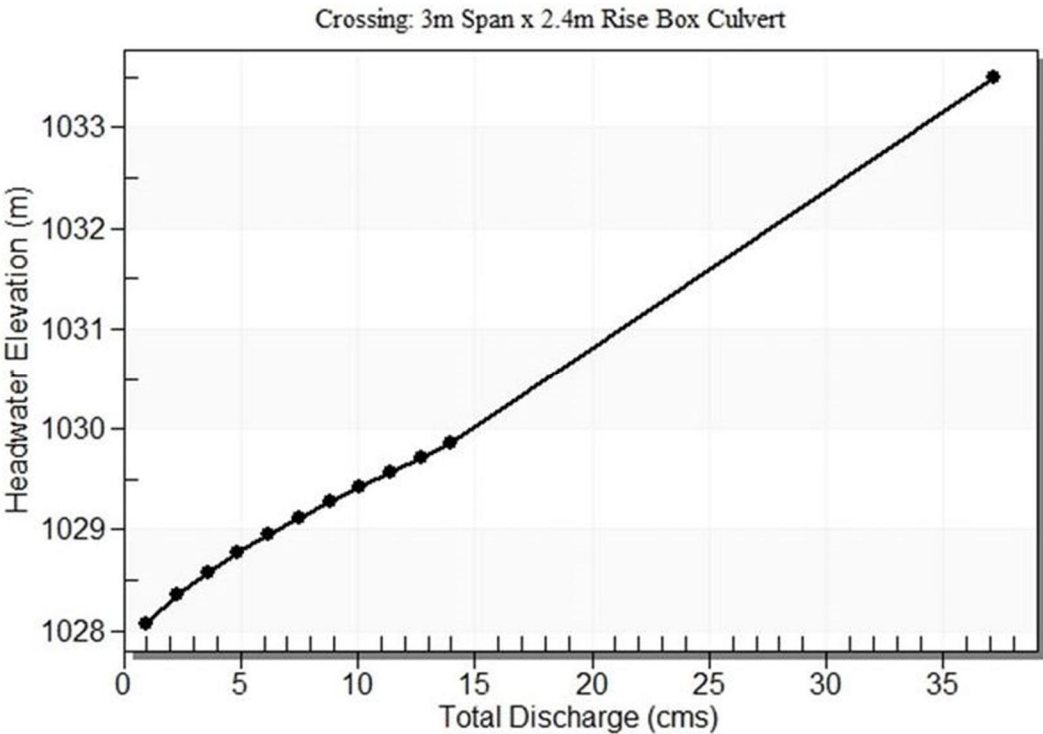


Figure 16: Option 2 Culvert Rating Curve

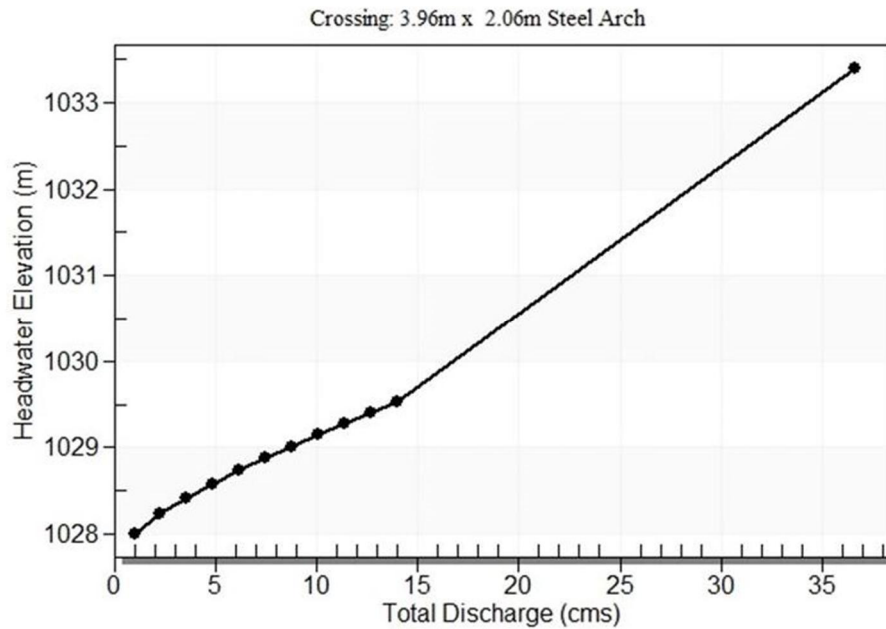


Figure 17: Option 3 Culvert Rating Curve

4. Recommendations for Detailed Design

All above mentioned options are able to convey the 1:200 year design flow of $14.0 \text{ m}^3/\text{s}$ without having any road overtopping elevation at the spill elevation of 1033.048 m. Headwater elevations are within the pipe overt except option 1 where a minimum freeboard of 2.918 m was maintained. Option 1 headwater elevation was estimated at 1030.13 m at design flow of $14 \text{ m}^3/\text{s}$, which is 0.432 m above the culvert overt elevation. Option 2 of concrete box section of 3.48 m spam and 2.21 m rise among the three (3) options was considered for detail design per Parks Canada's reviews and its construction cost, maintenance and projected life span. A separate technical memo dated December 18, 2017 was prepared by AECOM for the design of fish passage for the new culvert.

5. Closure

We trust this memorandum satisfies your present requirements. We would be pleased to provide any further information required during the course of this project. Feel free to contact the undersigned should you have any questions.

Respectfully Submitted,

AECOM Canada Ltd.

Prepared by:



July 29, 2018

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**PERMIT TO PRACTICE
AECOM CANADA LTD.**

Signature

Date 29 Jan 2018

PERMIT NUMBER: P10450

The Association of Professional
Engineers and Geoscientists of Alberta

Encl: Appendix A – Existing Culvert HY-8 Culvert Analysis Results
Appendix B – Proposed Culverts HY-8 Culvert Analysis Results

Appendix A

Existing Culvert

HY-8 Culvert Analysis Results

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.0 m³/s

Design Flow: 14.0 m³/s

Maximum Flow: 33.58 m³/s

Table 1 - Summary of Culvert Flows at Crossing: 3482mm Span x 2215mm Pipe Arch

Headwater Elevation (m)	Total Discharge (cms)	Existing Condition Discharge (cms)	Roadway Discharge (cms)	Iterations
1028.13	1.00	1.00	0.00	1
1028.38	2.30	2.30	0.00	1
1028.58	3.60	3.60	0.00	1
1028.75	4.90	4.90	0.00	1
1028.92	6.20	6.20	0.00	1
1029.07	7.50	7.50	0.00	1
1029.22	8.80	8.80	0.00	1
1029.36	10.10	10.10	0.00	1
1029.50	11.40	11.40	0.00	1
1029.64	12.70	12.70	0.00	1
1029.78	14.00	14.00	0.00	1
1033.05	33.58	33.58	0.00	Overtopping

Rating Curve Plot for Crossing: 3482mm Span x 2215mm Pipe Arch

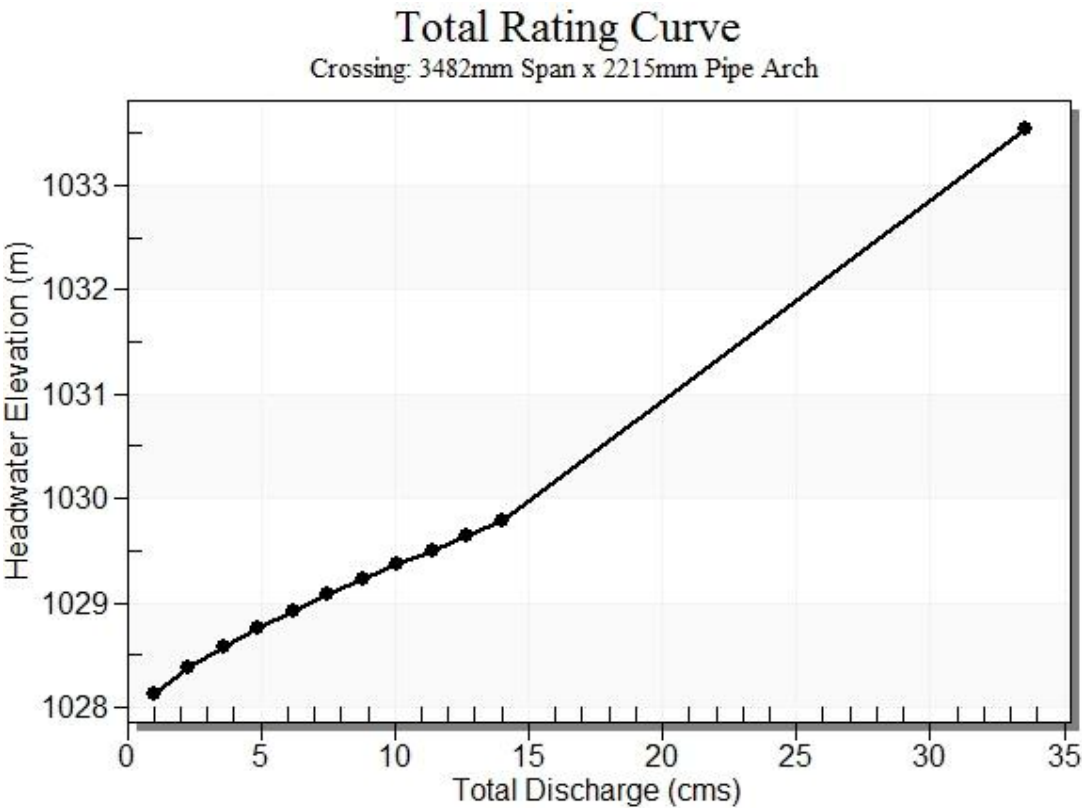


Table 2 - Culvert Summary Table: Existing Condition

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
1.00	1.00	1028.13	0.426	0.0*	1-S2n	0.223	0.300	0.223	0.192	2.162	1.279
2.30	2.30	1028.38	0.672	0.0*	1-S2n	0.326	0.462	0.326	0.309	2.889	1.684
3.60	3.60	1028.58	0.868	0.0*	1-S2n	0.406	0.589	0.406	0.396	3.374	1.938
4.90	4.90	1028.75	1.041	0.0*	1-S2n	0.474	0.696	0.474	0.469	3.752	2.129
6.20	6.20	1028.92	1.208	0.0*	1-S2n	0.536	0.796	0.536	0.533	4.064	2.283
7.50	7.50	1029.07	1.365	0.0*	1-S2n	0.593	0.888	0.593	0.590	4.332	2.414
8.80	8.80	1029.22	1.513	0.0*	1-S2n	0.648	0.974	0.648	0.642	4.567	2.528
10.10	10.10	1029.36	1.655	0.0*	1-S2n	0.701	1.054	0.701	0.690	4.774	2.629
11.40	11.40	1029.50	1.794	0.0*	1-S2n	0.752	1.128	0.752	0.735	4.960	2.721
12.70	12.70	1029.64	1.933	0.0*	1-S2n	0.803	1.202	0.803	0.777	5.129	2.804
14.00	14.00	1029.78	2.074	0.0*	1-S2n	0.852	1.273	0.852	0.817	5.283	2.882

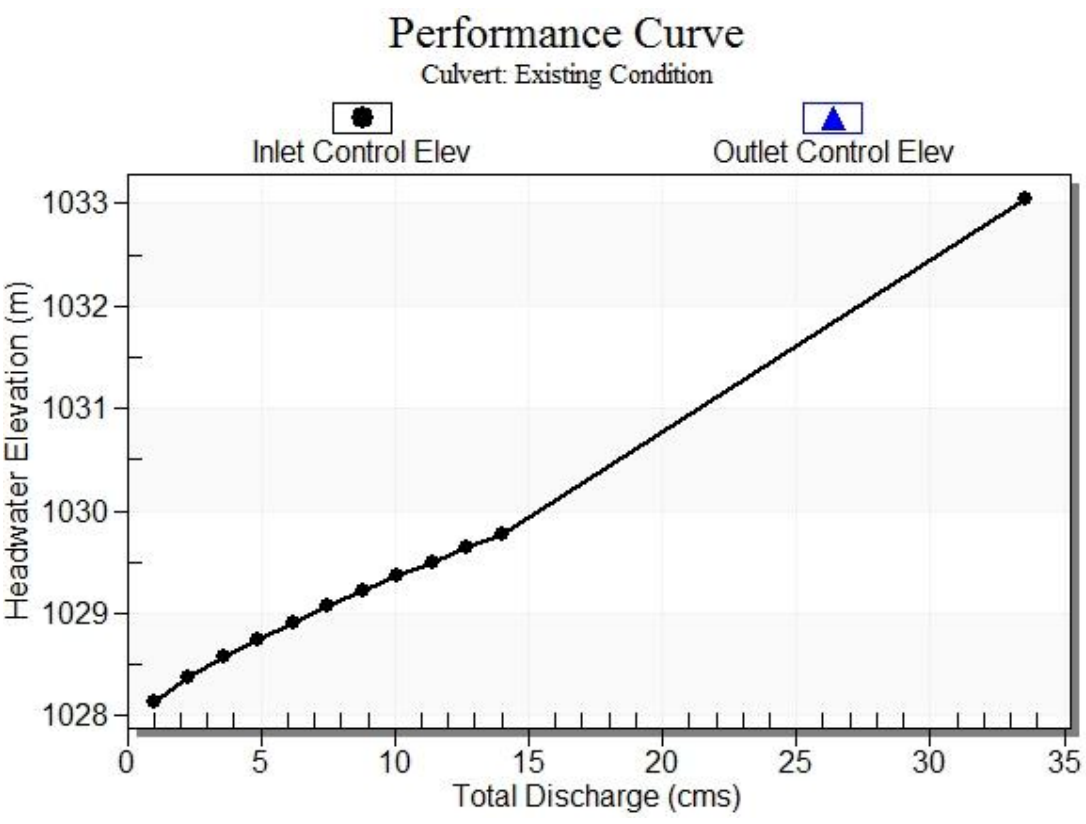
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

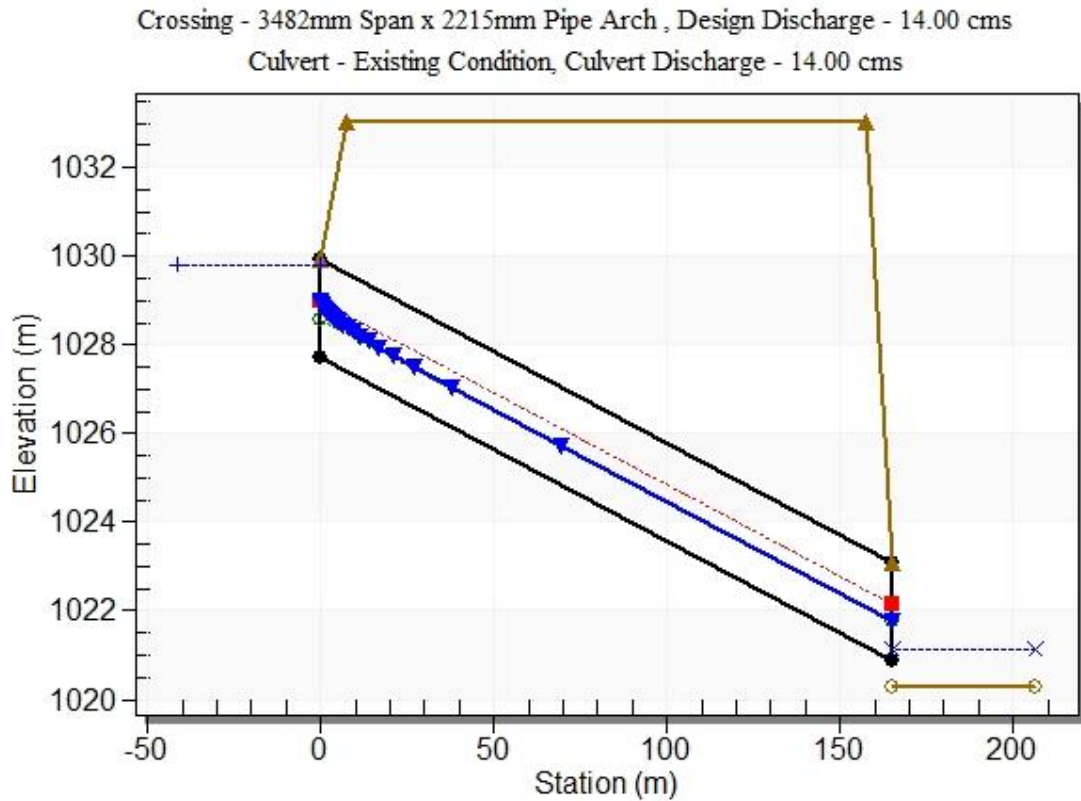
Inlet Elevation (invert): 1027.71 m, Outlet Elevation (invert): 1020.89 m

Culvert Length: 165.14 m, Culvert Slope: 0.0413

Culvert Performance Curve Plot: Existing Condition



Water Surface Profile Plot for Culvert: Existing Condition



Site Data - Existing Condition

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 1027.71 m

Outlet Station: 165.00 m

Outlet Elevation: 1020.89 m

Number of Barrels: 1

Culvert Data Summary - Existing Condition

Barrel Shape: Pipe Arch

Barrel Span: 3479.80 mm

Barrel Rise: 2209.80 mm

Barrel Material: Steel or Aluminum

Embedment: 0.00 mm

Barrel Manning's n: 0.0270

Culvert Type: Straight

Inlet Configuration: Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 3482mm Span x 2215mm

Flow (cms)	Water Surface Elev (m)	Depth (m)	Velocity (m/s)	Shear (Pa)	Froude Number
1.00	1020.49	0.19	1.28	41.36	1.00
2.30	1020.61	0.31	1.68	66.54	1.06
3.60	1020.70	0.40	1.94	85.43	1.10
4.90	1020.77	0.47	2.13	101.16	1.13
6.20	1020.83	0.53	2.28	114.88	1.14
7.50	1020.89	0.59	2.41	127.17	1.16
8.80	1020.94	0.64	2.53	138.39	1.17
10.10	1020.99	0.69	2.63	148.75	1.18
11.40	1021.03	0.73	2.72	158.42	1.19
12.70	1021.08	0.78	2.80	167.50	1.20
14.00	1021.12	0.82	2.88	176.08	1.21

Pipe Arch)**Tailwater Channel Data - 3482mm Span x 2215mm Pipe Arch**

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.50 m

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0220

Channel Manning's n: 0.0350

Channel Invert Elevation: 1020.30 m

Roadway Data for Crossing: 3482mm Span x 2215mm Pipe Arch

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 m

Crest Elevation: 1033.05 m

Roadway Surface: Paved

Roadway Top Width: 150.00 m

Appendix B

Proposed Culverts

HY-8 Culvert Analysis Results

Appendix B

Option 1

HY-8 Culvert Analysis Results

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.0 m³/s

Design Flow: 14.0 m³/s

Maximum Flow: 26.45 m³/s

Table 1 - Summary of Culvert Flows at Crossing: 3.09m x 1.99m Pipe Arch

Headwater Elevation (m)	Total Discharge (cms)	Option 1: 3097mm x 1990mm Pipe Arch Discharge (cms)	Roadway Discharge (cms)	Iterations
1028.16	1.00	1.00	0.00	1
1028.43	2.30	2.30	0.00	1
1028.65	3.60	3.60	0.00	1
1028.85	4.90	4.90	0.00	1
1029.04	6.20	6.20	0.00	1
1029.22	7.50	7.50	0.00	1
1029.39	8.80	8.80	0.00	1
1029.56	10.10	10.10	0.00	1
1029.74	11.40	11.40	0.00	1
1029.92	12.70	12.70	0.00	1
1030.13	14.00	14.00	0.00	1
1033.05	26.45	26.45	0.00	Overtopping

Rating Curve Plot for Crossing: 3.09m x 1.99m Pipe Arch

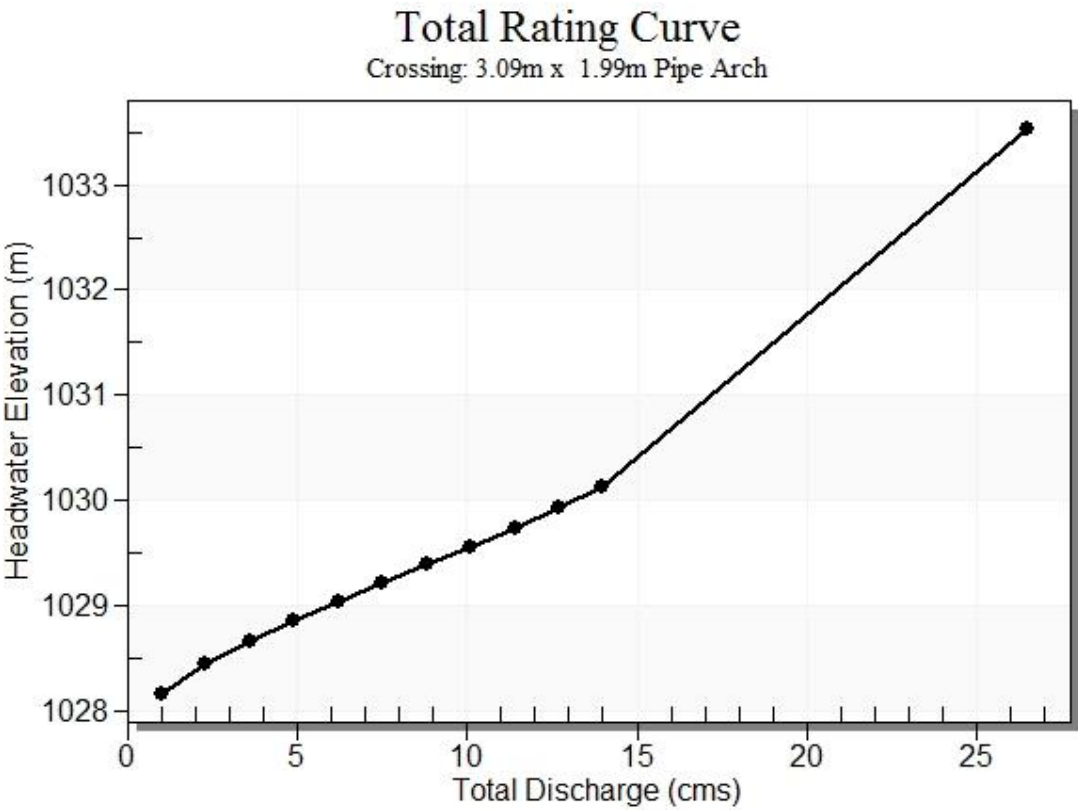


Table 2 - Culvert Summary Table: Option 1: 3097mm x 1990mm Pipe Arch

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
1.00	1.00	1028.16	0.456	0.0*	1-S2n	0.213	0.320	0.213	0.192	2.619	1.279
2.30	2.30	1028.43	0.725	0.0*	1-S2n	0.315	0.497	0.315	0.309	3.470	1.684
3.60	3.60	1028.65	0.943	0.0*	1-S2n	0.394	0.638	0.394	0.396	4.043	1.938
4.90	4.90	1028.85	1.145	0.0*	1-S2n	0.462	0.760	0.462	0.469	4.481	2.129
6.20	6.20	1029.04	1.332	0.0*	1-S2n	0.523	0.868	0.523	0.533	4.849	2.283
7.50	7.50	1029.22	1.508	0.0*	1-S2n	0.581	0.968	0.581	0.590	5.157	2.414
8.80	8.80	1029.39	1.678	0.0*	1-S2n	0.636	1.058	0.661	0.642	5.192	2.528
10.10	10.10	1029.56	1.850	0.0*	1-S2n	0.689	1.146	0.705	0.690	5.520	2.629
11.40	11.40	1029.74	2.028	0.0*	5-S2n	0.741	1.229	0.760	0.735	5.715	2.721
12.70	12.70	1029.92	2.216	0.0*	5-S2n	0.791	1.308	0.791	0.777	6.076	2.804
14.00	14.00	1030.13	2.418	0.0*	5-S2n	0.841	1.382	0.841	0.817	6.251	2.882

* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 1027.71 m, Outlet Elevation (invert): 1020.89 m

Culvert Length: 165.14 m, Culvert Slope: 0.0413

Appendix B

Option 2

HY-8 Culvert Analysis Results

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.0 m³/s

Design Flow: 14.0 m³/s

Maximum Flow: 37.16 m³/s

Table 1 - Summary of Culvert Flows at Crossing: 3m Span x 2.4m Rise Box Culvert

Headwater Elevation (m)	Total Discharge (cms)	Option 2: 3000mm x 2400mm Box Culvert Discharge (cms)	Roadway Discharge (cms)	Iterations
1028.08	1.00	1.00	0.00	1
1028.35	2.30	2.30	0.00	1
1028.57	3.60	3.60	0.00	1
1028.77	4.90	4.90	0.00	1
1028.95	6.20	6.20	0.00	1
1029.12	7.50	7.50	0.00	1
1029.28	8.80	8.80	0.00	1
1029.43	10.10	10.10	0.00	1
1029.58	11.40	11.40	0.00	1
1029.72	12.70	12.70	0.00	1
1029.86	14.00	14.00	0.00	1
1033.05	37.16	37.16	0.00	Overtopping

Rating Curve Plot for Crossing: 3m Span x 2.4m Rise Box Culvert

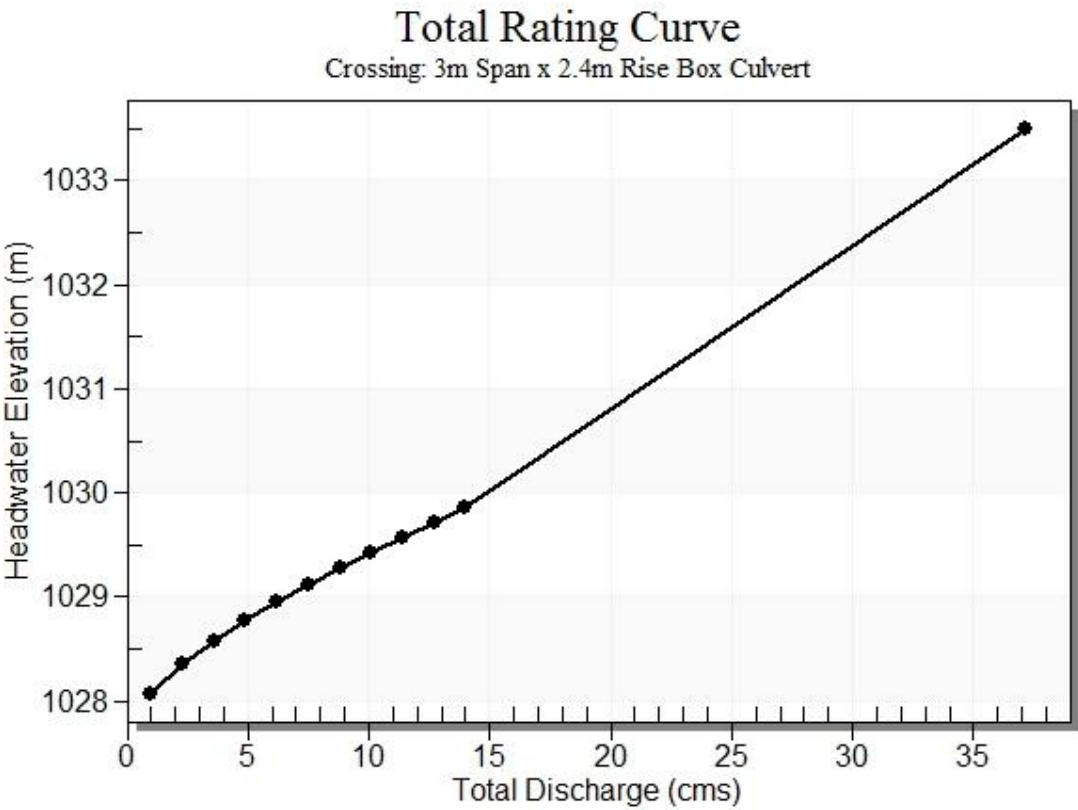


Table 2 - Culvert Summary Table: Option 2: 3000mm x 2400mm Box Culvert

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
1.00	1.00	1028.08	0.368	0.0*	1-S2n	0.092	0.225	0.092	0.192	3.610	1.279
2.30	2.30	1028.35	0.641	0.0*	1-S2n	0.158	0.391	0.158	0.309	4.847	1.684
3.60	3.60	1028.57	0.864	0.0*	1-S2n	0.211	0.527	0.211	0.396	5.697	1.938
4.90	4.90	1028.77	1.061	0.0*	1-S2n	0.257	0.648	0.257	0.469	6.353	2.129
6.20	6.20	1028.95	1.241	0.0*	1-S2n	0.299	0.758	0.316	0.533	6.543	2.283
7.50	7.50	1029.12	1.411	0.0*	1-S2n	0.338	0.860	0.355	0.590	7.052	2.414
8.80	8.80	1029.28	1.570	0.0*	1-S2n	0.376	0.957	0.376	0.642	7.807	2.528
10.10	10.10	1029.43	1.723	0.0*	1-S2n	0.411	1.049	0.426	0.690	7.911	2.629
11.40	11.40	1029.58	1.869	0.0*	1-S2n	0.445	1.137	0.466	0.735	8.149	2.721
12.70	12.70	1029.72	2.011	0.0*	1-S2n	0.479	1.222	0.502	0.777	8.432	2.804
14.00	14.00	1029.86	2.151	0.0*	1-S2n	0.511	1.304	0.537	0.817	8.689	2.882

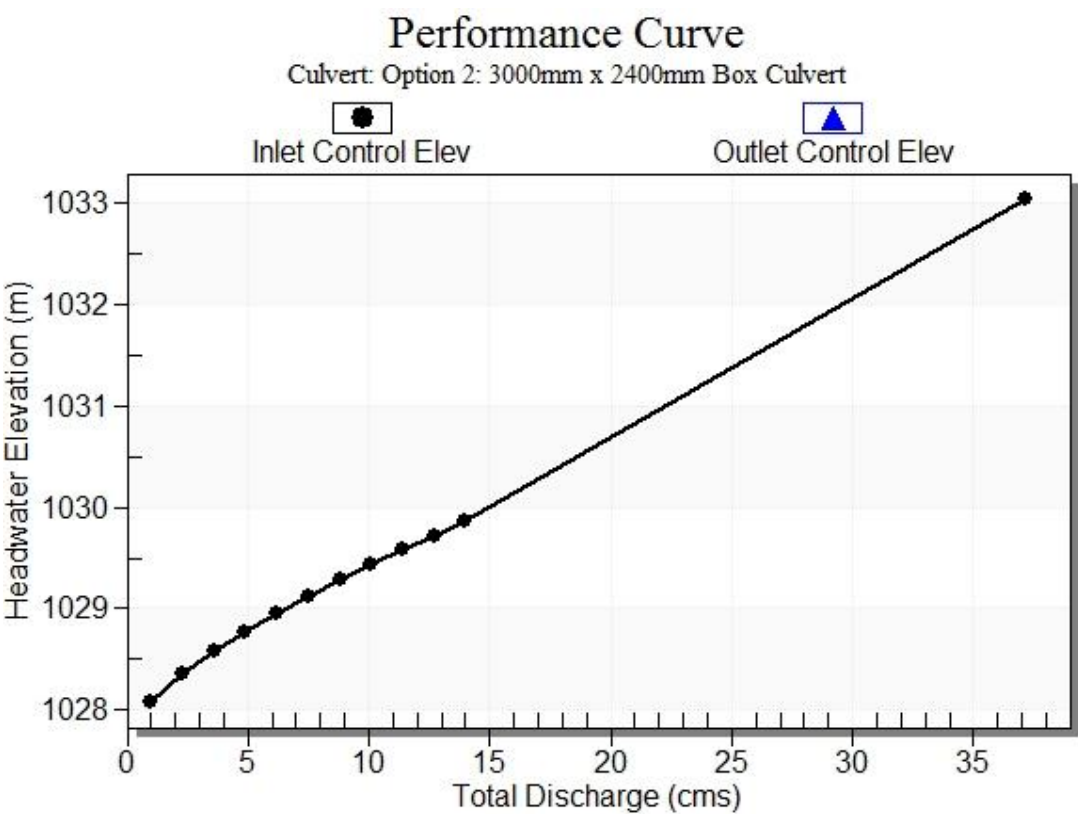
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 1027.71 m, Outlet Elevation (invert): 1019.95 m

Culvert Length: 165.18 m, Culvert Slope: 0.0470

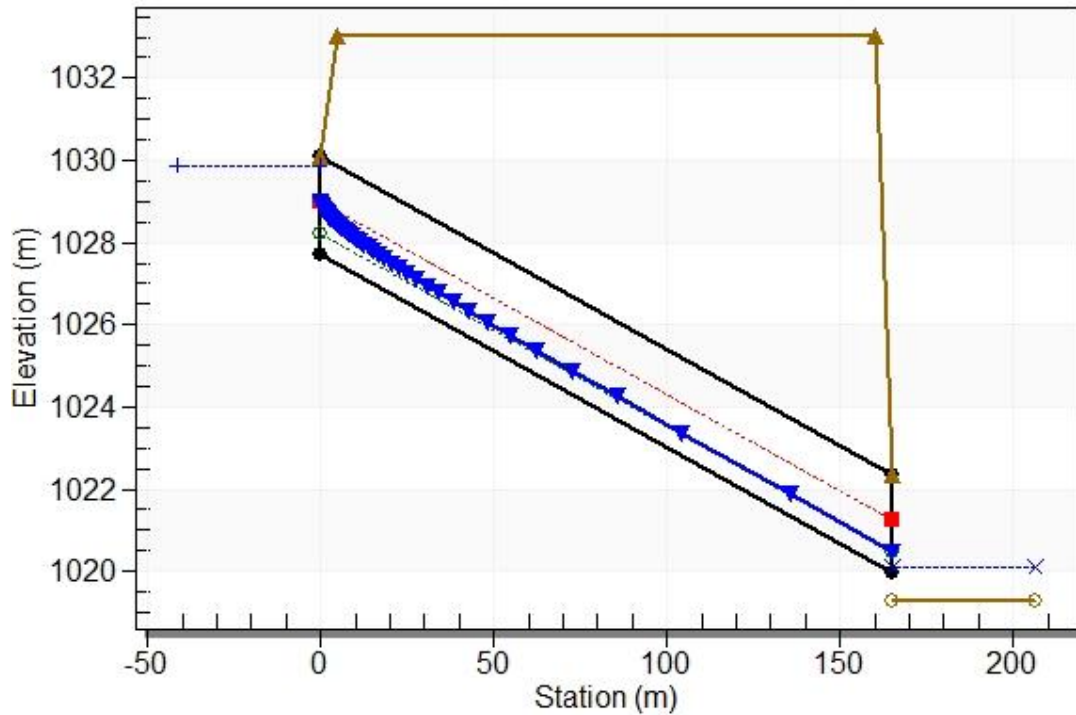
Culvert Performance Curve Plot: Option 2: 3000mm x 2400mm Box Culvert



Water Surface Profile Plot for Culvert: Option 2: 3000mm x 2400mm Box Culvert

Crossing - 3m Span x 2.4m Rise Box Culvert, Design Discharge - 14.00 cms

Culvert - Option 2: 3000mm x 2400mm Box Culvert, Culvert Discharge - 14.00 cms



Site Data - Option 2: 3000mm x 2400mm Box Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 1027.71 m

Outlet Station: 165.00 m

Outlet Elevation: 1019.95 m

Number of Barrels: 1

Culvert Data Summary - Option 2: 3000mm x 2400mm Box Culvert

Barrel Shape: Concrete Box

Barrel Span: 3000.00 mm

Barrel Rise: 2400.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge (90°) Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 3m Span x 2.4m Rise Box

Flow (cms)	Water Surface Elev (m)	Depth (m)	Velocity (m/s)	Shear (Pa)	Froude Number
1.00	1019.49	0.19	1.28	41.36	1.00
2.30	1019.61	0.31	1.68	66.54	1.06
3.60	1019.70	0.40	1.94	85.43	1.10
4.90	1019.77	0.47	2.13	101.16	1.13
6.20	1019.83	0.53	2.28	114.88	1.14
7.50	1019.89	0.59	2.41	127.17	1.16
8.80	1019.94	0.64	2.53	138.39	1.17
10.10	1019.99	0.69	2.63	148.75	1.18
11.40	1020.03	0.73	2.72	158.42	1.19
12.70	1020.08	0.78	2.80	167.50	1.20
14.00	1020.12	0.82	2.88	176.08	1.21

Culvert)**Tailwater Channel Data - 3m Span x 2.4m Rise Box Culvert**

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.50 m

Side Slope (H:V): 3.00 (1:1)

Channel Slope: 0.0220

Channel Manning's n: 0.0350

Channel Invert Elevation: 1019.30 m

Roadway Data for Crossing: 3m Span x 2.4m Rise Box Culvert

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 m

Crest Elevation: 1033.05 m

Roadway Surface: Paved

Roadway Top Width: 155.00 m

Appendix B

Option 3

HY-8 Culvert Analysis Results

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.0 m³/s

Design Flow: 14.0 m³/s

Maximum Flow: 33.13 m³/s

Table 1 - Summary of Culvert Flows at Crossing: 3.48m x 2.06m Pipe Arch

Headwater Elevation (m)	Total Discharge (cms)	Option 3: 3480mm x 2060mm Pipe Arch Discharge (cms)	Roadway Discharge (cms)	Iterations
1028.20	1.00	1.00	0.00	1
1028.44	2.30	2.30	0.00	1
1028.63	3.60	3.60	0.00	1
1028.80	4.90	4.90	0.00	1
1028.96	6.20	6.20	0.00	1
1029.12	7.50	7.50	0.00	1
1029.28	8.80	8.80	0.00	1
1029.42	10.10	10.10	0.00	1
1029.56	11.40	11.40	0.00	1
1029.69	12.70	12.70	0.00	1
1029.84	14.00	14.00	0.00	1
1033.05	32.13	32.13	0.00	Overtopping

Rating Curve Plot for Crossing: 3.48m x 2.06m Pipe Arch

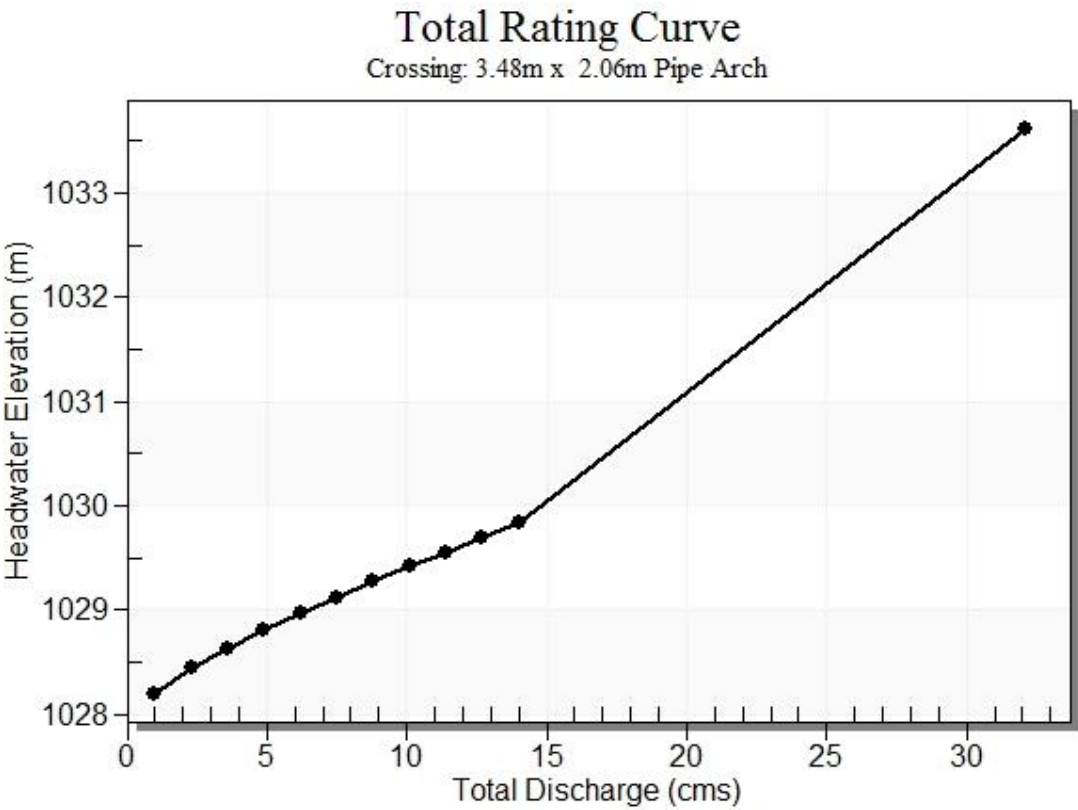


Table 2 - Culvert Summary Table: Option 3: 3480mm x 2060mm Pipe Arch

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
1.00	1.00	1028.20	0.347	0.0*	1-S2n	0.148	0.229	0.148	0.192	2.264	1.279
2.30	2.30	1028.44	0.585	0.0*	1-S2n	0.241	0.387	0.241	0.309	3.060	1.684
3.60	3.60	1028.63	0.777	0.0*	1-S2n	0.314	0.510	0.314	0.396	3.582	1.938
4.90	4.90	1028.80	0.947	0.0*	1-S2n	0.378	0.622	0.378	0.469	3.993	2.129
6.20	6.20	1028.96	1.106	0.0*	1-S2n	0.435	0.720	0.435	0.533	4.333	2.283
7.50	7.50	1029.12	1.265	0.0*	1-S2n	0.488	0.812	0.488	0.590	4.623	2.414
8.80	8.80	1029.28	1.424	0.0*	1-S2n	0.540	0.898	0.562	0.642	4.668	2.528
10.10	10.10	1029.42	1.564	0.0*	1-S2n	0.589	0.978	0.589	0.690	5.102	2.629
11.40	11.40	1029.56	1.700	0.0*	1-S2n	0.637	1.051	0.637	0.735	5.305	2.721
12.70	12.70	1029.69	1.835	0.0*	1-S2n	0.684	1.124	0.700	0.777	5.360	2.804
14.00	14.00	1029.84	1.981	0.0*	1-S2n	0.730	1.196	0.730	0.817	5.658	2.882

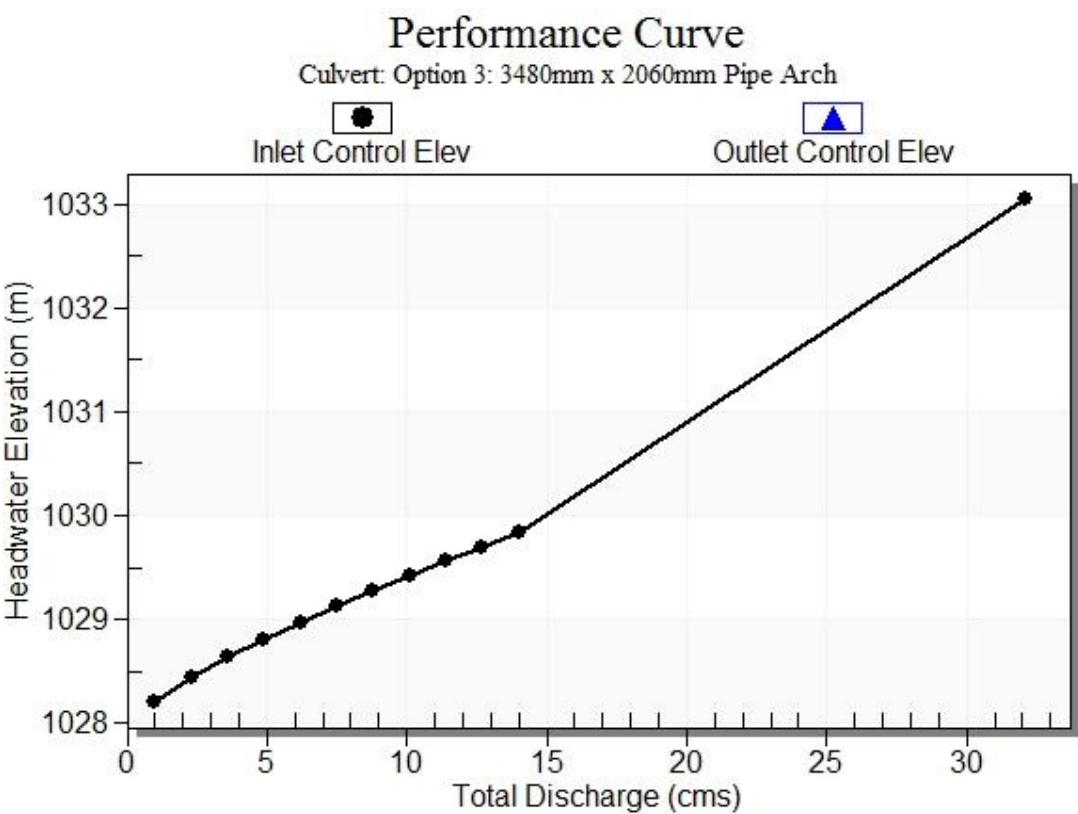
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 1027.86 m, Outlet Elevation (invert): 1021.04 m

Culvert Length: 165.14 m, Culvert Slope: 0.0413

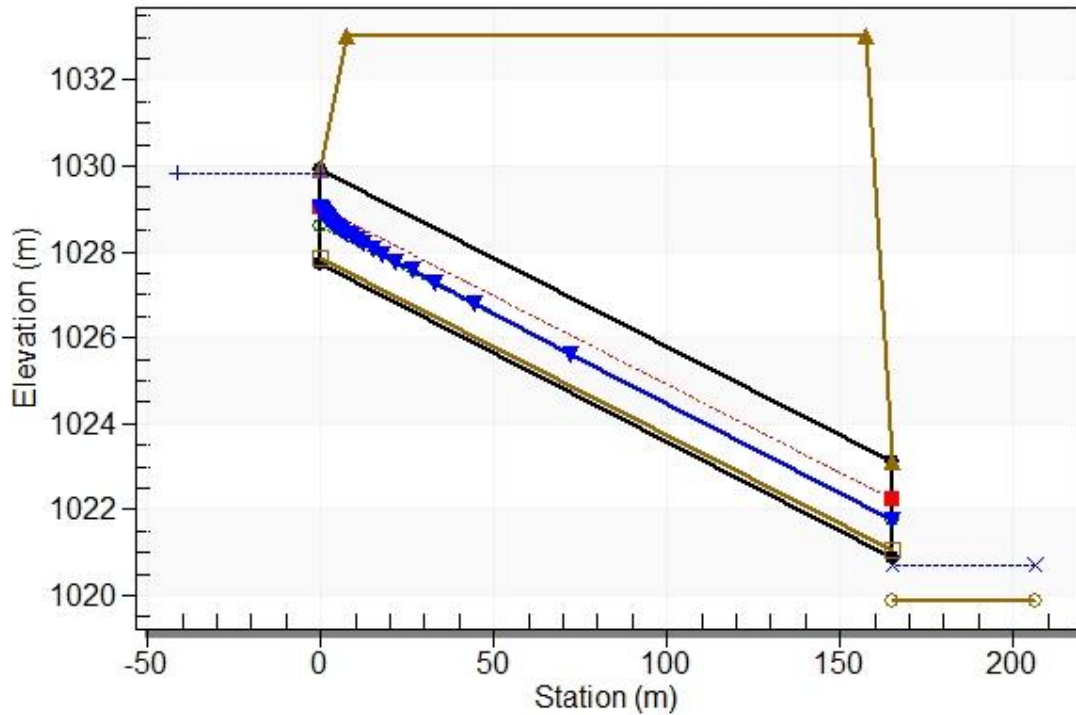
Culvert Performance Curve Plot: Option 3: 3480mm x 2060mm Pipe Arch



Water Surface Profile Plot for Culvert: Option 3: 3480mm x 2060mm Pipe Arch

Crossing - 3.48m x 2.06m Pipe Arch, Design Discharge - 14.00 cms

Culvert - Option 3: 3480mm x 2060mm Pipe Arch, Culvert Discharge - 14.00 cms



Site Data - Option 3: 3480mm x 2060mm Pipe Arch

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 1027.71 m

Outlet Station: 165.00 m

Outlet Elevation: 1020.89 m

Number of Barrels: 1

Culvert Data Summary - Option 3: 3480mm x 2060mm Pipe Arch

Barrel Shape: Pipe Arch

Barrel Span: 3479.80 mm

Barrel Rise: 2209.80 mm

Barrel Material: Steel or Aluminum

Embedment: 149.00 mm

Barrel Manning's n: 0.0240 (top and sides)

Manning's n: 0.0240 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 3.48m x 2.06m Pipe Arch)

Flow (cms)	Water Surface Elev (m)	Depth (m)	Velocity (m/s)	Shear (Pa)	Froude Number
1.00	1020.08	0.19	1.28	41.36	1.00
2.30	1020.20	0.31	1.68	66.54	1.06
3.60	1020.29	0.40	1.94	85.43	1.10
4.90	1020.36	0.47	2.13	101.16	1.13
6.20	1020.43	0.53	2.28	114.88	1.14
7.50	1020.48	0.59	2.41	127.17	1.16
8.80	1020.53	0.64	2.53	138.39	1.17
10.10	1020.58	0.69	2.63	148.75	1.18
11.40	1020.63	0.73	2.72	158.42	1.19
12.70	1020.67	0.78	2.80	167.50	1.20
14.00	1020.71	0.82	2.88	176.08	1.21

Tailwater Channel Data - 3.48m x 2.06m Pipe Arch

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.50 m

Side Slope (H:V): 3.00 (1:1)

Channel Slope: 0.0220

Channel Manning's n: 0.0350

Channel Invert Elevation: 1019.89 m

Roadway Data for Crossing: 3.48m x 2.06m Pipe Arch

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 m

Crest Elevation: 1033.05 m

Roadway Surface: Paved

Roadway Top Width: 150.00 m

Appendix 4

Effects Identification Matrix

Section A focuses on direct effects of the project and **Section B** on indirect effects that are caused by changes to the environment.

▪ Direct Effects									
			Valued components potentially directly affected by the proposed project						
			Natural Resources					Cultural Resources	
			Air	Soil & landforms	Water (surface, ground, crossings, etc.)	Flora (specify, including SAR)	Fauna (specify, including SAR)	Historical Resources	Visitor Experience
Project Components	Phase	Examples of Associated Activities							
	Preparation & Construction – Highway 93 North	Supply and storage of materials	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Clearing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
		Disposal of waste	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Drainage	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
		Excavation	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
		Grading	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
		Backfilling	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
		Use of machinery	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
		Transport of materials/ equipment	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
		Use of Chemicals	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
		Set up of temporary facilities	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

➤ Direct effects continued									
			Valued components potentially directly affected by the proposed project						
			Natural Resources					Cultural Resources	
			Air	Soil & landforms	Water (surface, ground, crossings, etc.)	Flora (specify, including SAR)	Fauna (specify, including SAR)	Historical Resources	Visitor Experience
	Phase	Examples of Associated Activities							
Project Components	Preparation & Construction – Highway 93 South	Supply and storage of materials	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Clearing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
		Disposal of waste	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Drainage	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
		Excavation	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
		Grading	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
		Backfilling	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
		Use of machinery	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
		Transport of materials/ equipment	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
		Use of Chemicals	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
		Set up of temporary facilities	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Other...	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Project Components	Hwy 93N/S Operation & Maintenance	Maintenance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Use	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Use/Removal of temporary facilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Vehicle Traffic	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Section B of the matrix should be used to identify potential indirect effects that may result from impacts of the project to components of the environment you have identified on the preceding pages (see Section A - direct effects to natural resources). Consideration of indirect effects is required under CEAA 2012 Sections 5(1)(c) and 5(2)(b), and by the PCA mandate. For example:

- o *if the proposed project could lead to adverse effects to water quality and quantity, could this then effect the quantity and quality of water resources (e.g. potable water) used by an Aboriginal community?*
- o *could there also be adverse socio-economic effects to a community that relies on recreational fishing tourism?*
- o *could changes to the environment (e.g. digging, clearing) affect visitor access, opportunities, or safety?*

[illegible]

Appendix 5

PCA Biotics Search Results

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[Biotics Web Explorer](#)
[Home](#) → [Biotics Web Explorer](#) → Biotics Web Explorer

Biotics Web Explorer

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Scientific Name	Common Name	SARA Schedule	Managed Area Name	Regularity
Contopus cooperi	Olive-sided Flycatcher	Schedule 1	Kootenay National Park of Canada	Regularly occurring
Asio flammeus	Short-eared Owl	Schedule 1	Kootenay National Park of Canada	Regularly occurring
Chordeiles minor	Common Nighthawk	Schedule 1	Kootenay National Park of Canada	Regularly occurring
Pinus albicaulis	Whitebark Pine	Schedule 1	Kootenay National Park of Canada	Regularly occurring
Charina bottae	Northern Rubber Boa	Schedule 1	Kootenay National Park of Canada	Regularly occurring
Melanerpes lewis	Lewis's Woodpecker	Schedule 1	Kootenay National Park of Canada	Unknown/Undetermined
Myotis lucifugus	Little Brown Myotis	Schedule 1	Kootenay National Park of Canada	Unknown/Undetermined
Taxidea taxus jeffersonii	American Badger - jeffersonii subspecies	Schedule 1	Kootenay National Park of Canada	Regularly occurring
Coturnicops noveboracensis	Yellow Rail	Schedule 1	Kootenay National Park of Canada	
Oncorhynchus clarkii pop. 8	Westslope Cutthroat Trout - Pacific populations	Schedule 1	Kootenay National Park of Canada	Regularly occurring
Falco peregrinus pop. 1	Peregrine Falcon anatum/tundrius	Schedule 1	Kootenay National Park of Canada	Accidental/Nonregular
Psiloscoops flammeolus	Flammulated Owl	Schedule 1	Kootenay National Park of Canada	Accidental/Nonregular
Megascops kennicottii macfarlanei	Western Screech-owl macfarlanei subspecies	Schedule 1	Kootenay National Park of Canada	Accidental/Nonregular
Euphagus carolinus	Rusty Blackbird	Schedule 1	Kootenay National Park of Canada	Accidental/Nonregular
				Number Of Records Returned 14

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Date Modified:

2017-01-23

Appendix 6

SARA Search Results

Species at Risk Public Registry

[Home](#)
[> A to Z Species Index](#)

A to Z Species Index

The Act establishes Schedule 1 as the official list of wildlife species at risk. However, please note that while Schedule 1 lists species that are extirpated, endangered, threatened and of special concern, the [prohibitions](#) do not apply to species of special concern. The [SARA and You guides](#) can help you determine the presence of these SARA Schedule 1 species in any region of Canada.

Total: 211 record(s) found.

Species Index

Common name *	Scientific name	Population	Taxon	Range	COSEWIC status	Schedule	SARA status
<input type="text"/>	<input type="text"/>	<input type="text"/>	All ▼	British Co ▼	All ▼	Schedule ▼	All ▼
<input type="button" value="Filter Again"/>							
* A common name search will search all common names in English and French as well as aliases and former names which are not displayed below.							
Alkaline Wing-nerved Moss	<i>Pterygoneurum kozlovii</i>		Mosses	British Columbia, Saskatchewan	Threatened	Schedule 1	Threatened
American Badger jeffersonii subspecies	<i>Taxidea taxus jeffersonii</i>		Mammals	British Columbia	Non-active	Schedule 1	Endangered
Ancient Murrelet	<i>Synthliboramphus antiquus</i>		Birds	British Columbia, Pacific Ocean	Special Concern	Schedule 1	Special Concern
Band-tailed Pigeon	<i>Patagioenas fasciata</i>		Birds	British Columbia	Special Concern	Schedule 1	Special Concern
Banded Cord-moss	<i>Entosthodon fascicularis</i>		Mosses	British Columbia	Special Concern	Schedule 1	Special Concern
Bank Swallow	<i>Riparia riparia</i>		Birds	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Threatened	Schedule 1	Threatened
Barn Owl	<i>Tyto alba</i>	Western population	Birds	British Columbia	Threatened	Schedule 1	Special Concern
Barn Swallow	<i>Hirundo rustica</i>		Birds	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Threatened	Schedule 1	Threatened

Batwing Vinyl Lichen	<i>Leptogium platynum</i>		Lichens	British Columbia	Endangered	Schedule 1	Endangered
Bear's-foot Sanicle	<i>Sanicula arctopoides</i>		Vascular Plants	British Columbia	Threatened	Schedule 1	Endangered
Bearded Owl-clover	<i>Triphysaria versicolor</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Behr's Hairstreak	<i>Satyrrium behrii</i>		Arthropods	British Columbia	Endangered	Schedule 1	Endangered
Bent Spike-rush	<i>Eleocharis geniculata</i>	Southern Mountain population	Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Blue-grey Tailedropper	<i>Prophysaon coeruleum</i>		Molluscs	British Columbia	Threatened	Schedule 1	Endangered
Bobolink	<i>Dolichonyx oryzivorus</i>		Birds	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Threatened	Schedule 1	Threatened
Bog Bird's-foot Trefoil	<i>Lotus pinnatus</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Branched Phacelia	<i>Phacelia ramosissima</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Brook Spike-primrose	<i>Epilobium torreyi</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>		Birds	Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec	Special Concern	Schedule 1	Special Concern
Burrowing Owl	<i>Athene cunicularia</i>		Birds	British Columbia, Alberta, Saskatchewan, Manitoba	Endangered	Schedule 1	Endangered
California Buttercup	<i>Ranunculus californicus</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Canada Warbler	<i>Cardellina canadensis</i>		Birds	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia	Threatened	Schedule 1	Threatened
Caribou	<i>Rangifer tarandus</i>	Boreal population	Mammals	Yukon, Northwest Territories, British Columbia,	Threatened	Schedule 1	Threatened

				Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Newfoundland and Labrador			
Cliff Paintbrush	<i>Castilleja rupicola</i>		Vascular Plants	British Columbia	Threatened	Schedule 1	Threatened
Coast Microseris	<i>Microseris bigelovii</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Coastal Giant Salamander	<i>Dicamptodon tenebrosus</i>		Amphibians	British Columbia	Threatened	Schedule 1	Threatened
Coastal Scouler's Catchfly	<i>Silene scouleri</i> ssp. <i>grandis</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Coastal Tailed Frog	<i>Ascaphus truei</i>		Amphibians	British Columbia	Special Concern	Schedule 1	Special Concern
Coastal Wood Fern	<i>Dryopteris arguta</i>		Vascular Plants	British Columbia	Special Concern	Schedule 1	Special Concern
Coastrange Sculpin	<i>Cottus aleuticus</i>	Cultus-L population	Fishes	British Columbia	Threatened	Schedule 1	Threatened
Coeur d'Alene Salamander	<i>Plethodon idahoensis</i>		Amphibians	British Columbia	Special Concern	Schedule 1	Special Concern
Collared Pika	<i>Ochotona collaris</i>		Mammals	Yukon, Northwest Territories, British Columbia	Special Concern	Schedule 1	Special Concern
Columbia Sculpin	<i>Cottus hubbsi</i>		Fishes	British Columbia	Special Concern	Schedule 1	Special Concern
Columbian Carpet Moss	<i>Bryoerythrophyllum columbianum</i>		Mosses	British Columbia	Special Concern	Schedule 1	Special Concern
Common Nighthawk	<i>Chordeiles minor</i>		Birds	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Threatened	Schedule 1	Threatened
Contorted-pod Evening-primrose	<i>Camissonia contorta</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Crumpled Tarpaper Lichen	<i>Collema coniophilum</i>		Lichens	British Columbia	Threatened	Schedule 1	Threatened
Cryptic Paw Lichen	<i>Nephroma occultum</i>		Lichens	British Columbia	Special Concern	Schedule 1	Special Concern
Deltoid Balsamroot	<i>Balsamorhiza deltoidea</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Dense Spike-primrose	<i>Epilobium densiflorum</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Dense-flowered Lupine	<i>Lupinus densiflorus</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Desert Nightsnake	<i>Hypsiglena chlorophaea</i>		Reptiles	British Columbia	Endangered	Schedule 1	Endangered
Dromedary Jumping-slug	<i>Hemphillia dromedarius</i>		Molluscs	British Columbia	Threatened	Schedule 1	Threatened

Dun Skipper vestris subspecies	Euphyes vestris vestris		Arthropods	British Columbia	Threatened	Schedule 1	Threatened
Dwarf Sandwort	Minuartia pusilla		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Dwarf Woolly-heads	Psilocarphus brevissimus	Southern Mountain population	Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Edwards' Beach Moth	Anarta edwardsii		Arthropods	British Columbia	Endangered	Schedule 1	Endangered
Enos Lake Benthic Threespine Stickleback	Gasterosteus aculeatus		Fishes	British Columbia	Endangered	Schedule 1	Endangered
Enos Lake Limnetic Threespine Stickleback	Gasterosteus aculeatus		Fishes	British Columbia	Endangered	Schedule 1	Endangered
Ermine haidarum subspecies	Mustela erminea haidarum		Mammals	British Columbia	Threatened	Schedule 1	Threatened
Flammulated Owl	Otus flammeolus		Birds	British Columbia	Special Concern	Schedule 1	Special Concern
Foothill Sedge	Carex tumulicola		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Fragrant Popcornflower	Plagiobothrys figuratus		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Golden Paintbrush	Castilleja levisecta		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Grand Coulee Owl-clover	Orthocarpus barbatus		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Gray's Desert-parsley	Lomatium grayi		Vascular Plants	British Columbia	Threatened	Schedule 1	Threatened
Great Basin Gophersnake	Pituophis catenifer deserticola		Reptiles	British Columbia	Threatened	Schedule 1	Threatened
Great Basin Spadefoot	Spea intermontana		Amphibians	British Columbia	Threatened	Schedule 1	Threatened
Great Blue Heron fannini subspecies	Ardea herodias fannini		Birds	British Columbia	Special Concern	Schedule 1	Special Concern
Greater Sage-Grouse phaios subspecies	Centrocercus urophasianus phaios		Birds	British Columbia	Extirpated	Schedule 1	Extirpated
Green Sturgeon	Acipenser medirostris		Fishes	British Columbia, Pacific Ocean	Special Concern	Schedule 1	Special Concern
Grey Whale	Eschrichtius robustus	Eastern North Pacific population	Mammals	Yukon, Northwest Territories, British Columbia, Pacific Ocean, Arctic Ocean	Non-active	Schedule 1	Special Concern
Half-moon Hairstreak	Satyrrium semiluna		Arthropods	British Columbia, Alberta	Endangered	Schedule 1	Endangered
Haller's Apple Moss	Bartramia halleriana		Mosses	British Columbia, Alberta	Threatened	Schedule 1	Threatened
Harbour Porpoise	Phocoena phocoena vomerina	Pacific Ocean population	Mammals	British Columbia, Pacific Ocean, Arctic Ocean	Special Concern	Schedule 1	Special Concern
Horned Grebe	Podiceps auritus	Western population	Birds	Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan,	Special Concern	Schedule 1	Special Concern

				Manitoba, Ontario			
Horned Lark strigata subspecies	Eremophila alpestris strigata		Birds	British Columbia	Endangered	Schedule 1	Endangered
Hotwater Physa	Physella wrighti		Molluscs	British Columbia	Endangered	Schedule 1	Endangered
Howell's Triteleia	Triteleia howellii		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Island Blue	Plebejus saepiolus insulanus		Arthropods	British Columbia	Endangered	Schedule 1	Endangered
Island Marble	Euchloe ausonides insulanus		Arthropods	British Columbia	Extirpated	Schedule 1	Extirpated
Kellogg's Rush	Juncus kelloggii		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Lemmon's Holly Fern	Polystichum lemmonii		Vascular Plants	British Columbia	Threatened	Schedule 1	Threatened
Lewis's Woodpecker	Melanerpes lewis		Birds	British Columbia	Threatened	Schedule 1	Threatened
Lindley's False Silverpuffs	Uropappus lindleyi		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Little Brown Myotis	Myotis lucifugus		Mammals	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Endangered	Schedule 1	Endangered
Long-billed Curlew	Numenius americanus		Birds	British Columbia, Alberta, Saskatchewan	Special Concern	Schedule 1	Special Concern
Lyall's Mariposa Lily	Calochortus lyallii		Vascular Plants	British Columbia	Special Concern	Schedule 1	Special Concern
Macoun's Meadowfoam	Limnanthes macounii		Vascular Plants	British Columbia	Threatened	Schedule 1	Threatened
Magnum Mantleslug	Magnipelta mycophaga		Molluscs	British Columbia	Special Concern	Schedule 1	Special Concern
Marbled Murrelet	Brachyramphus marmoratus		Birds	British Columbia	Threatened	Schedule 1	Threatened
Margined Streamside Moss	Scouleria marginata		Mosses	British Columbia	Endangered	Schedule 1	Endangered
Mexican Mosquito-fern	Azolla mexicana		Vascular Plants	British Columbia	Threatened	Schedule 1	Threatened
Misty Lake Lentic Threespine Stickleback	Gasterosteus aculeatus		Fishes	British Columbia	Endangered	Schedule 1	Endangered
Misty Lake Lotic Threespine Stickleback	Gasterosteus aculeatus		Fishes	British Columbia	Endangered	Schedule 1	Endangered
Monarch	Danaus plexippus		Arthropods	Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New	Endangered	Schedule 1	Special Concern

				Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador			
Mormon Metalmark	<i>Apodemia mormo</i>	Southern Mountain population	Arthropods	British Columbia	Endangered	Schedule 1	Endangered
Mountain Beaver	<i>Aplodontia rufa</i>		Mammals	British Columbia	Special Concern	Schedule 1	Special Concern
Mountain Holly Fern	<i>Polystichum scopulinum</i>		Vascular Plants	British Columbia, Quebec, Newfoundland and Labrador	Threatened	Schedule 1	Threatened
Mountain Sucker	<i>Catostomus platyrhynchus</i>	Pacific populations	Fishes	British Columbia	Special Concern	Schedule 1	Special Concern
Muhlenberg's Centaury	<i>Centaureum muhlenbergii</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Nooksack Dace	<i>Rhinichthys cataractae ssp.</i>		Fishes	British Columbia	Endangered	Schedule 1	Endangered
Northern Abalone	<i>Haliotis kamtschatkana</i>		Molluscs	British Columbia, Pacific Ocean	Endangered	Schedule 1	Endangered
Northern Goshawk laingi subspecies	<i>Accipiter gentilis laingi</i>		Birds	British Columbia	Threatened	Schedule 1	Threatened
Northern Leopard Frog	<i>Lithobates pipiens</i>	Rocky Mountain population	Amphibians	British Columbia	Endangered	Schedule 1	Endangered
Northern Myotis	<i>Myotis septentrionalis</i>		Mammals	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Endangered	Schedule 1	Endangered
Northern Red-legged Frog	<i>Rana aurora</i>		Amphibians	British Columbia	Special Concern	Schedule 1	Special Concern
Northern Rubber Boa	<i>Charina bottae</i>		Reptiles	British Columbia	Special Concern	Schedule 1	Special Concern
Northern Saw-whet Owl brooksi subspecies	<i>Aegolius acadicus brooksi</i>		Birds	British Columbia	Threatened	Schedule 1	Threatened
Nugget Moss	<i>Microbryum vlassovii</i>		Mosses	British Columbia	Endangered	Schedule 1	Endangered
Nuttall's Cottontail nuttallii subspecies	<i>Sylvilagus nuttallii nuttallii</i>		Mammals	British Columbia	Special Concern	Schedule 1	Special Concern
Okanagan Efferia	<i>Efferia okanagana</i>		Arthropods	British Columbia	Endangered	Schedule 1	Endangered
Oldgrowth Specklebelly Lichen	<i>Pseudocyphellaria rainierensis</i>		Lichens	British Columbia	Special Concern	Schedule 1	Special Concern
Olive Clubtail	<i>Stylurus olivaceus</i>		Arthropods	British Columbia	Endangered	Schedule 1	Endangered
Olive-sided Flycatcher	<i>Contopus cooperi</i>		Birds	Yukon, Northwest Territories,	Threatened	Schedule 1	Threatened

				British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador			
Olympia Oyster	<i>Ostrea lurida</i>		Molluscs	British Columbia, Pacific Ocean	Special Concern	Schedule 1	Special Concern
Oregon Forestsnail	<i>Allogona townsendiana</i>		Molluscs	British Columbia	Endangered	Schedule 1	Endangered
Oregon Lupine	<i>Lupinus oreganus</i>		Vascular Plants	British Columbia	Extirpated	Schedule 1	Extirpated
Oregon Spotted Frog	<i>Rana pretiosa</i>		Amphibians	British Columbia	Endangered	Schedule 1	Endangered
Pacific Gophersnake	<i>Pituophis catenifer catenifer</i>		Reptiles	British Columbia	Extirpated	Schedule 1	Extirpated
Pacific Pond Turtle	<i>Actinemys marmorata</i>		Reptiles	British Columbia	Extirpated	Schedule 1	Extirpated
Pacific Water Shrew	<i>Sorex bendirii</i>		Mammals	British Columbia	Endangered	Schedule 1	Endangered
Pallid Bat	<i>Antrozous pallidus</i>		Mammals	British Columbia	Threatened	Schedule 1	Threatened
Paxton Lake Benthic Threespine Stickleback	<i>Gasterosteus aculeatus</i>		Fishes	British Columbia	Endangered	Schedule 1	Endangered
Paxton Lake Limnetic Threespine Stickleback	<i>Gasterosteus aculeatus</i>		Fishes	British Columbia	Endangered	Schedule 1	Endangered
Peacock Vinyl Lichen	<i>Leptogium polycarpum</i>		Lichens	British Columbia	Special Concern	Schedule 1	Special Concern
Peregrine Falcon anatum/tundrius	<i>Falco peregrinus anatum/tundrius</i>		Birds	Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, Newfoundland and Labrador	Not at Risk	Schedule 1	Special Concern
Peregrine Falcon pealei subspecies	<i>Falco peregrinus pealei</i>		Birds	British Columbia	Special Concern	Schedule 1	Special Concern
Phantom Orchid	<i>Cephalanthera austiniiae</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Threatened
Pink Sand-verbena	<i>Abronia umbellata</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Pink-footed Shearwater	<i>Ardenna creatopus</i>		Birds	British Columbia, Pacific Ocean	Endangered	Schedule 1	Threatened
Poor Pocket Moss	<i>Fissidens pauperculus</i>		Mosses	British Columbia	Endangered	Schedule 1	Endangered
Porsild's Bryum	<i>Haplodontium macrocarpum</i>		Mosses	Nunavut, British Columbia, Alberta,	Threatened	Schedule 1	Threatened

				Newfoundland and Labrador			
Prairie Lupine	Lupinus lepidus		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Puget Oregonian	Cryptomastix devia		Molluscs	British Columbia	Extirpated	Schedule 1	Extirpated
Purple Sanicle	Sanicula bipinnatifida		Vascular Plants	British Columbia	Threatened	Schedule 1	Threatened
Pygmy Pocket Moss	Fissidens exilis		Mosses	British Columbia, Ontario, Quebec, Nova Scotia	Not at Risk	Schedule 1	Special Concern
Pygmy Short-horned Lizard	Phrynosoma douglasii		Reptiles	British Columbia	Extirpated	Schedule 1	Extirpated
Rayless Goldfields	Lasthenia glaberrima		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Red Knot roselaari type	Calidris canutus roselaari type		Birds	Yukon, Northwest Territories, British Columbia	Threatened	Schedule 1	Threatened
Red Knot rufa subspecies	Calidris canutus rufa		Birds	Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Endangered	Schedule 1	Endangered
Rigid Apple Moss	Bartramia stricta		Mosses	British Columbia	Endangered	Schedule 1	Endangered
Rocky Mountain Ridged Mussel	Gonidea angulata		Molluscs	British Columbia	Endangered	Schedule 1	Special Concern
Rocky Mountain Sculpin	Cottus sp.	Westslope populations	Fishes	British Columbia	Special Concern	Schedule 1	Special Concern
Rocky Mountain Tailed Frog	Ascaphus montanus		Amphibians	British Columbia	Threatened	Schedule 1	Endangered
Rosy Owl-clover	Orthocarpus bracteosus		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Rusty Blackbird	Euphagus carolinus		Birds	Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Special Concern	Schedule 1	Special Concern
Rusty Cord-moss	Entosthodon rubiginosus		Mosses	British Columbia, Saskatchewan	Special Concern	Schedule 1	Endangered

Sage Thrasher	<i>Oreoscoptes montanus</i>		Birds	British Columbia, Alberta, Saskatchewan	Endangered	Schedule 1	Endangered
Salish Sucker	<i>Catostomus</i> sp. cf. <i>catostomus</i>		Fishes	British Columbia	Threatened	Schedule 1	Endangered
Sand-verbena Moth	<i>Copablepharon fuscum</i>		Arthropods	British Columbia	Endangered	Schedule 1	Endangered
Scarlet Ammannia	<i>Ammannia robusta</i>		Vascular Plants	British Columbia, Ontario	Endangered	Schedule 1	Endangered
Sea Otter	<i>Enhydra lutris</i>		Mammals	British Columbia, Pacific Ocean	Special Concern	Schedule 1	Special Concern
Seaside Birds-foot Lotus	<i>Lotus formosissimus</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Seaside Bone Lichen	<i>Hypogymnia heterophylla</i>		Lichens	British Columbia	Threatened	Schedule 1	Threatened
Seaside Centipede Lichen	<i>Heterodermia sitchensis</i>		Lichens	British Columbia	Endangered	Schedule 1	Endangered
Sharp-tailed Snake	<i>Contia tenuis</i>		Reptiles	British Columbia	Endangered	Schedule 1	Endangered
Short-eared Owl	<i>Asio flammeus</i>		Birds	Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Special Concern	Schedule 1	Special Concern
Short-rayed Alkali Aster	<i>Symphyotrichum frondosum</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Short-tailed Albatross	<i>Phoebastria albatrus</i>		Birds	British Columbia, Pacific Ocean	Threatened	Schedule 1	Threatened
Shorthead Sculpin	<i>Cottus confusus</i>		Fishes	British Columbia	Special Concern	Schedule 1	Special Concern
Showy Phlox	<i>Phlox speciosa</i> ssp. <i>occidentalis</i>		Vascular Plants	British Columbia	Threatened	Schedule 1	Threatened
Silver Hair Moss	<i>Fabronia pusilla</i>		Mosses	British Columbia	Endangered	Schedule 1	Endangered
Slender Collomia	<i>Collomia tenella</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Slender Popcornflower	<i>Plagiobothrys tenellus</i>		Vascular Plants	British Columbia	Threatened	Schedule 1	Threatened
Small-flowered Lipocarpa	<i>Lipocarpa micrantha</i>		Vascular Plants	British Columbia, Ontario	Endangered	Schedule 1	Endangered
Small-flowered Tonella	<i>Tonella tenella</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Sonora Skipper	<i>Polites sonora</i>		Arthropods	British Columbia	Not at Risk	Schedule 1	Special Concern
Southern Maidenhair Fern	<i>Adiantum capillus-veneris</i>		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Spalding's Campion	<i>Silene spaldingii</i>		Vascular	British	Endangered	Schedule 1	Endangered

			Plants	Columbia			
Speckled Dace	Rhinichthys osculus		Fishes	British Columbia	Endangered	Schedule 1	Endangered
Spotted Bat	Euderma maculatum		Mammals	British Columbia	Special Concern	Schedule 1	Special Concern
Spotted Owl caurina subspecies	Strix occidentalis caurina		Birds	British Columbia	Endangered	Schedule 1	Endangered
Steller Sea Lion	Eumetopias jubatus		Mammals	British Columbia, Pacific Ocean	Special Concern	Schedule 1	Special Concern
Stoloniferous Pussytoes	Antennaria flagellaris		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Streambank Lupine	Lupinus rivularis		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Tall Bugbane	Actaea elata		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Tall Woolly-heads	Psilocarphus elatior		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Taylor's Checkerspot	Euphydryas editha taylori		Arthropods	British Columbia	Endangered	Schedule 1	Endangered
Threaded Vertigo	Nearctula sp.		Molluscs	British Columbia	Special Concern	Schedule 1	Special Concern
Tiger Salamander	Ambystoma tigrinum	Southern Mountain population	Amphibians	British Columbia	Non-active	Schedule 1	Endangered
Toothcup	Rotala ramosior		Vascular Plants	British Columbia, Ontario	Non-active	Schedule 1	Endangered
Townsend's Mole	Scapanus townsendii		Mammals	British Columbia	Endangered	Schedule 1	Endangered
Twisted Oak Moss	Syntrichia laevipila		Mosses	British Columbia	Special Concern	Schedule 1	Special Concern
Vananda Creek Benthic Threespine Stickleback	Gasterosteus aculeatus		Fishes	British Columbia	Endangered	Schedule 1	Endangered
Vananda Creek Limnetic Threespine Stickleback	Gasterosteus aculeatus		Fishes	British Columbia	Endangered	Schedule 1	Endangered
Vancouver Island Beggarticks	Bidens amplissima		Vascular Plants	British Columbia	Special Concern	Schedule 1	Special Concern
Vancouver Island Marmot	Marmota vancouverensis		Mammals	British Columbia	Endangered	Schedule 1	Endangered
Vancouver Lamprey	Entosphenus macrostomus		Fishes	British Columbia	Threatened	Schedule 1	Threatened
Vesper Sparrow affinis subspecies	Poocetes gramineus affinis		Birds	British Columbia	Endangered	Schedule 1	Endangered
Victoria's Owl-clover	Castilleja victoriae		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Wallis' Dark Saltflat Tiger Beetle	Cicindela parowana wallisi		Arthropods	British Columbia	Endangered	Schedule 1	Endangered
Warty Jumping-slug	Hemphillia glandulosa		Molluscs	British Columbia	Special Concern	Schedule 1	Special Concern
Water-plantain Buttercup	Ranunculus alismifolius		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
Western Brook Lamprey	Lampetra richardsoni	Morrison Creek population	Fishes	British Columbia	Endangered	Schedule 1	Endangered
Western Grebe	Aechmophorus occidentalis		Birds	British Columbia, Alberta, Saskatchewan, Manitoba	Special Concern	Schedule 1	Special Concern

Western Harvest Mouse megalotis subspecies	Reithrodontomys megalotis megalotis		Mammals	British Columbia	Special Concern	Schedule 1	Special Concern
Western Painted Turtle	Chrysemys picta bellii	Pacific Coast population	Reptiles	British Columbia	Threatened	Schedule 1	Endangered
Western Painted Turtle	Chrysemys picta bellii	Intermountain - Rocky Mountain population	Reptiles	British Columbia	Special Concern	Schedule 1	Special Concern
Western Rattlesnake	Crotalus oreganus		Reptiles	British Columbia	Threatened	Schedule 1	Threatened
Western Screech-owl kennicottii subspecies	Megascops kennicottii kennicottii		Birds	British Columbia	Threatened	Schedule 1	Threatened
Western Screech-owl macfarlanei subspecies	Megascops kennicottii macfarlanei		Birds	British Columbia	Threatened	Schedule 1	Threatened
Western Skink	Plestiodon skiltonianus		Reptiles	British Columbia	Special Concern	Schedule 1	Special Concern
Western Toad	Anaxyrus boreas		Amphibians	Yukon, Northwest Territories, British Columbia, Alberta	Non-active	Schedule 1	Special Concern
Western Yellow-bellied Racer	Coluber constrictor mormon		Reptiles	British Columbia	Threatened	Schedule 1	Special Concern
Westslope Cutthroat Trout	Oncorhynchus clarkii lewisi	Pacific populations	Fishes	British Columbia	Special Concern	Schedule 1	Special Concern
White Meconella	Meconella oregana		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered
White Sturgeon	Acipenser transmontanus	Kootenay River population	Fishes	British Columbia	Non-active	Schedule 1	Endangered
White Sturgeon	Acipenser transmontanus	Nechako River population	Fishes	British Columbia	Non-active	Schedule 1	Endangered
White Sturgeon	Acipenser transmontanus	Upper Columbia River population	Fishes	British Columbia	Non-active	Schedule 1	Endangered
White Sturgeon	Acipenser transmontanus	Upper Fraser River population	Fishes	British Columbia	Non-active	Schedule 1	Endangered
White-headed Woodpecker	Picoides albolarvatus		Birds	British Columbia	Endangered	Schedule 1	Endangered
White-top Aster	Sericocarpus rigidus		Vascular Plants	British Columbia	Special Concern	Schedule 1	Special Concern
Whitebark Pine	Pinus albicaulis		Vascular Plants	British Columbia, Alberta	Endangered	Schedule 1	Endangered
Williamson's Sapsucker	Sphyrapicus thyroideus		Birds	British Columbia	Endangered	Schedule 1	Endangered
Wood Bison	Bison bison athabasca		Mammals	Yukon, Northwest Territories, British Columbia, Alberta, Manitoba	Special Concern	Schedule 1	Threatened
Woodland caribou	Rangifer tarandus caribou	Northern Mountain population	Mammals	Yukon, Northwest Territories, British Columbia	Non-active	Schedule 1	Special Concern
Woodland caribou	Rangifer tarandus caribou	Southern Mountain population	Mammals	British Columbia	Non-active	Schedule 1	Threatened
Yellow Montane Violet praemorsa subspecies	Viola praemorsa ssp. praemorsa		Vascular Plants	British Columbia	Endangered	Schedule 1	Endangered

Yellow Rail	Coturnicops noveboracensis		Birds	Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick	Special Concern	Schedule 1	Special Concern
Yellow-breasted Chat auricollis subspecies	Icteria virens auricollis	Southern Mountain population	Birds	British Columbia	Endangered	Schedule 1	Endangered

Date modified: 2018-01-03

Appendix 7

Species Recovery Planning KNP

Species	Scientific Name	SARA STATUS	COSEWIC STATUS	1. Is the species regularly occurring at the site?	2. Is intervention required in order for the species' current population to remain stable and at expected population and distribution levels?	3. Can KNP management actions contribute to conservation of the species at the site?	4. Can KNP management actions contribute significantly to the species' national recovery beyond our boundaries?
Grizzly Bear, Western Population	<i>Ursus arctos</i>	No Status	Special Concern	YES	YES	YES	NO
Limber Pine	<i>Pinus flexilis</i>	No Status	Endangered	YES	YES	YES	NO
Rocky Mountain Bighorn Sheep	<i>Ovis canadensis</i>	No Status	No Status	YES	YES	YES	NO
Westslope Cutthroat Trout, BC population	<i>Oncorhynchus clarkii lewisi</i>	Special Concern	Special Concern	YES	YES	YES	NO
Whitebark Pine	<i>Pinus albicaulis</i>	Endangered	Endangered	YES	YES	YES	NO
Wolverine	<i>Gulo gulo</i>	No Status	Special Concern	YES	YES	YES	NO
American badger, jeffersonii	<i>Taxidea taxus jeffersonii</i>	Endangered	Endangered	YES	YES	YES	NO
Bank Swallow	<i>Riparia riparia</i>	No Status	Threatened	YES	YES	NO	NO
Barn Swallow	<i>Hirundo rustica</i>	No Status	Threatened	YES	YES	NO	NO
Black Swift	<i>Cypseloides niger</i>	No Status	Endangered	YES	Unknown	NO	NO
Common Nighthawk	<i>Chordeiles minor</i>	Threatened	Threatened	YES	YES	NO	NO
Little Brown Myotis	<i>Myotis lucifugus</i>	Endangered	Endangered	YES	YES	NO	NO
Olive-sided Flycatcher	<i>Contopus cooperi</i>	Threatened	Threatened	YES	YES	NO	NO
Northern Rubber Boa	<i>Charina bottae</i>	Special Concern	Special Concern	YES	Unknown	NO	NO
Western Toad	<i>Anaxyrus boreas</i>	Special Concern	Special Concern	YES	YES	NO	NO

Non-Regularly Occurring SAR			
Peregrine Falcon (anatum/Tun...)	<i>Falco peregrinus anatum/tundrius</i>	Special Concern	Special Concern
Short-eared Owl	<i>Asio flammeus</i>	Special Concern	Special Concern
Rusty Blackbird	<i>Euphagus carolinus</i>	Special Concern	Special Concern
Flammulated Owl	<i>Otus flammeolus</i>	Special Concern	Special Concern
Southern Maidenhair Fern	<i>Adiantum capillus-veneris</i>	Endangered	Endangered

Appendix 8

Rationale for Self-Assessment and Pathway of Effects



Memorandum

Date: December 21, 2017

Project #: 16022 – Barr
Engineering

To: Evan Bridson-Pateman and Paul Fraser, Barr Engineering
From: Rick Palmer and Irene Mencke, Palmer Environmental Consulting Group Inc.
cc:
Re: Sinclair Creek Culvert Replacement on Highway 93S, Kootenay National Park
Rationale for self-assessment under the *Fisheries Act*

1. Introduction

The Sinclair Creek culvert is located at kilometre (km) 100.6 on Highway 93 South (93S) at the overflow parking lot of Radium Hot Springs, in Kootenay National Park, British Columbia (BC). As part of Parks Canada's highway improvement works, replacement of the existing culvert is proposed. The existing culvert is a 180 m long corrugated steel plate arch section of 3.5 m span and 2.3 m rise. The culvert conveys Sinclair Creek underneath the Radium Hot Springs overflow parking lot (the new location of the South Park Gates) and is parallel with Highway 93S at km 100.6. The culvert was installed in the 1962 and was not designed as a fish bearing culvert. The new culvert is designed to allow fish passage for brook trout (*Salvelinus fontinalis*), which are known to reside within this reach of Sinclair Creek (AECOM, 2017). The proposed plan for construction will involve the replacement of the existing culvert with a concrete boxed culvert in a kinked alignment partly offset from the existing alignment. A fish habitat assessment of the project site was conducted by Palmer Environmental Consulting Group Inc. (PECG) on September 21, 2017. This memorandum presents our field findings, results from desktop investigations on fish presence, and our understanding of the proposed works and their potential to interact with fish and fish habitat. Finally, we present our rationale for why this project can be self-assessed under the *Fisheries Act*, i.e. why the project is not expected to result in serious harm to a commercial, recreational, or Aboriginal (CRA) fishery, as defined by the *Fisheries Act*.

2. Potential Fish Species

Sinclair Creek is a 4th order stream that flows west and connects with the Columbia River near the town of Radium Hot Springs, approximately 6 km downstream of the project site. A search of the BC Fisheries



Information Summary System (BC FISS; BC MoE 2017a) and Habitat Wizard (BC MoE 2017b) databases (maintained by BC Ministry of Environment; BC MoE) was conducted to identify fish species potentially present in Sinclair Creek near the project site. The search found that the following fish species are documented in Sinclair Creek: Bull trout (*Salvelinus confluentus*), brook trout (*Salvelinus fontinalis*), Kokanee salmon (*Oncorhynchus nerka*), mountain whitefish (*Prosopium williamsoni*), slimy sculpin (*Cottus cognatus*), and prickly sculpin (*Cottus asper*). The recorded locations for those occurrences are several kilometres downstream of the project site, where Sinclair Creek flows through the town of Radium Hot Springs (surveys conducted by Naito Environmental, September 2011). Parks Canada Agency (PCA) confirmed that brook trout are the only species present in Sinclair Creek within the 6-km reach (approximately) where the culvert ('project site') is located (Shelley Humphries, PCA, personal communication, December 19, 2017). The downstream reach break is a waterfall located approximately 2 km downstream of the project site (approximately km 102.3) in the canyon near the Kootenay Park Boundary (Shelley Humphries, PCA, personal communication, December 19, 2017). The upstream limit of brook trout distribution in Sinclair Creek (*i.e.* the upstream reach break) is a second waterfall located approximately 4 km upstream of the project site (approximately km 96.4), 500 m below the Kimpton Creek confluence (Shelley Humphries, PCA, personal communication, December 19, 2017). This information was provided by PCA Aquatic Specialist Shelley Humphries from the Lake Louise Yoho Kootenay (LLYK) Field Unit, and is based on fish sampling conducted by PCA during the last decade.

Westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) occur within the Columbia River drainage (DFO 2017), but have not been recorded in Sinclair Creek. The closest record is at Forster Creek (BC MoE 2017b) which is another tributary of the Columbia River just upstream of Sinclair Creek. BC populations of Westslope cutthroat trout are listed as Special Concern under Schedule 1 of the Species at Risk Act (SARA). The Management Plan for the Westslope cutthroat trout, BC Population (DFO 2017), identifies Westslope cutthroat trout in the Columbia River (Columbia River mainstem from headwaters to border including Pend d'Oreille) as a peripheral range population group, meaning that this group comprises fairly disjunct, sparsely distributed populations considered more in the periphery of the native range. PCA confirmed that Westslope cutthroat trout are not present in Sinclair Creek within the reach where the project is located (*i.e.* above the downstream waterfall at km 102.3) (Shelley Humphries, PCA, personal communication, December 19, 2017).

3. Fish Habitat

A site visit to assess fish habitat was conducted on September 21, 2017 by PEGC. Sinclair Creek at the project site is dominated by fast flowing, boulder and cobble cascade habitat (Figure 1). The creek lacks deep pool habitat for approximately 100 m upstream and downstream of the culvert (excluding the outlet plunge pool), but contains some sheltered, slow-water areas along the stream margins. Average water depth at time of assessment was 30 cm, and average wetted width was 3.5 m. Stream gradient upstream of the culvert was 6%. Riparian vegetation at the site consisted primarily of mature mixed forest. The culvert outlet is perched approximately 150 cm at the outlet (Figure 2). A large plunge pool (approximately 8 m wide and 2 m deep) has formed at the culvert outlet. The culvert presents an impediment to upstream fish passage owing to its length, perch height, lack of substrate, and flow constriction (*i.e.* increased velocities).

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Figure 1: Looking upstream from culvert inlet at Sinclair Creek at the Highway 93S Radium Hot Springs overflow parking lot. Date taken: September 21, 2017.



Figure 2: Culvert outlet on Sinclair Creek at the Highway 93S Radium Hot Springs overflow parking lot. Date taken: September 21, 2017.



4. Proposed Works

The existing culvert is a corrugated structural plate pipe arch section of 3.5 m span and 2.3 m rise with a longitudinal slope of 4.13%. The culvert was installed in the early 1960s. The latest inspection reports identify damage including deformation, cracking, and corrosion of the culvert and damage to both inlet and outlet headwalls. Replacement is therefore recommended, and provides the opportunity to improve fish passage at the site by installing a fish-friendly culvert and removing the perch at the culvert outlet. The works are scheduled to occur between July and October 2018, with estimated duration of two months.

To understand the culvert design and proposed works to replace the culvert, the following documents were reviewed:

- Project drawings prepared by AECOM (Drawing Set No. 60547362 – XX);
- The project description (prepared by Barr Engineering);
- Preliminary design memorandum (AECOM, 2017).

The preliminary design proposes a new rectangular precast concrete box culvert with 3.5 m span and 2.9 m rise, about 170 m long. The culvert is designed for the 1:200 year flow of 14.0 m³/s. The culvert design was also based on fish passage requirements, specifically the maximum velocity and minimum flow depth at which fish (brook trout) could navigate through the culvert (AECOM, 2017). The proposed culvert also has a 4.13% longitudinal slope (same as existing), which would result in flow velocities that inhibit fish passage through the culvert. To address this, placement of concrete baffles within the culvert is proposed. The baffles create small pools for increasing depth during low flow conditions and reducing velocities during high flow conditions. The hydraulic drop at the culvert outlet is to be eliminated by providing tailwater control weirs and energy dissipation pool to increase flow depths in the culvert during periods of low fish passage flows (AECOM, 2017).

The new culvert alignment will partially overlap with the existing culvert alignment. As such, the existing culvert will need to be removed before the new culvert can be excavated and installed. A diversion system will be put in place to divert Sinclair Creek around the work area while the works (*i.e.* removal of the existing culvert and installation of the new culvert) are completed. The diversion system will be constructed in the dry, and will consist of two water diversion pipes. Once the diversion system is in place, and immediately preceding removal of the existing culvert, Sinclair Creek will be routed through the diversion pipes. A fish salvage will be carried out to collect fish that may be stranded when the existing culvert and areas around the inlet and outlet are dewatered. Removal of the existing culvert and head walls, and new culvert installation, will then be completed in the dry. Once the new culvert is in place, the flow will be directed through the new culvert.

5. Measures to avoid harm

Works will follow appropriate mitigation measures and best management practices to avoid or mitigate potential harm to fish and fish habitat, namely Fisheries and Oceans Canada Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2016a), and Parks Canada National Best Management Practices for Roadway, Highway, Parkway and Related Infrastructure (Parks Canada 2015). In-channel work will be completed in-the-dry through the implementation of a diversion system to safely by-pass streamflow around



the work area, which will be isolated between temporary coffer dams. A standard fish salvage/rescue and downstream release will be completed within the isolated work area. Work on or adjacent to the watercourse will be monitored by a Qualified Aquatic Environmental Specialist (QAES). The requirement and techniques for site isolation, fish salvaging, and erosion and sediment control will be confirmed with the QAES.

Key mitigation measures include:

- Implement Erosion and Sediment Control Plan for that site that minimizes the risk of sedimentation of the waterbody during all project phases
- Minimize clearing of riparian vegetation and avoid soil compaction around riparian vegetation.
- Immediately stabilize shoreline or banks disturbed by any activity associated with the project to prevent erosion and/or sedimentation, preferably through re-vegetation with native species suitable for the site.
- Screen any water intakes or outlet pipes, in accordance with DFO guidelines to prevent fish entrainment or impingement (DFO 1995)
- Schedule work during a low flow period, and avoid rainy periods that may increase erosion and sedimentation
- Develop a response plan that is to be implemented immediately in the event of a sediment release or spill of a deleterious substance and keep an emergency spill kit on site.
- Ensure that machinery arrives on site in a clean condition and is maintained free of fluid leaks, invasive species and noxious weeds
- Adhere to Parks Canada protocols to avoid spread of whirling disease, for equipment and personnel
- Operate machinery on land above the high-water mark, whenever possible, in a manner that minimizes disturbance to the banks and bed of the waterbody.
- Where possible, conduct instream works during BC timing windows to protect fish

Although the project site is in BC, the Alberta Eastern Slopes Zone 1 (ES1) restricted activity periods (RAPs) are considered more applicable by PCA for the project site, based on a decade of direct fish observations in Yoho and Kootenay National Parks (Shelley Humphries, PCA, personal communication, December 19, 2017). The ES1 RAP for brook trout is October 1 to April 15 (AEP, 2009). The project works are scheduled to occur between July and October 2018, and it is expected that instream work will occur outside of the RAP for brook trout.

6. Rationale for Self-Assessment

6.1 Legislative context

As the primary legislation for the protection of aquatic species, subsection 35(1) of the *Fisheries Act* prohibits any projects from causing serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery.

'Serious Harm' is defined as:

- the death of fish;



- a permanent alteration to fish habitat of a spatial scale, duration or intensity that limits or diminishes the ability of fish to use such habitats as spawning grounds, or as nursery, rearing, or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes;
- the destruction of fish habitat of a spatial scale, duration, or intensity that fish can no longer rely upon such habitats for use as spawning grounds, or as nursery, rearing, or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes.

The potential effects of a project on local fish or fish habitat can be determined either by the proponent in a self-assessment, or through a DFO regulatory review. Self-assessment is a decision tool to determine if a project needs DFO review. Certain activities, or projects taking place within specified waterbody types, are permitted without DFO review.

Where project activities do not meet the criteria as outlined by DFO, or serious harm cannot be completely avoided, or there is a risk of contravening the Species at Risk Act (SARA) prohibitions, then a Request for Review should be submitted to DFO.

6.2 Self-Assessment Rationale

To assess the potential for serious harm from the Sinclair Creek culvert replacement, the proposed works, (including construction methods, timing and duration of instream work) and mitigation measures were considered in the context of the habitat quality and potential fish species at the site. The project criteria were also screened against the list of projects and activities on DFO's "Projects Near Water" website (DFO 2016b) which do not require review. The project is not expected to result in serious harm to fish, as defined by the *Fisheries Act*, because:

- The proposed works will follow appropriate mitigation measures and best management practices, such that harm to fish and fish habitat will be avoided or mitigated;
- The new culvert is designed based on fish passage requirements, and will allow access for fish to upstream habitat, thereby potentially increasing the range and productivity of fish residing in Sinclair Creek downstream of the culvert;
- The new culvert design includes fish baffles, which reduce water velocities and increase depth through a culvert, and provide areas for fish to rest and seek refuge as they migrate through the culvert, thereby improving fish passage;
- An energy dissipation pool at the culvert outlet is designed to reduce erosion potential and improve fish passage into the culvert:
 - Rip-rap (for 1:200 year flood protection) will line the base of the pool and will extend up at a 2:1 slope from the bottom of the energy dissipation pool up to the invert elevation of the culvert, and downstream to the top of a weir at the pool outlet.
 - The top of the most downstream fish baffle in the culvert will be at the same elevation as the downstream control (*i.e.* weir) of the energy dissipation pool.
 - The culvert outlet perch will be eliminated;
- Permanent habitat alteration will be limited to rip rap placement at the culvert inlet and outlet (the existing inlet and outlet headwalls will be retained). The rip rap (class 2) will be keyed into the channel bed, and provides scour protection for 1:200 year flood. The rip rap placement for scour control will improve channel stability and help prevent formation of a perch at the culvert outlet.



7. Summary

Replacement of the Sinclair Creek culvert is not expected to result in serious harm to fish, as defined by *Fisheries Act*. Moreover, the culvert replacement is expected to improve fish habitat conditions by allowing fish passage and thereby providing fish with access to upstream habitat. This conclusion is based on a review of background information for the site, the purposed works and new culvert design, and field assessment of the fish habitat. This conclusion is contingent on implementation of appropriate avoidance and mitigation measures. Changes to the proposed culvert design or construction methods may also have a bearing on the information and conclusions presented herein.

8. References

- AECOM. 2017. Fish Passage Design for Sinclair Culvert at Parks Gate, Kootenay National Park, BC. Memorandum prepared for Parks Canada. December 7, 2017.
- Alberta Environment and Parks (AEP). 2009. Restricted Activity Periods (RAPs) for Fish Species in the 10 Fish Management Zones of Alberta. Available at: <http://aep.alberta.ca/fish-wildlife/fish-research-licence/documents/RestrictedPeriodsFishSpecies10FMZs-Jan2010.pdf> [Accessed December 2017]
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Pathway of Effects					
Waterbody	Pathway of Effects (Activity)	Stressor (Potential Impact)	Mitigation Measures	Residual Effects	Serious Harm
Sinclair Creek	Excavation	Bank stability and exposed soils; change in slope	<ul style="list-style-type: none">Implement Erosion and Sediment Control PlanStabilize shoreline and banks disturbed by worksSchedule work to avoid rainy periods that may increase erosion and sedimentationConstruction in-stream works during period of low flow and to respect fisheries timing windowsAppropriately-sized, naturally-occurring clean rock will be used for armouring, and will be installed at a similar slope to maintain a uniform bank/shoreline and natural shoreline alignment	None. No anticipated change in habitat structure and cover	No: any potential change in instream sediment concentration is expected to be of short duration (hours) and localized.
Sinclair Creek	Grading	Bank stability and exposed soils; change in slope	<ul style="list-style-type: none">Implement Erosion and Sediment Control PlanStabilize shoreline and banks disturbed by worksSchedule work to avoid rainy periods that may increase erosion and sedimentationConstruction in-stream works during period of low flow and to respect fisheries timing windowsAppropriately-sized, naturally-occurring clean rock will be used for armouring, and will be installed at a similar slope to maintain a uniform bank/shoreline and natural shoreline alignment	None. No anticipated change in habitat structure and cover	No: any potential change in instream sediment concentration is expected to be of short duration (hours) and localized.
Sinclair Creek	Use of industrial equipment	Increased erosion potential	<ul style="list-style-type: none">Implement Erosion and Sediment Control PlanIsolate work area (or work in the dry) and relocate fishStabilize shoreline and banks disturbed by worksWork outside of restricted activity periodAdherence to Parks Canada protocols to avoid spread of whirling disease, for equipment and personnel	None.	No: any potential change in instream sediment concentration is expected to be of short duration (hours) and localized.
Sinclair Creek	Use of industrial equipment	Oil, grease and fuel leaks from equipment	<ul style="list-style-type: none">Maintain machinery clean and free of leaksSpill kit and response plan on siteNo refueling or stockpiles of materials within 30m of watercourse	None.	No
Sinclair Creek	Vegetation Clearing	Bank stability and exposed soils	<ul style="list-style-type: none">Implement Erosion and Sediment Control PlanStabilize shoreline and banks disturbed by worksAppropriately-sized, naturally-occurring clean rock will be used for armouring, and will be installed at a similar slope to maintain a uniform bank/shoreline and natural shoreline alignment	None. No anticipated change in habitat structure and cover	No: any potential change in instream sediment concentration is expected to be of short duration (hours) and localized.
Sinclair Creek	Vegetation Clearing	Change in shade	<ul style="list-style-type: none">Clearing of riparian vegetation will be kept to a minimumCleared area will be re-vegetated with native species suitable for the site after works are completed	None. No anticipated change in habitat structure and cover	No
Sinclair Creek	Vegetation Clearing	Change in external nutrient/energy inputs	<ul style="list-style-type: none">Clearing of riparian vegetation will be kept to a minimumCleared area will be re-vegetated with native species suitable for the site after works is completedRiparian vegetation will not be removed if the riparian area is identified as part of critical habitat of an aquatic listed species at risk.	None.	No
Sinclair Creek	Structure Removal	Change in shoreline morphology	<ul style="list-style-type: none">Implement Erosion and Sediment Control PlanBanks will be immediately restored to their original contour and gradient, or to a gradient that does not increase erosion or sedimentation.Appropriately-sized, naturally-occurring clean rock will be used for armouring, and will be installed at a similar slope to maintain a uniform bank/shoreline and natural shoreline alignment	None. No anticipated change in habitat structure and cover	No

Sinclair Creek	Structure Removal	Resuspension and entrainment of sediment	<ul style="list-style-type: none">Isolate flow and work in the dry during in channel worksInstall effective erosion and sediment control measures before initiating work	None.	No: any potential change in instream sediment concentration is expected to be of short duration (hours) and localized.
Sinclair Creek	Fish Passage Issues	Change in access to habitat. (temporary diversion pipes will be put in places during works, to divert Sinclair Creek around the work area)	<ul style="list-style-type: none">If required, any water intakes or outlet pipes will be screened in accordance with DFO guidelines to prevent fish entrainment or impingement	None.	The replacement culvert will improve fish passage for brook trout and provide access to upstream habitat.

- Guidelines being used to avoid negative effects to fish and fish habitat include:
- Fisheries and Oceans Canada. 2016. *Measures to Avoid Causing Harm to Fish and Fish Habitat*,
 - Parks Canada. 2016. *Parks Canada National Best Management Practices for Roadway, Highway, Parkway and Related Infrastructure*

CONCLUSION

No serious harm to fish are anticipated from this Project after taking into account the avoidance and mitigation measures described above.