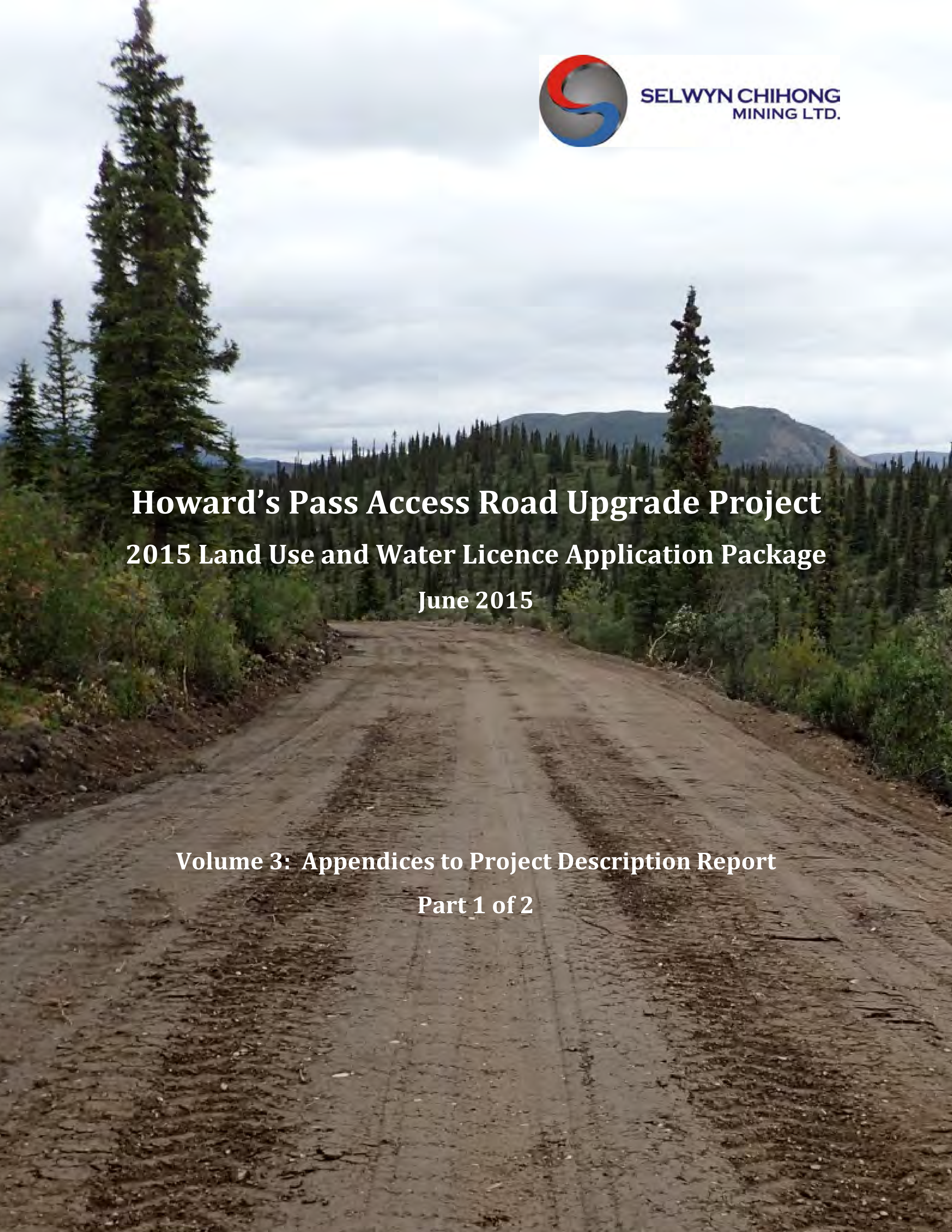

SELWYN CHIHONG MINING LTD.

Howard's Pass Access Road Upgrade Project

2015 Land Use and Water Licence Application Package

June 2015

Volume 3: Appendices to Project Description Report

Part 1 of 2

SELWYN CHIHONG MINING LTD.

Howard's Pass Access Road Upgrade Project

Project Description Report

June 2015

APPENDICES

APPENDIX I. APPLICABLE STANDARD OPERATING PROCEDURES

SCML, 2015. Standard Operating Procedure – Fuel Handling. April, 2015.

SCML, 2015. Standard Operating Procedure – Working In and Around Water. April, 2015.

SCML, 2015. Standard Operating Procedure – Work Site Cleanliness. April, 2015.

SCML, 2015. Standard Operating Procedure – Heritage Resources (Draft – Pending Management Approval). June, 2015.

Standard Operating Procedure
Fuel Handling

Prepared by	J. Chown (Snr.Env.Scient.)	Jillian Chown	April 7, 2015
Approved by	J. Hill (Mgr.Env.Affairs)		April 7, 2015
	J. O'Donnell (VP Exploration)		April 24, 2015
	J. Haggett (Don Camp Mgr)		April 22/15

Purpose:

This Standard Operating Procedure (SOP) applies to all staff and contractors who are responsible for fuel handling at SCML's operations. The purpose of this document is to bring together legislative requirements, industrial standards and best management practices as it relates to handling, storage and transportation of fuel.

This SOP is intended to help promote good fuel management, and is not intended to supersede legislative requirements or criteria. Applicable Legislation and Regulation includes; Transportation Dangerous Goods, WHMIS, the Yukon Quartz Mining Regulation, SCML's permits under the Regulation, Yukon Spills Regulation, and Northwest Territories Spill Contingency Planning and Reporting Regulation.

This document describes Standard Operating Procedures for transport, storage and dispensing of fuel from the following classifications of transportable containers:

- Small Fuel Containers <230 L Includes drums, pails and canisters typically used to transport, store and dispense small quantities of fuel, oil and solvent (Table 1)
- Small Mobile (Truck Box) Tanks 230L to 450L Ancillary tank located in the box of a pickup truck used to transport, store and dispense fuel (Table 2).

Management, cleanup and reporting of spills are covered under SCML's Spill Contingency Plan (EMP 1).

This document is posted in camp; additional copies are available from the manager in charge of camp operations. All staff and contractors should be familiar with this document and adhere to its contents.

TABLE #1 SMALL FUEL CONTAINERS (Volume < 230L) Drums, Jerry Cans, Pails, Canisters

TYPE	CONDITION, DESIGN & MAINTENANCE	STORING AND SECURING	DISPENSING	TRANSPORT	PREVENTION, RESPONSE & REPORTING
SMALL FUEL CONTAINERS (Volume < 230L)	☐ Must be filled and capped so that under normal conditions there will be no leakage that would endanger worker safety. ☐ Containers must be in good condition – not damaged, rusting, or leaking. **Construction Standard** ☐ Containers must be specifically designed for the product. **Inspections** ☐ Regularly inspect containers for leaks or maintenance issues.	☐ Store empty fuel drums upright (**do not** store them on their sides). ☐ Do not store small containers within 30 metres of the ordinary high water mark of any water body. ☐ Do not smoke where fuel is stored or dispensed. **Securing** ☐ Containers must be appropriately secured to prevent shifting, swaying, damage or escape from the vehicle. **Labelling** ☐ WHMIS labelling or appropriate <u>Product Identification</u> is required when storing hazardous products **Secondary Containment** Fuel caches of multiple containers with an aggregate capacity of >230 litres must utilize secondary containment.	☐ Maintain current MSDS in a location available to worker ☐ Do not dispense fuel within 30 metres of the ordinary high water mark of any water body. One exception is water pumps. Where water supply pumps are within 30m of a waterbody: •Maximum fuel storage at pump is 230 l (1 barrel) •All fuel stored, regardless of amount, must be within secondary containment •All refuelling and fuel transfer activities must be done within secondary containment •A #2 spill kit (per Spill Contingency Plan) must be kept near the pump at all times ☐ Dispense all flammable and combustible substances only from drums in an upright position ☐ Do not fill containers beyond their safe filling level *(approximate safe level – 90%).* ☐ Store the dispensing hose above the pump (and drum) to avoid siphoning.	☐ Drums must be properly arranged by stacking in an upright, vertical position, and separating and protecting through use of boards, stakes or sides on the vehicle to protect the load from moving. ☐ If multiple containers of Class 3 products are transported and the <u>combined capacity</u> exceeds 2000L, the following conditions apply: • A shipping document must be completed for the goods hauled • The operator must have TDG training and possess a certificate • The load must have placards on all visible sides **Labelling** ☐ Any container over 30 litres must have appropriate safety marks: • Label or Placard, • UN number & • Shipping Name ☐ TDG safety marks on the outside of an enclosed unit must be visible if containers are stored within	☐ Take reasonable measures to prevent leaks & spills. ☐ Spill control measures are required: • Spill Kit as per minimum requirements in SCML's Spill Contingency Plans. • Locate containers of fuel where potential spills cannot reach water bodies. ☐ Additional spill prevention and control measures may be required in higher risk areas for caches. **Fire Control and Response** ☐ Maintain one suitable BC-rated fire extinguisher. **Spill Response Plans** All staff and contractors must be familiar with SCML's Spill Contingency Plans – available from the camp manager and posted in the camp office. **Reporting** All spills must be recorded in the camp spill log. All spills >10 litres must be reported to the camp manager.

TABLE #2 SMALL MOBILE (TRUCK BOX) TANKS (Volumes: 230L – 450L)					
TYPE	**CONDITION, DESIGN, & MAINTENANCE**	**STORING AND SECURING**	**DISPENSING**	**TRANSPORT**	**PREVENTION, RESPONSE & REPORTING**
SMALL MOBILE (TRUCK BOX) TANKS (Volumes: 230L – 450L)	Must be filled and capped so that under normal conditions there will be no leakage that would endanger worker safety Containers must be in good condition – not damaged, rusting, or leaking **Construction Standard** **Diesel:** a spec or non-spec tank may be used. This tank capacity (<450L) is exempt under the TDG regulation **Gasoline:** a spec tank is required and must show the spec plate of the design standard Spec tanks may include: • CGSB 43.146 • UN31A **Inspections** Regularly inspect containers for leaks or maintenance issues.	Use a pressure relief cap that meets manufacturers design specifications Do not store small mobile tanks within 30 metres of the ordinary high water mark of any water body. Do not smoke where fuel is stored or dispensed **Securing** Containers must be appropriately secured to prevent shifting, swaying, damage or escape from the vehicle Tie down straps must have safe combined working load ratings *greater* than the secured load **Labelling** WHMIS labelling or appropriate Product Identification is required when storing hazardous products	**Operators must stay with the nozzle at all times while dispensing fuel.** Use dispensing pumps and hoses designed for the products being handled Hoses and nozzles must be maintained and not leak. Make sure there is suitable grounding to prevent static charges when dispensing gasoline. Maintain current MSDS in a location available to workers Do not dispense fuel within 30 metres of the ordinary high water mark of any water body. (Water supply pumps are a minor exception with requirements outlined in Table 1) Nozzles must be secured in drip containment after use or in an upright position so that it is above the tank Do not fill tanks beyond their safe filling level *(approximate safe level – 90%)*	If multiple tanks of Class 3 product (diesel) are carried on the vehicle and the combined capacity exceeds 2000 litres, the following conditions apply: • A shipping document must be completed for the goods hauled • The operator must have a TDG training and possess a valid certificate • The load must be placarded on all visible sides **Labelling** Maintain visible safety marks: • Label or placard, • UN number and • Shipping name TDG safety marks must be visible on the tank or any enclosed storage unit	Take reasonable measures to prevent leaks & spills Spill prevention and control measures are required: • Spill Kit as per minimum requirements in SCML's Spill Contingency Plans. • Locate small mobile tanks where potential spills cannot reach water bodies. Mobile tanks (>230L) stored on the ground and in higher risk areas may require collision protection. **Fire Control and Response** Maintain one suitable BC-rated fire extinguisher **Spill Response Plans** All staff and contractors must be familiar with SCML's Spill Contingency Plans – available from the camp manager and posted in the camp office. **Reporting** All spills must be recorded in the camp spill log. All spills >10 litres must be reported to the camp manager.

Standard Operating Procedure
Working in and Around Water

Prepared by	J. Chown (Snr.Env.Scient.)	Jillian Chown	April 7, 2015
Approved by	J. Hill (Mgr.Env.Affairs)		April 7, 2015
	J. O'Donnell (VP Exploration)		April 24, 2015
	J. Haggett (Don Camp Mgr)		April 22/15

Purpose:

This Standard Operating Procedure (SOP) applies to all SCML staff and contractors. Its purpose is to minimize the impacts to water bodies during project activities. Applicable Legislation and Regulation includes: Yukon Quartz Mining Act and Regulations; Yukon Waters Act; "Best Management Practices for Works Affecting Water in the Yukon" published by Water Resources Branch, Environment Yukon; Northwest Territories Waters Act and Regulations, Mackenzie Valley Land Use Regulations, and Canadian Fisheries Act.

Definitions:

Deleterious substance - is one that will harm fish or fish habitat; any substance when introduced into water could adversely affect the quality of the water (sediment, oil, gas, antifreeze, lubricants, etc.).

PPE - personal protective equipment

Waterbody - rivers, creeks, lakes, groundwater, swamps, bogs, wetlands, etc.

Application:

Item	Procedure
Waterbodies	✓ Avoid working in or around water bodies whenever possible. Try and plan projects so that they avoid work in or near water whenever possible.
Permission	✓ Ensure you have the proper regulatory authorizations to complete the work. Check with the on-site Environmental Compliance Coordinator and ensure that the work you are planning conforms to applicable guidelines, has been authorized by regulatory authorities, and that your environmental safeguards and monitoring protocols meet industry best practices

Clearing around water bodies	✓ Minimize the work-site footprint; only clear and excavate to the extent necessary. Ensure that all applicable safety protocols are being followed. Working in and around water can be dangerous and specific PPE may be required for the job. ✓ When clearing vegetation, only cut down to ground level, leaving rootstock in place. This will greatly reduce erosion and sedimentation and will promote more rapid re-vegetation.
Erosion and Sediment control	✓ Install silt fences where there is potential for disturbed sediments to be washed into receiving waters. ✓ Avoid scraping (blading) down to mineral soil ✓ Re-vegetate disturbed surfaces as soon as possible ✓ Use existing trails and roads as much as possible. ✓ Maximize retention of natural vegetation cover—it is the best and cheapest defense against erosion. ✓ Maintain vegetation buffers, particularly near water. ✓ Minimize the amount of mass grading and soil compaction at the site. ✓ Avoid working on unstable areas and steep slopes. ✓ Minimize water crossings. ✓ Sequence and schedule construction to take advantage of drier weather. ✓ Avoid disturbing permafrost and the overlying vegetation, otherwise it can cause melting and further instability and erosion. ✓ Stockpile mineral soil and organic soil separately; when spreading, spread mineral soil first and organics last. This will prevent erosion and encourage re-vegetation (surface stabilization).
Refueling equipment	✓ Equipment should be refueled and serviced >30m from a water body such that no deleterious substance enters any water body ✓ One exception is water pumps. Where water supply pumps are within 30m of a waterbody: • Maximum fuel storage at pump is 230 l (1 barrel) • All fuel stored, regardless of amount, must be within secondary containment • All refuelling and fuel transfer activities must be done within secondary containment • A #2 spill kit (per Spill Contingency Plan) must be kept near the pump at all times

Depositing material into water course	✓ Do not deposit any deleterious substances in the watercourse. This includes but is not limited to sediment, fuels, lubricants, hydraulics, and coolants. ✓ The only fill material that should ever be placed in a water body, such as for riprap, is coarse gravel and non-acid generating rock. It must be clean and free of fines. Often, this means washing rock away from creeks prior to placement. ✓ Never pump construction water directly into a natural water body. Normally, it is pumped to a vegetated depression, sump or sediment trap to remove sediment and avoid erosion of the natural water body.
In-stream works	✓ Equipment should be cleaned prior to working in or adjacent to water bodies. Particular attention should be placed on cleaning tracks and undercarriage of heavy equipment. ✓ Equipment should be inspected for leaks before working in or adjacent to waterbodies. Equipment with leaks must not work in or near water. ✓ If in-stream works are required, and permitted, do not work in stream areas with soft or silty bottoms. Select areas with larger cobble bottoms to minimize sediment disturbance.
Steam Crossings	✓ All stream crossing approaches should be made at right angles to the stream. This will minimize impacts to the riparian area and reduce the overall length of in-stream activity.
Record keeping	✓ Ensure that approved environmental safeguards are in place; spill kits and erosion control materials are available, crew has been properly briefed on environmental concerns, and a documentation protocol has been established to record the work (notes, photographs, checklists, worker confirmation documentation, etc., as appropriate).

All contractors are required under their contracts to comply with all legislation and follow SCML's environmental management plans and standard operating procedures. Compliance, health and safety, and environmental protection are the responsibilities of everyone on site.

SCML representatives will periodically monitor and audit all exploration activities to ensure compliance with all government regulations and ensure SOP procedures are followed.

Standard Operating Procedure
Worksite Cleanliness

Prepared by	J. Chown (Snr.Env.Scient.)	Jillian Chown	April 7, 2015
Approved by	J. Hill (Mgr.Env.Affairs)	J. Hill	April 7, 2015
	J. O'Donnell (VP Exploration)	[signature]	April 24, 2015
	J. Haggett (Don Camp Mgr)	[signature]	April 2015

Purpose:
This Standard Operating Procedure (SOP) applies to all SCML staff and contractors. Its purpose is to minimize the disruption of the local receiving environment at each worksite set-up and ensure there are safe working conditions.

Definitions:
Worksite - an area where an industry is located or where work takes place. It can include, but is not limited to, an office, a desk, a shop, a kitchen, camp site area, drill site, etc.

Application:

Items	Procedure
Scrap material and wrappings, loose parts, scattered tools and equipment, or oil spills can cause injury.	✓ Debris should be swept up and disposed of in designated areas. ✓ Parts should be kept on work benches. ✓ Tools should be placed where they cannot fall and cause damage or injury. ✓ Oil spills should be covered with absorbent material and cleaned up.
Floors and benches	✓ Clean to reduce fire and tripping hazards. Clean the area completely after a job is finished. ✓ Empty trash containers regularly. ✓ Eliminate clutter which is a common cause of accidents, such as slips, trips, and falls, and fires and explosions. ✓ Keep exits and entrances clear. ✓ Keep floors clean, dry and in good condition. ✓ Keep aisles, alleys, paths, roads and parking areas clear.

	✓ Stack and store items safety. ✓ Vacuum or wet sweep dusty areas frequently. ✓ Store all work materials (for example, paper products, flammable liquids, etc.) in approved, clearly labeled containers in designated storage areas only. ✓ Use proper waste containers that are suitable to the environment (bear proof, water proof, etc.)
Sprinklers and fire alarms	✓ Keep sprinklers, fire alarms and fire extinguishers clear.
Spills and Leaks	✓ Clean up spills and leaks of any type quickly and properly following the Spill Contingency Plan.
Tools and Equipment	✓ Clean and store tools, items and equipment properly.
	✓ Fix or report broken or damaged tools, equipment, etc.
	✓ Keep lighting sources clean and clear.
	✓ Follow maintenance requirements.

All contractors are required under their contracts to comply with all legislation and follow SCML's environmental management plans and standard operating procedures. Compliance, health and safety, and environmental protection are the responsibilities of everyone on site.

SCML representatives will periodically monitor and audit all exploration activities to ensure compliance with all government regulations and ensure SOP procedures are followed.

Standard Operating Procedure
Heritage Resources

Prepared by	J. Chown (Snr.Env.Scient.)		
Approved by	J. Hill (Mgr.Env.Affairs)		
	J. O'Donnell (VP Exploration)		
	J. Haggett (Don Camp Mgr)		

Purpose:
This Standard Operating Procedure (SOP) applies to all SCML staff and contractors. Its purpose is to minimize the impacts to heritage resources in areas where SCML operates, which includes sites in Yukon and Northwest Territories that are within the traditional territories of the Dehcho and Kaska Dena First Nations, within the settlement area of the Sahtu First Nation, and within the Nahanni and Nááts'ihch'oh National Park Reserves. This SOP describes procedures to maintain compliance with legislation and conformity with community objectives regarding historical resource preservation.

Regulatory Context by Operational Area:
Yukon – SCML mineral claims and leases. Within Yukon, applicable legislation and regulation includes the *Historic Resources Act* and *Quartz Mining Act,* and associated regulations. The Yukon Mineral Exploration Best Management Practices for Heritage Resources was used in the development of this SOP.

Northwest Territories – SCML mineral claims and leases and Howard's Pass Access Road (HPAR) Km 60 to km 79. In Northwest Territories, archaeological sites are protected by the *Archaeological Sites Regulations* pursuant to the *Archaeological Sites Act*. Heritage resources are also protected by the *Mackenzie Valley Land Use Regulations*. This operational area is in the Sahtu Settlement Area, and provisions of the Sahtu Land Use Plan apply here including Conformity Requirements for protection of archaeological and burial sites.

Northwest Territories - HPAR km 14 to km 60.
This operational area is within the Nahanni and Nááts'ihch'oh National Park Reserves (Kms 14-36 and 36-60 respectively). Archaeological resources in these areas are protected under the federal jurisdiction of the *Canada National Parks Act and Regulations*.

Northwest Territories - HPAR km 0 to km 14. In Northwest Territories, archaeological sites are protected by the *Archaeological Sites Regulations* pursuant to the *Archaeological Sites Act*.

Heritage resources are also protected by the *Mackenzie Valley Land Use Regulations*. This operational area is in the traditional territory of the Dehcho First Nations. Dehcho Final Draft Land Use Plan applies here (although not yet legally in force) and includes provision for the protection of significant traditional land use and occupancy sites.

Definitions:

Historic resources as defined in legislation include historical, archaeological and palaeontological sites and resources. Historic resources are abandoned sites, archaeological artifacts and objects of greater than 50 years in antiquity. Cabins, caches, graves, bush camps, and other man-made structures, features or objects are the most readily recognized historic resources. Historic human remains and burial sites are also protected.

Archaeological sites and resources may be historic (more than 50 years old) or may date to before European contact. Prehistoric archaeological resources may be found on or under the ground surface, and generally consist of the remains of ancient camps, hearths, stone tools, and stone, bone and shell debris.

Palaeontological objects are the fossil remains of ancient plants and animals.

Existing Resources:

Within the vicinity of the Selwyn Project site in Yukon, ground surveys in 2014 identified pre-contact lithic scatter sites (stone chip debris from tool making) and a potential hearth site on many of the esker formations through the Don Creek valley. This indicates that historically people traveled through the valley, likely hunting and camping along the way. Not all sites have been found, so these are the types of artifacts to watch for during clearing. Artifacts from these sites cannot be removed or kept. If heritage resources are found, Yukon Government authorities indicated below will be notified and the sites archived and managed in consultation with the Ross River Dene Council and Liard First Nation.

In Northwest Territories, a heritage overview desktop study and helicopter reconnaissance flight was conducted in 2014 over the HPAR corridor area. The majority of the road footprint is considered to have low pre-contact heritage potential, however a ground-based Heritage Resource Impact Assessment will be performed in 2015 so that any potential impacts to heritage resources that may result from the proposed road upgrade activities can be identified and managed. This SOP will be revised following this assessment and prior to commencement of road widening.

No known sites are registered with the Prince of Wales Northern Heritage Centre within the HPAR footprint area. However, evidence of historic activities in the HPAR footprint area may be in the form of brush structures, drying racks, tent remains, and trapping equipment. There may also be remains from small-scale mining and prospecting activities.

Application:

Item	Procedure
Brushing/Clearing and Line Cutting Brushing or clearing of cut lines, helicopter pads or clearings may impact surface or built heritage sites such as bush camps, traps, or burial sites, or other traces of historic human presence such as snares or marked trees	**Before any exploration or road works begin SCML will:** ✓ Obtain information on location of heritage sites (historical, archaeological and palaeontological) and burial sites in the project area from Government of Yukon, NWT and First Nations if project is on settlement lands. Known or suspected heritage sites will be cordoned off with flagging providing a minimum 30 m buffer area. Buffer areas in the Sahtu Settlement Area will be established as described below. ✓ Assure that brushing, clearing, or use of equipment or vehicles does not occur in any areas cordoned off with flagging. ✓ Assure that land use activities will not take place within 500 m of known or suspected* burial sites, or within 150 m of known or suspected archaeological sites within the Sahtu Settlement Area (Km 36-79). If there is a high risk of impact to a known or suspected archaeological site, an archeological impact assessment will be conducted prior to commencement of activity. Mitigation measures will be developed in conformity with the Sahtu Land Use Plan (Conformity Requirement # 4). ✓ Inform crews on laws protecting heritage resources and of resources available to assist in identifying heritage features and sites on the land. The Yukon Government *"Handbook for the Identification of Heritage Sites and Features"* will be available for review at the main project administration offices. ✓ Remind crews regularly that no disturbance is permitted of heritage sites and objects may not be removed from heritage sites
Road and Access Development/Upgrading Development of trails, access road, access upgrading are activities which substantially impact both above ground and buried archaeological and palaeontological) heritage resources	
Trenching and Drilling Trenching activities substantially impact the ground surface. These activities are most likely to impact buried archaeological sites and palaeontological sites.	

Camps and Infrastructure Mineral Exploration camps and other infrastructure will likely result in subsurface ground disturbance.	
If a historic or archaeological site or resource is discovered:	✓ **Work at this location will be halted and the site marked or flagged and buffered from any further disturbance by at least 30 m. Artifacts will not be collected or disturbed.** ✓ Report find to SCML Site Manager and Environmental Department. ✓ Prepare a brief report including: -Date and GPS location: latitude/longitude or UTM coordinates and NAD (27 or 83). -Estimate of site or feature extent (area) -Brief description of setting and access to assist others in locating the site. -Brief description of site features (e.g., cabin with collapsed cache and scatter of household goods). -Photographs. -Site Manager to report find and coordinate follow up with appropriate authorities (contact information below) and the Environmental Affairs manager.
Yukon heritage sites and features are reported to:	✓ Heritage Resources - Department of Tourism and Culture Government of Yukon Box 2703, Whitehorse, Yukon Y1A 2C6 Phone: (867) 667-5983 or toll-free 1-800-661-0408 Email: ruth.gotthardt@gov.yk.ca ✓ Chief of Mining Land Use Government of Yukon Box 2703 (K-9) Whitehorse, Yukon Y1A 2C6 Phone: (867) 456-3822 Fax: (867) 456-3899 ✓ Ross River Dene Council 867-969-2277 and Liard First Nation 867-536-2393

Northwest Territories heritage sites and features are reported to:	✓ Department of Education, Culture and Employment Culture and Heritage Division Territorial Archaeologist (867) 873-7688 Assessment Archaeologist (867) 920-6182 ✓ Prince of Wales Northern Heritage Resource Center Yellowknife, NT X1A 2L9 Phone: (867) 873-7258 Fax: (867) 873-0205 Email: archaeology@gov.nt.ca ✓ Mackenzie Valley Land and Water Board 7th Floor – 4922 48th Street Yellowknife, NT X1A 2P6 Phone: (867) 669-0506 Fax: (867) 873-6610 ✓ Parks Canada (for areas within Nahanni and Nááts'ihch'oh National Park Reserves 10002 100 Street PO Box 348 Fort Simpson, NT X0E 0N0 Phone: (867) 695-7750 Fax: (867) 695-2446 Email: nahanni.info.@pc,gc,ca

* The Sahtu Land Use Plan defines *known or suspected sites* as archaeological sites registered in the NWT Archaeological Sites Database, or identified by the Prince of Wales Northern Heritage Centre during project review, or identified by community members during public engagement and through traditional knowledge

All contractors are required under their contracts to comply with all legislation and follow SCML's environmental management plans and standard operating procedures. Compliance and protection of heritage resources are the responsibilities of everyone on site.

SCML representatives will periodically monitor and audit all exploration and road activities to ensure compliance with all government regulations and ensure SOP procedures are followed.

APPENDIX II. WASTE MANAGEMENT PLAN FOR THE HOWARD'S PASS ACCESS ROAD

SCML (2015). Waste Management Plan for the Howard's Pass Access Road. Revision date June 15, 2015. Selwyn Chihong Mining Ltd., Vancouver, BC.

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SELWYN CHIHONG MINING LTD.

WASTE MANAGEMENT PLAN
for the
HOWARD'S PASS ACCESS ROAD

Revision Date: June 15, 2015

SELWYN CHIHONG MINING LTD.

Waste Management Plan

For

Howard's Pass Access Road

Reviewed by:

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Doug Reeve, Manager, Permitting and Regulatory Affairs
Selwyn Chihong Mining Ltd.

Reviewed by:

____

Maurice Albert, VP External Affairs
Selwyn Chihong Mining Ltd.

Approved by:

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Richard (Shilin) Li, President & CEO
Selwyn Chihong Mining Ltd.

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Tables

1.0 INTRODUCTION

1.1 Company and Site Information

Selwyn Chihong Mining Ltd (SCML) is a Vancouver-based base metals exploration and development company with mining claims and leases that straddle the Yukon (YT) and Northwest Territories (NWT) border in the Howard's Pass area. SCML is currently conducting pre-feasibility studies for a proposed zinc-lead mine on the Yukon side of Howard's Pass, referred to as the Selwyn Project.

The Selwyn Project is located 350 km northeast of Whitehorse and 260 km north of Watson Lake. Other communities close to the Project are Ross River, YT (180 km east), and Tungsten, NWT (75 km southeast). Access to the Project is by aircraft (via Don and XY airstrips), or by ground on the Howard's Pass Access Road (HPAR).

The HPAR is currently a single-lane, gravel surfaced, all-season access road, approximately 4 metres wide, and which crosses 32 streams. The HPAR will be upgraded to a two lane, 8.5 m wide, year-round road that will be suitable for commercial use in support of mine operations at Howard's Pass, including the bulk haul of mine concentrates.

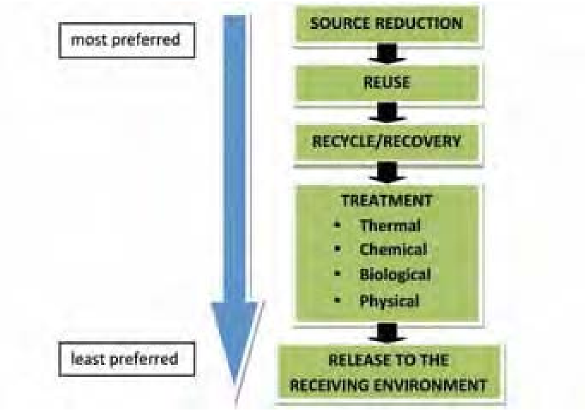
1.2 Effective Date of the Plan

This WMP will be effective upon the initiation of project activities related to the HPAR upgrade project.

1.3 SCML Environmental Policy

SCML is committed to the responsible exploration and development of mineral resources, which includes:

- Seeking to minimize the impact of operations on the environment through all stages of exploration and development;
- Seeking to prevent accidental release of pollutants into the environment; and,
- Practicing continuous improvement through the application of new technology, innovation and reasonable best practices in all facets of our operation.



In the context of waste management, SCML is committed to adhering to the *Waste Management Hierarchy* to the greatest degree practicable. This means that source reduction is the most preferable method of managing wastes, followed by reuse, recycling/recovery, treatment, with the least preferable method being disposal. The Waste

Management Hierarchy is embodied in the guiding principles of the MVLWB's 'Water and Effluent Management Policy', as well as the Canadian Council of Ministers of the Environment's environmental non-degradation policy.

1.4 Purpose, Approach, and Scope of Plan

The overall purpose of the WMP is to provide a formal framework for waste management during the HPAR Road Upgrade Project. Adherence to the WMP will ensure that there will be minimal or no effect from the waste on the project personnel, local communities and the surrounding environment, and that applicable regulations are followed.

The estimated waste types and quantities presented in this WMP reflect SCML's best estimates at this time. SCML recognizes that waste types and quantities may vary as the project progresses and that this may necessitate modifications to how these wastes are managed. In all cases SCML is committed to ensuring that waste management activities are based on following the 'Waste Management Hierarchy' and are in compliance with all applicable legislation.

The upgrading of the HPAR will be supported by between two and three construction camps over the period from 2016 to 2018, and this WMP addresses waste management activities for these camps. There are several key considerations that have guided the preparation of this WMP:

- The operation of the construction camps will be contracted out, and as such the contractor will need to be allowed some flexibility in determining the approach to waste management. As such the WMP will identify permissible options where appropriate. Adherence to the WMP will be a contractual requirement for contractors operating the camps and undertaking waste management activities.

- The HPAR upgrades will occur over a relatively short duration (e.g. 3 years), and the construction camps will be decommissioned and removed following construction. Accordingly SCML's approach will be to ensure that waste materials are properly handled and stored at the construction camps, and subsequently removed to existing permitted, off-site recycling, treatment and/or disposal facilities. There will be no permanent waste disposal facilities that will remain along the HPAR that are associated with the upgrade project.

Waste generated during HPAR operations (mine resupply and hauling of concentrate) would be the result of accidental discharges from vehicles (i.e. soil or water contaminated from spills of fuels or lubricants from haulage vehicles, or spills from products being carried, etc.), or temporary activities related to road maintenance activities (i.e. ditch clearing, road grading, etc.). The activities required to minimize impacts from HPAR operational use are dealt with in Appendix III to the PDR entitled '*Spill Contingency Plan for the Northwest Territories'*, and in a *Road Operations Plan* that will be developed at for a future stage of this project.

This WMP is required under the *Mackenzie Valley Resource Management Act* and *Mackenzie Valley Land Use Regulations*. This plan is designed to be in compliance with the Act and Regulations, and follows MVLWB Guidelines (specifically, the WMP template provided in the Guidelines) for developing a Waste Management Plan. The WMP includes:

a) Identification of Waste Types. This will identify the waste types that will be generated, including:

- description of characteristics;
- description of the source of generation;
- estimation of the volume/mass to be produced; and,
- potential environmental effects.

b) Requirements for Waste Management. This will include:

- a description of the activities involved in the management (e.g., handling, storage, processing, collection, separation, transportation, treatment, disposal, etc.) from generation to disposal; and,

c) Infrastructure Required for Waste Management. This will include:

- a summary of the waste storage facilities that will be required at the construction camps, and the permitted off-site recycling/disposal facilities that will be required.

1.5 Description of Project

For the purposes of the HPAR upgrade work, two temporary trailer camps will be established with capacity for approximately 60 people each at HPAR Km 3 (2016 – 2018) and Km 63.5 (2016, 2017). For the 2018 construction season the km 63.5 camp as well as a second construction camp in the Yukon at Howard's Pass will be moved to ~ Km 37. Once road upgrades are complete, the trailer camps will be removed. As such, for the period between 2016 and 2017 there will be two camps in operation (at Km 3 and Km 63.5), and in 2018 there will be three camps in operation (one at Km 3 and two at Km 37). The HPAR routing and construction camp locations are shown in Figure 4.4-1, attached.

Work to upgrade the HPAR will include:

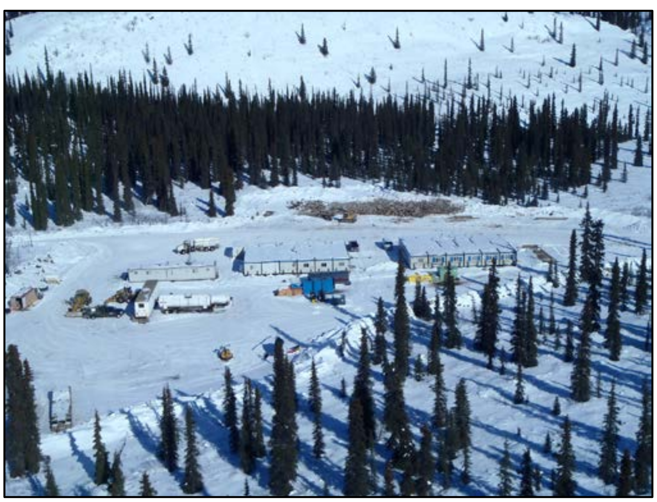
- clearing of vegetation within the road right-of-way to an average width of 25 m to accommodate the upgraded road;
- grubbing adjacent to the roadway to accommodate road widening;
- widening of the road surface to 8.5 m, plus widening at curves, pullouts and bridge approaches where required;

- road subgrade improvements in localized soft areas, including placement of geogrid, geotextile and granular fill;
- upgrading of drainage systems, including widening of existing ditches and installation/extension of culverts;
- localized changes to the road alignment and profile for road safety;
- application of gravel surfacing to the road as required; and.
- development and use of roadside borrow areas.

Waste management activities will be centered around the construction camps, where construction crews will be housed and construction equipment maintenance will primarily be carried out.

1.6 Location and Description of Construction Camps

In years 2016 and 2017, one construction camp will be located at Km 3 and one construction camp will be located at Km 63.5. In 2018, the construction camp at Km 3 will continue to be operational and 2 construction camps will be established at Km 37.



Temporary construction camp at HPAR km 3 in 2014

Each of the temporary construction camps will consist of prefabricated modular trailer units with capacity to accommodate up to 60 people. Facilities will include sleeping accommodations, kitchen, dining area, recreation space, office space, washrooms, showers and a camp dry. Other camp infrastructure to support personnel will include diesel/propane generators for power and infrastructure for heating, water supply, solid waste storage, and sewage containment and storage.

A plan showing a typical layout of a construction camp is attached. This layout will be adjusted to suit actual site conditions as required.

Waste management infrastructure is described further in Section 4 of this WMP.

1.7 Distribution and Adherence to Waste Management Plan

This plan will be distributed to all SCML staff (casual and permanent) as well as contractors, consultants and other service providers prior to undertaking work on the HPAR. Adherence to this plan is a requirement of employment with SCML and will be referenced in all contractor agreements. Staff and contractors will review this plan, and must acknowledge that they have read and understand the plan.

Contractors selected by SCML will be required to comply with the following:

- Contractors must follow company and government health and safety standards, and environmental protection policies and measures.
- All transportation equipment and storage of equipment must be maintained in good working order while on the project and will be subject to routine inspections to confirm that the appropriate standards are being maintained.
- All material on the site and material to be transported will be packaged, labeled and documented accordingly to WHIMS, MSDS and Transport Canada.
- Waste material will be transported to only an approved facility.

A copy of this plan must be kept in vehicles involved in upgrade works along the road, at temporary construction camps along the HPAR, at centers of operations for the Selwyn Project (Don and XY Camps), and at the SCML Corporate Office in Vancouver, B.C.

2.0 IDENTIFICATION OF WASTE TYPES

2.1 Definitions

The following terms are used throughout this document and are defined below:

- "Waste" means solid and special waste;
- "Solid waste" means refuse, ashes, garbage, domestic waste, compost or any other waste prescribed by regulation whether or not the waste has any commercial value or is capable of being used for a useful purpose;
- "Special waste" means a waste requiring special handling, storage, or destruction and prescribed as special waste by regulation whether or not the waste has any commercial value or is capable of being used for a useful purpose[1;]
- "Putrescible Waste" contains organic matter that is capable of being decomposed and may be capable of attracting or providing food for birds or animals;
- "Non-putrescible Waste" means any waste that contains no more than trivial amounts of putrescible materials or minor amounts of putrescible materials contained in such a way that they can be easily separated from the remainder of the load without causing contamination of the load. This category includes construction, demolition debris, and land clearing debris; but excludes clean-up materials contaminated by hazardous substances and source-separated recyclable materials whether or not sorted into individual material categories by the generator[2];
- "Greywater" means all liquid wastes from showers, baths, sinks, kitchens, and domestic washing facilities but does not include toilet wastes; and,
- "Blackwater" means all toilet wastes.

2.2 Waste Types, Quantities, and Characteristics

Tables 1 through 3 provide a summary of the Solid Wastes, Greywater and Blackwater, and Special Wastes anticipated to be generated during the HPAR upgrade work, respectively.

[1] *Yukon Environment Act* definitions (2002)
[2] http://www.oregon metre.gov/files/business/gb1_putrescilbewaste1.pdf

Table 1: Solid Wastes

Description	Main Source	Quantity	Potential Effects
Putrescible Waste	Kitchen	60 tonnes per camp per year (all solid wastes combined)[3]	• Can attract wildlife if stored improperly. • Potential to produce environmental pollutants such as salts, metals, and nutrients. • Can be degraded by micro-organisms. • May contain disease related organisms.
Solid Waste	Office, sleeper units		• Can attract wildlife if stored improperly. • Potential to produce environmental pollutants such as salts, metals, and nutrients.
Plastic Containers and Packaging	Office, sleeper units, kitchen, equipment maintenance, materials laydown areas.		• Minimal assuming containers/packaging used to store non-hazardous materials are recyclable.
Wood Waste	General camp construction, material laydown areas.		• Minimal • Potentially reusable
Scrap Metal	Equipment maintenance, materials laydown areas.		• Minimal • Recyclable
Cardboard	Equipment maintenance, materials laydown areas.		• Minimal • Recyclable
Incinerator Ash	Solid waste incinerator		• Environmental pollutant; incineration of solid waste concentrates metals, which are environmental pollutants.
Used Tires	Equipment maintenance		• Minimal • Relatively inert
Raw Wood	Clearing activities for road widening	not estimated	• Minimal

[3] Estimate based on average waste generation rates for other mining projects as a function of number of staff employed. Data from:

- Osisko Malartic Mine (1424 T generated in 2011 from work force of 752; source: http://www.osisko.com/sustainable-development/reporting);
- Agnico Eagle LaRonde and Goldex Mines (2,024 T and 813 T generated in 2011 from work force of 994 and 328 respectively; source: http://www.agnicoeagle.com/en/Sustainability).

These data suggest an average generation rate of about 2 T per person per year. Estimate that HPAR upgrade would generate approximately half of this amount given that construction activities (and thus camp operation) would occur 6 months per year.

Table 2: Greywater and Blackwater

Description	Source	Quantity	Potential Effects
Greywater	Kitchen drains, washbasins, showers	6,000 L/day per camp.[4]	• Potential environmental pollutant that may contain disease organisms harmful to humans or ecosystems.
Blackwater	Toilets	6,000 L/day per camp.[5]	• Odourous • Environmental pollutant that may contain disease related organisms.

Table 3: Special Wastes

Description	Source	Quantity	Potential Effects
Waste Oil and Hydraulic Fluid	• The primary sources of waste oil are from mobile equipment and generator maintenance. • The most common types of used oil are crank case oil, gear oil, transmission fluid, and hydraulic oil.	Approximately 21,000 L[6]	• Flammable • Toxic • Environmental pollutant, contains hydrocarbons. • Non-aqueous phase liquid
Waste Oil Filters	• From equipment and generator maintenance.	Approximately 420 [7]	• Flammable • Environmental pollutant, contains hydrocarbons.
Miscellaneous maintenance waste (grease tubes, oily rags, etc.)	From equipment and generator maintenance.	Not estimated	• Flammable • Environmental pollutant, contains hydrocarbons.

[4] Each camp personnel will require 200 L/day, and camps will each house 60 personnel. As such each camp will use 12,000L/d. Approximately 50% of this will be greywater, and 50% blackwater.

[5] Same as note 4.

[6] Calculated based on following: Number of pieces equipment = 73 (48 pcs heavy equipment, 25 trucks). Equipment in use for 2880 hours per year (2x8 hour shifts/day, 180 construction days/year). Service interval assumed to be every 500 hours, resulting in approx. 6 services per piece equipment per year, and total of 420 services. Assume 50 L waste oil and 1 waste oil filter generated per service = 21,000L waste oil and 240 waste oil filters generated per year.

[7] Per note 6.

Description	Source	Quantity	Potential Effects
Waste Fuel (contaminated, out of date)	From equipment and generator maintenance.		• Flammable • Toxic • Environmental pollutant • Non-aqueous phase liquid
Waste solvents	From equipment and generator maintenance.		• Flammable • Toxic • Environmental pollutant • May be carcinogenic • Can be a non-aqueous phase liquid, or could be soluble.
Waste glycol	From equipment and generator maintenance.		• Toxic • Environmental pollutant
Waste paints	General camp maintenance.		• Toxic • Environmental pollutant, may contain metals and solvents.
Waste fuel and chemical containers	From equipment and generator maintenance.		• May contain toxic residues • Residues are environmental pollutant, may contain metals and solvents.
Lead-Acid Batteries	From equipment and generator maintenance.		• Corrosive • Environmental pollutant, contains metals and acids.
Electronic Waste	Office, sleeper units		• Environmental pollutant containing heavy metals.
Hazardous Biological Waste (i.e. medical equipment, blood, tissue)	First aid station		• Biohazard
Contaminated soils and sorbents, etc.	Potential materials spilled that may include hydrocarbons (i.e., diesel, waste oil, and hydraulic oil), antifreeze, solvents, lubricants spill cleanup.		• Environmental pollutant
Dry-Cell Batteries	Offices, sleeper units		• Environmental pollutant
Fluorescent Lamps	Offices, sleeper units, kitchen		• Environmental pollutant

3.0 REQUIREMENTS FOR WASTE MANAGEMENT

3.1 Solid Waste Management Procedures

As noted above, the adherence to the Waste Management Hierarchy is an overarching principle in this WMP. This means that source reduction is the most preferable method of managing wastes, followed by reuse, recycling/recovery, treatment, with the least preferable method being disposal.

The following general procedures will be followed:

- Non- hazardous solid waste will be handled and disposed of in a manner that neither causes nor is likely to cause a threat to worker safety and health, an adverse environmental effect, or an attraction to wildlife. Waste management activities will be in compliance with all applicable regulations, licensing terms and conditions and Selwyn Chihong corporate policies.

- The HPAR upgrade project is a relatively short duration undertaking (3 years), and with few exceptions all waste will be removed from the camps to an existing permitted, off-site recycling, treatment and/or disposal facilities. There will be no permanent waste disposal facilities that will remain along the HPAR.

Table 4 provides specific procedures for the handling, storage, and disposal of non-hazardous solid wastes. The rationale for the waste handling, storage, recycling and disposal methods proposed is based on following all applicable regulations, maximizing worker health and safety, and adhering to the Waste Management Hierarchy to the greatest degree practicable.

Table 4: Handling, Storage and Disposal of Solid Waste

Type	Handling/Storage	Recycling/Disposal
Putrescible Waste	Putrescible waste from the kitchen facilities will be collected and placed into wildlife-proof containers, located behind the camp kitchen. All personnel are responsible to ensure that vehicles are kept clean of all waste, and particularly putrescible waste. Waste will not be stored for longer than 7 days at camp.	Incineration at camp or hauled off site to permitted landfill facility (to be determined- potentially Watson Lake or Fort Nelson).
Domestic Waste	Non-putrescible wastes from sleeper and office units will be collected from units daily and placed into wildlife-proof garbage bins adjacent to the camp. Waste will not be stored for longer than 7 days at camp.	
Plastic Containers and Packaging	Plastics waste will be kept in a weather-proof plastics storage bin at camp. Contractors will be requested to give preference to shipping products in bulk in order to reduce packaging volume.	Hauled to an approved recycling depot (to be determined- potentially Watson Lake).
Wood Waste	Wood waste will be kept at a waste storage area near the construction camp. Wood will be segregated as either non-treated or treated.	Non-treated wood waste will be piled and burned. Treated wood will be periodically hauled to a permitted disposal facility (to be determined- potentially Watson Lake or Fort Nelson).
Scrap Metal	Metal waste will be kept at a waste storage area near the construction camp Metal waste will sorted by metal type.	Hauled off site to permitted disposal or recycling facility (to be determined- potentially Watson Lake).
Cardboard	Cardboard waste will be kept in a weatherproof cardboard storage bin at camp. Contractors will be requested to give preference to shipping products in bulk in order to reduce packaging volumes.	Hauled to permitted recycling depot (to be determined- potentially Watson Lake).
Incinerator Ash	Ash waste will be kept at a weatherproof storage bin at the temporary incinerator (if applicable) at camp.	Hauled off site to permitted dump facility (to be determined- potentially Watson Lake).
Used Tires	Tires stored at tire stockpile area.	Tires to be reused as storage mats at lay-down areas if appropriate. Tires subsequently hauled off-site to disposal/recycling facility (to be determined: potentially Watson Lake or Fort Nelson).
Raw Wood	Stockpiled at clearing locations as appropriate.	Useable timber hauled off-site for salvage. Unusable brush and trees cut, bucked, and dispersed at roadside.

3.2 Management of Greywater and Blackwater

Table 5 provides procedures for management of greywater and blackwater. The handling, storage, and disposal methods proposed are based on accepted practices which follow applicable regulations and maximize worker health and safety.

Table 5: Handling, Storage and Disposal of Greywater and Blackwater

Type	Handling/Storage	Disposal
Greywater	Stored in dedicated greywater holding tank.	Holding tank decant discharged to in-ground sump located no closer than 30 m to any watercourse. Sludge in bottom of greywater tank transferred to blackwater holding tank and disposed with blackwater. Upon decommissioning of construction camp. sumps will be backfilled and sites restored.
Blackwater	Stored in dedicated blackwater holding tank.	Hauled to permitted sewage treatment/disposal station.

3.3 Management of Special Waste

Special Waste will be temporarily stored at the HPAR construction camps in a secure holding area in sealed, labelled drums. Special Wastes will be segregated and not mixed at any time during temporary storage in order to avoid potentially adverse chemical reactions, and to maximize potential for subsequent chemical recycling.

Personnel working with Special Wastes will follow Standard Operating Procedures (SOPs) with the correct Personal Protective Equipment (PPE) to ensure there is no exposure or risk to exposure. In addition, all personnel will be trained to react rapidly and effectively for any spills with the appropriate clean up equipment. Clean up equipment will inventoried and checked on a routine basis to ensure that it is available for at both temporary camp facilities and in vehicles transporting Special Waste.

All Special Wastes will be transported from the HPAR to an approved off-site disposal facility according to legislative requirements and permit conditions. Transport of Special Waste will have a Waste Permit Number that will be tracked by SCML through a Chain of Custody process that will require verification of arrival at way points and the final destination for disposal. All vehicles transporting special waste will be secured at all times to prevent access by unauthorized personnel.

Approved disposal facilities will be identified at the detailed planning stages and after a contractor has been selected to provide the infrastructure support necessary to complete the HPAR road widening project.

Table 6 summarizes the handling, transport and disposal of Special Wastes. The handling, storage, and disposal methods proposed are based on accepted practices which follow applicable regulations and maximize worker health and safety.

Table 6: Handling, Storage and Disposal of Special Waste

Type	Handling/Storage	Disposal
Waste Oil and Hydraulic Fluid	Stored in double-walled holding tank at the construction camps.	Waste oil will be hauled off-site for incineration or will be shipped to a permitted facility (e.g. to be determined- potentially Watson Lake) for disposal.
Waste Oil Filters	Stored in secure, weather-proof, leak-proof containers at construction camps. Waste oil filters will be drained to the greatest degree practicable before disposal. This will include puncturing the top of the filter, setting the filter in a tray and allowing the oil to drain for approximately 24 hours, and crushing the filter.	Waste oil filters will be hauled off-site for incineration or will be shipped to a permitted facility (e.g.to be determined- potentially Watson Lake) for disposal.
Miscellaneous maintenance waste (grease tubes, oily rags, etc.)	Stored in secure, weather-proof, leak-proof containers at construction camps.	Waste hydrocarbons (grease) will be hauled off-site for incineration or will be shipped to a permitted facility (e.g. to be determined- potentially in Watson Lake) for disposal.
Waste Fuel (contaminated, out of date)	Stored in secure, weather-proof, leak-proof containers at construction camps.	Waste fuel will be hauled off-site for incineration or will be shipped to a permitted facility (e.g to be determined- potentially in Watson Lake) for disposal.
Waste solvents	Stored in secure, weather-proof, leak-proof containers at construction camps.	Waste solvents will be hauled off-site for incineration or will be shipped to a permitted facility (e.g. to be determined- potentially in Watson Lake) for disposal.
Waste glycol	Stored in secure, weather-proof, leak-proof containers at construction camps.	Waste glycol will be hauled off-site for incineration or will be shipped to a permitted facility (e.g to be determined- potentially.in Watson Lake) for disposal.
Waste fuel and chemical containers	Stored in a secure, weather-proof holding container at construction camps.	Containers will be shipped off-site to a permitted facility (e.g. to be determined- potentially in Watson Lake) for disposal.
Lead-Acid Batteries	Stored in a secure, weather-proof holding container at construction camps.	Batteries will be shipped off-site to a permitted facility (e.g. to be determined- potentially in Watson Lake) for disposal.
Electronic Waste	Stored in a secure, weather-proof holding container at construction camps.	Electronic waste will be shipped off-site to a permitted facility (e.g. to be determined- potentially in Watson Lake) for disposal.
Hazardous Biological Waste (i.e. medical equipment, blood, tissue)	Stored in a secure, weather-proof holding container at construction camps. This Special Waste will be managed by an on-site health professional at all times.	Biological waste will be shipped off-site to a permitted facility (e.g. to be determined- potentially in Watson Lake) for disposal.
Contaminated soil and snow and water.	Hydrocarbon contaminated soil will be held in engineered temporary stockpiles that will be covered and monitored to ensure there is no down gradient movement of hydrocarbon. Hydrocarbon contaminated snow and water will be temporarily stored in a leak proof container at the construction camps. Glycol contaminated soil will be held in engineered temporary stockpiles that will be covered and monitored to ensure there is no down gradient movement of hydrocarbons.	Hydrocarbon contaminated soil or water will be removed to a permitted disposal facility (e.g. to be determined- potentially Watson Lake). Glycol contaminated soil will also be transported to an approved disposal facility.
Dry-Cell Batteries	Stored in a secure, weather-proof holding container at construction camps.	Batteries will be shipped off-site to a permitted facility (e.g. to be determined- potentially in Watson Lake) for disposal.
Fluorescent Lamps	Stored in a secure, weather-proof holding container at construction camps.	Lamps will be shipped off-site to a permitted facility (e.g. to be determined- potentially n Watson Lake) for disposal.

4.0 INFRASTRUCTURE REQUIRED FOR WASTE MANAGEMENT

The overall management of waste for the HPAR road widening project requires approved temporary storage and disposal at an approved facility. The HPAR project is of short duration over 1 pre-construction season and 2 construction seasons and the entire necessary infrastructure to manage the limited waste that will be produced is considered to be commercially available. It will be a standard requirement for all service suppliers such as heavy equipment operators, general machinery providers, and camp accommodation and support staff that the SCML Waste Management Plan be followed.

Specific details in terms of infrastructure will be provided at the detailed planning stage of this project. ***Table 7*** provides a summary of the temporary storage requirements prior to the final disposal of all wastes that will be developed through road construction and related activities. ***Table 8*** provides a summary of permitted disposal facilities for wastes removed from the construction camps.

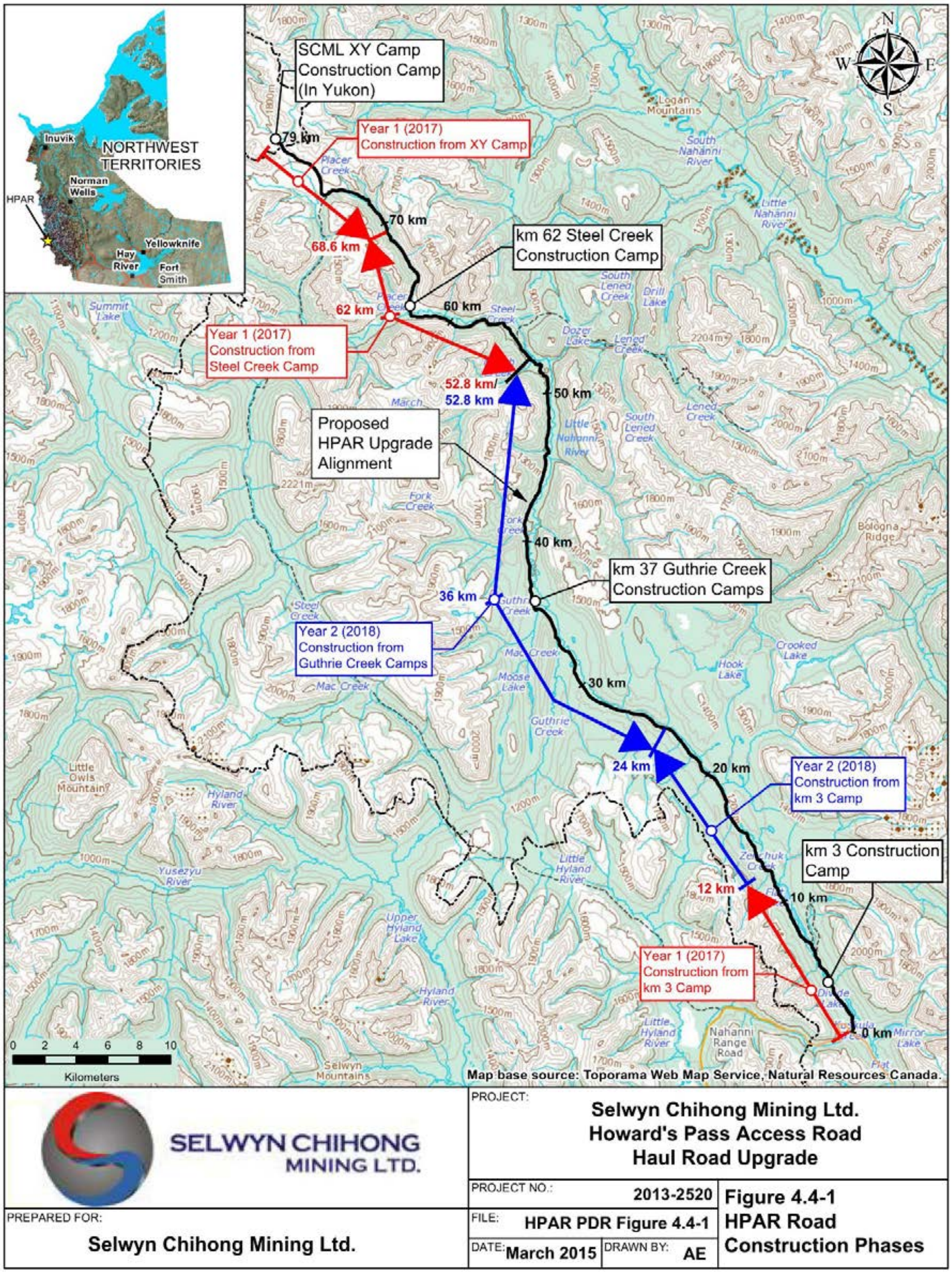
Table 7: Waste Management Infrastructure – On-site

Infrastructure	Location
Wildlife-proof Putrescible Waste Containment	Construction camp
Wildlife-proof Garbage Bins for Non-Putrescible Waste Containment	
Waste Wood/Metal Pile	
Plastic Recyclables Holding Bin	
Cardboard Recyclables Holding Bin	
Special Waste Holding Area, including labeled, sealed containers as required. Double-walled storage tank for waste oils.	
Sewage (Blackwater) Holding Tank	
Greywater Sump	
Incinerator	

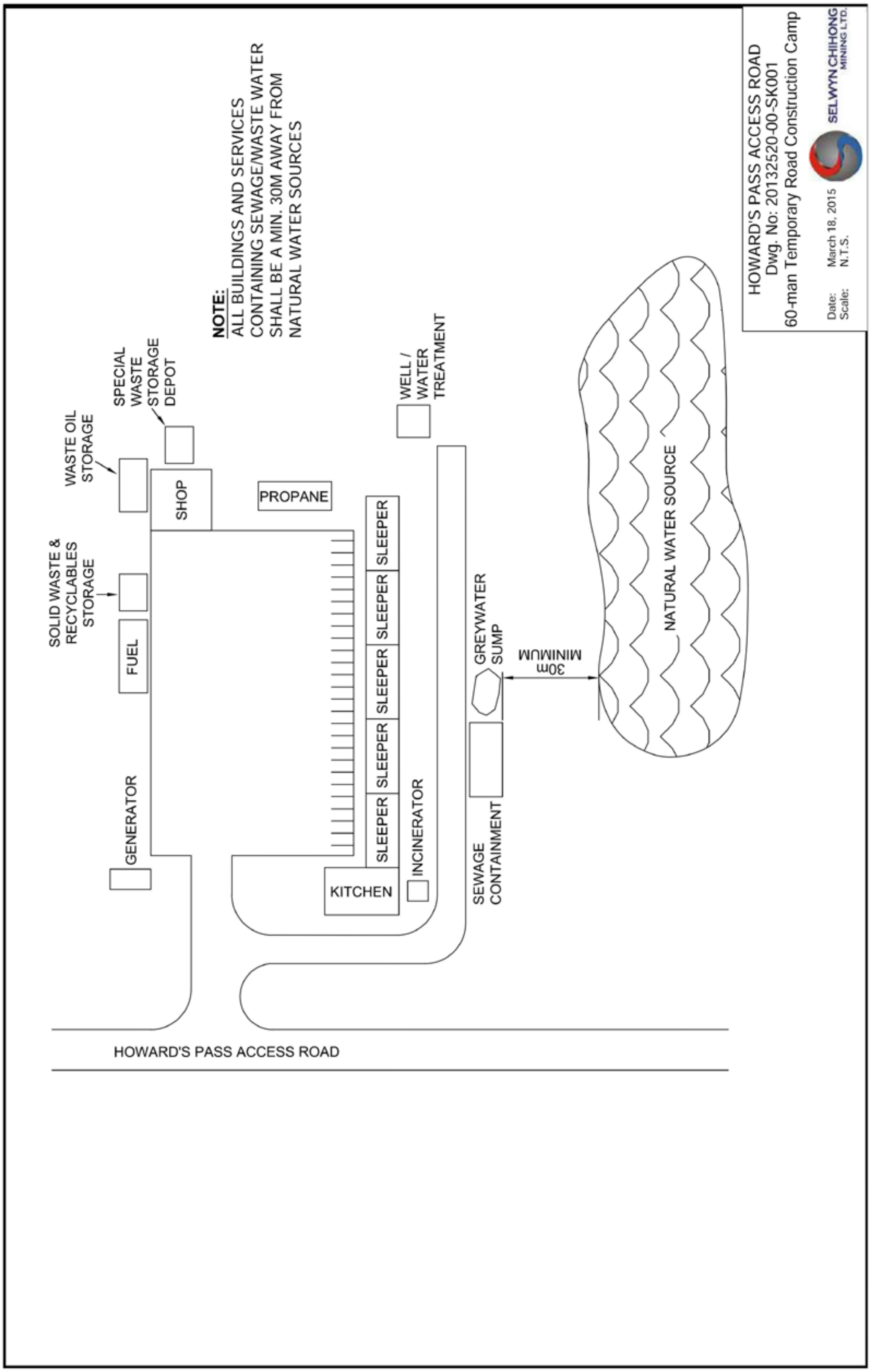
Table 8: Waste Management Infrastructure – Off-site

Infrastructure (Permitted Facility)	Location
Permitted Waste Oil Burner	SCML's Don Camp (Yukon) or other permitted facility.
Special Waste Disposal Facility	Rudy's Enviro Services, Watson Lake
Solid Waste Disposal Facility	Watson Lake Landfill

FIGURES



SCML XY Camp Construction Camp (In Yukon)
Year 1 (2017) Construction from XY Camp
79 km
70 km
68.6 km
km 62 Steel Creek Construction Camp
60 km
62 km
Year 1 (2017) Construction from Steel Creek Camp
52.8 km/
52.8 km
50 km
Proposed HPAR Upgrade Alignment
40 km
km 37 Guthrie Creek Construction Camps
36 km
Year 2 (2018) Construction from Guthrie Creek Camps
30 km
24 km
20 km
Year 2 (2018) Construction from km 3 Camp
km 3 Construction Camp
12 km
10 km
Year 1 (2017) Construction from km 3 Camp
0 km
NORTHWEST TERRITORIES
Inuvik
Norman Wells
HPAR
Yellowknife
Hay River
Fort Smith
Nahanni Range Road
0 2 4 6 8 10
Kilometers
Map base source: Toporama Web Map Service, Natural Resources Canada.
SELWYN CHIHONG MINING LTD.
PROJECT:
Selwyn Chihong Mining Ltd.
Howard's Pass Access Road
Haul Road Upgrade
PROJECT NO.: 2013-2520
Figure 4.4-1
HPAR Road
Construction Phases
FILE: HPAR PDR Figure 4.4-1
DATE: March 2015
DRAWN BY: AE
PREPARED FOR:
Selwyn Chihong Mining Ltd.


HOWARD'S PASS ACCESS ROAD
Dwg. No: 20132520-00-SK001
60-man Temporary Road Construction Camp
Date: March 18, 2015
Scale: N.T.S.
SELWYN CHIHONG MINING LTD.
NOTE:
ALL BUILDINGS AND SERVICES CONTAINING SEWAGE/WASTE WATER SHALL BE A MIN. 30M AWAY FROM NATURAL WATER SOURCES
SPECIAL WASTE STORAGE DEPOT
WASTE OIL STORAGE
SHOP
PROPANE
WELL / WATER TREATMENT
SOLID WASTE & RECYCLABLES STORAGE
FUEL
SLEEPER
SLEEPER
SLEEPER
SLEEPER
SLEEPER
SLEEPER
GREYWATER SUMP
30m MINIMUM
NATURAL WATER SOURCE
GENERATOR
INCINERATOR
KITCHEN
SEWAGE CONTAINMENT
HOWARD'S PASS ACCESS ROAD

APPENDIX III. SPILL CONTINGENCY PLAN FOR THE NORTHWEST TERRITORIES

SCML (2015). Spill Contingency Plan for the Northwest Territories. Revision date June 15, 2015. Selwyn Chihong Mining Ltd., Vancouver, BC.

SELWYN CHIHONG MINING LTD.

2701 – 1055 West Georgia Street
Vancouver, BC V6E 0B6
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SELWYN CHIHONG MINING LTD.

SPILL CONTINGENCY PLAN
FOR
THE NORTHWEST TERRITORIES

Revision Date: June 15, 2015

SELWYN CHIHONG MINING LTD.

SPILL CONTINGENCY PLAN

FOR THE

NORTHWEST TERRITORIES

Reviewed by:

____

Doug Reeve, Manager, Permitting and Regulatory Affairs
Selwyn Chihong Mining Ltd.

Reviewed by:

____

Maurice Albert, VP External Affairs
Selwyn Chihong Mining Ltd.

Approved by:

____

Richard (Shilin) Li, President & CEO
Selwyn Chihong Mining Ltd.

Table of Contents

Tables

1.0 INTRODUCTION

1.1 Project Information

Selwyn Chihong Mining Ltd (SCM) is a base metals exploration and development company with mineral claims and leases that straddle the Yukon (YT) and Northwest Territories (NT) border in the Howard's Pass area. The collective claims area is referred to as the Selwyn Project.

The claims form a roughly rectangular 60-km long northwest-trending block covering an area of about 32,000 hectares. The majority of the claims (~85%) are in the YT, the remainder is in the NT. SCM maintains two 50-man camps on the Yukon side; XY Camp is located near the YT/NT border at the southeast end of the claim blocks at about 1500 m asl, Don Camp is located at the center of the claims at about 1200 m asl. Each camp is serviced by a gravel airstrip.

The claim block is located 350 km northeast of Whitehorse and 260 km north of Watson Lake. Other communities close to the Project are Ross River, YT (180 km to the west), and Tungsten, NT (75 km to the southeast).

Ground access to the Selwyn Project is via the Howard's Pass Access Road (HPAR). The HPAR is an 80 km long gravel road wholly in the NT that links the Project site to the public highway system in the YT. The HPAR originates at km 188 of the Nahanni Range Road (about 10 km north of Tungsten) and terminates near SCM's XY Camp at Howard's Pass.

This Spill Contingency Plan (the Plan) applies to all SCML operations in the NT, including lands under mineral claims/leases and the Howard's Pass Access Road during the period of upgrading (the construction phase of the HPAR Upgrade Project). Figure 1 shows the location of those operations (Appendix I). The NT claims and lease at the north end of the road are held by SCML.

1.2 Spill Contingency Planning for the HPAR Operational Phase

This plan will remain in effect until replaced by SCML's Spill Contingency Plan for HPAR Operations. The plan for road operations will build on the current plan, but will incorporate spill mitigation planning for the period of use of the HPAR for transport of materials for minesite construction, and for mine operation, including the for the bulk transport of ore concentrates.

Quantities and details of transportation timing and methods for materials to be transported, including for ore concentrates, fuels, reagents and other mining goods and supplies, have not yet been finalized. The plan for HPAR operations will include lists of goods expected to be shipped along the road, and estimated quantities and timeframes for shipment of each. Where there is potential for environmental effects if the substance is spilled, contingency plans for spillage at various points along the road will be provided.

1.3 SCM Environmental Policy

SCM is committed to the responsible exploration and development of mineral resources. In accordance with the Mining Association of Canada, SCM has adopted a responsible approach to social, economic, and environmental performance that is aligned with the evolving priorities of our communities of interest.

SCM is committed to:

- Seeking to minimize the impact of our operations on the environment through all stages of exploration and development;
- Seeking to minimize any adverse effects caused by the accidental release of pollutants into the environment; and
- Practicing continuous improvement through the application of new technology, innovation and reasonable best practices in all facets of our operation.

1.4 Regulatory Background – Northwest Territories

Spill contingency planning, response and reporting for SCM's operations in the NT are regulated under the Northwest Territories *Environmental Protection Act*, the *Mackenzie Valley Resource Management Act*, the Federal *Real Property Act*, the Federal *Fisheries Act*, the Federal *Transport of Dangerous Goods Act*, and the *Canada National Parks Act*, their respective Regulations, and by licenses and permits issued to SCM under these Regulations. This Spill Contingency Plan is intended to be in compliance with these Acts, Regulations and permits/licenses.

Contaminants are classified in Schedule B of the Northwest Territories Spill Contingency Planning and Reporting Regulations (Appendix II). Classifications in those regulations are based upon classifications and/or divisions set out in the Federal Transportation of Dangerous Goods Act (1992).

The requirement for SCM to develop a spill contingency plan is established in Land Use Permits issued to SCM by the Mackenzie Valley Land and Water Board (Permit MV2005F0028 clause 42) and Parks Canada (Permit 2009-L01 clause 44). Under these permits, SCM is required to ensure that adequate contingency plans and spill kits are in place, prior to commencement of operations, and to respond to any potential spills.

1.5 Purpose & Scope of the Spill Contingency Plan

This Spill Contingency Plan (the Plan) is designed to provide staff and contractors working at the Selwyn Project with a formal framework of responsibilities and actions to be taken when responding to spills. The Plan is consistent with SCM's Environmental Policy, and is intended to be compliant with the applicable acts, regulations and permits. This Plan has been prepared for specific levels of operation – those related to advanced exploration and construction.

This Plan identifies specific lines of authority and responsibility, details reporting and communication procedures and describes an action plan to be implemented in the event of a spill. All information necessary to effectively control and clean up a spill is included in this Plan.

This Plan covers all activities that are undertaken by SCM in the NT, inclusive of mineral claims/leases and the Howard's Pass Access Road. It applies to all staff and contractors working under SCM's direction. This Plan does not apply to contractors or suppliers not working under SCM's direction, such as materials transport firms, who may be required to have Spill Contingency Plans specific to their operations; such plans must be reviewed and accepted by SCM. This Plan was developed specifically for SCM's NT operations; however, the principles of this Plan may, with modification, be applicable to areas beyond.

1.6 Distribution of Plan

This Plan is to be distributed to all staff (casual and permanent) and all contractors prior to undertaking work on the lands. Adherence to this Plan is a requirement of employment and contractor agreements. Staff and contractors will review this Plan, and must acknowledge that they have read and understood it.

A copy of this Plan must be kept at centers of operations at the Selwyn Project (Don and XY Camps, and any temporary construction camps) at all times and at the Corporate Office.

2.0 CONTAMINANTS & SPILLS - DEFINITIONS AND CATEGORIES

2.1 Contaminant Definition

A contaminant is defined in the Northwest Territories Environmental Protection Act as "any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment,

a) endangers the health, safety or welfare of persons,

b) interferes or is likely to interfere with normal enjoyment of life or property,

c) endangers the health of animal life, or

d) causes or is likely to cause damage to plant life or to property".

2.2 Spill Definition

A spill is defined in the Northwest Territories Spill Contingency Planning and Reporting Regulations as **"a discharge of a contaminant in contravention of the Act or regulations made under the Act or a permit or license made under the Act or regulations made under the Act".**

2.2.1. Reportable (Major) Spills

The NT Spill Contingency Planning and Reporting Regulation (Appendix II) defines thresholds for the reporting of spills to the NT Spill Report Line. Thresholds for contaminants commonly stored or used at the Selwyn Project are given below in Table 1. The discharge of a contaminant to the environment in quantities below the thresholds is not considered a spill under the Regulations, and is not reportable.

Table 1: Contaminant Spill Reporting Thresholds

Contaminant Spilled	Spill Reporting Threshold
Diesel Fuel	$\geq$ 100 litres
Gasoline	$\geq$ 100 litres
Jet A/B Aviation Fuel	$\geq$ 100 litres
Propane	Any amount from containers with a capacity greater than 100 litres.
Mechanical Lubricants	$\geq$ 100 litres
Special Wastes	$\geq$ 100 litres

2.2.2. Non-Reportable (Minor) Spills

Non-reportable spills, or those that fall below reporting thresholds (Table 1) are to be handled in accordance with Initial Actions and Containment and Cleanup of spills described in Sections 4.2 and 4.3 of this Plan, but do not need to be reported to outside agencies.

3.0 CONTAMINANTS – TYPES, LOCATION & QUANTITIES

3.1 Types of Contaminants

Contaminants are defined as any material classified in Schedule B of the Northwest Territories Spill Contingency Planning and Reporting Regulations (Appendix II). The specific contaminants this Plan will address are those which are commonly used and/or stored at the Selwyn Project.

Contaminants used and/or stored at the Selwyn Project include:

- Diesel Fuel (Schedule B, Item 6, TDGA Class 3);
- Gasoline, unleaded (Schedule B, Item 6, TDGA Class 3);
- Jet A / Jet B Aviation Turbine Fuel (Schedule B, Item 6, TDGA Class 3);
- Propane (Schedule B, Item 1, TDGA Class 2.1);
- Lubricants (generally not regulated, treated as TDGA Class 3);
- Special Waste* (unclassified).

*For the purposes of this Plan, special wastes generated through operations at the Selwyn Project include waste petroleum fuels (typically stale or contaminated with dirt/water) and used lubrication oils. Management of special waste generated as part of SCM's operations in the NT will be handled as part of SCM's Yukon-based operations and are covered under SCM's Waste Management Permit, as issued by Yukon Environment.

3.2 Fixed Location Storage

Due to the nature of SCM's operations in the NT, there are no permanent long-term storage facilities for contaminants (such as those with permanent concrete foundations), only mobile containment that is deployed temporarily, on an as and where needed basis.

3.3 Mobile Storage

Mobile storage containers are used to transfer and store fuel where it is required for short-term use (such as drill sites or construction sites), or to refuel mobile heavy equipment. Mobile containers used at the Selwyn Project include:

- 75,000-litre double walled, skid-mounted enviro tanks for storage of diesel fuels
- 10,000-litre double walled, skid-mounted enviro tanks for storage of gasoline
- 4,700-litre double-walled, stackable cubes for storage of diesel, gasoline or aviation fuel[1].
- 3,000-litre double-walled, skid-mounted traveler tanks for storage of diesel, gasoline or aviation fuel[1].
- 300-litre Tidy Tanks (truck mounted) for transfer of diesel from bulk storage to heavy equipment.
- 205-litre drums for transfer and/or temporary storage of diesel, gasoline or aviation fuel.
- 100 lb (90 litre) propane tanks.

[1] Based on permitting held by SCM at the time this plan was prepared, fuel cubes and traveler tanks are not currently permitted for stationary use on the HPAR.

4.0 SPILL ACTION PLAN

All spills of contaminants will require immediate action, with priorities of:

a) protecting lives and preventing injury;

b) protecting the environment;

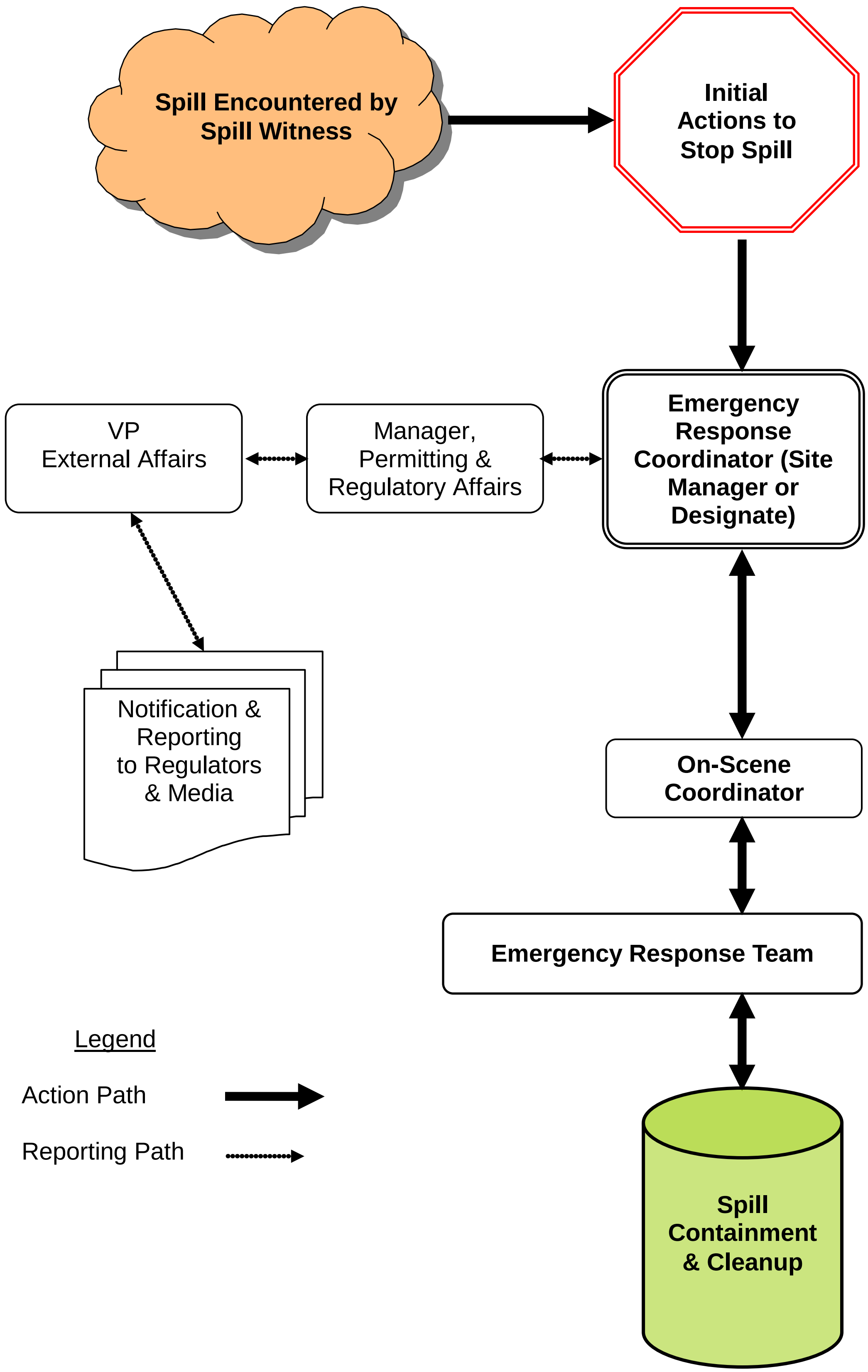
c) protecting the property; and

d) minimizing disruption or interference with SCM's business activities.

This Plan is intended to provide guidance for actions to be taken in the event of a spill of contaminants.

4.1 Duties & Responsibilities

The organizational chart below outlines the responsibilities and procedural sequences of events that will be followed in the event of a reportable spill of a contaminant. Detailed description duties and responsibilities follow.


Spill Encountered by Spill Witness
Initial Actions to Stop Spill
VP External Affairs
Manager, Permitting & Regulatory Affairs
Emergency Response Coordinator (Site Manager or Designate)
Notification & Reporting to Regulators & Media
On-Scene Coordinator
Emergency Response Team
Legend
Action Path
Reporting Path
Spill Containment & Cleanup

Spill Witness

The Spill Witness is the individual who first discovers a spill.
Reports to: Emergency Response Coordinator.
Duty Station: At the spill scene.
Communication Systems: 2-way radio and/or portable satellite phone
General Responsibility: Implement Initial Actions, as defined in Section 4.2. Participate in spill cleanup as directed by Emergency Response Coordinator or On-Scene Coordinator.

Emergency Response Coordinator

The Site Manager stationed at camp will act as the Emergency Response Coordinator. If there is no Site Manager stationed at camp, an alternate will be designated by the VP External Affairs and this designation will be clearly communicated and documented.
Reports to: Manager of Permitting & Regulatory Affairs.
Duty Station: Camp Office.
Communication Systems: Satellite Telephone (604) 424-8101 (may change yearly)
2-way radios
General Responsibility: Manages all aspects of on-scene emergency response in consultation with the Corporate Office (Manager of Permitting & Regulatory Affairs and/or VP External Affairs). Devises and directs the implementation of actions necessary to affect the response.

Specific Duties:

- Coordinates initial response actions.
- Designates an On-Scene Coordinator.
- Logs individuals assigned to the scene.
- Communicates with the Corporate Office.
- Coordinates all third party (government) visitations to the spill scene.
- Develops secondary response actions in consultation with Corporate Office.
- Arranges for acquisition of additional manpower and/or equipment needed for spill response, in consultation with Corporate Office.
- Controls access on and off the property.
- Receives reports from On-Scene Coordinator.
- Documents all actions taken and all spill-related communications from site.

On-Scene Coordinator

Reports to: Emergency Response Coordinator.
Duty Station: At the spill scene.
Communication Systems: 2-way radio and/or portable satellite phone
General Responsibility: Implement Action Plan at the scene.

Specific Duties:
- Co-ordinates all activities at the spill scene.
- Directs actions of the Emergency Response Team.
- Acts as the point of contact for on-scene technical inquiries.
- Relays information to Emergency Response Coordinator.

Emergency Response Team
Reports to: On-Scene Coordinator.
Duty Station: At the spill scene (as assigned).
General Responsibility: Implements Action Plan.

Specific Duties: As assigned.

Manager of Permitting & Regulatory Affairs
Reports to: VP External Affairs
Duty Station: Corporate Office
Communication Systems: Office phone & cell phone (see Table 4)
General Responsibility: Manages all details of public and regulatory interaction in consultation with the VP External Affairs

Specific Duties:
- Follow up with public and regulatory communications following initial contact by the Emergency Response Coordinator.
- Carry out post spill investigation and report on causative factors, response efficacy, and corrective actions.
- Maintain communications with regulatory officials and public until spill incident file is closed.

VP External Affairs
Reports to: President & CEO
Duty Station: Corporate Office
Communication Systems: Office phone & cell phone (see Table 4)
General Responsibility: Provides direction to the Emergency Response Coordinator, and arranges for external resources in consultation with the President & CEO.

Specific Duties:
- Assist the Emergency Response Coordinator with initial response activity to the extent possible.
- Assists the Emergency Response Coordinator in developing secondary response actions.
- Arranges for external assistance if necessary, including additional manpower and equipment.
- Communication with SCM management team.

4.2 Initial Action

These procedures are to be followed by the Spill Witness upon discovery of a spill:

a) **Ensure Safety First**. Safety of the Spill Witness and others at site is the first priority; warn and/or evacuate personnel if a spill is jeopardizing their safety.

b) **Prevent Fire**. Shut off ignition sources near the spill if safe to do so.

c) **Control the spill**. Stop the spill at its point of origin if safe to do so.

d) **Report the Spill**. Notify the Emergency Response Coordinator (Site Manager or designate).

e) **Contain the Spill**. Take initial actions to contain the spill, if possible and safe to do so.

4.3 Containment & Cleanup

All contaminants stored or used at the Selwyn Project that can be contained are liquid phase and hydrocarbon-based (diesel, gasoline, aviation fuel, lubricants and waste derived from them). Propane is gas phase when released, and containment should not be attempted.

Containment methods will depend on spill site factors, including the size of spill, the local terrain and soil type, proximity to water, climatic conditions and availability of manpower and equipment.

All persons involved in containment and cleanup efforts must wear appropriate personal protective equipment (PPE). Material Safety Data Sheets (MSDS) for all contaminants are available at both the XY Camp and Don Camp. The MSDS contain toxicity details for the substances and list appropriate PPE.

Two types of containment and cleanup strategies for hydrocarbon-based contaminants are presented below. They are distinguished on the basis of volatility (gasoline and Jet A/B being volatile, the remainder less so).

Table 2: Containment & Cleanup – Diesel, Lubricants & Special Waste

Location	**Response**
On Land	• Contain with earthen berm or other barrier(s); block entry into ditches or waterways. • Recover contaminant using appropriate means, including shovels and/or pumps. • Recover residual contaminants with sorbent pads or particulate sorbents. • On tundra use peat moss and leave in place to degrade, if practical.
On Snow & Ice	• Contain with barrier of snow or other material(s); block entry into waterways. • Recover contaminant using appropriate means, including shovels and/or pumps. • Recover residual contaminant with sorbent pads, particulate sorbents and/or snow. • Use ice augers and pump when feasible to recover contaminant from under ice. • Burn using Tiger Torches if unrecoverable by other methods; and, if feasible and safe to do so.
On Open Water	• Contain spill as close to the point of release as possible. • Use a spill containment boom to concentrate slicks for recovery. • For smaller spills, recover contaminant with sorbent pads. • For larger spills, recover contaminant from within booms by skimming.
Creeks & Streams	• Prevent entry into water, if possible, by building an earthen berm or trench. • Intercept moving slicks in slow moving water using sorbent pads or booms. • Do not use sorbent booms/pads in fast moving water.
Disposal	• Segregate waste types. • Place contaminated materials into appropriate containers (typically drums) and clearly mark the contents. • Store outside & away from ignition sources. • Consult VP External Affairs on any post spill requirements.

Table 3: Containment & Cleanup – Gasoline & Jet A/B Aviation Fuel

Location	Response
On Land	• Block entry into waterways by dyking with earthen berm or other barrier. • Do not contain spill if there is any chance of igniting vapors. • On shop floors, work yards and gravel roads, use particulate sorbents. • On tundra use peat moss and leave to degrade if feasible to do so.
On Snow & Ice	• Block entry into waterways by dyking with snow or other barrier(s). • Do not contain spill if there is any chance of igniting vapors. • In work yards, apply particulate sorbents.
On Water	• Do not attempt to contain or remove spills. • Use booms to protect water intakes and sensitive areas.
Transfer	• Electrically ground containers and vehicles during transfer to designated disposal/treatment area.
Disposal	• Segregate waste types. • Place contaminated materials into appropriate containers (typically drums) and clearly mark the contents. • Store in cool ventilated area outside & away from ignition sources. • Consult VP External Affairs on any post spill requirements.

4.4 Spill Reporting – Major Spills

A spill of a contaminant that exceeds thresholds in the NT Spill Contingency Planning and Reporting Regulations (see Table 1) must be reported. Initial spill reporting is to be undertaken by the VP External Affairs or designate, and must be made to the NT **24 Hour Spill Report Line by calling (867) 920-8130**. A person reporting a spill shall give as much of the following information as possible:

a) date and time of spill;

b) location of spill;

c) direction spill is moving;

d) name and phone number of a contact person close to the location of spill;

e) type of contaminant spilled and quantity spilled;

f) cause of spill;

g) whether spill is continuing or has stopped;

h) description of existing containment;

i) action taken to contain, recover, clean up and dispose of spilled contaminant;

j) name, address and phone number of person reporting spill;

k) name of owner or person in charge, management or control of contaminants at time of spill.

To assist in ensuring that all the appropriate information is collected prior to the reporting of a spill, a NT Spill Report form (Appendix III) should be completed by the Emergency Response Coordinator or his/her designate. The NT Spill Report Form is also available at http://www.enr.gov.nt.ca/_live/documents/content/NT-NU_Interactive_Spill_Form.pdf. Information from this form can also be used as a guide for the detailed spill report that will be written by the Emergency Response Coordinator.

Where a spill of a contaminant exceeding thresholds in Table 1 occurs within Nahanni National Park Reserve, it must be also be reported to Parks Canada by (867) 695-3732.

Table 4: SCM Staff Contact Information

Position	Name	Office Phone	Cell Phone
President & CEO	Richard Li	(604) 620-9888	(778) 227-5669
VP External Affairs	Maurice Albert	(604) 620-6188 ext 801	(778) 847-0880
Manager of Permitting Regulatory Affairs	Doug Reeve	(604) 620-6188 ext 805	(604) 202-3888
Alternate	Jillian Chown	(867) 668-2551	(867) 335-8910

Table 5: Government Contact Information

Agency	Phone	Fax
*NT Spill Report Line (24 hrs)	(867) 920-8130	(867) 873-6924
Fisheries & Oceans Canada, Yellowknife (if spill to water)	(867) 669-4931	(867) 669-4940
*Nahanni National Park Reserve, Fort Simpson (spill in Park)	(867) 695-7750 (867) 695-3732 (summer 24 hr number)	(867) 695-2446
AANDC, Fort Simpson (spill outside Park)	(867) 695-2626	(867) 695-2615

*Notification of a reportable spill to this agency is required by law.

4.5 Spill Reporting – Minor Spills

All minor spills – those greater than 1 litre but less than 100 litres - are to be recorded in a spill log. An SCM Spill Log, to be used to record details of non-reportable spills, is included in Appendix IV. This log is to be maintained at the nearest center of operations, and is to be made available to regulators on request.

4.6 Managing Spill-Related Wastes

Spill-related wastes will be managed on a case-by-case basis at the discretion of VP External Affairs. Common management options for spill-related wastes are provided below in Table 6.

Table 6: Management of Spill-Related Waste

Waste	Management Options
Hydrocarbon-water mixture	• Reclaim hydrocarbon from mixture by gravimetric means. • Hydrocarbon can be incinerated at dump, or can be fed into waste oil burner at Don Camp.
Hydrocarbon-snow mixture	• Mixture can be burned as is with refuse at dump. • Mixture can be stored in berm, pumped to barrel when thawed, then separated and burned.
Hydrocarbon-soil mixture	• Mixture can be burned with refuse at dump. • Mixture can be land farmed.
Hydrocarbon-soaked sorbents	• Sorbents can be burned with refuse at dump.

4.7 Restoring Areas Affected by Spills

Restoration of areas affected by spills of contaminants will be undertaken on a site-specific basis as required. Restoration planning, implementation and monitoring will be completed under the direction of VP External Affairs.

5.0 SPILL RESPONSE RESOURCES

5.1 On-Site Resources

Spill kits are kept at all fixed storage locations for contaminants at Don and XY Camps. Spill kits are also kept onboard of vehicles used to transport contaminants, and are also kept at sites where contaminants are temporarily stored (such as drill sites).

Spill kit types and contents are provided below in Table 7.

Table 7: Spill Kit Contents

Spill Kit	Contents
#1 Kit	• 100 oil sorbent pads • 6 small pillows • 2 large pillows • 5 – 10' socks • 25 lb bag granular sorbent • plug pattie (instant leak stop) • neoprene drain cover • 2 disposal bags • splash goggles • nitrile gloves • 2 shovels • 1 rake • 2 plastic tarps • poly-coated Tyvec suit • disposable respirator
#2 Kit	• 50 oil sorbent pads • 4 small pillows • 2 large pillows • 4 - 4' socks • 1 – 8' sock • plug pattie (instant leak stop) • 2 disposal bags • pr nitrile gloves • 1 shovel • 1 plastic tarp • splash goggles • disposable respirator
Truck Kit	• 24 oil sorbent pads • 2 small pillows • 2 - 4' socks • plug pattie (instant leak stop) • disposal bags • pr nitrile gloves • 1 plastic tarp

Hand-operated tools such as shovels and rakes are invaluable in any spill clean-up and recovery operation, and are kept with the #1 and #2 kits. The use of heavy equipment, such as excavators and haul trucks, for larger spill situations makes the removal of material easier. It also ensures that all materials, including absorbent soil, snow etc. have been removed from the site.

5.2 Off-Site Resources

Off-site resources that may provide assistance to SCM in responding to a major spill are listed below in Table 8.

Table 8: Off-Site Spill Response Resources

Resource	Phone	Fax
Spill Response Products		
West Coast Spill Supplies	(250) 652-4549	(250) 652-5052
Raymac Environmental	(250) 390-1032	(250) 390-1051
Yukon Pump	(867) 633-3478	-
Air Transport		
Alkan Air (fixed wing)	(867) 668-2107	(867) 667-6617
Trans North Helicopters	(867) 668-2177	(867) 668-3420
Heli Dynamics	(867) 668-3536	(867) 668-5637
Technical Support		
*Canutec - emergency	(613) 996-6666	-
*Canutec - information	(613) 992-4624	(613) 954-5105

*Canutec is the Canadian Transport Emergency Centre operated by Transport Canada to assist emergency response personnel in handling dangerous goods emergencies. Canutec has set up a scientific data bank on chemicals manufactured, stored and transported in Canada and is staffed by professional scientists specialized in emergency response and experienced in interpreting technical information and providing advice.

Taking into consideration the characteristics of the dangerous goods involved and the particular conditions at the emergency site, Canutec's professional staff can provide immediate advice on:

- chemical, physical and toxicological properties and incompatibilities of the dangerous goods;
- health hazards and first aid;
- fire, explosion, spill or leak hazards;
- remedial actions for the protection of life, property and the environment;
- evacuation distances;
- personal protective clothing and decontamination.

6.0 TRAINING PROGRAMS

SCM employees will receive training to include instruction in spill recognition and assessment, spill hazards, spill reporting, communications, clean up procedures and general emergency response. All personnel will be familiar with the spill reporting requirements. This training schedule will be set forward by the VP External Affairs for SCM in order to maintain the integrity and ability for rapid deployment of the Spill Response Team.

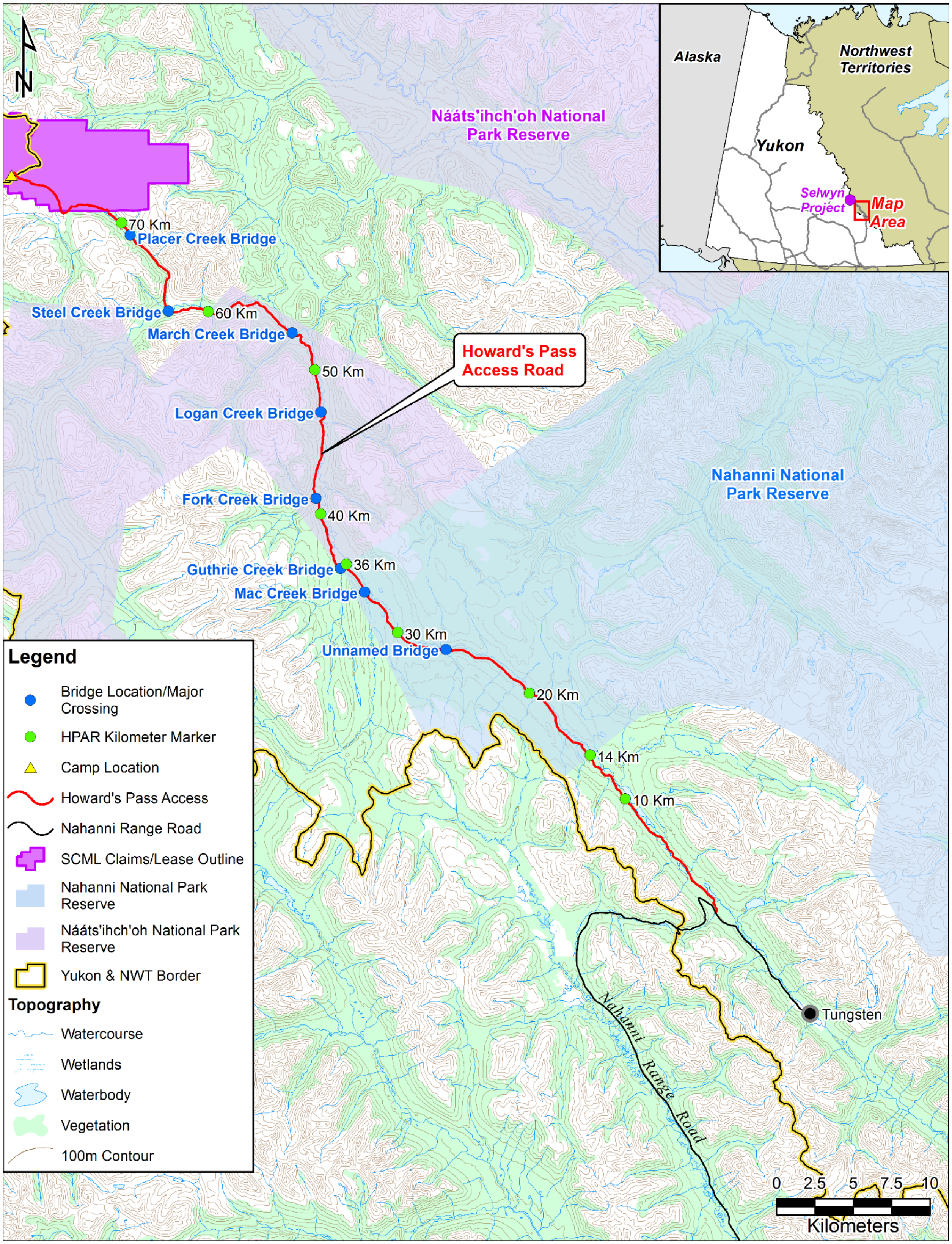
Fuel handling employees will be fully trained in the safe operation of the fuel handling facilities, spill prevention techniques and fully cognizant of the spill reporting procedure. The employees will also undertake regular spill response exercises to test the spill response procedure. The timing and frequency of these exercise is to be determined by the VP External Affairs.

This Spill Contingency Plan will be reviewed once per year, or when there is a substantial change to operations, or storage/use of any contaminants not identified in this Plan. Review of this Plan is the responsibility of the VP External Affairs

Appendix I

Figure 1. SCML Operations in NT

Figure 1. SCML Operations in NT



Appendix II

NT Spill Contingency Planning and Reporting Regulations

ENVIRONMENTAL PROTECTION ACT

LOI SUR LA PROTECTION DE L'ENVIRONNEMENT

SPILL CONTINGENCY PLANNING AND REPORTING REGULATIONS
R-068-93

REGLEMENT SUR LES EXIGENCES EN MATIERE DE DEVERSEMENTS
R-068-93

INCLUDING AMENDMENTS MADE BY

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ENVIRONMENTAL PROTECTION ACT

SPILL CONTINGENCY PLANNING AND REPORTING REGULATIONS

The Commissioner, on the recommendation of the Minister, under section 34 of the *Environmental Protection Act* and every enabling power, makes the *Spill Contingency Planning and Reporting Regulations*.

1. In these regulations,

"above ground facility" means a facility that is stationary for a period of 30 days or more and is not an underground facility; (*installation en surface*)

"Act" means the *Environmental Protection Act*; (*Loi*)

"facility" means any thing capable of storing or containing contaminants and includes any thing used in the transfer of contaminants to and from the facility; (*installation*)

"PCB" means the chlorobiphenyls that have the molecular formula $C_{12} H_{10-N} C1_N$ in which N is greater than 2; (*BPC*)

"spill" means a discharge of a contaminant in contravention of the Act or regulations made under the Act or a permit or licence issued under the Act or regulations made under the Act; (*déversement*)

"storage capacity" means the aggregate capacity of all facilities placed together in one location; (*capacité d'entreposage*)

"TDGA Class" means a class of dangerous goods set out in the Schedule to the *Transportation of Dangerous Goods Act, 1992* (Canada), and any division of a class established in regulations made or continued under that Act; [*classe (LTMD)*]

"underground facility" means a facility having more than 10% of its structure beneath ground level. (*installation souterraine*)

2. (1) Sections 3 to 8 of these regulations do not

LOI SUR LA PROTECTION DE L'ENVIRONNEMENT

RÈGLEMENT SUR LES EXIGENCES EN MATIÈRE DE DÉVERSEMENTS

Le commissaire, sur la recommandation du ministre, en vertu de l'article 34 de la *Loi sur la protection de l'environnement* et de tout pouvoir habilitant, prend le *Règlement sur les exigences en matière de déversements*.

1. Les définitions qui suivent s'appliquent au présent règlement.

«BPC» Désigne tout biphényle polychloré caractérisé par la structure moléculaire $C_{12}H_{10-N}C1_N$, où N est supérieur à 2. (*PCB*)

«capacité d'entreposage» Capacité d'entreposage de l'ensemble des installations réunies en un lieu. (*storage capacity*)

«classe (LTMD)» Classe de marchandises dangereuses prévue à l'annexe de la *Loi de 1992 sur le transport des marchandises dangereuses* (Canada), ou toute division d'une classe établie par un règlement pris ou maintenu en vertu de cette loi. (*TDGA Class*)

«déversement» Rejet de tout contaminant en contravention de la Loi ou de ses règlements ou en contravention d'un permis ou d'une licence délivré en vertu de la Loi ou de ses règlements. (*spill*)

«installation» Désigne tout objet dans lequel il est possible d'entreposer des contaminants ou qui peut contenir des contaminants, et comprend tout objet utilisé dans le transfert de contaminants en provenance ou à destination de l'installation. (*facility*)

«installation en surface» Désigne toute installation qui demeure stationnaire pendant 30 jours ou plus et qui n'est pas une installation souterraine. (*above ground facility*)

«installation souterraine» Toute installation dont plus de 10 % de la structure est située sous le niveau du sol. (*underground facility*)

«Loi» La *Loi sur la protection de l'environnement*. (*Act*)

2. (1) Les articles 3 à 8 du présent règlement ne apply to the following:

(a) a motor vehicle, as defined in the *Motor Vehicles Act*, unless that motor vehicle is an above ground facility;
(b) sewage and sewage sludge.

s'appliquent pas :

a) à un véhicule automobile au sens de la *Loi sur les véhicules automobiles*, à moins que le véhicule automobile ne soit une installation en surface;
b) aux eaux usées ni aux boues d'épuration.

(2) Contaminants used solely for domestic purposes and discharged from within a dwelling-house are exempt from the requirements of these regulations.

(2) Le présent règlement ne s'applique pas aux contaminants utilisés uniquement à des fins domestiques dont le rejet provient de l'intérieur d'une maison d'habitation.

(3) In Schedule A, the amounts set out in column 3 under the heading "STORAGE CAPACITY" refer to liquids, where the amount is expressed in litres, and to solids, where the amount is expressed in kilograms.

(3) Les quantités prévues à la troisième colonne de l'annexe A, sous l'intertitre «CAPACITÉ D'ENTREPOSAGE», visent les matières liquides lorsque la mesure se fait en litres, et les matières solides lorsque la mesure se fait en kilogrammes.

(4) In Schedule B, the amounts set out in column 4 under the heading "AMOUNT SPILLED" refer to liquids, where the amount is expressed in litres, and to solids, where the amount is expressed in kilograms.

(4) Les quantités prévues à la quatrième colonne de l'annexe B, sous l'intertitre «QUANTITÉ DÉVERSÉE», visent les matière liquides lorsque la mesure se fait en litres, et les matières solides lorsque la mesure se fait en kilogrammes.

SPILL CONTINGENCY PLAN

PLAN DE CONTRÔLE DES DÉVERSEMENTS

3. (1) No person shall store contaminants in a facility where the storage capacity of the facility equals or exceeds the storage capacity shown in Schedule A unless a spill contingency plan has been prepared and filed in accordance with these regulations.

3. (1) Il est interdit d'entreposer des contaminants dans une installation dont la capacité d'entreposage est égale ou supérieure à celle indiquée à l'annexe A, à moins d'avoir établi un plan de contrôle des déversements et de l'avoir soumis en conformité avec le présent règlement.

(2) Where the storage capacity of a facility is less than the storage capacity shown in Schedule A and where, in the opinion of the Chief Environmental Protection Officer a spill contingency plan is necessary for the protection of the environment, the Chief Environmental Protection Officer may require the owner or person in charge, management or control of a facility to prepare a spill contingency plan.

(2) Dans le cas où la quantité de contaminants entreposés est inférieure à la capacité d'entreposage indiquée à l'annexe A, le directeur de la protection de l'environnement peut exiger du propriétaire ou du responsable d'une installation l'établissement d'un plan de contrôle des déversements, si le directeur est d'avis qu'un tel plan est nécessaire aux fins de protection de l'environnement.

(3) Where the Chief Environmental Protection Officer is satisfied, on reasonable grounds, that a person uses a means of storing contaminants and a method of dealing with the spill of contaminants, that provide a level of environmental protection at least equivalent to that which would be provided by compliance with these regulations, the Chief Environmental Protection Officer may, in writing, subject to such conditions as the Chief Environmental Protection Officer considers necessary,

(a) exempt a person from the requirement to

(3) S'il est convaincu, pour des motifs raisonnables, que la méthode qu'utilise une personne pour l'entreposage des contaminants et celle qu'elle utilise pour faire face au déversement de contaminants offrent un degré de protection de l'environnement qui n'est pas inférieur à celui exigé en application du présent règlement, le directeur de la protection de l'environnement peut par écrit, sous réserve des autres conditions qu'il estime nécessaires :

a) soit soustraire cette personne de l'obligation de soumettre un plan de file a spill contingency plan under subsection (1); or

(b) exempt a person from the requirement to include in a spill contingency plan information required in one or more of paragraphs 4(2)(a) to (j).

4. (1) The owner or person in charge, management or control of a facility shall ensure that a spill contingency plan is prepared.

(2) A spill contingency plan for a facility must contain the following information:

(a) the name, address and job title of the owner or person in charge, management or control;

(b) the name, job title and 24-hour telephone number for the persons responsible for activating the spill contingency plan;

(c) a description of the facility including the location, size and storage capacity;

(d) a description of the type and amount of contaminants normally stored at the location described in paragraph (c);

(e) a site map of the location described in paragraph (c);

(f) the steps to be taken to report, contain, clean up and dispose of contaminants in the case of a spill;

(g) the means by which the spill contingency plan is activated;

(h) a description of the training provided to employees to respond to a spill;

(i) an inventory of and the location of response and clean-up equipment available to implement the spill contingency plan;

(j) the date the contingency plan was prepared.

5. (1) Subject to subsection (2), the person responsible for preparing a spill contingency plan shall file the plan with the Chief Environmental Protection Officer before making use of a facility.

contrôle des déversements en vertu du paragraphe (1);

b) soit soustraire cette personne de l'obligation d'inclure au plan de contrôle des déversements l'un ou l'autre des renseignements prévus aux alinéas 4(2)a) à j).

4. (1) Le propriétaire ou le responsable d'une installation doit faire en sorte qu'un plan de contrôle des déversements soit établi.

(2) Le plan de contrôle des déversements applicable à une installation fait état des renseignements suivants :

a) le nom, l'adresse et le poste du propriétaire ou du responsable;

b) le nom et le poste des responsables de la mise en oeuvre du plan de contrôle des déversements, ainsi que le numéro de téléphone où ils peuvent être rejoints 24 heures par jour;

c) la description de l'installation, notamment le lieu, les dimensions et la capacité d'entreposage;

d) la nature des contaminants habituellement entreposés dans l'installation mentionnée à l'alinéa c), ainsi que la quantité de contaminants qui y sont habituellement entreposées;

e) une carte du lieu mentionné à l'alinéa c);

f) la procédure de rapport, ainsi que les mesures de confinement, de nettoyage et d'élimination prévues en cas de déversement;

g) la procédure de mise en oeuvre du plan de contrôle des déversements;

h) la description de la formation donnée aux employés en matière de mesures à prendre en cas de déversement;

i) l'inventaire et le lieu d'entreposage de l'équipement de nettoyage et de mise en oeuvre du plan de contrôle des déversements;

j) la date d'établissement du plan de contrôle des déversements.

5. (1) Sous réserve du paragraphe (2), le respon-sable de l'établissement d'un plan de contrôle des déversements soumet le plan au directeur de la protection de l'environnement avant de faire usage d'une installation.

(2) Where a facility is already in use on the day these regulations come into force, the person responsible for preparing a spill contingency plan shall file the plan with the Chief Environmental Protection Officer within one year after that day.

6. (1) The Chief Environmental Protection Officer shall review each spill contingency plan after it is filed.

(2) The Chief Environmental Protection Officer may require the person who filed the spill contingency plan to make changes to it.

(3) Where the Chief Environmental Protection Officer requires changes under subsection (2), he or she may indicate a reasonable period of time within which the changes must be filed.

(4) The person who filed a spill contingency plan shall make and file any changes required under subsection (2).

7. (1) The person responsible for preparing a spill contingency plan shall review the plan annually.

(2) The person responsible for preparing a spill contingency plan shall, in writing, notify the Chief Environmental Protection Officer when a review under subsection (1) has been completed and shall immediately file with the Chief Environmental Protection Officer any changes made to the plan.

8. Once a spill contingency plan has been filed, the person responsible for preparing the plan shall implement the plan.

SPILLS

9. (1) The owner or person in charge, management or control of contaminants at the time a spill occurs shall immediately report the spill where the spill is of an amount equal to or greater than the amount set out in Schedule B.

(2) Where there is a reasonable likelihood of a spill in an amount equal to or greater than the amount set out in Schedule B, the owner or person in charge, management or control of the contaminants shall immediately report the potential spill.

(2) Dans le cas où une installation est déjà en usage à la date d'entrée en vigueur du présent règlement, le responsable de l'établissement du plan de contrôle des déversements doit soumettre le plan au directeur de la protection de l'environnement dans l'année qui suit cette entrée en vigueur.

6. (1) Le directeur de la protection de l'environnement révise chaque plan de contrôle des déversements qui lui est soumis.

(2) Le directeur de la protection de l'environnement peut exiger que la personne qui soumet un plan de contrôle des déversements y apporte des modifications.

(3) Dans le cas où le directeur de la protection de l'environnement exige, en vertu du paragraphe (2), que des modifications soient apportées au plan de contrôle des déversements, il peut fixer un délai raisonnable pour la soumission de ces modifications.

(4) La personne qui soumet un plan de contrôle des déversements doit apporter et soumettre toute modification exigée en vertu du paragraphe (2).

7. (1) Le responsable de l'établissement d'un plan de contrôle des déversements doit le réviser annuellement.

(2) Le responsable de l'établissement d'un plan de contrôle des déversements doit aviser par écrit le directeur de la protection de l'environnement de la révision du plan en vertu du paragraphe (1), et lui soumettre immédiatement toute modification apportée au plan.

8. Après avoir soumis un plan de contrôle des déversements, le responsable de l'établissement du plan le met en oeuvre.

DÉVERSEMENTS

9. (1) Lorsque survient le déversement d'une quantité de contaminants au moins égale à celles stipulées à l'annexe B, le propriétaire ou le responsable du contaminant au moment du déversement est tenu de le signaler sur-le-champ.

(2) Le propriétaire ou le responsable de contaminants a l'obligation de signaler sur-le-champ un déversement potentiel lorsqu'il est raisonnablement possible que la quantité déversée soit au moins égale à celle stipulée à l'annexe B.

10. A person reporting a spill shall contact the 24 Hour Spill Report Line by calling **(867) 920-8130.**

11. (1) A person reporting a spill shall give as much of the following information as possible:

(a) date and time of spill;
(b) location of spill;
(c) direction spill is moving;
(d) name and phone number of a contact person close to the location of spill;
(e) type of contaminant spilled and quantity spilled;
(f) cause of spill;
(g) whether spill is continuing or has stopped;
(h) description of existing containment;
(i) action taken to contain, recover, clean up and dispose of spilled contaminant;
(j) name, address and phone number of person reporting spill;
(k) name of owner or person in charge, management or control of contaminants at time of spill.

(2) No person shall delay reporting a spill because of lack of knowledge of any of the factors listed in subsection (1).

12. No person shall knowingly make a false report of a spill or a potential spill.

13. (1) For the purposes of evaluating the effectiveness of the spill contingency plan, the Chief Environmental Protection Officer may require, in writing, the owner or person in charge, management or control of a facility at the time a spill occurred to prepare and file a written report concerning the spill.

(2) The person required to prepare the report described in subsection (1) shall provide all information required by the Chief Environmental Protection Officer.

10. La personne qui signale un déversement le fait à toute heure en téléphonant à SOS Déversement, au **(867) 920-8130**.

11. (1) La personne qui signale un déversement doit indiquer, dans la mesure du possible :

a) la date et l'heure du déversement;
b) le lieu du déversement;
c) la direction dans laquelle le déversement s'étend;
d) le nom et le numéro de téléphone d'une personne vivant à proximité des lieux du déversement et qui peut être contactée;
e) la nature des contaminants et la quantité déversée;
f) la cause du déversement;
g) le fait que le déversement soit terminé ou non;
h) les moyens de confinement déjà en place;
i) les mesures prises pour confiner, ramasser et éliminer les contaminants et nettoyer les lieux;
j) le nom, l'adresse et le numéro de téléphone de la personne qui signale le déversement;
k) le nom du propriétaire ou celui du responsable des contaminants au moment du déversement.

(2) Il est interdit de retarder le signalement d'un déversement en raison d'un manque de connaissance des éléments d'information indiqués au paragraphe (1).

12. Il est interdit de faire sciemment un faux signalement d'un déversement ou d'un déversement potentiel.

13. (1) Le directeur de la protection de l'environnement peut, à des fins d'évaluation de l'efficacité du plan de contrôle des déversements, exiger par écrit du propriétaire ou du responsable d'une installation au moment d'un déversement qu'il présente un rapport écrit relatif au déversement.

(2) La personne à qui le directeur de la protection de l'environnement demande de présenter un rapport sur un déversement doit fournir tous les renseignements exigés par le directeur.

SCHEDULE A *(Section 3)*

(1)	(2)	(3)
ITEM NO.	TYPE OF FACILITY	STORAGE CAPACITY
1.	Above ground facility	20,000 ℓ or 20,000 kg
2.	Under-ground facility	4,000 ℓ or 4,000 kg

ANNEXE A (*article 3*)

(1)	(2)	(3)
Nº	TYPE DE DÉPÔT	CAPACITÉ D'ENTRE-POSAGE
1.	Installation en surface	20 000 l ou 20 000 kg
2.	Installation souterraine	4 000 l ou 4 000 kg

SCHEDULE B *(Section 9)*

(1)	(2)	(3)	(4)
ITEM NO.	TDGA CLASS	DESCRIPTION OF CONTAMINANT	AMOUNT SPILLED
1.	1	Explosives	Any amount
2.	2.1	Compressed gas (flammable)	Any amount of gas from containers with a capacity greater than 100 ℓ
3.	2.2	Compressed gas (non-corrosive, non flammable)	Any amount of gas from containers with a capacity greater than 100 ℓ
4.	2.3	Compressed gas (toxic)	Any amount
5.	2.4	Compressed gas (corrosive)	Any amount
6.	3.1, 3.2, 3.3	Flammable liquid	100 ℓ
7.	4.1	Flammable solid	25 kg
8.	4.2	Spontaneously combustible solids	25 kg
9.	4.3	Water reactant solids	25 kg
10.	5.1	Oxidizing substances	50 ℓ or 50 kg
11.	5.2	Organic Peroxides	1 ℓ or 1 kg
12.	6.1	Poisonous substances	5 ℓ or 5 kg

ANNEXE B *(article 9)*

(1)	(2)	(3)	(4)
Nº	CLASSE (LTMD)	CONTAMINANT	QUANTITÉ DÉVERSÉE
1.	1	Explosif	Toute
2.	2.1	Gaz comprimé (inflammable)	Toute quantité de gaz provenant d'un contenant d'une capacité supérieure à 100 l
3.	2.2	Gaz comprimé (non corrosif, ininflammable)	Toute quantité de gaz provenant d'un contenant d'une capacité supérieure à 100 l
4.	2.3	Gaz comprimé (toxique)	Toute
5.	2.4	Gaz comprimé (corrosif)	Toute
6.	3.1, 3.2, 3.3	Liquide inflammable	100 l
7.	4.1	Solide inflammable	25 kg
8.	4.2	Solide sujet à l'inflammation spontanée	25 kg
9.	4.3	Solide réagissant au contact de l'eau	25 kg
10.	5.1	Matière comburante	50 l ou 50 kg
11.	5.2	Peroxyde organique	1 l ou 1 kg
12.	6.1	Matière toxique	5 l ou 5 kg

13.	6.2	Infectious substances	Any amount
14.	7	Radioactive	Any amount
15.	8	Corrosive substances	5 ℓ or 5 kg
16.	9.1 (in part)	Miscellaneous products or substances, excluding PCB mixtures	50 ℓ or 50 kg
17.	9.2	Environmentally hazardous	1 ℓ or 1 kg
18.	9.3	Dangerous wastes	5 ℓ or 5 kg
19.	9.1 (in part)	PCB mixtures of 5 or more parts per million	0.5 ℓ or 0.5 kg
20.	None	Other contaminants	100 ℓ or 100 kg

13.	6.2	Matière infectieuse	Toute
14.	7	Matière radioactive	Toute
15.	8	Matière corrosive	5 l ou 5 kg
16.	9.1 (en partie)	Matière diverse ou produit divers (mélanges contenant des BPC exclus)	50 l ou 50 kg
17.	9.2	Matière nocive pour l'environnement	1 l ou 1 kg
18.	9.3	Déchet toxique	5 l ou 5 kg
19.	9.1 (en partie)	Mélange contenant 5 parties ou plus de BPC par million	0,5 l ou 0,5 kg
20.	Aucune	Autre contaminant	100 l ou 100 kg

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Appendix III

NT Spill Report Form

NT-NU SPILL REPORT

OIL, GASOLINE, CHEMICALS AND OTHER HAZARDOUS MATERIALS

Northwest Territories   Nunavut   Canada

NT-NU 24-HOUR SPILL REPORT LINE
TEL: (867) 920-8130
FAX: (867) 873-6924
EMAIL: spills@gov.nt.ca

REPORT LINE USE ONLY

A	REPORT DATE: MONTH – DAY – YEAR	REPORT TIME	☐ ORIGINAL SPILL REPORT, OR	REPORT NUMBER
B	OCCURRENCE DATE: MONTH – DAY – YEAR	OCCURRENCE TIME	☐ UPDATE # ______ TO THE ORIGINAL SPILL REPORT	___-______
C	LAND USE PERMIT NUMBER (IF APPLICABLE)	WATER LICENCE NUMBER (IF APPLICABLE)		
D	GEOGRAPHIC PLACE NAME OR DISTANCE AND DIRECTION FROM NAMED LOCATION	REGION ☐ NWT ☐ NUNAVUT ☐ ADJACENT JURISDICTION OR OCEAN		
E	LATITUDE DEGREES MINUTES SECONDS	LONGITUDE DEGREES MINUTES SECONDS		
F	RESPONSIBLE PARTY OR VESSEL NAME	RESPONSIBLE PARTY ADDRESS OR OFFICE LOCATION		
G	ANY CONTRACTOR INVOLVED	CONTRACTOR ADDRESS OR OFFICE LOCATION		
H	PRODUCT SPILLED	QUANTITY IN LITRES, KILOGRAMS OR CUBIC METRES	U.N. NUMBER	
	SECOND PRODUCT SPILLED (IF APPLICABLE)	QUANTITY IN LITRES, KILOGRAMS OR CUBIC METRES	U.N. NUMBER	
I	SPILL SOURCE	SPILL CAUSE	AREA OF CONTAMINATION IN SQUARE METRES	
J	FACTORS AFFECTING SPILL OR RECOVERY	DESCRIBE ANY ASSISTANCE REQUIRED	HAZARDS TO PERSONS, PROPERTY OR ENVIRONMENT	
K	ADDITIONAL INFORMATION, COMMENTS, ACTIONS PROPOSED OR TAKEN TO CONTAIN, RECOVER OR DISPOSE OF SPILLED PRODUCT AND CONTAMINATED MATERIALS			

L	REPORTED TO SPILL LINE BY	POSITION	EMPLOYER	LOCATION CALLING FROM	TELEPHONE
M	ANY ALTERNATE CONTACT	POSITION	EMPLOYER	ALTERNATE CONTACT LOCATION	ALTERNATE TELEPHONE

REPORT LINE USE ONLY

N	RECEIVED AT SPILL LINE BY	POSITION STATION OPERATOR	EMPLOYER	LOCATION CALLED YELLOWKNIFE, NT	REPORT LINE NUMBER (867) 920-8130

LEAD AGENCY ☐ EC ☐ CCG ☐ GNWT ☐ GN ☐ ILA ☐ INAC ☐ NEB ☐ TC | SIGNIFICANCE ☐ MINOR ☐ MAJOR ☐ UNKNOWN | FILE STATUS ☐ OPEN ☐ CLOSED

AGENCY	CONTACT NAME	CONTACT TIME	REMARKS
LEAD AGENCY			
FIRST SUPPORT AGENCY			
SECOND SUPPORT AGENCY			
THIRD SUPPORT AGENCY			

Appendix IV

SCM Spill Log

SCML Spill Log (for spills greater than 1L)

Name of Witness	Date/Time	Contaminant	Quantity	Location and distance to nearest watercourse	Description of Incident, Initial Actions, Reporting, and Cleanup

* For spills greater than 100 L (for diesel, gasoline, jet fuel, lubricants, and special wastes) please reference Spill Contingency Plan.

** For propane spills of any amount from a container >100 L, please reference Spill Contingency Plan.

APPENDIX IV. EROSION AND SEDIMENT CONTROL PLAN

EDI (2015). Erosion and Sediment Control Plan for the Howard’s Pass Road Widening Project: Construction Phase - DRAFT. Prepared for Selwyn Chihong Mining Ltd. by EDI Environmental Dynamics Inc., Vancouver, BC.

Erosion and Sediment Control Plan for the Howards Pass Road Widening Project: Construction Phase - DRAFT

Prepared For

Selwyn Chihong Mining Ltd.
2701-1055 West Georgia Street
Vancouver, BC V6E 0B6

Prepared By

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Whitehorse, YT Y1A 3T8

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Pat Tobler, Branch Manager / Sr. Biologist
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EDI Project

15Y0226
June 2015

EDI
ENVIRONMENTAL DYNAMICS INC.
Down to Earth Biology

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REVISION SUMMARY

Version No.	Date	Notes
0	June 4, 2015	Preliminary draft issued to client as an outline of information to be included.
1	June 8, 2015	Draft report. Issued for inclusion in permitting documents.

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EXECUTIVE SUMMARY

The Howards Pass Access Road (HPAR) extends approximately 80 km northwest from the Nahanni Range Road in the Northwest Territories to the Yukon border in Howard's Pass near Selwyn Chihong Mining Ltd.'s (Selwyn Chihong) XY exploration camp. Selwyn Chihong is proposing upgrades to the HPAR for commercial hauling purposes. These upgrades will involve widening of the existing road, slight modifications to the road alignment and extending and/or relocating 23 culvert crossings. EDI Environmental Dynamics (EDI) was retained to develop an Erosion and Sediment Control Plan (ESCP); the intent of this document is to provide measures to mitigate potential effects of erosion and sedimentation resulting during the construction phase of the project.

Recent field assessments conducted by Triton Environmental Consultants (Triton) during the summer of 2014 provide crossing specific fisheries potential. All watercourses along the HPAR were surveyed and designated as fish bearing or non-fish bearing. Of the 23 watercourse crossings selected for culvert work, 9 were identified as having fish bearing potential (Triton 2014). Fish species documented in the Project area include Arctic grayling (*Thymallus arcticus*), burbot (*Lota lota*), slimy sculpin (*Cottus cognatus*) and lake trout (*Salvelinus namaycush*) (Triton 2014).

Selwyn Chihong is committed to minimizing potential effects associated with the road upgrades by adhering to mitigation measures outlined in this document and other regulatory requirements. Construction activities will be conducted in a manner that minimizes disturbance to fish and riparian habitat at all watercourse crossings.

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AUTHORSHIP

This report was prepared by EDI Environmental Dynamics Inc. Staff who contributed to this project include:

Kevin Christie, R.P.Bio., A.Ag. .... Primary Author

Meighan Kearns, R.P.Bio. .... Senior Review

Pat Tobler, R.P.Bio., CPESC .... Senior Advisor

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1 INTRODUCTION

Selwyn Chihong Mining Ltd. (Selwyn Chihong) is proposing further upgrades to the Howard's Pass Access Road (HPAR), which will involve widening of the existing road, slight modifications to the road alignment and extending and/or relocating 23 of the larger culvert crossings. Additional crossings may be identified for upgrading during detailed engineering; the methods outlined in this plan would apply any such additional upgrades. No upgrade works to eight of the existing bridge sites that were recently installed are proposed.

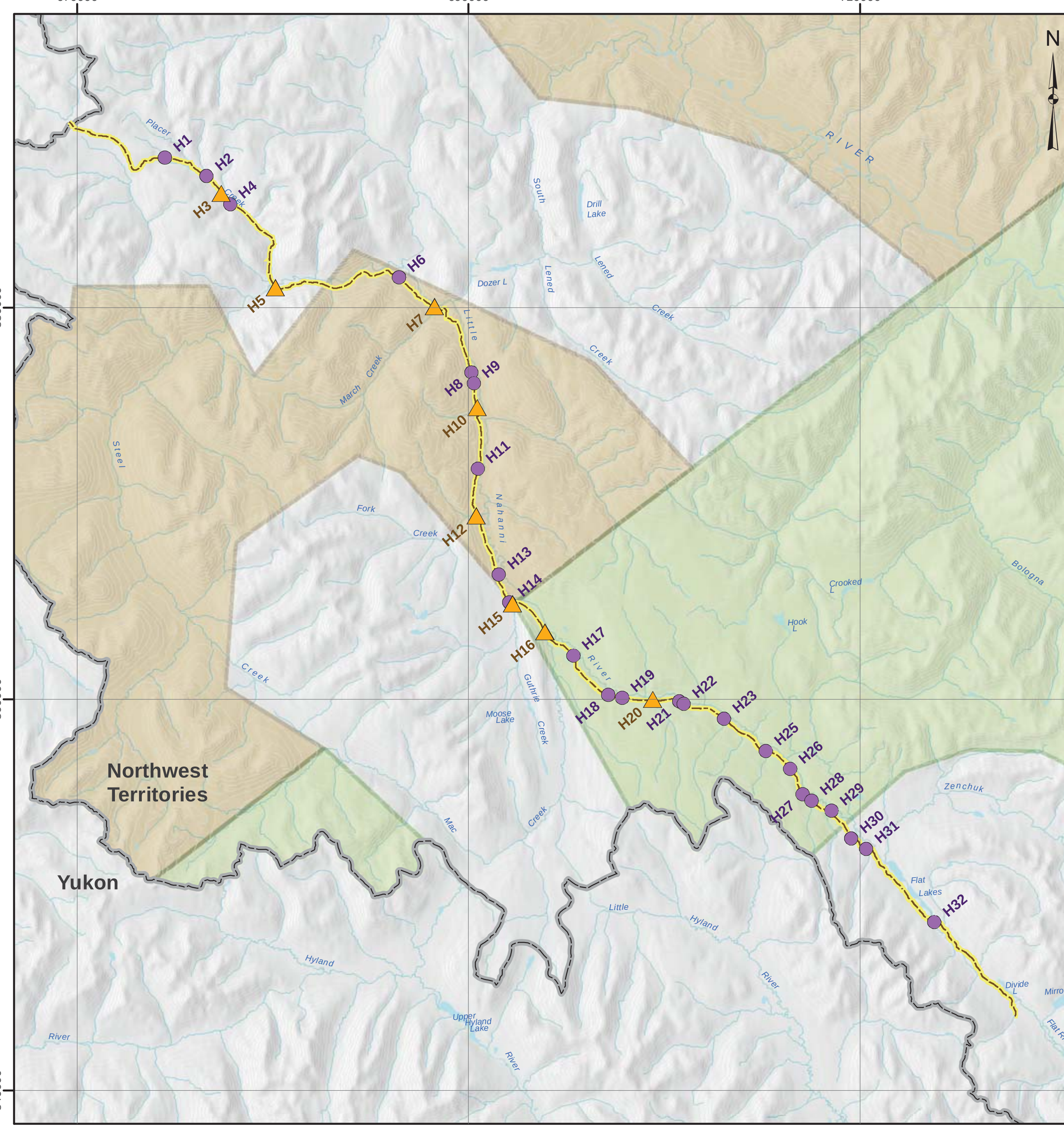
The Selwyn Project, a proposed zinc-lead mine in the environmental and socio-economic assessment and design phase, is located in eastern Yukon Territory (YT), approximately 300 km north of Watson Lake, YT, near the Northwest Territories (NWT) border. The HPAR starts at KM 188 on the Nahanni Range Road, near the Cantung Mine, NWT and follows the Little Nahanni River drainage (NWT) for approximately 80 km to the YT border in Howard's Pass (Figure 1).

EDI Environmental Dynamics Inc. (EDI) was retained by Selwyn Chihong to develop an Erosion and Sediment Control Plan (ESCP) for construction works associated with the proposed upgrades.

The purpose of this document is to:

1) Identify site-specific erosion and sedimentation issues that may result from proposed construction works;
2) Outline measures and Best Management Practices (BMP) designed to minimize erosion and sedimentation at the sites;
3) Provide a robust ESCP to protect aquatic resources (fish and fish habitat).

The focus of this plan is to prevent and mitigate environmental effects resulting from erosion and sedimentation issues during the **construction phase** of the road upgrades. This document is intended to encompass and present standard BMP for erosion and sediment control (ESC) measures typically associated with stream crossing sites. These recommendations will require an adaptive management approach by the onsite environmental monitor (EM) and construction manager, as challenges may arise with construction equipment and supplies given the sites' remote location and the dynamic, unpredictable nature of stream flow characteristics and weather patterns.



Legend

- Culvert (upgrades planned)
- Bridge (upgrades completed in 2014)
- Howard's Pass Access Road
- Nahanni National Park Reserve
- Nááts'ihch'oh National Park Reserve
- Yukon/Northwest Territories Border

Bridge and proposed culvert upgrade locations along the Howard's Pass Access Road

1:50,000 and 1:250,000 Topographic Spatial Data courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

NWT Centre for Geomatics, ENR-ITI Shared Services, Government of the Northwest Territories, 2013.

Culvert and bridge locations provided by Selwyn Chihong Mining Ltd.

Project data displayed is site specific. Data used by EDI Environmental Dynamics Inc. (2014) was obtained from Yukon Government and Access Consulting.

This document is not an official land survey and the spatial data presented is subject to change.

0 5 10 15
kilometres

Map Scale: 1:300,000 (printed on 8.5 x 11)
Map Projection: NAD 1983 CSRS Yukon Albers

SELWYN CHIHONG MINING LTD.
EDI

Drawn: MP	Checked: MK/KC	Date: 08/06/2015	FIGURE 1

Path: J:\Yukon\Projects\2015\15Y0226_HPAR\Mapping\FinalMaps\Map1_StreamCrossing_03June2015_MP.mxd

2 AQUATIC RESOURCES

The HPAR is situated in the Little Nahanni River watershed; fish species documented in this watershed include Arctic grayling (*Thymallus arcticus*), burbot (*Lota lota*), slimy sculpin (*Cottus cognatus*), and lake trout (*Salvelinus namaycush*). Biophysical assessments and fish sampling were conducted at select watercourses along the HPAR by Selwyn Resources Ltd. (2008). More recently, Triton Environmental Consultants (2014) conducted a fish and fish habitat inventory of watercourses intersecting the HPAR.

Of the 23 watercourse crossings identified for culvert work, nine were identified as having fish bearing potential (Triton 2014). A summary of fish-bearing status and habitat suitability of all crossing upgrade sites is provided in Table 1. Fish-bearing status is based on fish presence or unobstructed connectivity to a fish-bearing watercourse. Triton (2014) found the habitat suitability varied considerable by site. Spawning potential was noted at some sites (i.e., rated moderate to good). Overwintering habitat suitability was rated poor to nil at most sites and it was concluded that fish likely out-migrate to overwinter in Steel Creek, Little Nahanni River or Nahanni River (Triton 2014).

Table 1. Summary of fish and fish habitat suitability for watercourse crossing upgrade sites.

Crossing ID[1]	Fisheries Site ID[2]	HPAR km	Fish Bearing (Y/N)	Species Captured	Habitat Suitability Rating			
					Rearing	Spawning	Migration	Overwintering
H1	HPAR76	72.561	no		good	nil	poor	nil
H2	HPAR74	70.122	no		poor	poor	poor	poor
H4	HPAR70	68.161	no		poor	poor	poor	poor
H6	HPAR65	55.573	no		poor	poor	poor	poor
H8	HPAR62	48.756	no		poor	poor	poor	nil
H9	HPAR61	48.155	no		poor	poor	poor	poor
H11	HPAR58	43.551	no		poor	nil	nil	nil
H13	HPAR56	37.787	no		poor	poor	poor	poor
H14	HPAR55	36.251	**yes**		moderate	moderate	moderate	moderate
H17	HPAR51	31.622	no		poor	nil	nil	nil
H18	HPAR50	28.802	no		good	nil	nil	nil
H19	HPAR49	28.066	**yes**		moderate	nil	nil	poor
H21	not identified	25.091	no					
H22	HPAR46	24.818	no		poor	poor	nil	nil
H23	HPAR42	22.537	**yes**		moderate	moderate	unknown	moderate
H25	HPAR38	19.751	**yes**		moderate	poor	unknown	nil
H26	HPAR36	18.138	**yes**		poor	nil	unknown	nil
H27	HPAR 35	16.657	no		nil	nil	unknown	nil
H28	HPAR 33	16.087	**yes**		good	moderate	unknown	nil
H29	HPAR 32	14.915	**yes**	[3]GR	excellent	good	good	good
H30	HPAR29	13.129	no		poor	nil	unknown	nil
H31	HPAR25	11.923	**yes**		moderate	moderate	unknown	poor
H32	HPAR15	6.817	**yes**	[3]GR, CCG, BB	good	good	unknown	poor

[1] From Madrone Environmental Services Ltd., 2011

[2] From Triton Environmental Consultants Ltd., 2014

[3] Fish species: GR = Arctic grayling; CCG = Slimy sculpin; BB = Burbot

3 PROJECT DESCRIPTION

Selwyn Chihong is proposing additional upgrades to the HPAR for commercial hauling suitability. The HPAR proposed upgrades include:

- Modifications to the road alignment;
- Widen the existing roadbed to a width of 8.5 m;
- Installation of additional ESC measures at identified bridge sites (Table 2); and,
- Relocation or modifications to 23 existing culverts (Table 3).

Bridges installed in 2014 are engineered for commercial use; therefore, additional bridge work will not occur during the road widening project. However, approaches to six of the bridges were identified for additional ESC measures to prevent sediment transport into the adjacent waterbody due to high gradient slope aspects (Table 2).

Table 2. Bridge crossing locations.

Crossing ID[4]	Fisheries Site ID[5]	Watercourse Name	HPAR km	Easting[6]	Northing	Fish Bearing Status	Bridge Span (m)	Proposed Upgrade: Relocate or Extend
H3	HPAR73	Placer Creek	68.9	496699	6921336	yes	14.25	No Change
H5	HPAR69	Steel Creek	62.5	499196	6916365	yes	47.8	No Change
H7	HPAR64	March Creek	53.1	507265	6914954	yes	17.6	No Change
H10	HPAR60	Unnamed Creek (47.1 Km)	47	509153	6909696	yes	14.49	No Change
H16	HPAR52	Mac Creek	33.6	511993	6898066	yes	47.8	No Change
H20	HPAR48	Unnamed Creek (26.5 km)	26.5	517285	6894307	yes	14.49	No Change

A summary of the proposed culvert crossing upgrades are provided in Table 3. Culvert crossings listed do not encompass all crossings along the HPAR, only the larger more significant watercourses. An assessment of all watercourse crossings along the HPAR will be competed at a later date, which may result in the proposal of additional culvert upgrades. The preliminary road design drawings (Selwyn Chihong 2014) are provided in Appendix A.

[4] From Madrone Environmental Services Ltd., 2011

[5] From Triton Environmental Consultants, 2014

[6] Datum NAD83, Zone 9V

Table 3. Culvert crossing information and proposed upgrades.

Crossing ID[7]	Fisheries Site ID[8]	HPAR km	Easting	Northing	Fish-bearing (Y/N)	Existing Culvert Diameter (mm)	Proposed Upgrade
H1	HPAR76	72.561	493923	6923321	no	1100	Relocate, 51 m length
H2	HPAR74	70.122	495988	6922249	no	1200	Relocate, 27 m length
H4	HPAR70	68.161	497122	6920753	no	1200	Relocate, 30 m length
H6	HPAR65	55.573	505527	6916545	no	1000	Extend by 6 m
H8	HPAR62	48.756	508948	6911497	no	unknown	Relocate, 39 m length
H9	HPAR61	48.155	509045	6910940	no	unknown	Extend by 9 m
H11	HPAR58	43.551	509019	6906580	no	unknown	Relocate, 36 m length
H13	HPAR56	37.787	509775	6901106	no	1000	Extend by 6 m
H14	HPAR55	36.251	510227	6899669	yes	1200	Relocate, 15 m length
H17	HPAR51	31.622	513363	6896770	no	1000	Extend by 12 m
H18	HPAR50	28.802	515019	6894673	no	1000	Extend by 9 m
H19	HPAR49	28.066	515722	6894488	yes	2200	Extend by 9 m
H21	not identified	25.091	518632	6894144	no	600	Extend by 15 m
H22	HPAR46	24.818	518864	6894001	no	800	Extend by 12 m
H23	HPAR42	22.537	520869	6893136	yes	2000	Extend by 6 m
H25	HPAR38	19.751	522910	6891366	yes	2700	Extend by 6 m
H26	HPAR36	18.138	524107	6890370	yes	2200	Relocate, 15 m length
H27	HPAR 35	16.657	524665	6889048	no	1400	Relocate, 30 m length
H28	HPAR 33	16.087	525103	6888701	yes	2200	Extend by 12 m
H29	not identified	14.915	526076	6888126	yes	1400	Relocate, 30 m length
H30	HPAR29	13.129	527018	6886657	no	0	Relocate, 39 m length
H31	HPAR25	11.923	527748	6886088	yes	0	Relocate, 15 m length
H32	HPAR15	6.817	531017	6882160	yes	0	Extend by 9 m.

[7] From Madrone Environmental Services Ltd., 2011

[8] From Triton Environmental Consultants Ltd., 2014

4 MITIGATION MEASURES

The following sections outline various techniques and BMP's designed to avoid or mitigate impacts to the aquatic environment. It is anticipated the on-site EM will assist with proactive planning and field fit of the recommended BMPs. The EM will also identify additional areas of concern as construction activities progress. Detailed installation instructions for BMP's are provided in Appendix C.

4.1 TIMING OF WORKS

Timing of construction works is an important mitigation measure implemented during the planning stages. Selwyn Chihong intends to complete the proposed road widening works during the summer and fall seasons in 2017 and 2018. Table 4 illustrates the anticipated construction schedule in relation to seasonal environmental sensitivities. Instream works are anticipated to occur within the recommended DFO Timing Window to avoid spring spawners (e.g., Arctic grayling) in NWT Zone 2 (July 16 to March 31) (DFO 2013). Due to documentation of Arctic grayling in the Little Nahanni River (Selwyn 2008a; Triton 2014), it is recommended that the same timing window be followed for all crossings, where possible.

Table 4. Construction schedule, 2017 and 2018

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul[9]	Aug	Sep[10]	Oct	Nov	Dec
Construction	■	■	■				■	■	■			
Migratory bird breeding/nesting					■	■	■					
Caribou calving					■	■						
Caribou rutting									■	■		
Spring spawning (Arctic grayling)				■	■	■	■					

4.2 ON-SITE SUPPLIES

It is recommended the following supplies be available at the start of construction:

- silt fences (20 rolls);
- non-woven geotextile (20 rolls);
- t-bars or similar (to reinforce silt fence where needed);
- sand bags;
- polyethylene sheeting (6 mm thickness; 20 rolls);
- tarps; and,

[9] No clearing or instream activities are expected to occur during the associated sensitive timing windows for migratory breeding birds and spring spawning fish respectively.

[10] Additional mitigation measures may be taken during the caribou rutting period, as per Selwyn Chihong's Wildlife Protection Plan (Selwyn 2008b)

- large gravel and rip rap material.

4.3 PRE-WORK MEETING

A pre-work meeting should be held on site with all field staff and supervisors prior to construction commencement. The ESCP should be reviewed to ensure that all parties involved understand the objectives and their role in implementation of the plan.

4.4 BRIDGE APPROACHES

Bridges installed during the winter of 2014 will not require upgrades; however, some of the approaches were identified for additional mitigation (Table 5) to prevent or minimize erosion and sediment transport. For example; erosion control blankets or mulch, straw waddles or silt fence could be utilized on exposed slopes leading to watercourses whenever possible. Site specific recommendations will be provided on a site by site basis by the on-site EM.

Table 5. Bridge crossing locations identified for additional ESC measures

Crossing ID[11]	Fisheries Site ID[12]	Stream Name	Notes
H3	HPAR73	Placer Creek	High and low chain approaches to the crossing slope towards the creek
H5	HPAR69	Steel Creek	Low chain approach to the crossing slopes towards the creek
H7	HPAR64	March Creek	High chain approach to the crossing slopes towards the creek
H10	HPAR60	Unnamed Creek (47.1 km)	Low chain approach to the crossing slopes towards the creek
H16	HPAR52	Mac Creek	High chain approach to the crossing slopes towards the creek
H20	HPAR48	Unnamed Creek (26.5 km)	Low chain approach to the crossing slopes towards the creek

4.5 ROAD WIDENING

The primary objectives for erosion and sediment control associated with any road construction are the management of surface runoff and control of erosion to minimize the amount of sediment that has the potential to enter the natural drainages and environmentally sensitive areas.

4.5.1.1 Road Drainage

Ditching along a road alignment can act to control water draining from the road running surface as well as to control water from small natural drainages and seepage areas located along the road alignment. Techniques such as offtake/ interceptor ditches will be recommended as needed by the on-site EM as road building activities progress. ESC structures such as check dams can also be incorporated into roadside ditches to aid in the reduction of sediments suspended in the water column.

[11] From Madrone Environmental Services Ltd., 2011

[12] From Triton Environmental Consultants Ltd., 2014

Due to the relatively steep topography in many locations on the project, it may also be necessary to implement ESC measures above and below the road on exposed slopes to minimize and/or prevent the migration of sediment.

The following BMPs (Appendix C) will be recommended as needed by the on-site EM to manage road drainage.

- Grubbed woody material can be used to construct brush barriers at the base of road fills to minimize sediment transport out of disturbed areas. Sediment laden water generated from construction activities should be diverted to a flat, vegetated area or sediment trap to prevent releases into nearby water bodies.
- Rock check dams, rock lined ditches, and sediment traps are common ESC BMPs that are associated with road ditching. Rock check dams and rock lined ditches are used to slow water velocities such that erosion in the ditch is limited and some of the suspended sediments already in drainage water can settle out. A critical design specification for rock check dams is that the maximum height of the check dam is lower than the elevation of the road surface.
- Sediment traps consist of excavated areas within the ditch. The purpose of a sediment trap is to capture sediment-laden water before it is discharged into an existing natural drainage. By reducing water velocity, a sediment trap facilitates the settling of fine particulate matter thereby reducing sediment levels discharged into the receiving environment.
- Ditch blocks are commonly installed on the downslope side of culvert inlets. Ditch blocks are used to shorten the length of ditches and to convey surface drainage into the culvert inlet. The outlets of cross-drain culverts are installed such that surface drainage is directed towards stable terrestrial vegetation on the downslope of the road. Both the inlet and outlet of cross-drain culverts should be armoured with non-erodible material.
- The installation of cross-drain culverts and ditch blocks are additional BMPs associated with road construction. Cross-drain culverts are used to manage drainage from the road surface and drainage from roadside ditches.
- The outlet of a cross-drain culvert specifically should be well armoured such that under high flow conditions a scour pool does not develop. Armouring at the cross-drain outlet will also act as an energy dispersion structure, which will slow water velocities discharging from the cross-drain outlet thereby further reducing downslope erosion concerns.
- Dependent on the area in which the outlet of the cross-drain culvert is located, a tail-out ditch may be required. Tail-out ditches are used to direct the discharge from cross-drain culverts and/or ditches onto stable vegetation located adjacent to the road right-of-way.

4.5.1.2 Management of Stock Pile Materials

The proper placement and containment of stripped materials generated during road construction is an important technique in managing erosion and sediment transport. Exposed soils in high risk areas should be covered as soon as possible. Specific locations and cover types will be field fit with consultation with the onsite Construction Manager and the EM.

Materials not appropriate for road prism construction will be sidecast during road construction. All sidecast material will be placed in stable areas away from natural drainages. As a temporary measure, sediment fence can be installed adjacent to the downslope edge of any stockpiles if sediment delivery to an adjacent drainage is a concern. Alternatively or in conjunction with sediment fence, polyethylene sheeting can be used to cover the sidecast material, which will reduce erosion and the need for sediment collection.

4.5.1.3 Vegetation Removal/ Grubbing

It is recommended that the Construction Manager and the EM conduct a site assessment to identify any areas of concern requiring field fit erosion and sediment control structures prior to stripping and grubbing activities. When working on slopes, the initial grubbing should occur along the upslope areas and progressively proceed downslope. This approach will ensure that a vegetative buffer is maintained downslope, which will aid in reducing incidental ESC concerns. It is suggested that the grubbing occurs in stages to minimize the lag time between grubbing and actual development. Grubbing of areas not proposed for immediate development should be avoided as this procedure will minimize the areas susceptible to unnecessary erosion by wind and water.

- Whenever possible, vegetation should be removed by using cutting methods rather than clearing methods, leaving roots intact. This will encourage natural re-growth following construction activities.
- Clearing and grubbing within the riparian area and along the stream bank must be kept to a minimum and only completed were required for the crossing structure.
- In areas where clearing is required, vegetation should be salvaged and used, where suitable, to rehabilitate disturbed areas.
- Perimeter ditching with rock check dams may be recommended along the downslope boundary of specific project areas, it is recommended that tail-outs be incorporated to frequently divert ditch water into flat and well vegetated areas.
- Utilizing temporary ditches and small sediment basins throughout grubbed areas is also a standard BMP associated with grubbing. Temporary ditches and sediment basins are often located in lower elevation and downslope areas that typically receive surface water.
- Sediment fence can be used as a temporary ESC measure to minimize sediment mobilization during rain or runoff events. It is strongly recommended that the installation of sediment fence be considered during grubbing activities adjacent to any non-classifiable drainage and draws when inclement weather conditions are anticipated and more permanent ESC measures have not been installed.
- Drainage control berms can be constructed downslope of grubbed areas along the slope contour.
- Mulching of exposed soils can provide effective erosion control for the short term if precipitation events are anticipated. Any mulching conducted during vegetation clearing activities should be stockpiled onsite. Mulching of exposed soils adjacent to environmentally sensitive areas is strongly recommended.

- At the request of Parks Canada, no seeding will occur due to concerns regarding the introduction of non-native and invasive species. Other erosion and sediment control measures such as live willow staking and rip-rap placement are recommended.

Concurrent with, and following grubbing, the installation of the initial ESC measures will commence. Exposed soils will be covered (e.g.,, gravel or mulch) as soon as activities in the area are complete. The Construction Manager/onsite EM will supervise and direct the construction of the ESC structures to ensure that the generic BMPs are implemented properly and when required. Collection and diversion ditches may be constructed provided construction occurs in the absence of flowing water.

4.6 CULVERT INSTALLATION AND UPGRADES

Culverts should be appropriately sized and positioned within the drainage to ensure the natural channel processes are not compromised. Undersized culverts may constrict flow, which can result in substrate deposition at the inlet and the increased water velocities through the culvert can lead to increased erosion downstream. These long term impacts may increase sedimentation affecting downstream fish habitat and water quality and may impede fish movement in fish bearing streams. Erosion at the culvert inlet and outlet can be prevented by placing non-woven filter fabric along the immediate banks and overlaying with rock armoring.

The following sections provide a summary of mitigation and isolation methods typically used during culvert installation activities when flowing water is present. These measures may or may not be applicable to this project as conditions encountered on site will dictate installation activities. It is important to have mechanically sound equipment operating on site to ensure activities are completed in a timely and efficient manner. Culvert installations are expected to be completed within a one to two day timeframe. For additional information and diagrams, the following documents are both excellent references on culvert installation procedures and associated best management practices:

- *Best Management Practices for Works Affecting Water in Yukon* (Yukon Environment 2011)
- *Fish-stream Crossing Guidebook, Revised Edition* (BC Ministry of Forests et al. 2012)

4.6.1 CONSTRUCTION SEQUENCE AND SPECIAL PROVISIONS

The following construction sequence is recommended for the culvert installations if the crossing sites are substantially wetted at the time of construction to minimize the potential of sediment being transported to aquatic habitats downstream.

- Pre-work meeting with the construction superintendent/supervisor, Engineer (or alternate) and EM;
- Fish salvage operations, if necessary;
- Isolation of work area (e.g., dam and pump or diversion);
- Installation of new culvert or extension; and,

- Re-introduction of water flow into new culvert.

Culverts installed within watercourses that are dry or do not contain flowing water do not require site isolation. However, other standard sediment and erosion control practices remain an important aspect throughout all construction activities.

4.6.2 FISH SALVAGE

At crossing locations with fish bearing potential, fish salvage operations must be conducted prior to the culvert work. A Fish Collection and a Park Permit must be obtained prior to fish salvage operations. Fish salvage operations may include backpack electrofishing, minnow trapping and/or beach seining. Stop nets should be used to isolate the work site from fish. Once captured, fish are typically identified to species, measured and relocated outside the work area in similar habitat they were captured in. In fish-bearing waters pump inlets must be covered by fish screens meeting the requirements set out by DFO in the *Freshwater Intake End-of-Pipe Fish Screen Guidelines* (DFO 1995).

4.6.3 WORK AREA ISOLATION

Culvert installations in watercourses require isolation of the site and temporary diversion of water flow around the site to maintain downstream flow and water quality. There are a number of techniques commonly used to divert flowing water around work sites, most commonly the dam-and-pump and diversion channel techniques. Appropriate site isolation techniques should be employed during summer construction, where possible, if flowing water is encountered, minimizing potential for sediment transport downstream.

In preparation for both techniques and contingency measures, the following equipment and supplies are recommended to have on site in preparation for isolating the work area:

- sand bags;
- polyethylene sheeting (6 mm thickness);
- pumps of sufficient capacity to handle flows expected (e.g., two 2 inch and two 3-4 inch pumps);
- approximately 500 feet of discharge hose;
- intake hose for pumping systems with appropriately sized fish screens;
- non-woven geotextile/filter fabric;
- drip trays for all pumps and jerry can fuel storage; and,
- a large spill kit (e.g., barrel size)

Table 6 provides additional details for assistance with selection of the appropriate diversion technique for each culvert installation. The following sections describe the dam-and-pump and diversion channel techniques.

Table 6. Comparison of watercourse diversion techniques

Technique	Advantage	Disadvantage	Application
Dam and Pump	• Limited sedimentation • Can be maintained for extended period of time • Can use multiple pumps • No obstructions in the instream work site • Hoses can be routed to avoid work site • Can be set up quickly • Works best on steeper gradient streams • Can use instream features (pools) for diversion pump sump.	• Some sediment produced during setup and removal • Fish passage barrier • Susceptible to washout • Dam effectiveness dependent on substrate materials • Additional equipment may be needed to control groundwater seepage • Limited by pump capacity. • Requires backup equipment. • Susceptible to mechanical failure. • Hoses may get in the way of construction equipment. • Limited use on low gradient streams.	• On small watercourses with low flow, defined streambanks and a defined channel • On watercourses where fish passage is not required. • Where sediment must be controlled. • Where the upstream dam can be easily constructed and only a small or no downstream dam is required
Diversion Channel	• Can be maintained for extended period of time • Can maintain fish passage.	• Significant sedimentation during initial flushing. • May isolate a very large section of a watercourse. • Diversion dam susceptible to washout. • Slow and costly. • Water may still be encountered in the isolated worksite. Will require pumps to control. • May block fish passage if flow velocity in channel is excessive. • Results in upland disturbance of vegetation and soils. • Extensive restoration may be required. • Careful design is required. • May require specialized materials such as a channel liner to minimize sedimentation. • May require extensive excavation.	• Moderate to large waterbodies where dam and pump is not practical. • Where sediment must be controlled and fish passage must be maintained. • Braided streams. • Best application is when channel can be excavated in coarse materials low in fines

Source: Malaspina (2007)

4.6.3.1 Dam and Pump

A dam-and-pump system is usually used on drainages with minimal discharge. Temporary berms or coffer dams installed in the drainage must be constructed of non-erodible material or protected from erosion and must be completely removed following project completion. Flow levels must be assessed prior to initiating construction to ensure an appropriately sized pump is available. This site isolation method is only recommended for sites where the in-drainage works can be completed within one day as the pumps must remain in operation to ensure base flows are maintained downstream. During the isolation, a sump may be required directly upstream of the work area to prevent subsurface water from entering the work site during construction. A downstream sump or sandbag coffer dam must also be installed to capture any sediment-laden water associated with the work site. Any sediment-laden water from both sumps should be pumped off-site to a well-vegetated area, where sediment will not be able to re-enter the drainage. With the site properly isolated, installation of the culverts can be accomplished without the risk of adversely affecting downstream environments. 0 provides detailed typical installation procedures.

4.6.3.2 Diversion Channel

Sub-zero temperatures or higher discharge volumes may require the use of a diversion channel or temporary piping. A diversion channel requires excavating a shallow depression and lining it with impermeable material such as plastic sheeting to convey water. Temporary piping utilizes culverts to convey water around the construction footprint. It is important to begin channel construction or pipe installation at the downstream end and work towards the inlet to ensure everything is secured in place before pulling the plug at the upstream end (inlet). The diversion channel/pipe should divert flow both upstream and downstream of the new culverts construction footprint in a manner that enables the new culvert outlet and inlet to be tied into the existing stream bed in the dry. 0 provides detailed typical installation procedures.

4.6.4 RE-INTRODUCTION OF WATER FLOW

If flowing water is present, it must be introduced gradually into the new culvert once construction has been completed. If necessary, sediment-laden water generated during this process must be captured in the downstream sump and pumped to an area off-site.

4.7 ENVIONMENTAL MONITORING

For the duration of construction, EDI will be the primary on-site Environmental Monitor (EM), conducting site visits during instream works and other environmentally sensitive works. In addition, Selwyn Chihong will have monitors from local communities on site, working with EDI. Both the EDI and Selwyn Chihong EMs will work closely with the construction manager to implement the recommendations outlined in this ESCP and any associated regulatory requirements. The role of the EM will be to provide assistance and advice during instream works, and implementation of erosion control measures, fish habitat mitigation/rehabilitation works, and replanting activities. The EM will have the authority to stop work if there is an imminent threat to the environment or an incident has occurred. A work stoppage may be the result of an unexpected weather event (e.g., heavy precipitation) or poor work practices (e.g., leaking equipment); in any event, the EM and construction manager must confer to determine corrective actions.

During instream works the EM will measure suspended solids in Nephelometric Turbidity Units (NTUs). The EM will establish an upstream background site and monitor downstream compliance sites at least twice daily (e.g., 20 m upstream and 20 m and 100 m downstream). At the discretion of the EM, compliance monitoring may increase or decrease in frequency and take place at additional sites if construction activities pose an increased risk of sedimentation or in the event of an unexpected sediment release. Suitable and safe compliance sites will be determined in the field by the EM. It is anticipated that pertinent regulatory water quality guidelines will be met during construction.

The EM will prepare regular monitoring reports summarizing construction activities and implementation of mitigation strategies to-date. The report will also provide further recommendations with respect to implementing additional mitigation measures, if required. Copies of these reports will be submitted to the appropriate Selwyn representative. A final inspection report should be provided following project completion, summarizing mitigation/rehabilitation measures implemented throughout the construction phase.

4.8 INSPECTIONS AND MAINTENANCE

Inspection and maintenance of all temporary ESC measures and structures will be on-going throughout the construction phase. In addition, it is recommended that post-construction monitoring be conducted to ensure the site reclamation proceeds in an acceptable and timely manner. The road widening project is scheduled to occur from June through to November of 2017 and 2018. Therefore, post-construction inspections should take place during and after spring freshet (2018 and 2019) to assess site stability and implement additional ESC measures, should they be required. Inspections should also take place near the end of the growing season to assess live staking and ground cover (2018 and 2019). Any temporary sediment controls remaining in service must be inspected and maintained until the site has stabilized. These structures should be removed once the site has sufficient vegetation and stability.

The following items will be assessed during the inspections to ensure mitigation measures are functioning as intended:

- The watercourse crossing structure;
- Culvert discharge area;
- Riparian vegetation regeneration;
- Re-vegetation of road cut and fill slopes;
- Slope and bank stability;
- Ditches and permanent drainage structures.

Following each inspection a brief report should be prepared summarizing the findings and any recommended action items.

5 REFERENCES

Barnard, W.D. 1978. Prediction and Control of Dredged Material Dispersion Around Dredging and Open-water Pipeline Disposal Operations. Dredged Material Research Program Technical Report DS-78-13. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS.

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DFO. 2013. Fisheries and Oceans Canada website: Northwest Territories Restricted Activity Timing Windows for the Protection of Fish and Fish Habitat. Available at: http://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/nwt-eng.html Accessed June 1, 2015.

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APPENDIX A. **ENGINEERING DRAWINGS**

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SELWYN CHIHONG MINING LTD.

SELWYN CHIHONG MINING LTD.

HOWARDS PASS ACCESS ROAD

PRELIMINARY ROAD DESIGN

AE PROJECT NUMBER: 20112946-01

ASSOCIATED ENGINEERING QUALITY MANAGEMENT	QM SIGNATURE	DATE	PCL SIGNATURE	DATE

PRELIMINARY/
FOR DISCUSSION
NOT FOR CONSTRUCTION

DRAFT

REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

DRAWING	REVISION	SHEET
2946-01-G-000	B	1 / 25

IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

SHEET LIST TABLE

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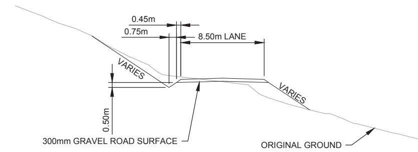
GENERAL				
1	2946-01-G-000	B	COVER SHEET	
CIVIL				
2	2946-01-C-100	B	SITE PLAN	LEGEND & GENERAL NOTES
3	2946-01-C-101	B	PLAN/PROFILE	STA 0+000 TO STA 3+700
4	2946-01-C-102	B	PLAN/PROFILE	STA 3+700 TO STA 7+400
5	2946-01-C-103	B	PLAN/PROFILE	STA 7+400 TO STA 11+100
6	2946-01-C-104	B	PLAN/PROFILE	STA 11+100 TO STA 14+800
7	2946-01-C-105	B	PLAN/PROFILE	STA 14+800 TO STA 18+500
8	2946-01-C-106	B	PLAN/PROFILE	STA 18+500 TO STA 22+200
9	2946-01-C-107	B	PLAN/PROFILE	STA 22+200 TO STA 25+900
10	2946-01-C-108	B	PLAN/PROFILE	STA 25+900 TO STA 29+600
11	2946-01-C-109	B	PLAN/PROFILE	STA 29+600 TO STA 33+300
12	2946-01-C-110	B	PLAN/PROFILE	STA 33+300 TO STA 37+000
13	2946-01-C-111	B	PLAN/PROFILE	STA 37+000.000 TO STA 40+717.262
14	2946-01-C-112	B	PLAN/PROFILE	STA 41+037.623 TO STA 44+730.000
15	2946-01-C-113	B	PLAN/PROFILE	STA 44+730 TO STA 48+430
16	2946-01-C-114	B	PLAN/PROFILE	STA 48+430 TO STA 52+130
17	2946-01-C-115	B	PLAN/PROFILE	STA 52+130 TO STA 55+830
18	2946-01-C-116	B	PLAN/PROFILE	STA 55+830 TO STA 59+530
19	2946-01-C-117	B	PLAN/PROFILE	STA 59+530 TO STA 63+230
20	2946-01-C-118	B	PLAN/PROFILE	STA 63+230 TO STA 66+930
21	2946-01-C-119	B	PLAN/PROFILE	STA 66+930 TO STA 70+630
22	2946-01-C-120	B	PLAN/PROFILE	STA 70+630 TO STA 74+330
23	2946-01-C-121	B	PLAN/PROFILE	STA 74+330 TO STA 78+030
24	2946-01-C-122	B	PLAN/PROFILE	STA 78+030.000 TO STA 78+456.637
25	2946-01-C-123	A	PLAN/PROFILE	SOUTH OPTION

1 PLAN 1:150,000
KEY PLAN

LEGEND

- EXISTING CONTOURS (EVERY 5m's)
- PERMITTED BORROW AREAS
- FUTURE BORROW AREAS
- CAMP AND LAYDOWN AREA
- LAYDOWN AREA
- EXISTING CREEK
- PARK BOUNDARY
- CULVERT & BRIDGE CROSSINGS — CROSSING H13
- 60m ROAD R.O.W. - NON PARK (#105I/1-14)
- ROAD R.O.W. - PARK
- PROPOSED TOES
- PROPOSED ROAD CENTRELINE
- PROFILE EXISTING GROUND
- PROFILE PROPOSED ROAD CENTRELINE



2 DETAIL 1:250
HPAR TYPICAL SECTION

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FOR DISCUSSION
NOT FOR CONSTRUCTION
DRAFT

REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
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SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: AS SHOWN

SELWYN CHIHONG MINING LTD.

CIVIL
SITE PLAN
LEGEND & GENERAL NOTES

DRAWING	REVISION	SHEET
2946-01-C-100	B	2 / 25

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DATE: 2014-12-17, Jonathan Ford

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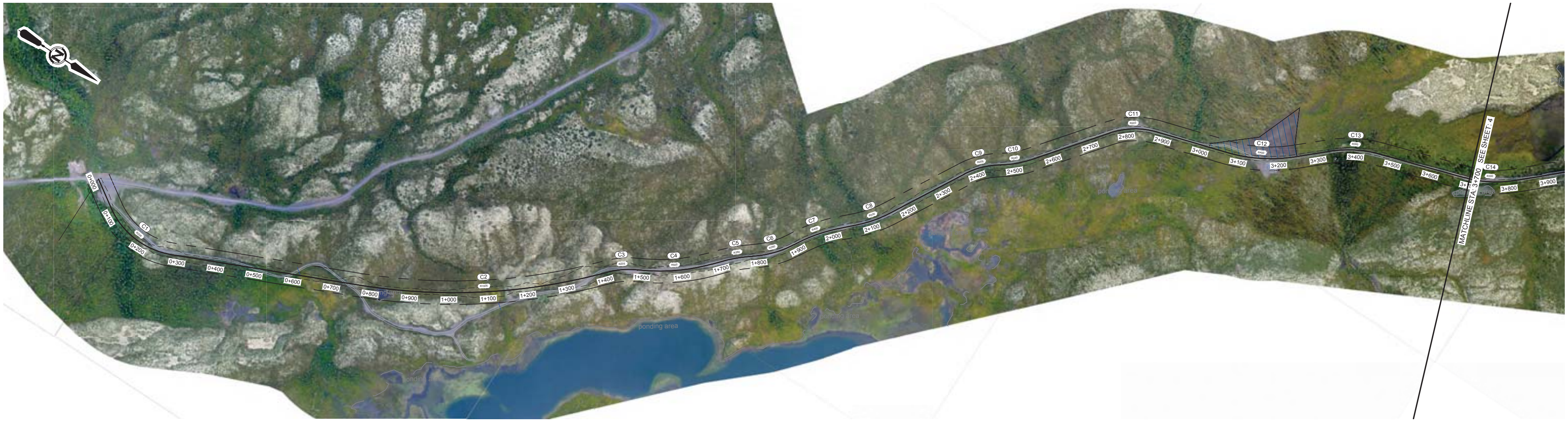

SOIL TYPES		RUBBLY SILTY SANDY OUTWASH DEPOSITS	MIX OF OUTWASH AND FLUVIAL DEPOSITS
CLEARING	sq. m	64,632	
EXCAVATION	cu. m	76,415	
EMBANKMENT	cu. m	69,067	
SURFACING	cu. m	9,849	
ROAD WIDTH	m	8.5	
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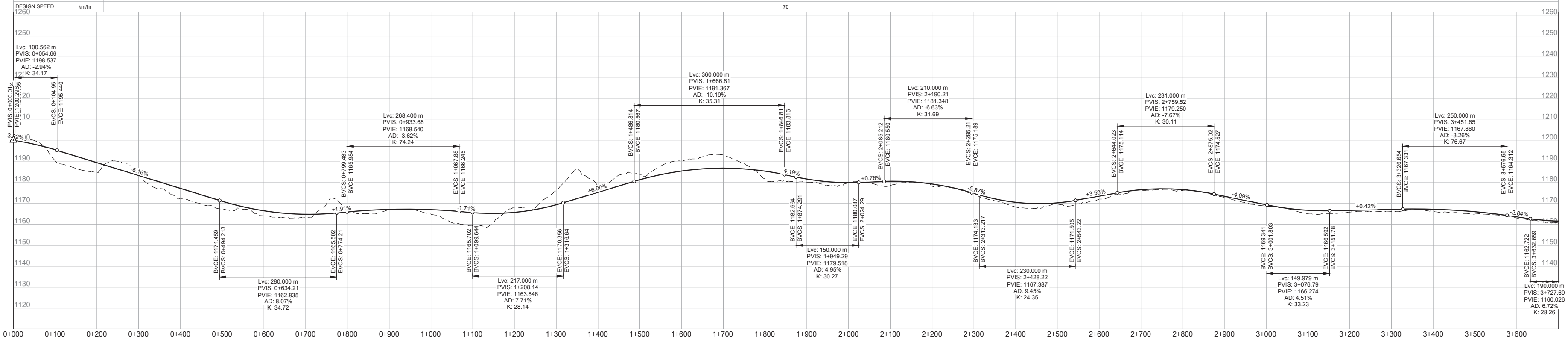
RIGHT TIE SLOPE		C 1.25:1 F 1.5:1	
DESIGN SPEED	km/hr	70	



Associated Engineering

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FOR DISCUSSION
NOT FOR CONSTRUCTION
DRAFT

REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

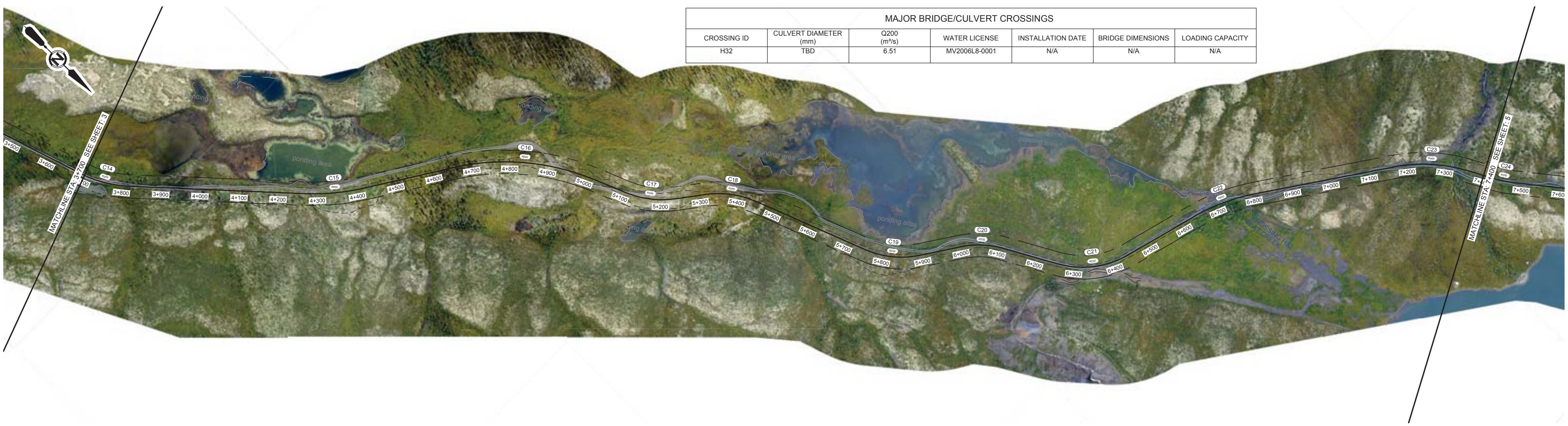
SCALE: H=1:5,000, V=1:1,000

SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 0+000 TO STA 3+700

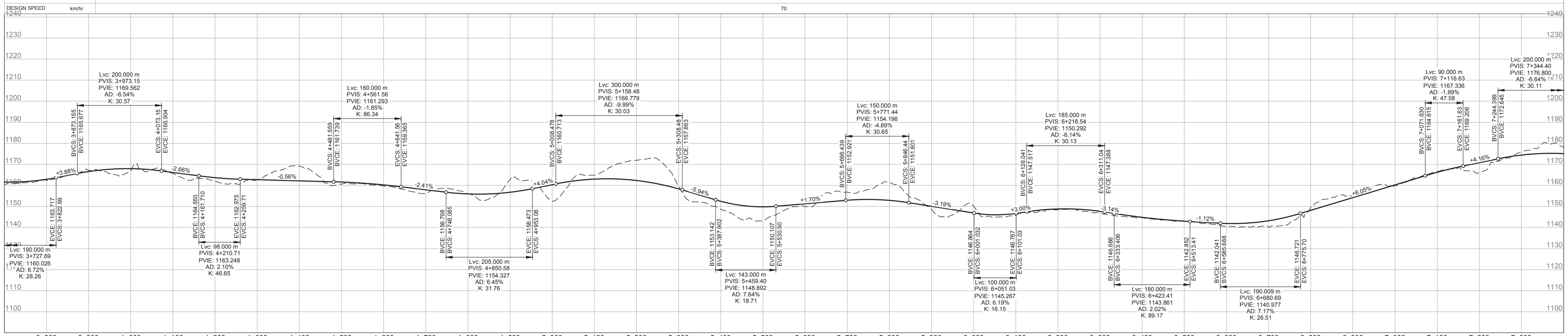
DRAWING	REVISION	SHEET
2946-01-c-101	B	3 / 25

IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



MAJOR BRIDGE/CULVERT CROSSINGS						
CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H32	TBD	6.51	MV2006L8-0001	N/A	N/A	N/A

SOIL TYPES		RUBBLY SANDY OUTWASH WITH FRACTURED BEDROCK EXPOSURES	RUBBLY SANDY OUTWASH MIXED WITH COLUVIUM	COMPLEX MIXED RUBBLY SANDY OUTWASH AND ALLUVIAL	RUBBLY SANDY OUTWASH DEPOSITS WITH VARIABLE SILT	RUBBLY SANDY OUTWASH TERRACE	MIXED RUBBLY SANDY OUTWASH AND COLLUVIUM	RUBBLY SANDY ALLUVIAL FAN	POORLY DRAINED SILTY SANDY ALLUVIAL DEPOSITS / FLAT CREEK	RUBBLY SANDY SILTY MORAINAL BLANKETS OVERLYING BEDROCK
CLEARING	sq. m					92,706				
EXCAVATION	cu. m					208,493				
EMBANKMENT	cu. m					66,009				
SURFACING	cu. m					9,849				
ROAD WIDTH						8.5				
LEFT TIE SLOPE						C 1.25:1 F 1.5:1				
RIGHT TIE SLOPE						C 1.25:1 F 1.5:1				
DESIGN SPEED	km/hr					70				



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DATE: 2014-12-17, Jonathan Ford

Associated Engineering

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FOR DISCUSSION
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REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:5,000, V=1:1,000

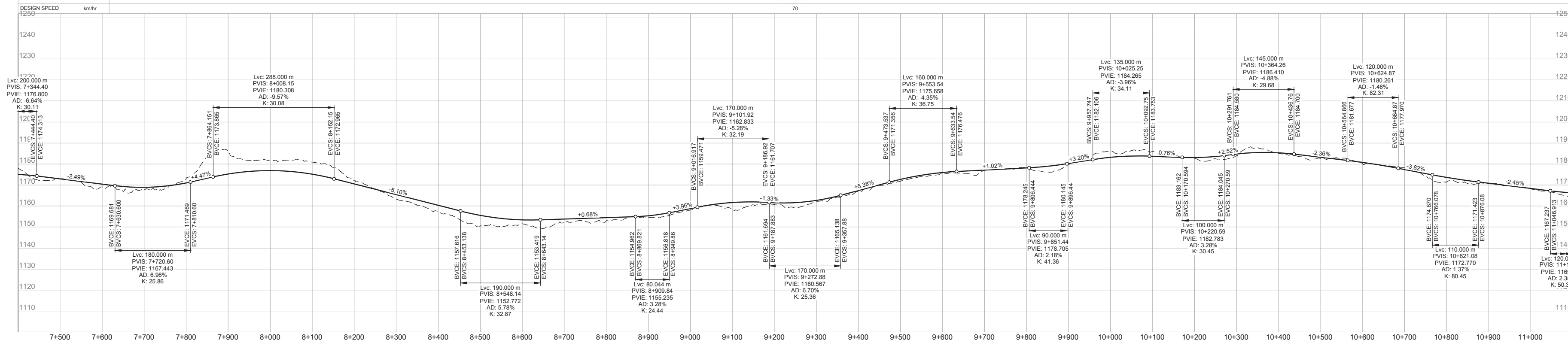
SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 3+700 TO STA 7+400

DRAWING	REVISION	SHEET
2946-01-c-102	B	4 / 25

IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

SOIL TYPES		RUBBLY SANDY SILTY MORAINAL BLANKETS	MORAINAL BLANKETS	RUBBLY SANDY SILTY MORAINAL BLANKETS	WELL DRAINED RUBBLY SAND TO RUBBLY SILTY SAND	WELL DRAINED RUBBLY SILTY SAND
		RUBBLY SANDY SILTY MORAINAL BLANKETS OVERLYING BEDROCK		RUBBLY SANDY SILTY MORAINAL BLANKETS		
CLEARING	sq. m	81,773				
EXCAVATION	cu. m	103,483				
EMBANKMENT	cu. m	65,692				
SURFACING	cu. m	9,849				
ROAD WIDTH		8.5				
LEFT TIE SLOPE		C 1.25:1 F 1.5:1				
RIGHT TIE SLOPE		C 1.25:1 F 1.5:1				
DESIGN SPEED	km/hr	70				



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DATE: 2014-12-17, Jonathan Ford

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DRAFT

REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

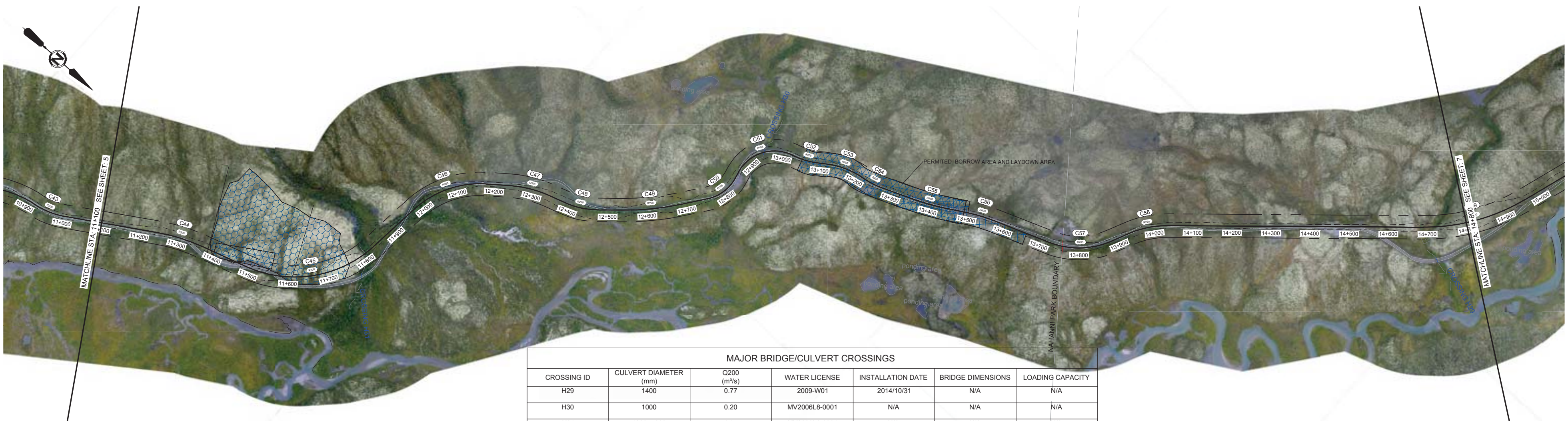
SCALE: H=1:5,000, V=1:1,000

SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 7+400 TO STA 11+100

DRAWING	REVISION	SHEET
2946-01-c-103	B	5 / 25

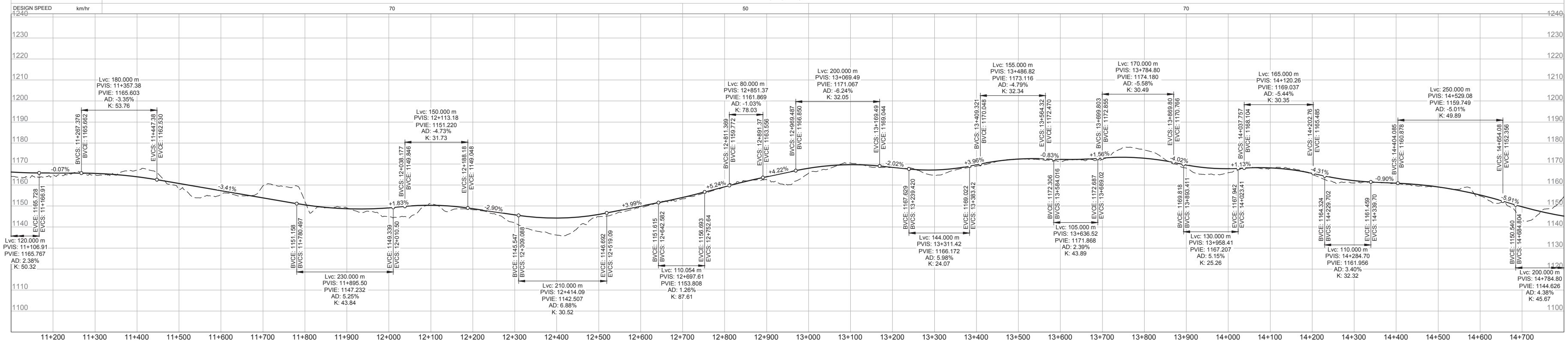
IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



MAJOR BRIDGE/CULVERT CROSSINGS

CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H29	1400	0.77	2009-W01	2014/10/31	N/A	N/A
H30	1000	0.20	MV2006L8-0001	N/A	N/A	N/A
H31	1200 + 600	1.17	MV2006L8-0001	N/A	N/A	N/A

SOIL TYPES		WELL DRAINED RUBBLY SILTY SAND; RUBBLY SILTY SANDY OUTWASH DEPOSITS; WELL DRAINED RUBBLY SILTY SAND; WELL DRAINED RUBBLY SAND TO RUBBLY SILTY SAND; WELL DRAINED GLACIOFLUVIAL DEPOSITS WITH SOME TILL
CLEARING	sq. m	66,497
EXCAVATION	cu. m	45,670
EMBANKMENT	cu. m	81,659
SURFACING	cu. m	9,849
ROAD WIDTH		8.5
LEFT TIE SLOPE		C 1.25:1 F 1.5:1
RIGHT TIE SLOPE		C 1.25:1 F 1.5:1
DESIGN SPEED	km/hr	70; 50; 70



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DATE: 2014-12-17, Jonathan Ford

Associated Engineering

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REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

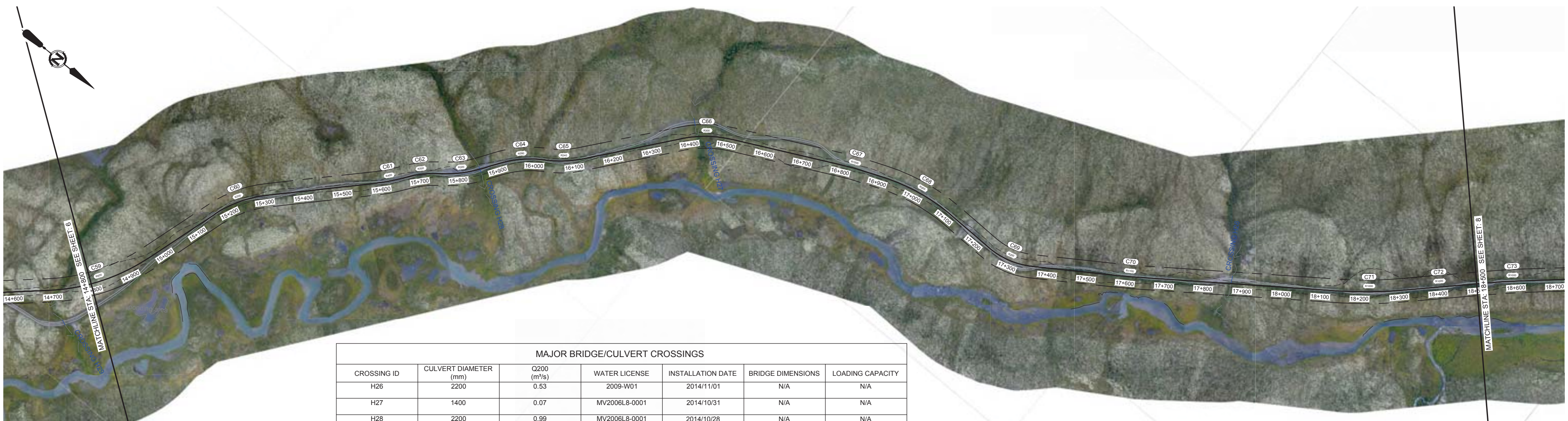
SCALE: H=1:5,000, V=1:1,000

SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 11+100 TO STA 14+800

DRAWING	REVISION	SHEET
2946-01-c-104	B	6 / 25

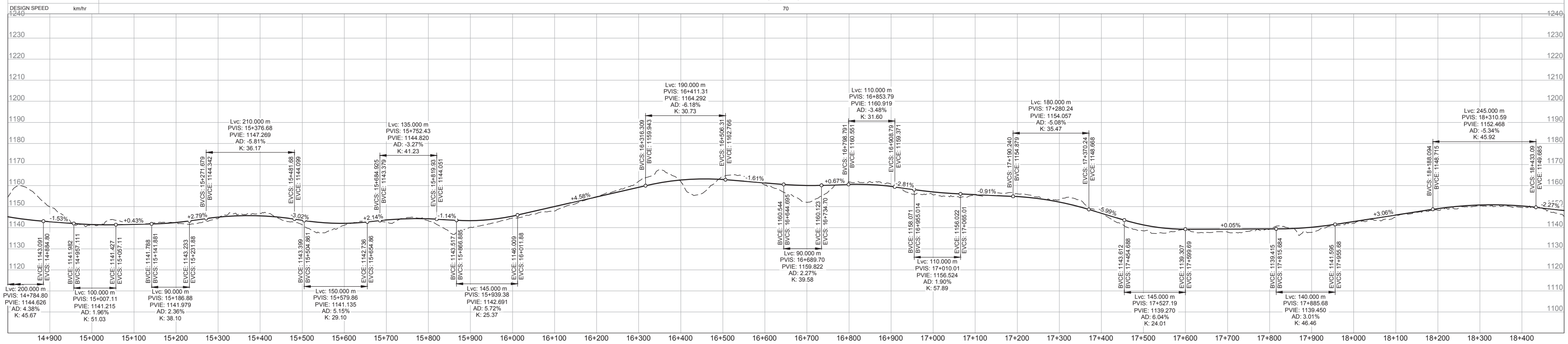
IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



MAJOR BRIDGE/CULVERT CROSSINGS

CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H26	2200	0.53	2009-W01	2014/11/01	N/A	N/A
H27	1400	0.07	MV2006L8-0001	2014/10/31	N/A	N/A
H28	2200	0.99	MV2006L8-0001	2014/10/28	N/A	N/A

SOIL TYPES		GLACIOFLUVIAL RUBBLY SANDY TO RUBBLY SANDY SILTY DEPOSITS / IMPERFECTLY TO MODERATELY WELL DRAINED RUBBLY SANDY SILT / MODERATELY WELL DRAINED RUBBLY SANDY SILT TO RUBBLY SAND / MODERATELY WELL DRAINED MORAINAL DEPOSITS WITH COLLUVIAL VENEERS / MODERATELY WELL DRAINED RUBBLY SAND TO RUBBLY SANDY SILT
CLEARING	sq. m	86,562
EXCAVATION	cu. m	99,798
EMBANKMENT	cu. m	83,626
SURFACING	cu. m	9,849
ROAD WIDTH		8.5
LEFT TIE SLOPE		C 1.25:1 F 1.5:1
RIGHT TIE SLOPE		C 1.25:1 F 1.5:1
DESIGN SPEED	km/hr	70



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DATE: 2014-12-17, Jonathan Ford

Associated Engineering

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FOR DISCUSSION
NOT FOR CONSTRUCTION
DRAFT

REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:5,000, V=1:1,000

SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 14+800 TO STA 18+500

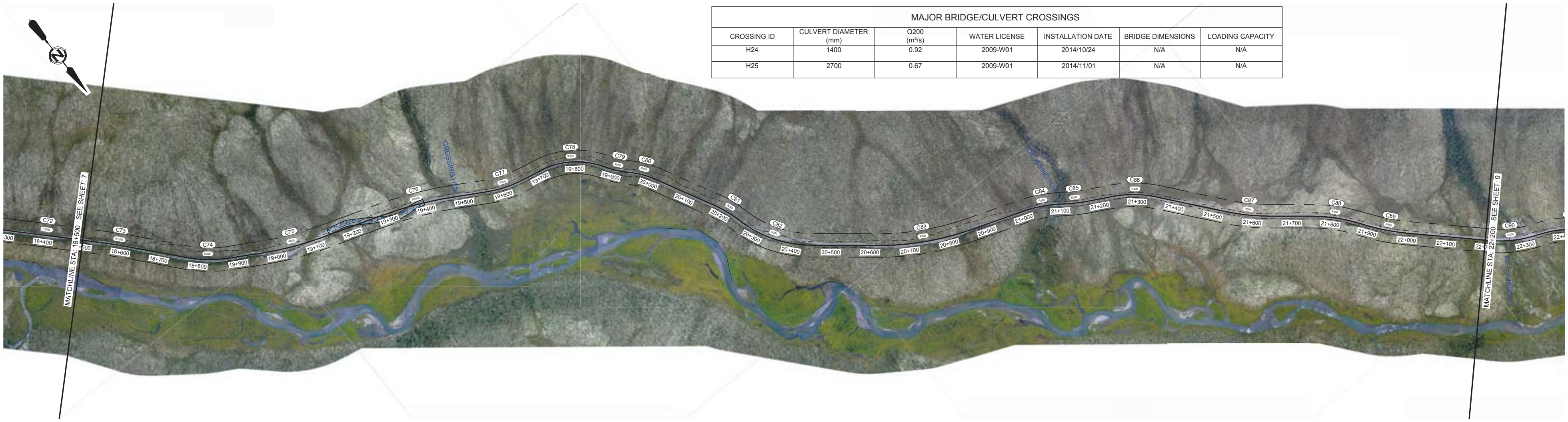
DRAWING	REVISION	SHEET
2946-01-c-105	B	7 / 25

IF NOT 50 mm ADJUST SCALES
50 mm

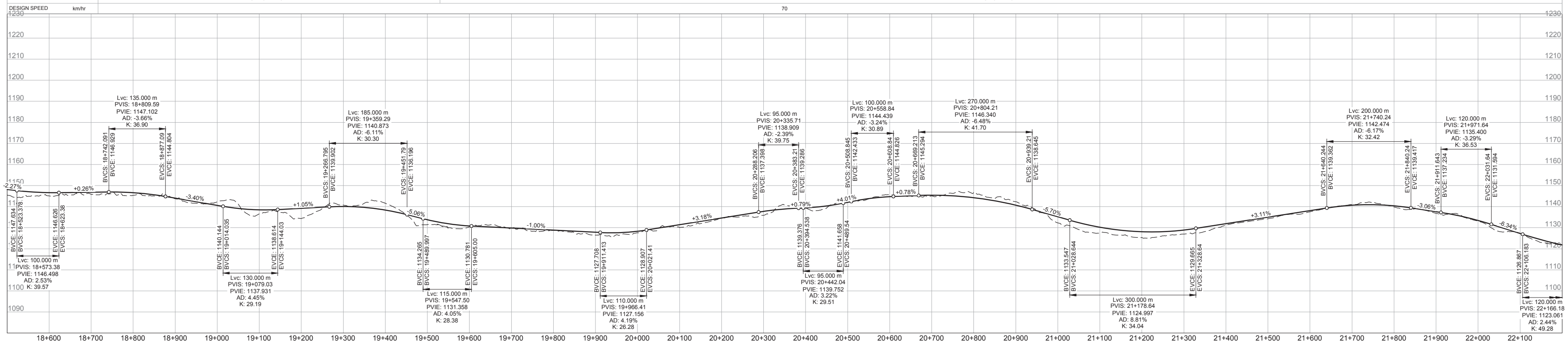
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

MAJOR BRIDGE/CULVERT CROSSINGS

CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H24	1400	0.92	2009-W01	2014/10/24	N/A	N/A
H25	2700	0.67	2009-W01	2014/11/01	N/A	N/A



SOIL TYPES		MODERATELY WELL DRAINED RUBBLY SANDY SILT TO RUBBLY SAND	MODERATELY WELL DRAINED RUBBLY SANDY SILTY MORRAINAL BLANKETS	IMPERFECTLY TO MODERATELY WELL DRAINED SANDY DIAMICTON SILTY MORRAINAL BLANKETS	PERMAFROST	WELL DRAINED RUBBLY SILTY SAND TO RUBBLY SAND	WELL DRAINED RUBBLY SANDT GLACIOFLUVIAL OUTWASH SEDIMENTS
CLEARING	sq. m	68,296					
EXCAVATION	cu. m	41,255					
EMBANKMENT	cu. m	45,306					
SURFACING	cu. m	9,849					
ROAD WIDTH		8.5					
LEFT TIE SLOPE		C 1.25:1 F 1.5:1	C 1.5:1 F 1.5:1				
RIGHT TIE SLOPE		C 1.25:1 F 1.5:1	C 1.5:1 F 1.5:1				
DESIGN SPEED	km/hr	70					



Associated Engineering

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FOR DISCUSSION
NOT FOR CONSTRUCTION

DRAFT

REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:5,000, V=1:1,000

SELWYN CHIHONG MINING LTD.

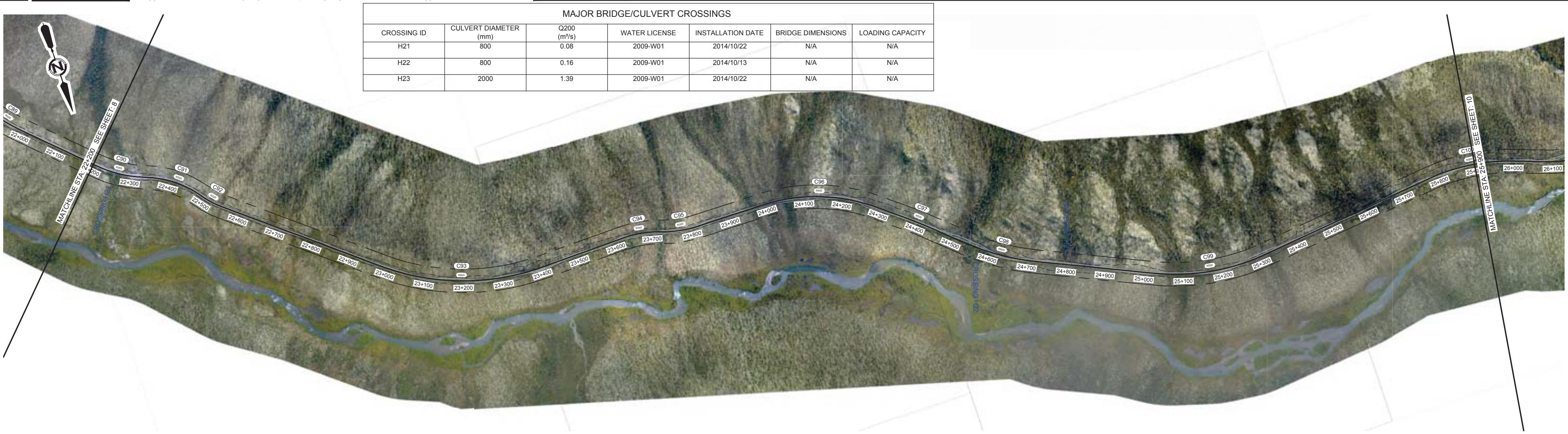
CIVIL
PLAN/PROFILE
STA 18+500 TO STA 22+200

DRAWING	REVISION	SHEET
2946-01-c-106	B	8 / 25

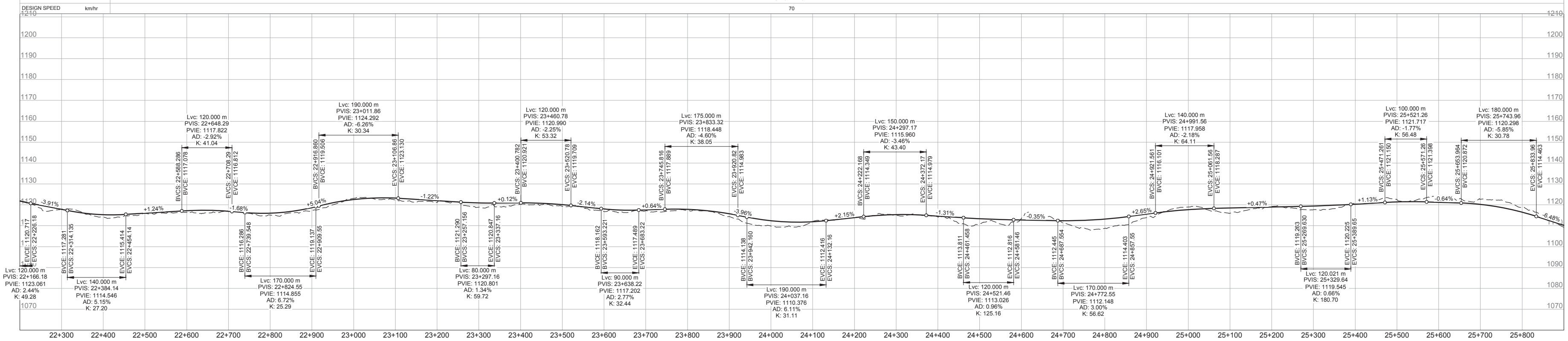
IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

MAJOR BRIDGE/CULVERT CROSSINGS

CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H21	800	0.08	2009-W01	2014/10/22	N/A	N/A
H22	800	0.16	2009-W01	2014/10/13	N/A	N/A
H23	2000	1.39	2009-W01	2014/10/22	N/A	N/A



SOIL TYPES		MODERATELY WELL DRAINED SANDY DIAMICTON SILTY MORAINAL DEPOSITS
CLEARING	sq. m	67,705
EXCAVATION	cu. m	27,010
EMBANKMENT	cu. m	46,148
SURFACING	cu. m	9,849
ROAD WIDTH		8.5
LEFT TIE SLOPE		C 1.5:1 F 1.5:1 / C 1.25:1 F 1.25:1
RIGHT TIE SLOPE		C 1.5:1 F 1.5:1
DESIGN SPEED	km/hr	70



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DATE: 2014-12-17, Jonathan Ford

Associated Engineering

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B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

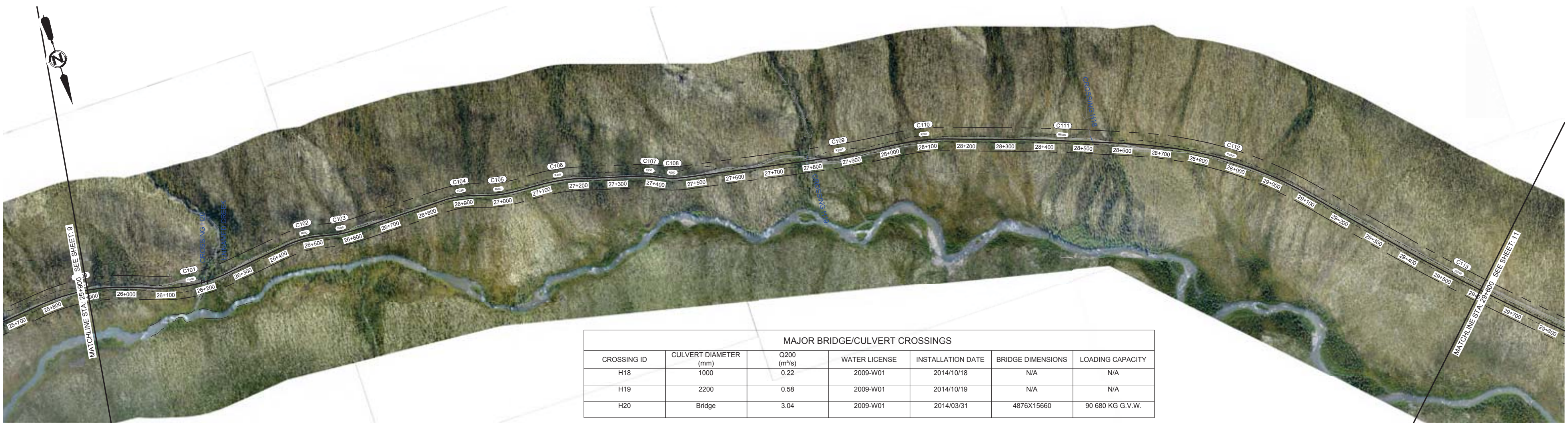
SCALE: H=1:5,000, V=1:1,000

SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 22+200 TO STA 25+900

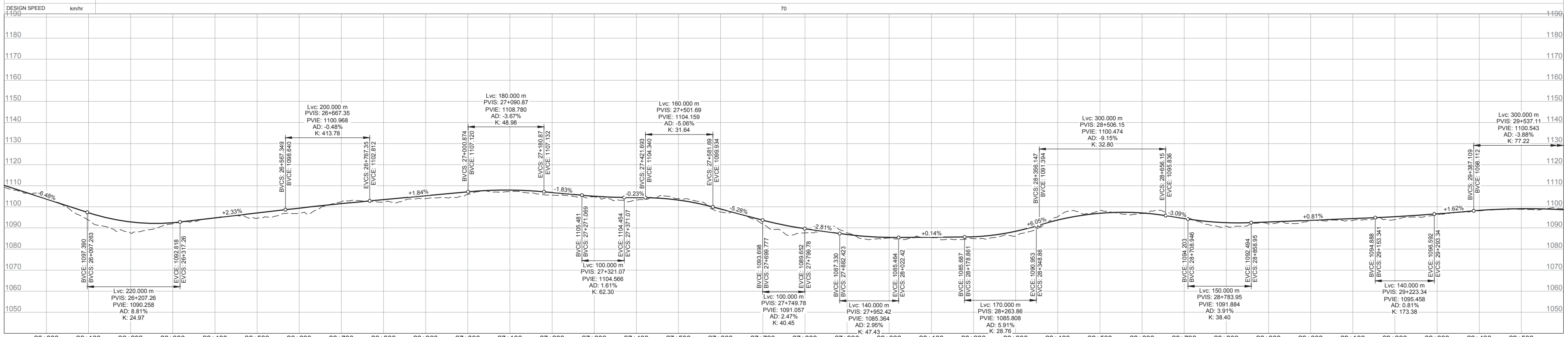
DRAWING	REVISION	SHEET
2946-01-c-107	B	9 / 25

IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



MAJOR BRIDGE/CULVERT CROSSINGS						
CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H18	1000	0.22	2009-W01	2014/10/18	N/A	N/A
H19	2200	0.58	2009-W01	2014/10/19	N/A	N/A
H20	Bridge	3.04	2009-W01	2014/03/31	4876X15660	90 680 KG G.V.W.

SOIL TYPES		WELL DRAINED MORAINAL BLANKETS OVER BEDROCK; MODERATELY WELL DRAINED SANDY DIAMICTON SILTY MORAINAL DEPOSITS; MODERATELY WELL TO IMPERFECTLY DRAINED SANDY DIAMICTON SILTY MORAINAL DEPOSITS; BLOCKY RUBBLY SANDY ALLUVIAL FAN; MODERATELY WELL TO IMPERFECTLY DRAINED SANDY DIAMICTON SILTY MORAINAL DEPOSITS
CLEARING	sq. m	63,051
EXCAVATION	cu. m	26,306
EMBANKMENT	cu. m	43,831
SURFACING	cu. m	9,849
ROAD WIDTH		8.5
LEFT TIE SLOPE		C 1.5:1 F 1.5:1
RIGHT TIE SLOPE		C 1.5:1 F 1.5:1
DESIGN SPEED	km/hr	70



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SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

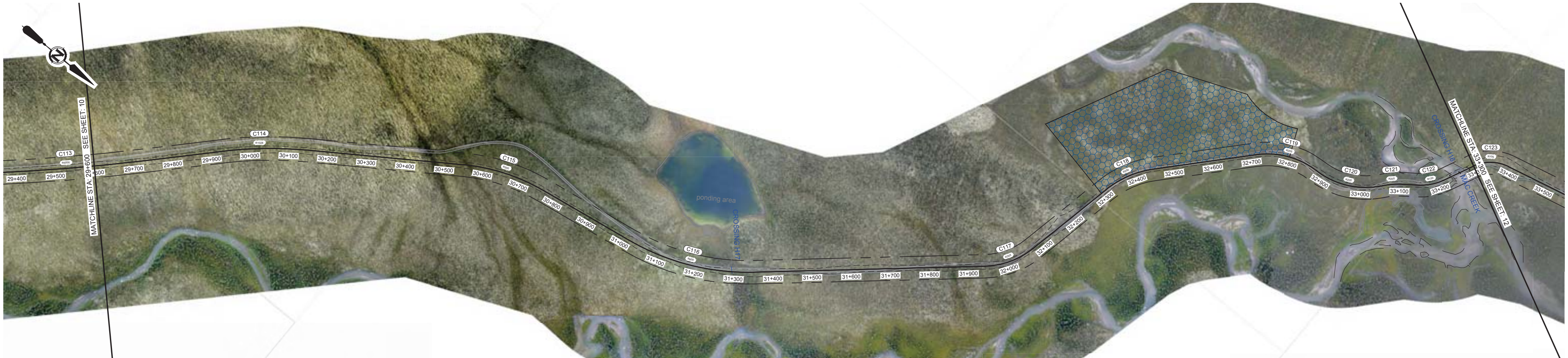
SCALE: H=1:5,000, V=1:1,000

SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 25+900 TO STA 29+600

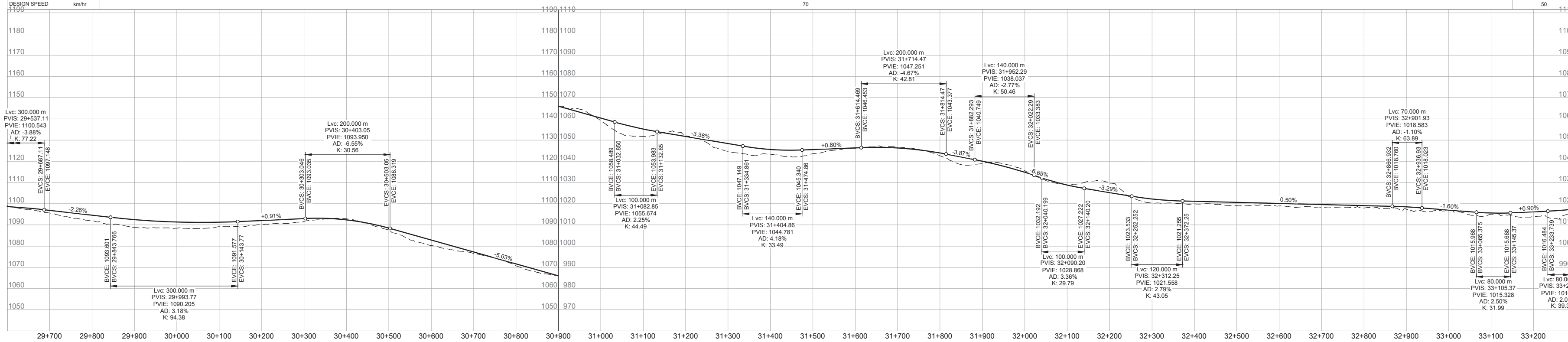
DRAWING	REVISION	SHEET
2946-01-c-108	B	10 / 25

IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



MAJOR BRIDGE/CULVERT CROSSINGS						
CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H16	Bridge	69.50	2009-W01	2014/03/31	4876X48669	90 680 KG G.V.W.
H17	1000	*special*	2009-W01	2014/10/17	N/A	N/A

SOIL TYPES		MODERATELY WELL TO IMPERFECTLY DRAINED SANDY DIAMICTON SILTY MORRAINAL DEPOSITS WITH PERMAFROST LIKELY	MODERATELY WELL TO IMPERFECTLY DRAINED SANDY DIAMICTON SILTY MORRAINAL DEPOSITS	RUBBLY SAND TO SANDY RUBBLE
		MODERATELY WELL TO IMPERFECTLY DRAINED SANDY DIAMICTON SILTY MORRAINAL DEPOSITS		
CLEARING	sq. m	54,321		
EXCAVATION	cu. m	17,117		
EMBANKMENT	cu. m	45,117		
SURFACING	cu. m	9,849		
ROAD WIDTH		8.5		
LEFT TIE SLOPE		C 1.5:1 F 1.5:1		
RIGHT TIE SLOPE		C 1.5:1 F 1.5:1		
DESIGN SPEED	km/hr	70		50



Associated Engineering

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SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:5,000, V=1:1,000

SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 29+600 TO STA 33+300

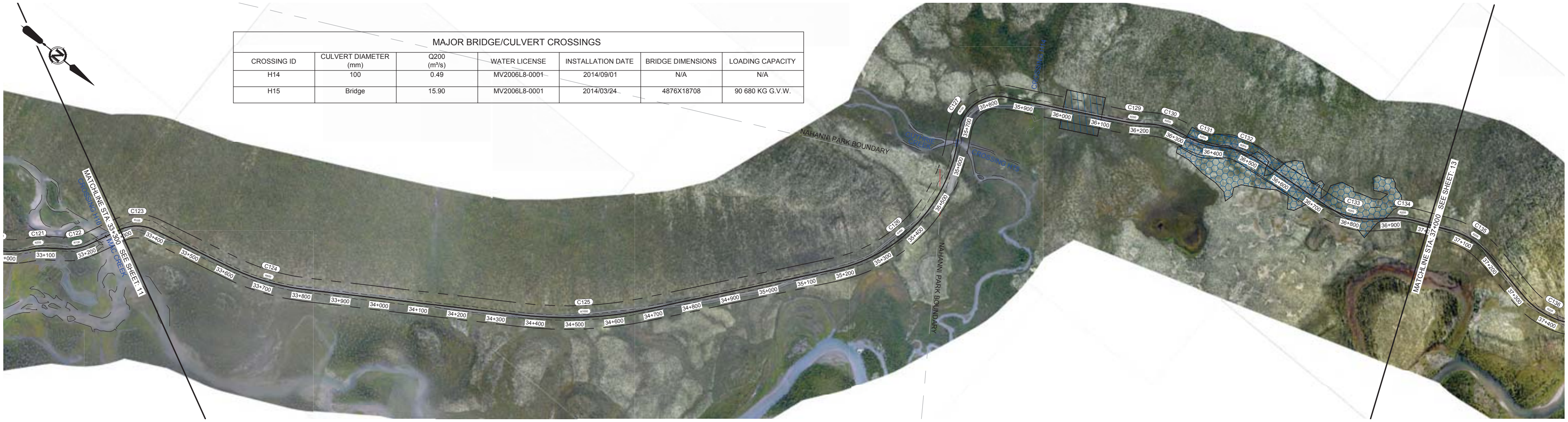
DRAWING	REVISION	SHEET
2946-01-c-109	B	11 / 25

IF NOT 50 mm ADJUST SCALES
50 mm

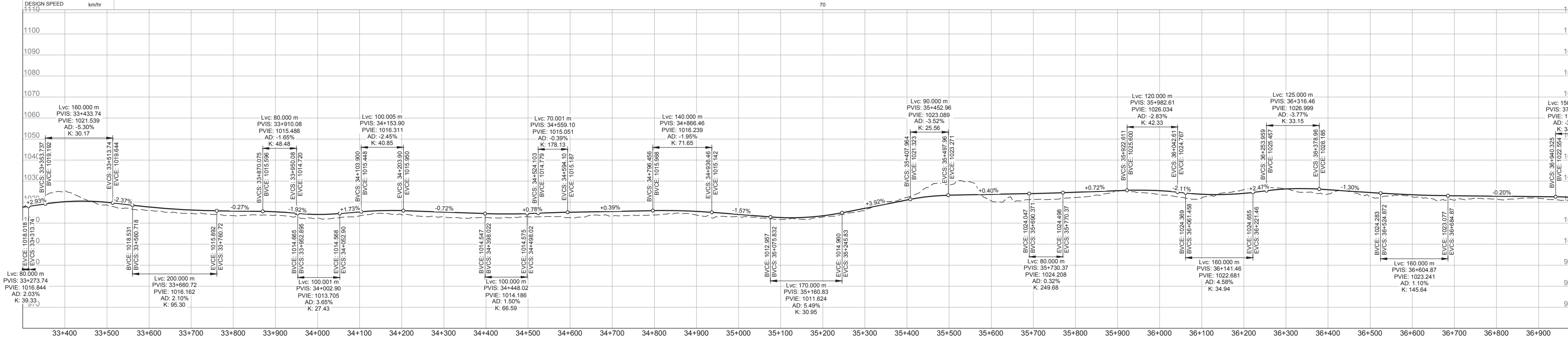
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

MAJOR BRIDGE/CULVERT CROSSINGS

CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H14	100	0.49	MV2006L8-0001	2014/09/01	N/A	N/A
H15	Bridge	15.90	MV2006L8-0001	2014/03/24	4876X18708	90 680 KG G.V.W.



SOIL TYPES		MODERATELY WELL TO IMPERFECTLY DRAINED SILTY RUBBLY SANDY DEPOSITS	WELL DRAINED SILTY RUBBLY SANDY TERRACES	WELL TO MODERATELY WELL DRAINED GLACIOFLUVIAL TERRACES	MODERATELLY WELL DRAINED GLACIOFLUVIAL DEPOSITS	MODERATELLY WELL TO POORLY DRAINED SANDY SILTY GLACIOLACUSTRINE AND MORRAINAL DEPOSITS
CLEARING	sq. m	54,553				
EXCAVATION	cu. m	22,245				
EMBANKMENT	cu. m	62,052				
SURFACING	cu. m	9,849				
ROAD WIDTH		8.5				
LEFT TIE SLOPE	C 1.25:1 F 1.25:1	C 1.5:1 F 1.5:1				
RIGHT TIE SLOPE		C 1.5:1 F 1.5:1				
DESIGN SPEED	km/hr	70				



THIS DRAWING IS FOR THE USE OF THE CLIENT AND PROJECT INDICATED - NO REPRESENTATIONS OF ANY KIND ARE MADE TO OTHER PARTIES

\\s-kel-fs-01\projects\20112946\01_14_HPAR_prmtg_upd\Working_Dwgs\100_Civil\2946-01-C-101.dwg
DATE: 2014-12-17, Jonathan Ford

Associated Engineering

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REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:5,000, V=1:1,000

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CIVIL
PLAN/PROFILE
STA 33+300 TO STA 37+000

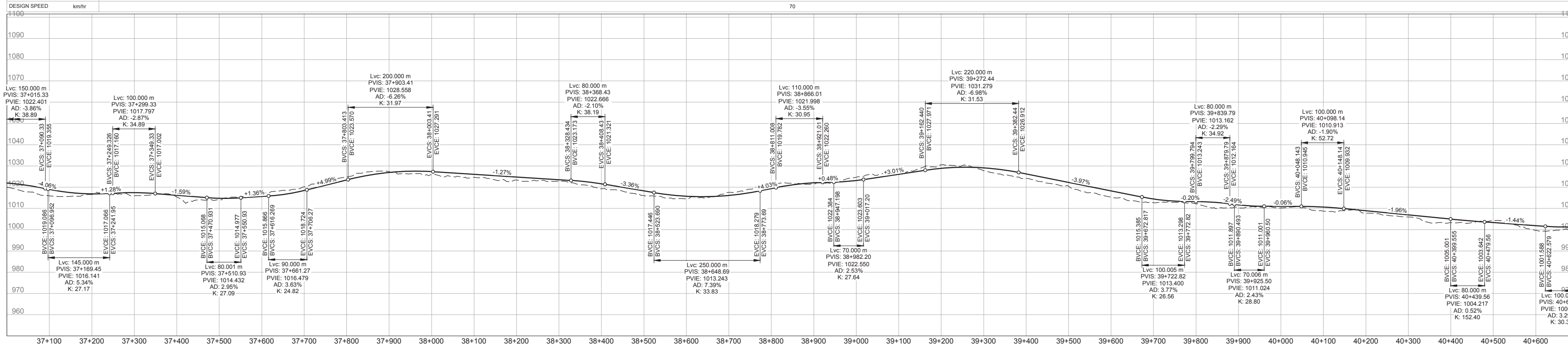
DRAWING	REVISION	SHEET
2946-01-c-110	B	12 / 25

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

MAJOR BRIDGE/CULVERT CROSSINGS						
CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H12	Bridge	18.60	MV2006L8-0001	2014/03/28	4876X24814	90 680 KG G.V.W.
H13	1000	0.38	MV2006L8-0001	2014/09/04	N/A	N/A

SOIL TYPES		WELL DRAINED SANDY RUBBLY GLACIOFLUVIAL DEPOSITS	WELL DRAINED RUBBLY SANDS	WELL TO MODERATELY WELL DRAINED RUBBLY SANDS
CLEARING	sq. m	54,414		
EXCAVATION	cu. m	13,320		
EMBANKMENT	cu. m	23,525		
SURFACING	cu. m	9,849		
ROAD WIDTH		8.5		
LEFT TIE SLOPE		C 1.5:1 F 1.5:1		
RIGHT TIE SLOPE		C 1.5:1 F 1.5:1		
DESIGN SPEED	km/hr	70		



\\s-kel-fs-01\projects\20112946\01_14_HPAR_prmtg_upd\Working_Dwgs\100_Civil\2946-01-C-101.dwg
DATE: 2014-12-17, Jonathan Ford

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FOR DISCUSSION
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REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:5,000, V=1:1,000

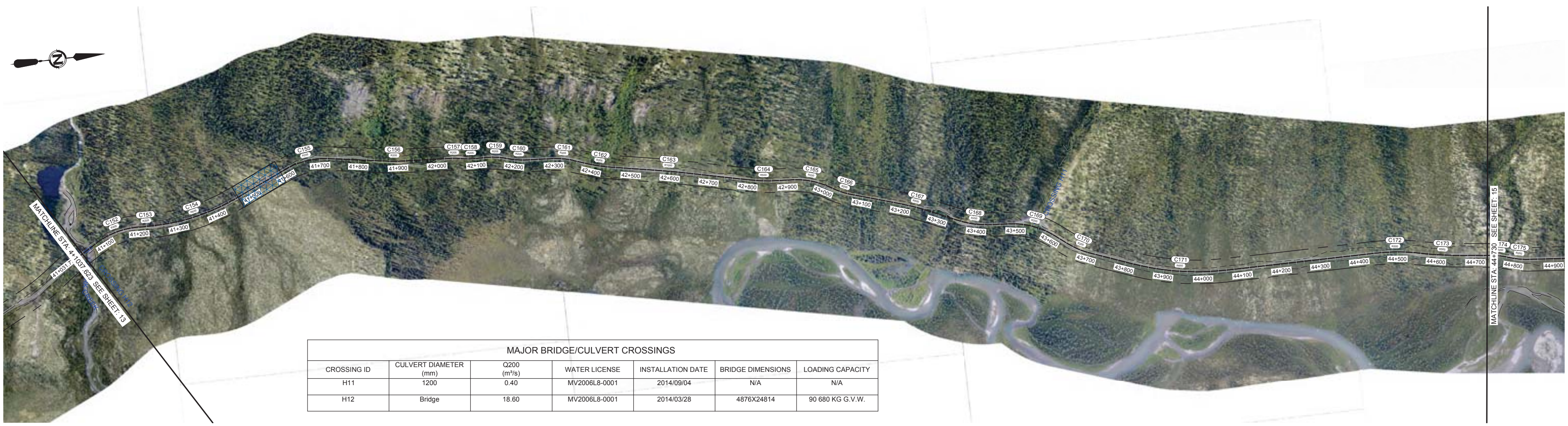
SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 37+000.000 TO STA 40+717.262

DRAWING	REVISION	SHEET
2946-01-c-111	B	13 / 25

IF NOT 50 mm ADJUST SCALES
50 mm

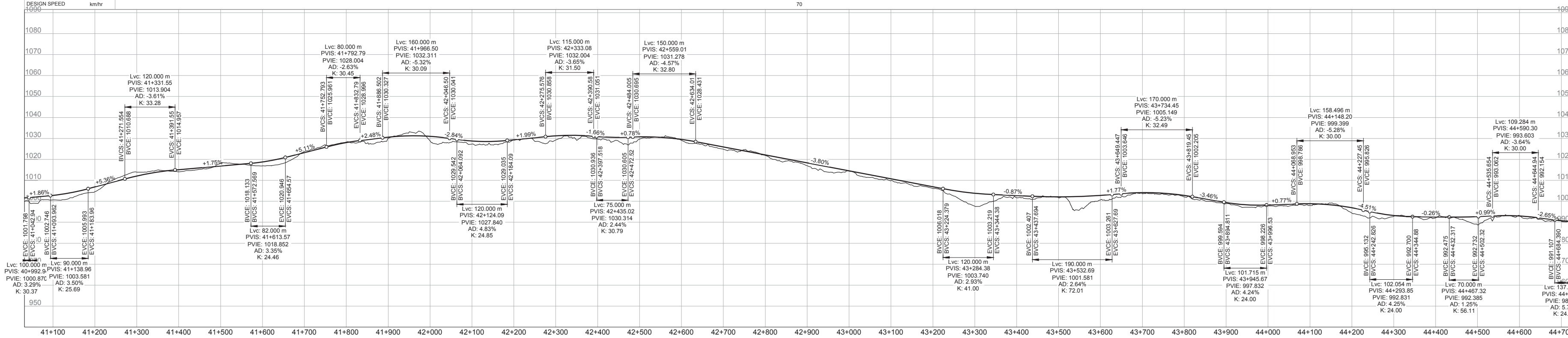
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



MAJOR BRIDGE/CULVERT CROSSINGS

CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m³/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H11	1200	0.40	MV2006L8-0001	2014/09/04	N/A	N/A
H12	Bridge	18.60	MV2006L8-0001	2014/03/28	4876X24814	90 680 KG G.V.W.

SOIL TYPES		WELL DRAINED SILTY RUBBLY SANDY TERRACES; IMPERFECTLY TO MODERATELY WELL DRAINED RUBBLY SILTY MORAINAL BLANKETS AND DEPOSITS; WELL DRAINED SANDY SILTY RUBBLY BLANKET; WELL DRAINED RUBBLY SANDY SILTY MORAINAL DEPOSIT; WELL DRAINED RUBBLY SANDY SILTY MORAINAL DEPOSIT WITH PERMAFROST; IMPERFECTLY TO WELL DRAINED RUBBLY SANDY SILTY MORAINAL BLANKET
CLEARING	sq. m	79,859
EXCAVATION	cu. m	28,124
EMBANKMENT	cu. m	83,187
SURFACING	cu. m	9,739
ROAD WIDTH	m	8.5
LEFT TIE SLOPE		C 1.25:1 F 1.25:1; C 1.25:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1
RIGHT TIE SLOPE		C 1.5:1 F 1.5:1
DESIGN SPEED	km/hr	70



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REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:5,000, V=1:1,000

SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 41+037.623 TO STA 44+730.000

DRAWING	REVISION	SHEET
2946-01-c-112	B	14 / 25

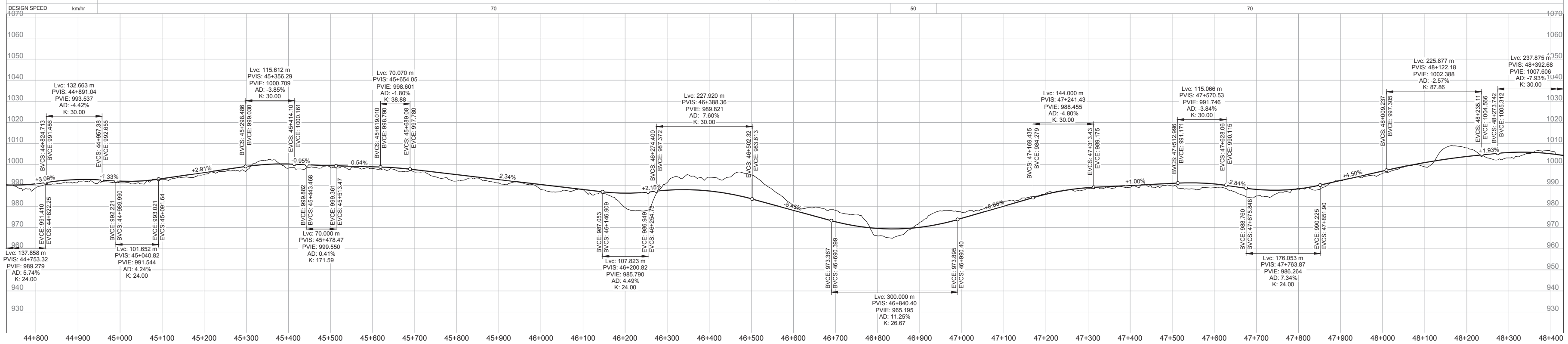
IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

MAJOR BRIDGE/CULVERT CROSSINGS

CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H9	1000	0.20	MV2006L8-0001	2014/09/07	N/A	N/A
H10	Bridge	1.86	MV2006L8-0001	2014/03/28	4876X15660	90 680 KG G.V.W.

SOIL TYPES		IMPERFECTLY TO MODERATELY WELL DRAINED RUBBLY SANDY SILTY MORAINAL DEPOSIT; WELL DRAINED MORRAINAL DEPOSIT; WELL DRAINED MORRAINAL DEPOSIT WITH SIGNIFICANT SILT; WELL DRAINED RUBBLY SAND TERRACE; WELL DRAINED RUBBLY SANDY SILTY TERRACE; SILTY RUBBLY ALLUVIAL FAN; WELL DRAINED RUBBLY SANDY SILT MORRAINAL DEPOSIT; MODERATELY WELL DRAINED RUBBLY SANDY SILT MORRAINAL DEPOSIT WITH PERMAFROST; WELL DRAINED RUBBLY SANDY SILTY BLANKET
CLEARING	sq. m	101,276
EXCAVATION	cu. m	120,621
EMBANKMENT	cu. m	93,421
SURFACING	cu. m	9,849
ROAD WIDTH	m	8.5
LEFT TIE SLOPE		C 1.25:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1
RIGHT TIE SLOPE		C 1.5:1 F 1.5:1
DESIGN SPEED	km/hr	70; 50; 70



Associated Engineering

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FOR DISCUSSION
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REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:5,000, V=1:1,000

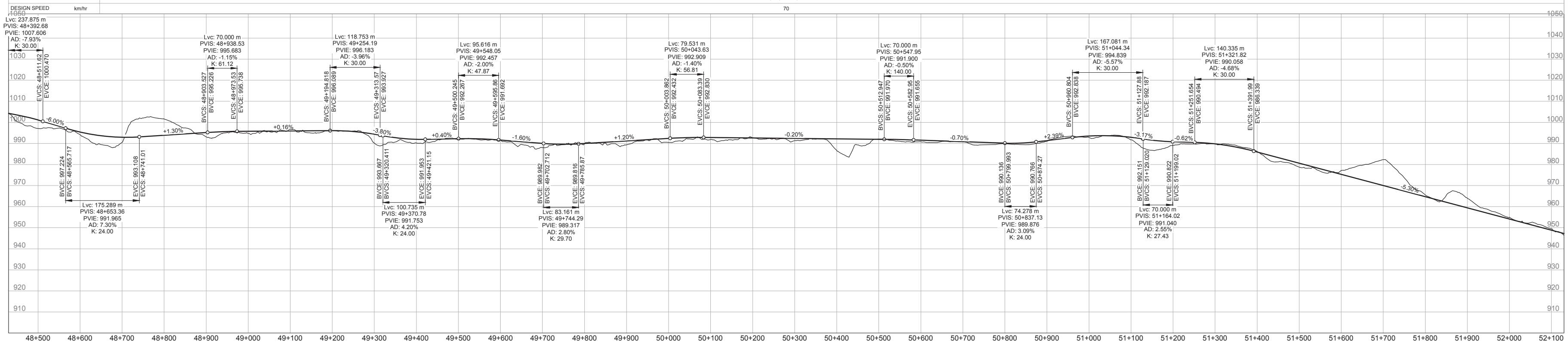
SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 44+730 TO STA 48+430

DRAWING	REVISION	SHEET
2946-01-c-113	B	15 / 25

MAJOR BRIDGE/CULVERT CROSSINGS						
CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H8	800	0.25	MV2006L8-0001	2014/09/07	N/A	N/A

SOIL TYPES		MORAINAL AND ALLUVIAL DEPOSITS; MORAINAL BLANKETS OVER BEDROCK WITH PERMAFROST; WELL DRAINED RUBBLY SANDY SILTY BLANKETS WITH PERMAFROST; IMPERFECTLY TO MODERATELY WELL DRAINED RUBBLY SANDY SILTY DEPOSITS WITH PERMAFROST; MODERATELY WELL TO WELL DRAINED BOULDERY GRAVELLY SILTY SANDY TERRACE
CLEARING	sq. m	86,249
EXCAVATION	cu. m	94,779
EMBANKMENT	cu. m	77,537
SURFACING	cu. m	9,849
ROAD WIDTH	m	8.5
LEFT TIE SLOPE		C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1; C 1.5:1 F 1.5:1
RIGHT TIE SLOPE		C 1.5:1 F 1.5:1
DESIGN SPEED	km/hr	70



Associated Engineering

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REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

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PRELIMINARY ROAD DESIGN
20112946-01

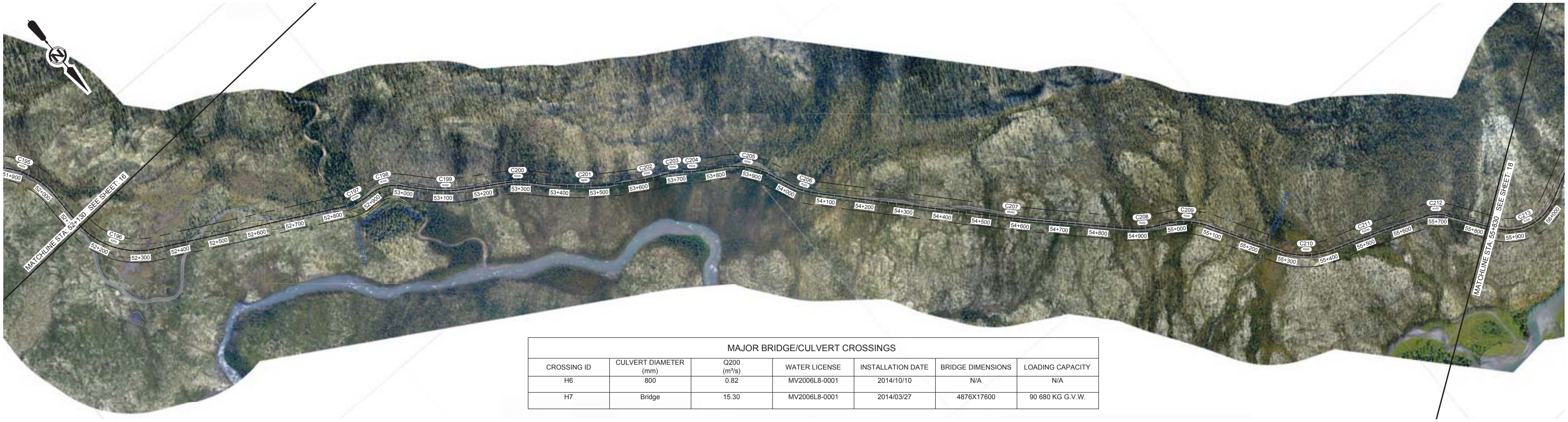
SCALE: H=1:5,000, V=1:1,000

SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 48+430 TO STA 52+130

DRAWING	REVISION	SHEET
2946-01-c-114	B	16 / 25

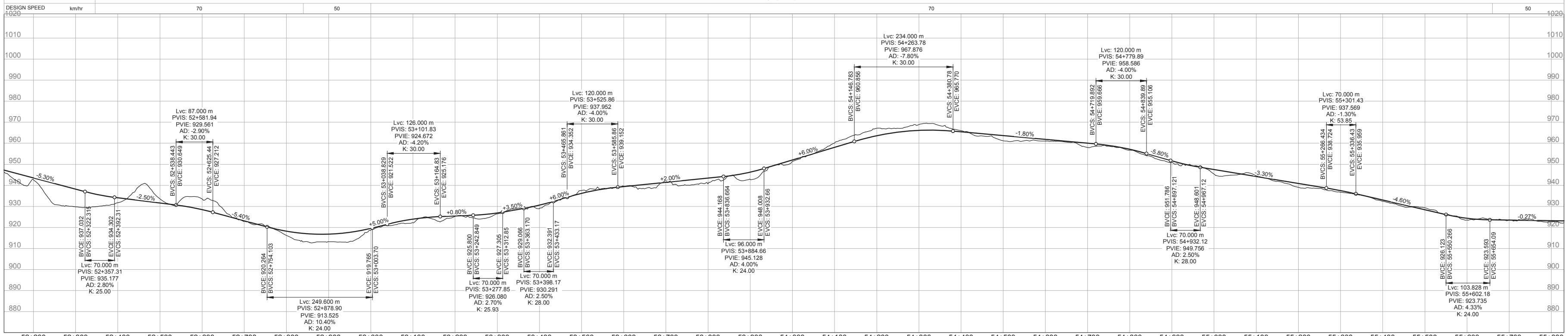
IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



MAJOR BRIDGE/CULVERT CROSSINGS

CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H6	800	0.82	MV2006L8-0001	2014/10/10	N/A	N/A
H7	Bridge	15.30	MV2006L8-0001	2014/03/27	4876X17600	90 680 KG G.V.W.

SOIL TYPES		MODERATELY WELL TO WELL DRAINED BOULDERY GRAVELLY SILTY SANDY TERRACE; ALLUVIAL SEDIMENTS; WELL DRAINED GLACIOFLUVIAL MAORAINAL DEPOSITS; WELL TO RAPIDLY DRAINED MORAINAL BLANKETS OVER BEDROCK; WELL TO MODERATELY WELL DRAINED RUBBLY SANDY SILTY BLANKETS; DEEP SANDY RUBBLY SILTY DEPOSITS WITH ORGANIC VENEERS AND WET AREAS
CLEARING	sq. m	75,263
EXCAVATION	cu. m	57,160
EMBANKMENT	cu. m	77,730
SURFACING	cu. m	9,849
ROAD WIDTH	m	8.5
LEFT TIE SLOPE		C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1; C 1.5:1 F 1.5:1
RIGHT TIE SLOPE		C 1.5:1 F 1.5:1
DESIGN SPEED	km/hr	70; 50; 70; 50



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REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

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SCALE: H=1:5,000, V=1:1,000

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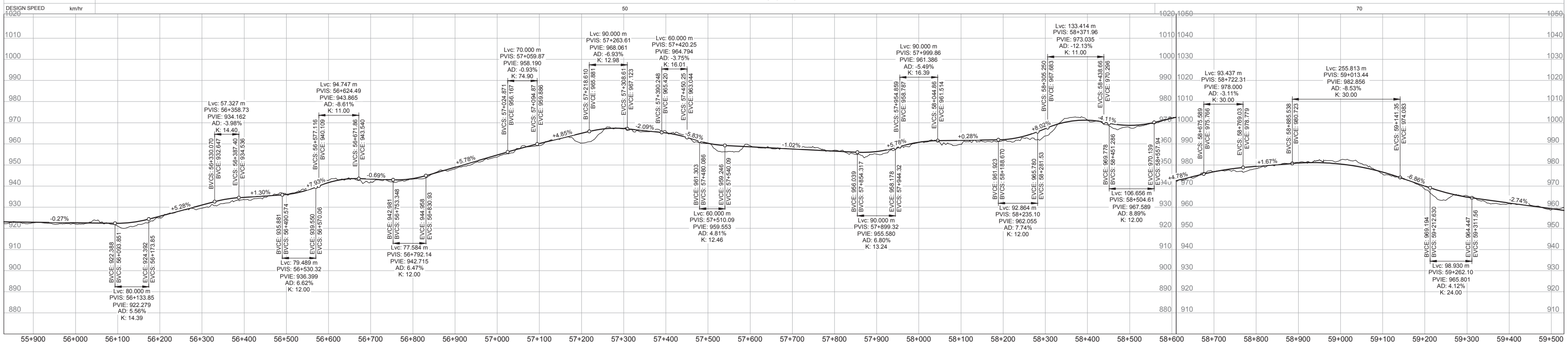
CIVIL
PLAN/PROFILE
STA 52+130 TO STA 55+830

DRAWING	REVISION	SHEET
2946-01-c-115	B	17 / 25

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

SOIL TYPES		DEEP SANDY RUBBLY SILTY DEPOSITS WITH ORGANIC VENEERS AND WET AREAS	RUBBLY SILTY BLANKETS	WELL TO RAPIDLY DRAINED RUBBLY SILTY MANTLES AND VENEERS	DEEP SANDY RUBBLY SILTY DEPOSITS WITH ORGANIC VENEERS AND WET AREAS; IMPERFECTLY TO MODERATELY WELL DRAINED RUBBLY SILTY BLANKETS; WELL DRAINED BLOCKY RUBBLY SANDY MANTLES OVERLYING BANKETS AND BEDROCK WITH PERMAFROST; WELL DRAINED RUBBLY SILTY BLANKETS WITH MINOR COLLUVIAL VENEERS
CLEARING	sq. m	102,220			
EXCAVATION	cu. m	68,985			
EMBANKMENT	cu. m	71,178			
SURFACING	cu. m	9,849			
ROAD WIDTH	m	8.5			
LEFT TIE SLOPE	C 1.5:1 F 1.5:1	C 1.25:1 F 1.25:1	C 1.5:1 F 1.5:1	C 1.25:1 F 1.25:1	C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1
RIGHT TIE SLOPE		C 1.5:1 F 1.5:1			
DESIGN SPEED	km/hr	50			70



\\s-kel-fs-01\projects\20112946\01_14_HAR_prmtg_upd\Working_Dwgs\100_Civil\2946-01-C-112-122.dwg
DATE: 2014-12-17, Jonathan Ford

Associated Engineering

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REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

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PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:5,000, V=1:1,000

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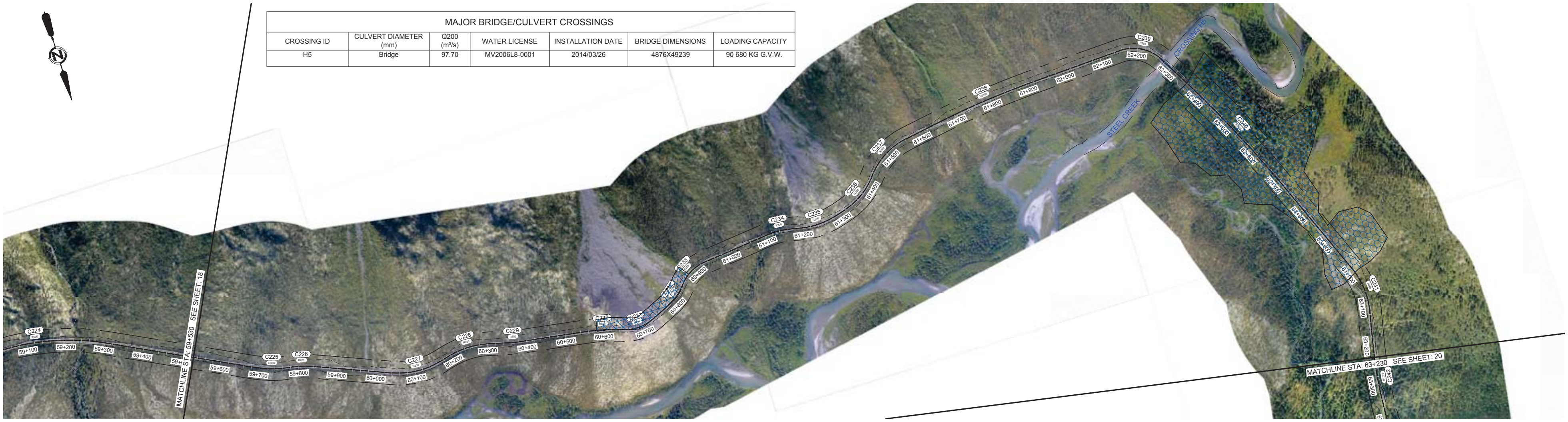
CIVIL
PLAN/PROFILE
STA 55+830 TO STA 59+530

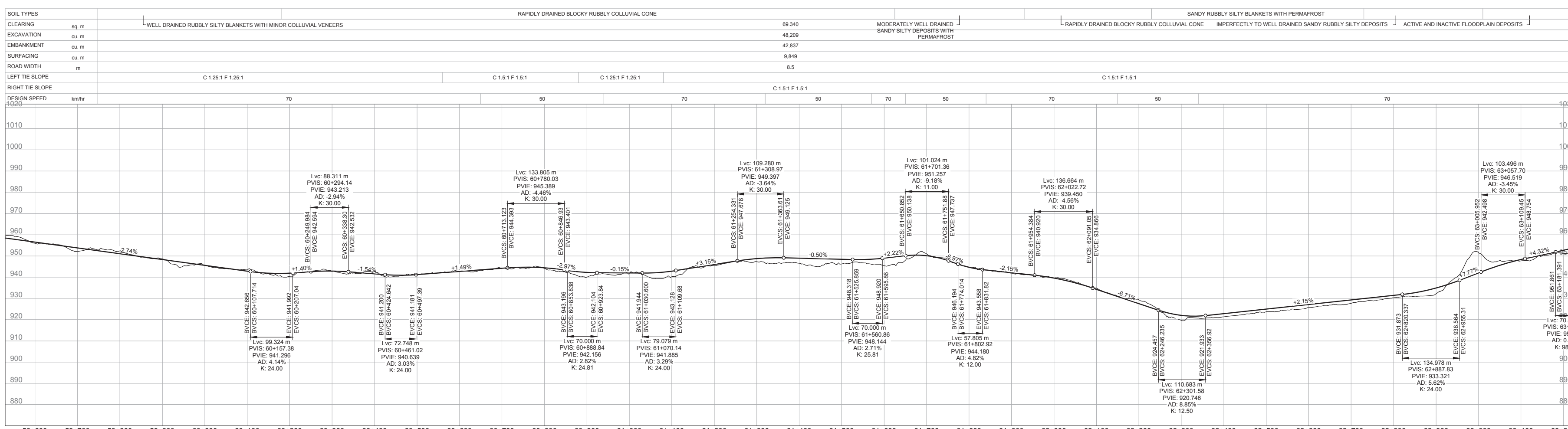
DRAWING	REVISION	SHEET
2946-01-c-116	B	18 / 25

IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

MAJOR BRIDGE/CULVERT CROSSINGS

CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m³/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H5	Bridge	97.70	MV2006L8-0001	2014/03/26	4876X49239	90 680 KG G.V.W.





Associated Engineering

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REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

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HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:5,000, V=1:1,000

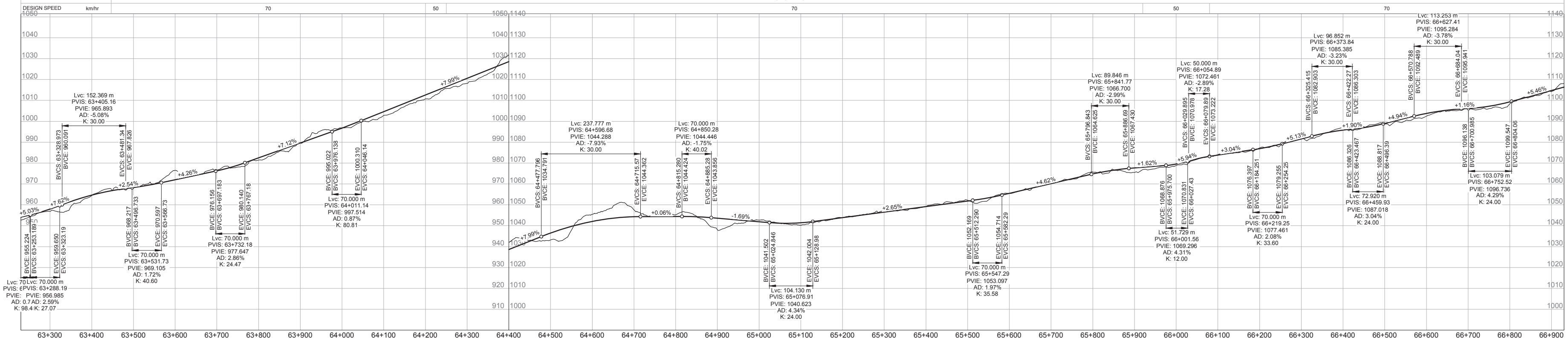
SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 59+530 TO STA 63+230

DRAWING	REVISION	SHEET
2946-01-c-117	B	19 / 25

IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

SOIL TYPES		MODERATELY WELL DRAINED RUBBLY SILTY BLANKETS	VARIABLY DRAINED DEEP SANDY RUBBLY SILTY DEPOSITS WITH PERMAFROST			VARIABLY DRAINED DEEP SANDY RUBBLY SILTY DEPOSITS			
		ACTIVE AND INACTIVE FLOODPLAIN DEPOSITS							
CLEARING	sq. m	89,682							
EXCAVATION	cu. m	80,733							
EMBANKMENT	cu. m	55,977							
SURFACING	cu. m	9,849							
ROAD WIDTH	m	8.5							
LEFT TIE SLOPE		C 1.25:1 F 1.25:1	C 1.5:1 F 1.5:1	C 1.25:1 F 1.25:1	C 1.5:1 F 1.5:1	C 1.25:1 F 1.25:1	C 1.5:1 F 1.5:1	C 1.25:1 F 1.25:1	C 1.5:1 F 1.5:1
RIGHT TIE SLOPE		C 1.5:1 F 1.5:1							C 1.25:1 F 1.25:1
DESIGN SPEED	km/hr	70	50	70	50	70			



Associated Engineering

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B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

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20112946-01

SCALE: H=1:5,000, V=1:1,000

SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 63+230 TO STA 66+930

DRAWING	REVISION	SHEET
2946-01-c-118	B	20 / 25

IF NOT 50 mm ADJUST SCALES
50 mm
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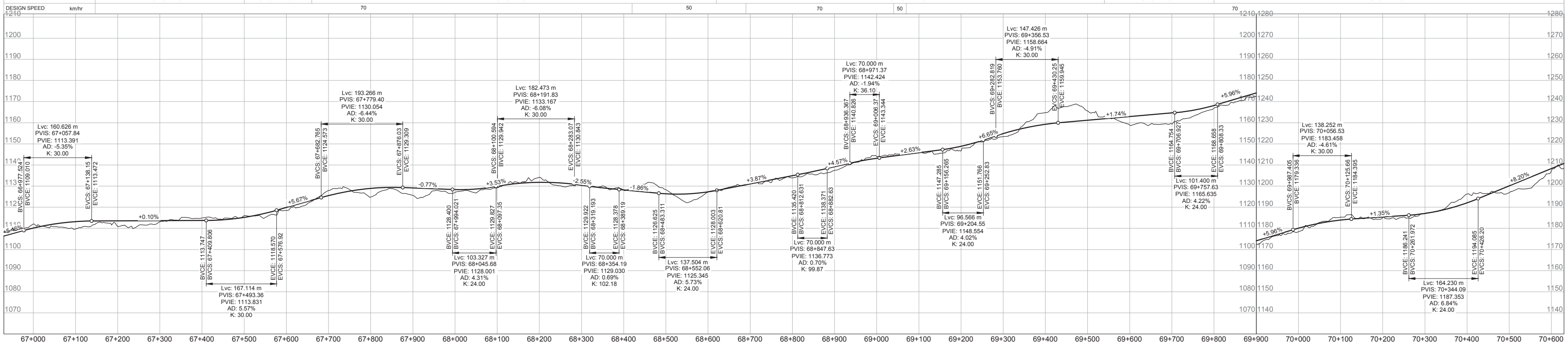
MAJOR BRIDGE/CULVERT CROSSINGS						
CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H2	1400	0.79	MV2006L8-0001	2014/09/02	N/A	N/A
H3	Bridge	5.06	MV2006L8-0001	2014/03/24	4876X15240	90 680 KG G.V.W.
H4	1200	0.65	MV2006L8-0001	2014/09/25	N/A	N/A

SOIL TYPES		VARIABLY DRAINED DEEP SANDY RUBBLY SILTY DEPOSITS; MODERATELY WELL DRAINED MORAINAL BLANKETS OVER BEDROCK WITH HIGH SEEPAGE AND PERMAFROST; IMPERFECTLY TO MODERATELY WELL DRAINED MORAINAL BLANKETS OVER BEDROCK WITH PERMAFROST; ALLUVIAL DEPOSITS; IMPERFECTLY TO MODERATELY WELL DRAINED SANDY RUBBLY SILTY DEPOSITS; IMPERFECTLY TO MODERATELY WELL DRAINED SANDY RUBBLY SILTY DEPOSITS WITH PERMAFROST; IMPERFECTLY TO WELL DRAINED SANDY RUBBLY SILTY DEPOSITS
CLEARING	sq. m	103,871
EXCAVATION	cu. m	119,092
EMBANKMENT	cu. m	76,376
SURFACING	cu. m	9,849
ROAD WIDTH	m	8.5
LEFT TIE SLOPE		C 1.25:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.5:1 F 1.25:1
RIGHT TIE SLOPE		C 1.5:1 F 1.5:1; C 1.5:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.5:1 F 1.25:1
DESIGN SPEED	km/hr	70; 50; 70; 50; 70



\\s-kel-fs-01\projects\20112946\01_14_HPAR_prmtg_upd\Working_Dwgs\100_Civil\2946-01-C-112-122.dwg
DATE: 2014-12-17, Jonathan Ford

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DRAFT

REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

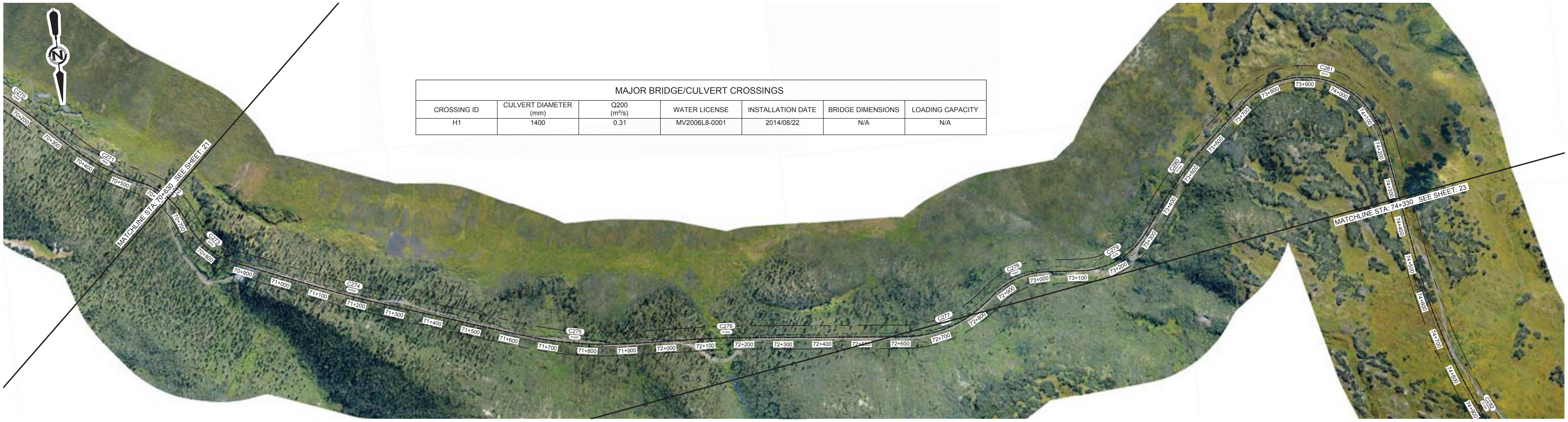
SCALE: H=1:5,000, V=1:1,000

SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
STA 66+930 TO STA 70+630

DRAWING	REVISION	SHEET
2946-01-c-119	B	21 / 25

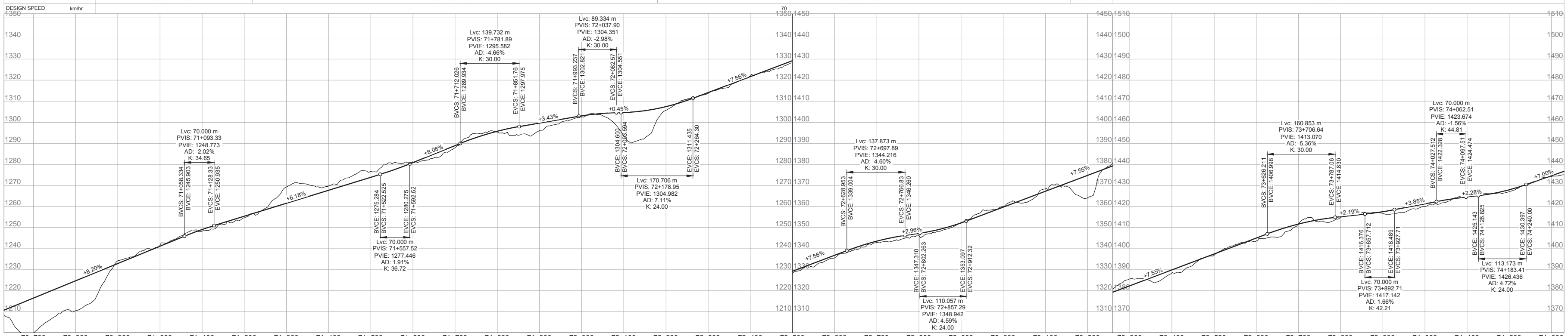
IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



MAJOR BRIDGE/CULVERT CROSSINGS

CROSSING ID	CULVERT DIAMETER (mm)	Q200 (m^3/s)	WATER LICENSE	INSTALLATION DATE	BRIDGE DIMENSIONS	LOADING CAPACITY
H1	1400	0.31	MV2006L8-0001	2014/08/22	N/A	N/A

SOIL TYPES		MODERATELY WELL DRAINED MORAINAL BLANKETS OVER BEDROCK WITH HIGH SEEPAGE; IMPERFECTLY TO WELL DRAINED SANDY RUBBLY SILTY DEPOSITS; MODERATELY WELL DRAINED MORAINAL BLANKETS; WELL DRAINED DEEP MORAINAL BLANKETS; WELL DRAINED MORAINAL BLANKETS; WELL TO RAPIDLY DRAINED MORAINAL MANTLES OVER BEDROCK
CLEARING	sq. m	95,267
EXCAVATION	cu. m	92,604
EMBANKMENT	cu. m	170,625
SURFACING	cu. m	9,849
ROAD WIDTH	m	8.5
LEFT TIE SLOPE		C 1.5:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1; C 1.25:1 F 1.25:1; C 1.5:1 F 1.25:1
RIGHT TIE SLOPE		C 1.5:1 F 1.25:1; C 1.25:1 F 1.25:1; C 1.5:1 F 1.25:1; C 1.5:1 F 1.5:1; C 1.25:1 F 1.25:1
DESIGN SPEED	km/hr	70



\\s-kel-fs-01\projects\20112946\01_14_HPAR_prmtg_upd\Working_Dwgs\100_Civil\2946-01-C-112-122.dwg
DATE: 2014-12-17, Jonathan Ford

Associated Engineering

PRELIMINARY/ FOR DISCUSSION
NOT FOR CONSTRUCTION
DRAFT

REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:5,000, V=1:1,000

SELWYN CHIHONG MINING LTD.

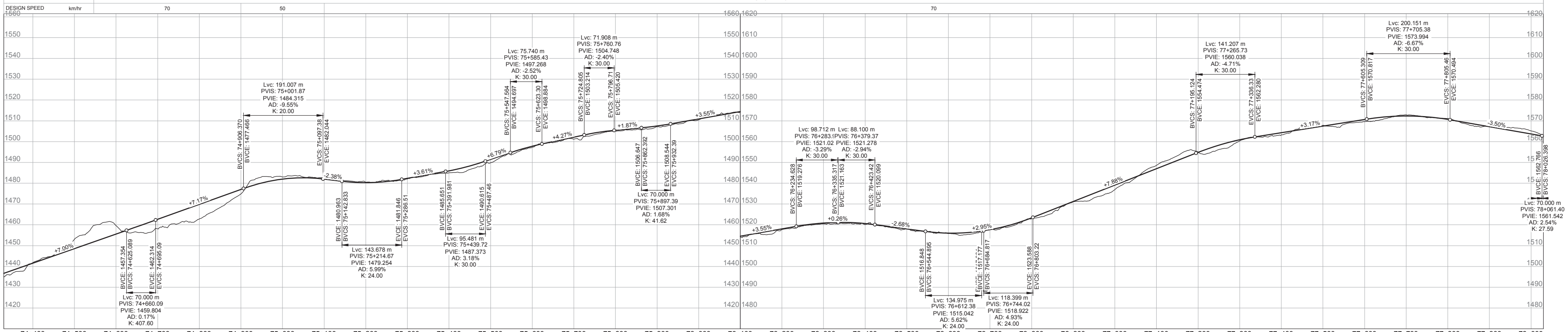
CIVIL
PLAN/PROFILE
STA 70+630 TO STA 74+330

DRAWING	REVISION	SHEET
2946-01-c-120	B	22 / 25

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

SOIL TYPES		MODERATELY WELL DRAINED MORAINAL MANTLES WITH BEDROCK / WELL TO RAPIDLY DRAINED MORAINAL MANTLES OVER BEDROCK / WELL TO RAPIDLY DRAINED MORAINAL MANTLES OVER BEDROCK
CLEARING	sq. m	61,215
EXCAVATION	cu. m	42,712
EMBANKMENT	cu. m	41,976
SURFACING	cu. m	9,849
ROAD WIDTH	m	8.5
LEFT TIE SLOPE		C 1.5:1 F 1.25:1
RIGHT TIE SLOPE		C 1.5:1 F 1.25:1
DESIGN SPEED	km/hr	70 / 50 / 70



Associated Engineering

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REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:5,000, V=1:1,000

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CIVIL
PLAN/PROFILE
STA 74+330 TO STA 78+030

DRAWING	REVISION	SHEET
2946-01-c-121	B	23 / 25

IF NOT 50 mm ADJUST SCALES
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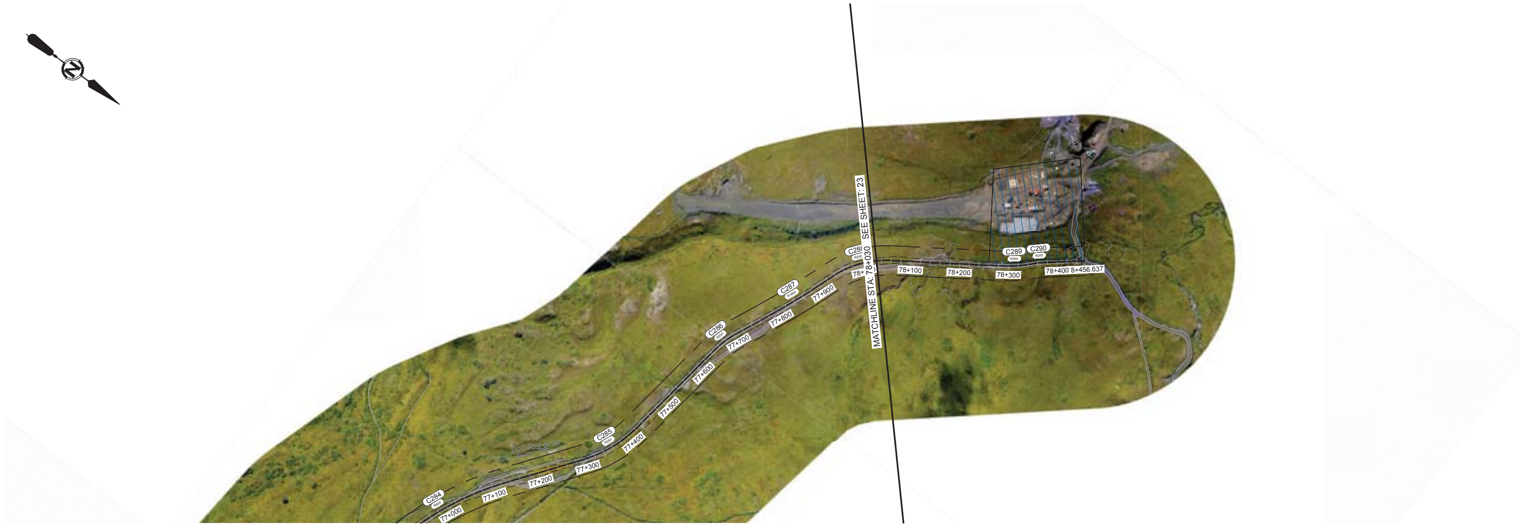
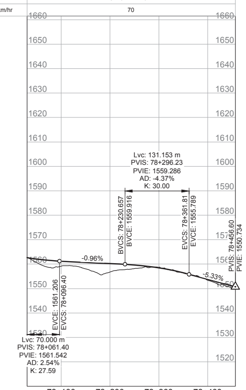


SOIL TYPES		WELL TO RAPIDLY DRAINED MORAINAL MANTLES OVER BEDROCK
CLEARING	sq. m	6,409
EXCAVATION	cu. m	10,054
EMBANKMENT	cu. m	8,084
SURFACING	cu. m	1,136
ROAD WIDTH	m	8.5
LEFT TIE SLOPE		C 1.5:1 F 1.25:1
RIGHT TIE SLOPE		C 1.5:1 F 1.25:1
DESIGN SPEED	km/hr	70



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DATE: 2014-12-17, Jonathan Ford

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REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW
A	2014NOV28	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:5,000, V=1:1,000

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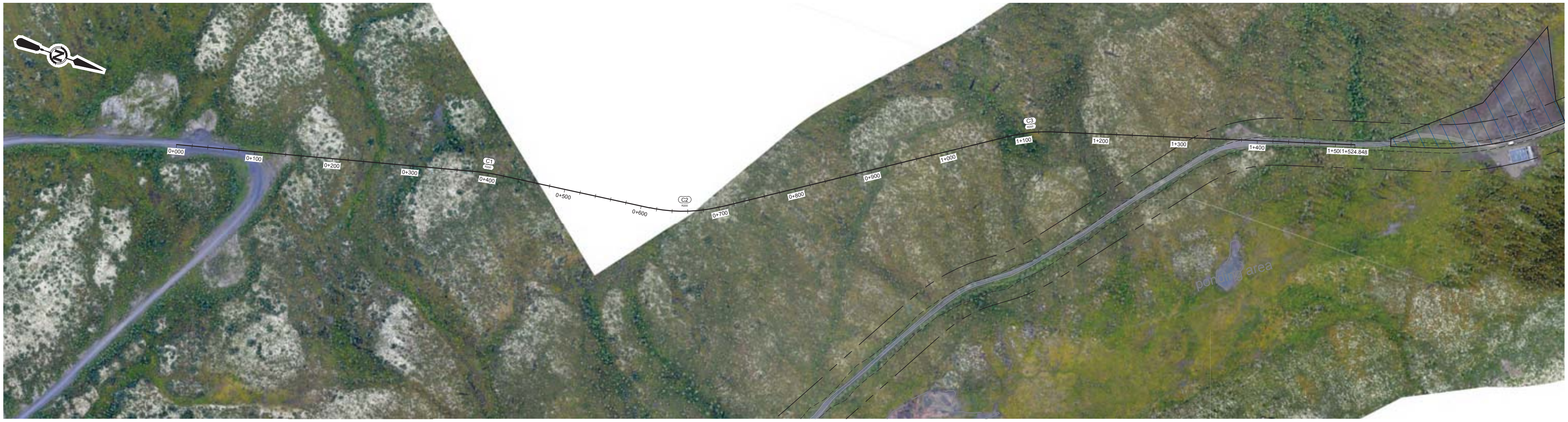
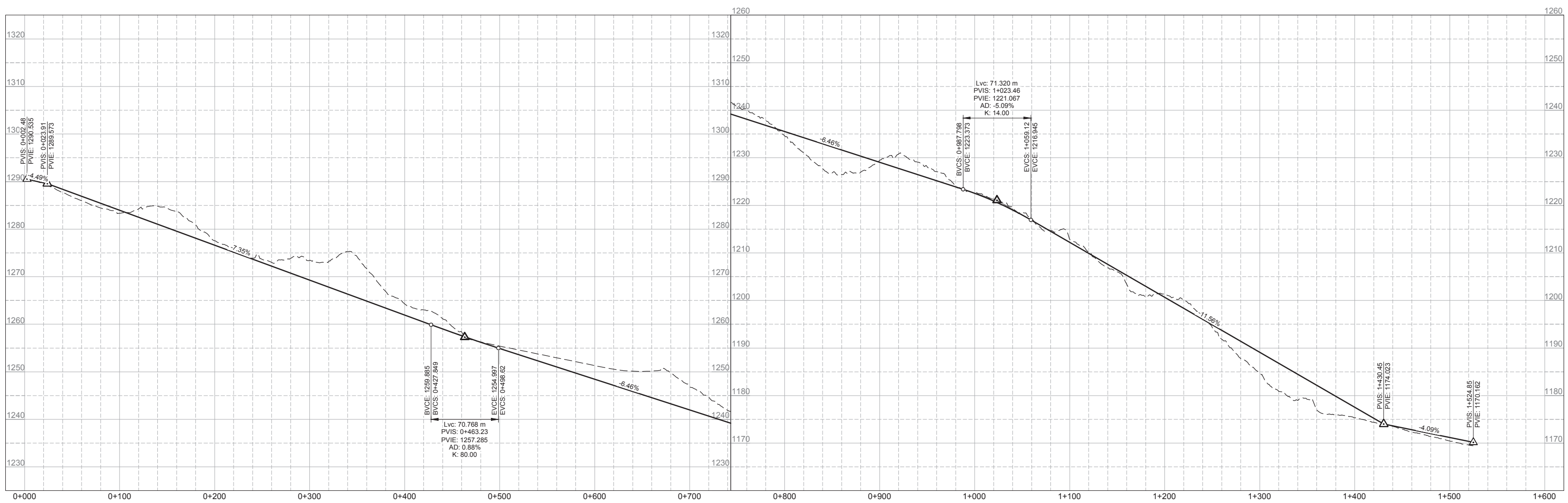
CIVIL
PLAN/PROFILE
STA 78+030.000 TO STA 78+456.637

DRAWING	REVISION	SHEET
2946-01-c-122	B	24 / 25

IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE





\\s-kel-fs-01\projects\20112946\01_14_HPAR_prmtg_upd\Working_Dwgs\100_Civil\2946-01-C-123.dwg
DATE: 2014-12-15, Jonathan Ford

Associated Engineering

PRELIMINARY/
FOR DISCUSSION
NOT FOR CONSTRUCTION
DRAFT

REV	DATE	DESIGN	DRAWN	DESCRIPTION
A	2014DEC17	S. KING	J. FORD	ISSUED FOR REVIEW

SELWYN CHIHONG MINING LTD.

HOWARD PASS ACCESS ROAD
PRELIMINARY ROAD DESIGN
20112946-01

SCALE: H=1:2,500, V=1:500

SELWYN CHIHONG MINING LTD.

CIVIL
PLAN/PROFILE
SOUTH OPTION

DRAWING	REVISION	SHEET
2946-01-C-123	A	25 / 25

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APPENDIX B. SITE ISOLATION TECHNIQUES

DAM-AND-PUMP SYSTEM

Typical Procedure (Malaspina 2007):

- Define the instream work area.
- Define where the upstream and downstream dams will be located ensuring there is sufficient room in the work area.
- If necessary, erect upstream and downstream fish exclusion fences and salvage all fish from the worksite. The fences must enclose a larger stream section than between the two dams. Maintain the fish fences throughout the construction period.
- On higher discharge streams it may be very difficult to set and maintain fish exclusion fences. In this case, any pump intake in water that has not been salvaged must meet DFO's Freshwater Intake End-of-Pipe Fish Screen Guidelines.
- Set-up the diversion pump and pump intake. The intake must be upstream of upstream dam. On small, low discharge watercourses, stream features such as a deep pool can be used.
- Lay out the discharge hoses for the diversion pump so they do not interfere with equipment access to the site. Direct this water back into the watercourse downstream of the worksite. Discharge must be directed into a wetted part of the watercourse or upstream of the downstream fish exclusion fence (fish must be salvaged from the entire watercourse area that will be dewatered). Prevent scouring and sediment production at the end of the discharge hose with an energy dissipater (e.g., filter fabric, plastic sheeting, etc.).
- Lay out the discharge hose for the wastewater pump.
- Start the diversion pump and erect the upstream dam. Dams can be constructed of various materials depending on site conditions and what is available on site (e.g., sandbags wrapped in poly sheeting)
- Assess whether the diversion pump has sufficient capacity to divert all flows. Use a larger pump or additional pumps if necessary.
- Let the area behind the dam dewater. On higher discharge or very low gradient watercourses, the area immediately downstream of the upstream dam may not dewater. In this case erect the downstream dam.
- Complete a fish salvage, if necessary.
- Pump pooled water out of the work area. If it is clean, it can be pumped back into the watercourse. If the pooled water is turbid, pump it to the designated wastewater disposal area.
- Excavate small sumps near the dams, as required, to collect ay seepage water. This water should be clean and can be pumped back into the watercourse.
- Pump away any turbid water collecting in the work area to the designated wastewater disposal site.
- Remove the downstream dam.
- Remove the upstream dam.
- Shut-down the main diversion pump
- Remove fish exclusion fencing

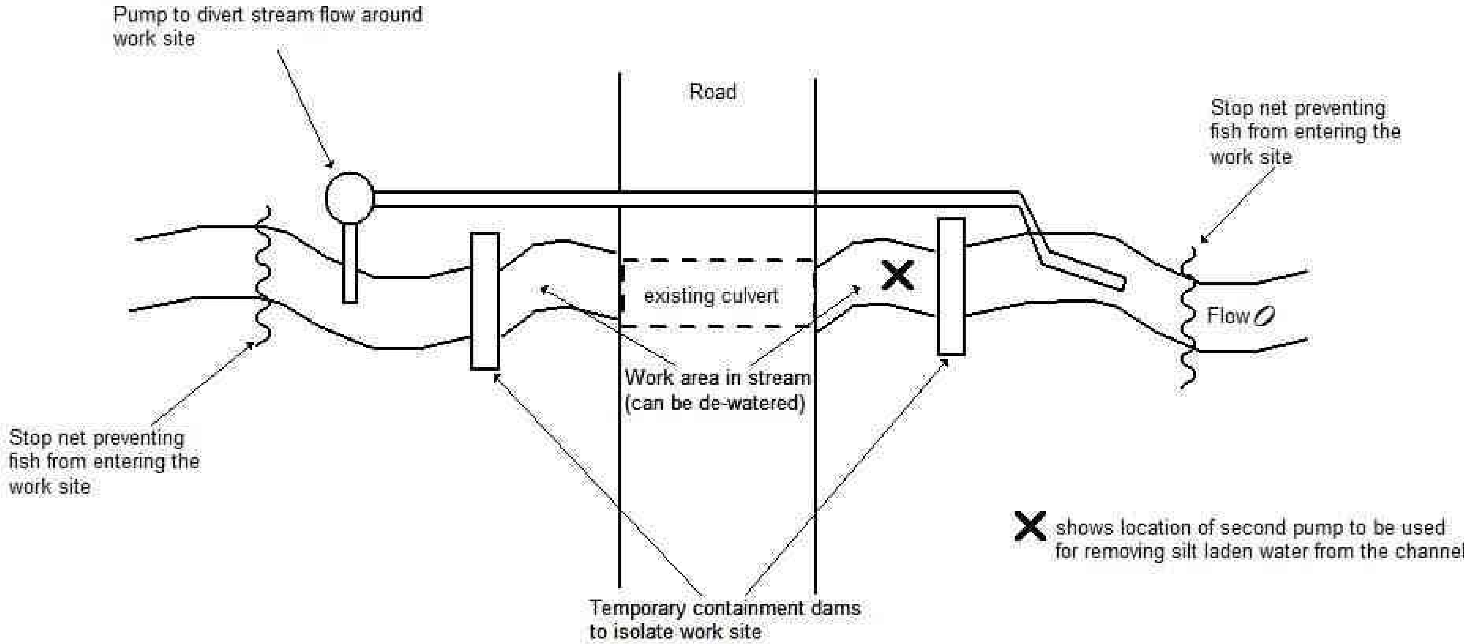

Figure C-1. Dam and pump isolation technique.

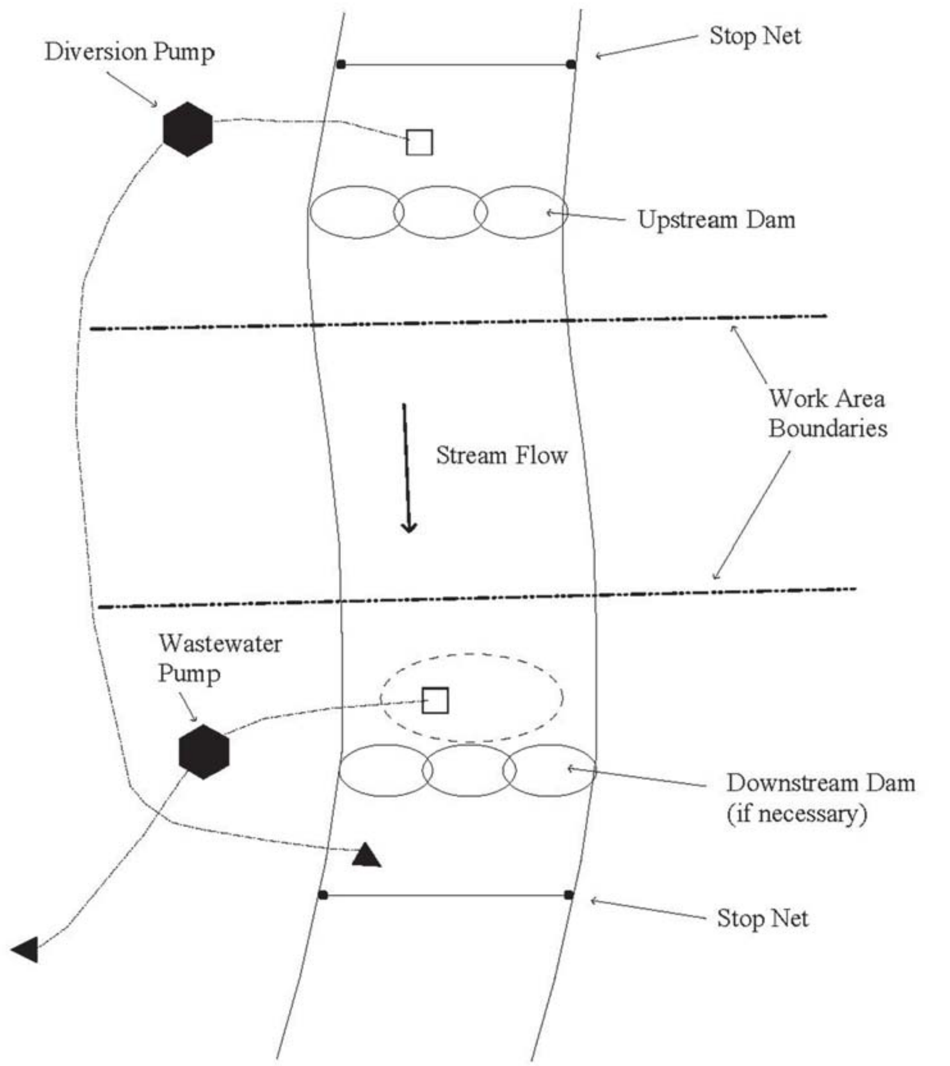

Figure C-2. Dam and pump isolation technique.

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DIVERSION CHANNEL

Typical Procedure (Malaspina 2007):

- Define the instream work area.
- Define an alignment for the diversion channel or assess the path of an abandoned channel.
- Define the location of the upstream diversion dam.
- Excavate the diversion channel or modify the abandoned channel starting downstream and working upstream.
- Excavate the channel at a consistent gradient. The gradient should be as low as possible. The channel should also be wide and flat bottomed to minimize flow velocity, scouring and sediment production.
- The channel bottom elevation at the inlet should be slightly higher than the top of water elevation in the stream, or a coffer dam can be constructed in the stream around the diversion channel inlet. Excavate the channel inlet down to the desired elevation (perhaps the same elevation as the stream channel bottom).
- Sediment control measures should be implemented. This may include lining the channel with polyethylene sheeting, geotextiles or rock.
- Remove the coffer dam (if used) and construct the diversion dam. The water level will increase in front of the dam and the stream will flow into the diversion channel or abandoned channel.
- Let the area downstream of the upper dam dewater. Erect a downstream dam if necessary.
- Complete a fish salvage (if necessary). Any water in the work area should still be clean. Use a pump to start draining the work area. Fish will be concentrated into small pools. Any pump withdrawing water from fish bearing waters must be screened in accordance with the DFO Freshwater Intake End-of-Pipe Fish Screen Guidelines.
- Pump pooled water out of the work area. If it is clean, it can be pumped into the watercourse or into the diversion channel If the pooled water is turbid, pump it to the designated wastewater disposal area.
- Excavate sumps at the dams, as required, to collect any seepage water. This water should be clean and can be pumped into the diversion channel.
- Pump away any turbid water collecting in the work site to the designated wastewater disposal site.
- Install the crossing structure and restore the work site.
- Remove the downstream dam.
- Remove the upstream dam.
- Complete a fish salvage on the diversion or abandoned channel (if necessary).
- Erect a dam to block all flows into the diversion channel prior to infilling the channel. Remove this dam.
- Restore stream banks.

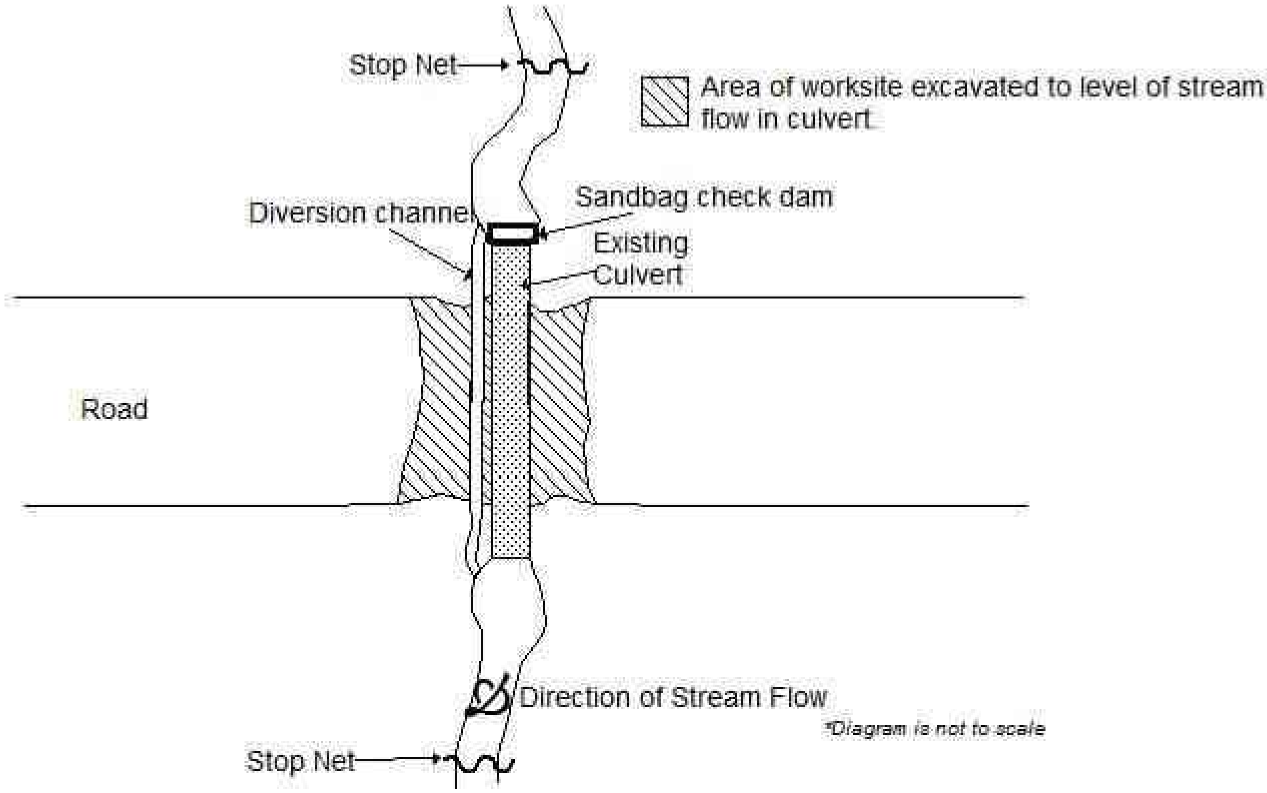

Figure C-3. Diversion channel isolation technique.

SEDIMENT CURTAIN

A sediment curtain is a flexible, temporary barrier placed within a watercourse or body of water to isolate sediment-laden water within a work area. Sediment curtains contain floats along the top and ballast chains on the bottom (Figure C-4). Curtains can be anchored in place with rope. It is important to ensure a tight seal along the stream bottom with the ballast chains, sand bags may be used as additional weight to ensure the bottom of the fabric conforms to the channel bed. Figure C-5 shows an instream sediment curtain application.

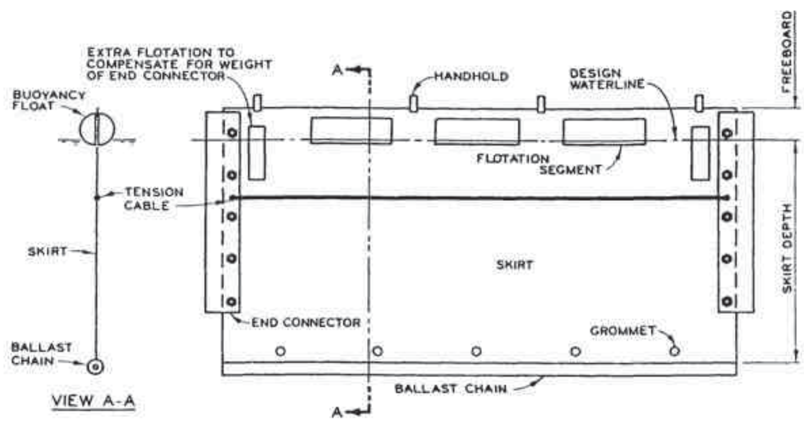

Figure C-4. Typical sediment curtain (Barnard 1978).

Figure C-5. **Instream sediment curtain application for rip-rap installation in a low gradient shallow stream channel**

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APPENDIX C. BEST MANAGEMENT PRACTICES (BMP'S)

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BEST MANAGEMENT PRACTICES (BMP'S)

BMP 1. Silt Fence.

BMP 2. Brush or Rock Filter Berm

BMP 3. Rock Check Dam.

BMP 4. Aggregate-Filled Sand Bag Check Dam.

BMP 5. Log Check Dam.

BMP 6. Straw Bale Check Dam.

BMP 7. Rolled Erosion Control Products (RECP) Channel Installation.

BMP 8. Energy Dissipater for Culvert Outlet.

BMP 9. Slope Drains.

BMP 10. Offtake Ditch.

BMP 11. Planting Trees and Shrubs.

BMP 12. Riparian Zone Preservation.

BMP 13. Scheduling.

BMP 14. Rolled Erosion Control Products (RECP) on Slopes.

BMP 15. Water Bars and Rolling Dips

BMP 16. Polyethylene Sheeting.

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BMP 1: SILT FENCE (FILTER FENCE)

SEDIMENT CONTROL

DESCRIPTION AND PURPOSE

- Permeable fabric barriers installed vertically on support posts along contours to collect and/or filter sediment laden sheet flow runoff.
- Causes water to pond allowing sediment to settle out as water filters through fabric.
- Decreases flow velocity in channels with low to moderate flows (< 0.03 m^3/s).
- Entraps and minimizes coarse sediment from sheet flow or overland flow from entering waterbodies.
- Perimeter control for sediment transport and deposition.

APPLICATIONS

- Temporary measure
- Used at bottom of cut or fill slopes to collect sediment laden runoff
- Used in swales or ditches with low flow velocity and flow less than 0.03 m^3/s
- Used along streams (or channels) banks
- Used around stockpiles
- Midslope grade-break (using "J-hook" or "smile" pattern to effect ponding, filtering and sedimentation)

ADVANTAGES

- Low permeability silt fences have high filtering capabilities for fine sand to coarse silt
- Filter fence more effective than straw bales at filtering out sediment

LIMITATIONS

- Applicable for sheet flow, normally cannot handle concentrated channel flow volumes
- May fail under high runoff events
- Limit to locations suitable for temporary ponding of sediment laden runoff
- Not to be used in swales or ditches with flow greater than 0.03 m^3/s
- Low permeability silt fences may not be strong enough to support weight of water retained behind it and may require reinforcement (i.e. wire mesh and stronger support post)
- Sediment build up needs to be removed at 1/2 height and on a regular basis
- Damage to fence may occur during sediment removal
- Useable life of approximately one year dependent on maintenance and sediment requirement

CONSTRUCTION

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Two methods of installation are commonly used
  - Trench method
  - Mechanical (slicing) installation method (e.g. Tommy Silt Fence Machine or equivalent)

- Trench Method
  - Select location of silt fence (usually along contours)
  - Drive support posts a minimum of 0.3 (preferable 0.6 m) into ground, spaced a maximum of 2 m apart
  - Excavate trench approximately 0.15 m deep by 0.15 m wide for entire length of fence along upstream side of posts
  - Attach the wire mesh or snow fencing, if used as reinforcement to fence fabric, to upstream side of posts with staples
  - Extend filter fabric to base of trench and attach over wire mesh or snow fence, if used, on upstream side of posts
  - Backfill and compact soil in trench, being careful not to damage fence

- Mechanical Installation Method
  - Select location of silt fence (usually along contours)
  - Use mechanical installation machine to embed the fabric a minimum of 0.15 m into the ground. One mechanical installation method is by slicing (with special equipment) the geotextile fabric to embed into the ground without excavation and backfill. Minor disturbance of ground if affected and only tamping of ground is required for compaction.
  - Drive support posts a minimum of 0.3 (preferable 0.6 m) into ground, spaced a maximum of 2 m apart
  - Attach the wire mesh or snow fencing, if used as reinforcement to silt fence fabric, to upstream side of posts with staples
  - Ex tend filter fabric to base of trench and attach over wire mesh or snow fence, if used, on upstream side of posts

CONSTRUCTION CONSIDERATIONS

- Site Selection
  - Size of drainage area should be no greater than 0.1 ha per 30 m length of silt fence
  - Maximum flow path length above silt fence should be no greater than 30 m
  - Maximum slope gradient above the silt fence should be no greater than 2H:1V
  - For use in swales, gradient should be less than 2% and drainage area less than 0.8 ha

- Fence should be placed on contour to produce proper ponding

- Fence should be placed far enough away from toe of slope to provide adequate ponding area (minimum of 1.8 m away from toe of slope is recommended)
- Ends of fence should be angled upslope to collect runoff
- Fence should not extend more than 0.6 m above grade
- Posts can be wood or metal material dependent on design and ground conditions Posts should be placed on downstream side of fence
- Posts should be driven at least 0.3 m (preferable 0.6 m) into the ground
- Posts should not be spaced greater than 2 m apart
- Wire mesh or standard snow fencing may be placed between the posts and filter fabric to provide additional strength and support reinforcement
- Filter fabric should be cut from a continuous roll to avoid joints (if joints are necessary, the wrapping of fabric around the fence post and a minimum overlap of 0.2 m with staples should be used to attach the fabric to the post)
- Fence (and wire mesh or snow fence, if used) should be attached to posts with heavy duty staples, tie wires, or hog rings
- Fence (and wire mesh or snow fence, if used) should be dug into a trench at least 0.15 m deep to prevent undercutting of fence by runoff
- Trench backfill should be compacted
- Long runs of silt fence are more prone to failure than short runs
  - Maximum length of each section of silt fence should be 40 m
  - Silt fence should be installed in 'J' hook or 'smile' configuration, with maximum length of 40 m, along contours allowing an escape path for ponded water (minimizes overtopping of silt fence structure)

INSPECTION AND MAINTENANCE

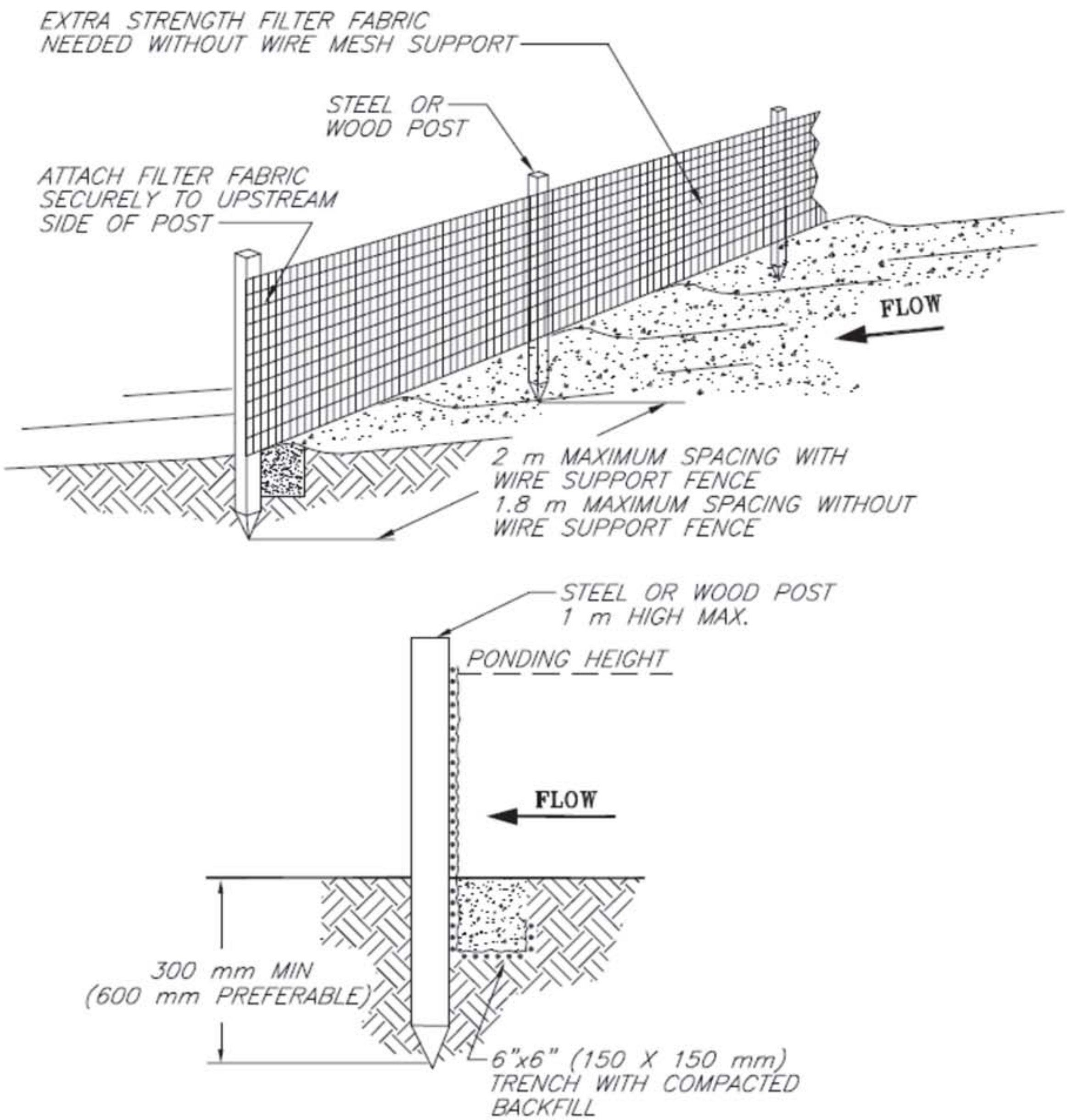
- Inspections should occur twice per week and after significant storm events (1:2 year storm event and/or +40 mm rainfall over 24 hours duration)
- Repair undercut fences and repair or replace split, torn, slumping or weathered fabric immediately
- Sediment build up should be removed once it accumulates to a depth of 0.2 m or at ½ height of fence
- Remove fence after vegetation is established
- Deactivate fabric by cutting-off top portion of fabric above ground; bottom trenched-in portion of fence fabric can be left in-ground thus minimizing ground disturbance

SIMILAR MEASURES

- Straw Bales
- Rock Barrier
- Check Dams
- Permeable/Synthetic Barriers

DESIGN CONSIDERATIONS

- For a silt fence e system to work as a whole, the following factors should be considered:
  - quantity – adequate number and frequency of fence for efficient ponding and sedimentation
  - installation – workmanship
  - compaction – backfill and trenching of fabric
  - support – posts adequately embedded and of strong material and close spacings
  - attachment – secure fabric to post
- Install silt fences in a 'J' hook or 'smile' configuration to allow efficient ponding and sedimentation as well as escape route for excess runoff along the ends
  - Minimizes overtopping of structure



TRENCH METHOD OPTION DETAIL

NOTES:

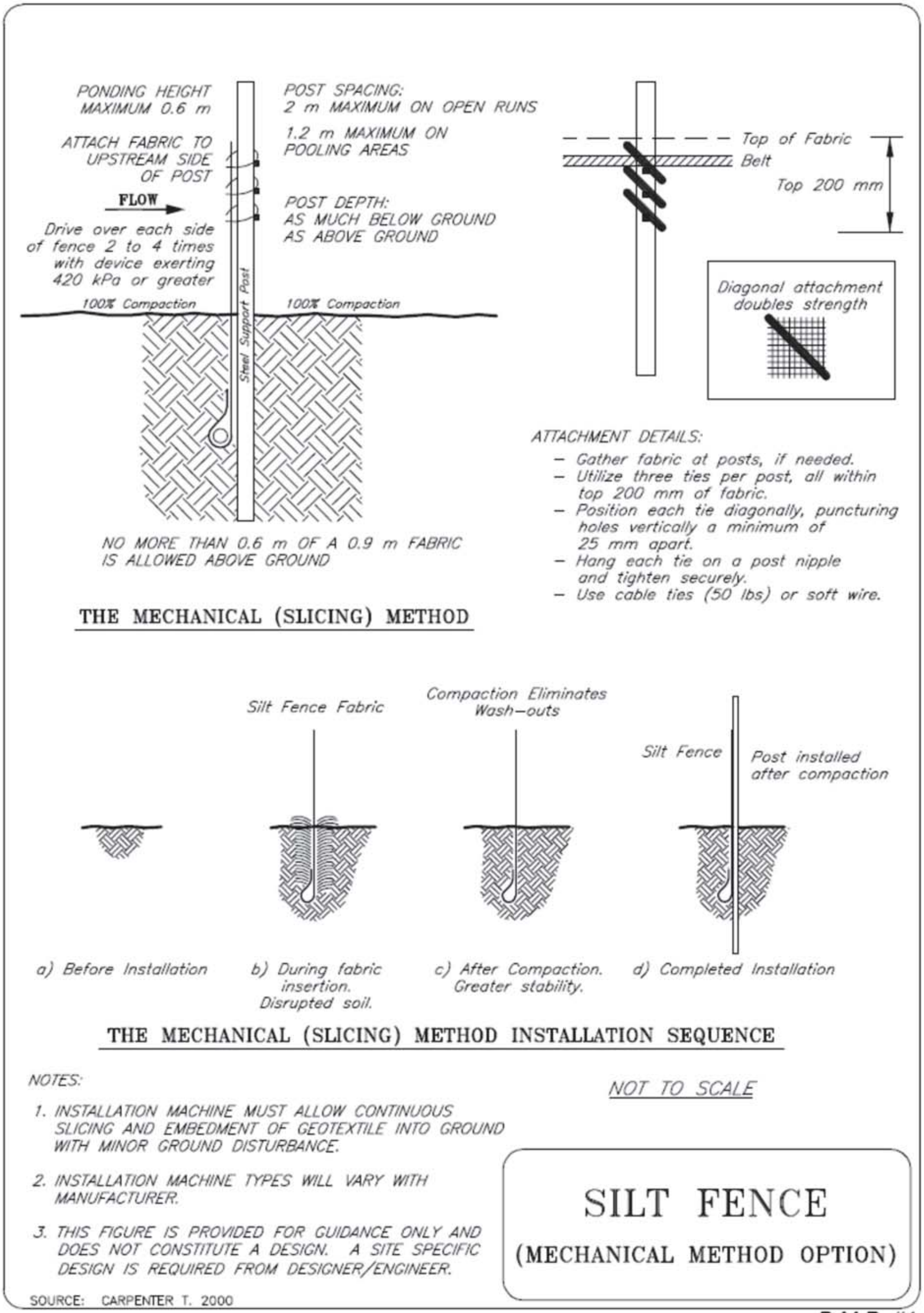
1. SILT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.
2. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT (1:2 YEAR STROM AND/OR +40 mm RAINFALL OVER 24 HOUR DURATION) AND REMOVE SEDIMENT WHEN ACCUMULATED SILT REACHES 1/2 FENCE HEIGHT OR 225 mm MAXIMUM SUGGESTED STORAGE HEIGHT.
3. REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA WILL NOT CONTRIBUTE SEDIMENT OFF-SITE.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

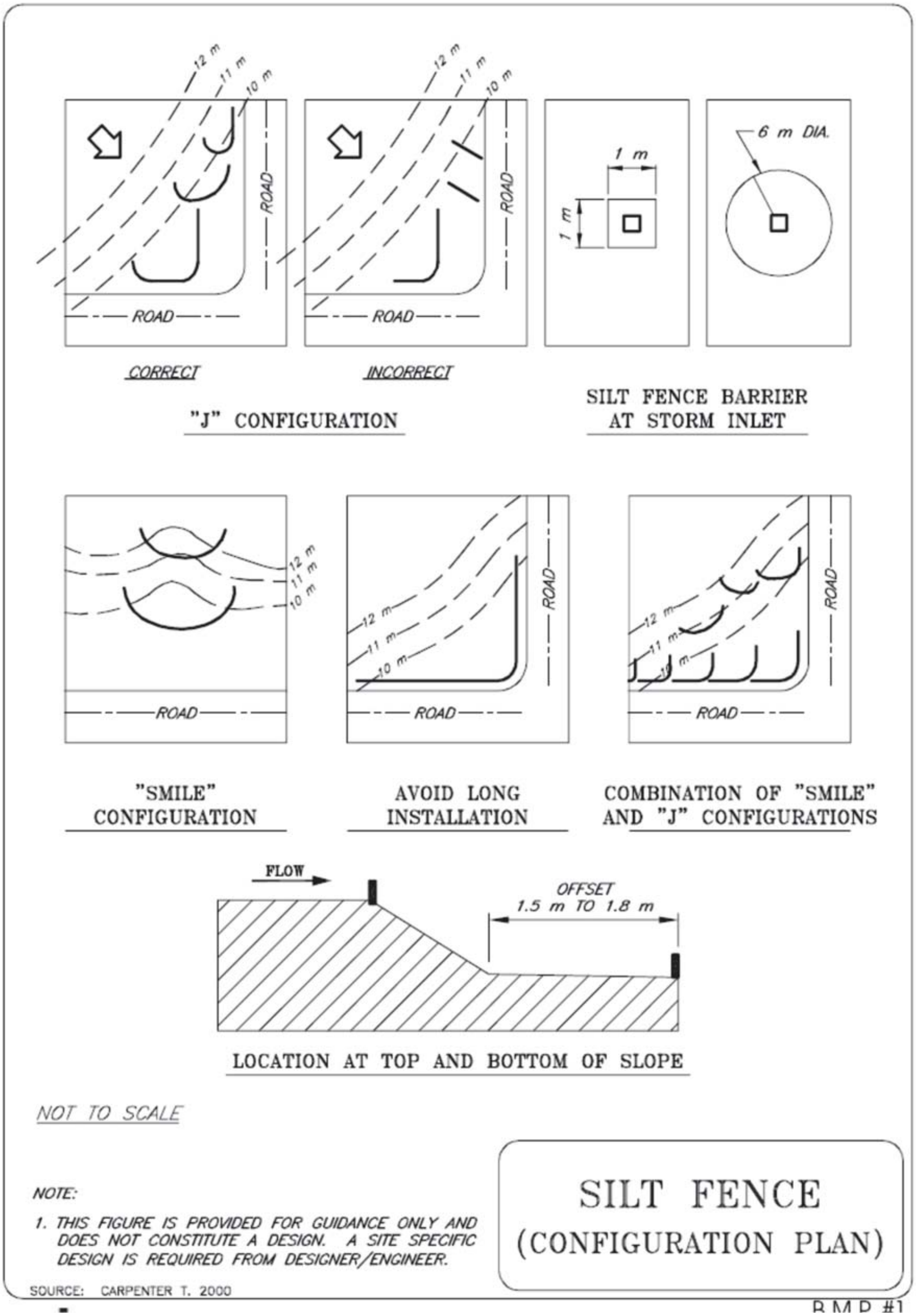
NOT TO SCALE

SILT FENCE

(TRENCH METHOD OPTION)

FILE: SILTFENC


PONDING HEIGHT MAXIMUM 0.6 m
ATTACH FABRIC TO UPSTREAM SIDE OF POST
FLOW
Drive over each side of fence 2 to 4 times with device exerting 420 kPa or greater
100% Compaction
Steel Support Post
100% Compaction
POST SPACING: 2 m MAXIMUM ON OPEN RUNS
1.2 m MAXIMUM ON POOLING AREAS
POST DEPTH: AS MUCH BELOW GROUND AS ABOVE GROUND
NO MORE THAN 0.6 m OF A 0.9 m FABRIC IS ALLOWED ABOVE GROUND
THE MECHANICAL (SLICING) METHOD
Top of Fabric
Belt
Top 200 mm
Diagonal attachment doubles strength
ATTACHMENT DETAILS:
– Gather fabric at posts, if needed.
– Utilize three ties per post, all within top 200 mm of fabric.
– Position each tie diagonally, puncturing holes vertically a minimum of 25 mm apart.
– Hang each tie on a post nipple and tighten securely.
– Use cable ties (50 lbs) or soft wire.
Silt Fence Fabric
Compaction Eliminates Wash–outs
Silt Fence
Post installed after compaction
a) Before Installation
b) During fabric insertion. Disrupted soil.
c) After Compaction. Greater stability.
d) Completed Installation
THE MECHANICAL (SLICING) METHOD INSTALLATION SEQUENCE
NOTES:
1. INSTALLATION MACHINE MUST ALLOW CONTINUOUS SLICING AND EMBEDMENT OF GEOTEXTILE INTO GROUND WITH MINOR GROUND DISTURBANCE.
2. INSTALLATION MACHINE TYPES WILL VARY WITH MANUFACTURER.
3. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.
NOT TO SCALE
SILT FENCE
(MECHANICAL METHOD OPTION)
SOURCE: CARPENTER T. 2000


12 m
11 m
10 m
ROAD
ROAD
CORRECT
INCORRECT
"J" CONFIGURATION
1 m
1 m
6 m DIA.
SILT FENCE BARRIER AT STORM INLET
"SMILE" CONFIGURATION
AVOID LONG INSTALLATION
COMBINATION OF "SMILE" AND "J" CONFIGURATIONS
FLOW
OFFSET 1.5 m TO 1.8 m
LOCATION AT TOP AND BOTTOM OF SLOPE
NOT TO SCALE
NOTE:
1. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.
SOURCE: CARPENTER T. 2000
SILT FENCE (CONFIGURATION PLAN)
BMP #1

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BMP 2: BRUSH OR ROCK FILTER BERM

SEDIMENT CONTROL

DESCRIPTION AND PURPOSE

- Temporary barriers of brush wrapped in filter fabric and secured in place, or rock anchored in place to intercept and filter sediment laden stormwater runoff from disturbed areas, retain sediment, and release water as sheet flow

APPLICATIONS

- Temporary measure
- Perimeter control
- Near toe of slopes subjected to sheet flow and rill erosion
- Along crest or tops streams and channels
- Around drain inlets
- Maximum drainage area of less than 250 m2 per 25 m length of barrier

ADVANTAGES

- May be equally effective filter as silt fences

LIMITATIONS

- Temporary measure only
- Maximum drainage area of less than 250 m2 per 25 m length of barrier
- Sufficient area behind berm required for ponding and clean out of sediment
- Not effective for diverting runoff (filters allow runoff to seep through)
- Rock filter berms are expensive to remove at completion of service life
- Not to be used across ditches, channels, or swales where high concentrated flows are anticipated

CONSTRUCTION

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Brush filter berm
  - Size of the brush filter berm will vary depending upon amount of material available and condition of the site
  - The height of the berm shall be at least 1 m tall and the width shall be a minimum of 1.5 m at its base
  - Berm is constructed by piling brush, roots, stumps and/or stones into a mounded row along contours
    - During clearing and grubbing, equipment can push the material into windrows along toe of slopes or other areas prone to erosion
    - Filter fabric is then laid across the berm, with edges overlapping, and secured in a trench immediately upstream of the berm
    - Trench shall be 15 cm wide and 15 cm deep and shall run for the entire length of the berm
    - The filter fabric in the trench shall be staked down with stakes spaced approximately 1 m apart
    - The trench is then backfilled and compacted over the staked filter fabric
    - The fabric is anchored with twine/wire to stakes on the downstream side of the berm
- Rock filter berm
  - Constructed similar to brush filter berm, replacing brush with rock (D50 = 75 mm to 150 mm)

CONSTRUCTION CONSIDERATIONS

- Use rock or brush material smaller than 150 mm in diameter, or use filter cloth to encapsulate the material, to promote filtration
- There is no predetermined shape for filters
- Water must be forced to filter through the berm and not flow around it
- Brush barriers can generally be constructed of clean organic material made available from clearing and grubbing operations that is normally burned or discarded
- Rock and brush filter berms are temporary measures and should be removed upon completion of service life, but not prior to re-vegetation of areas upslope

INSPECTION AND MAINTENANCE

- Inspect berms on a weekly basis and before and after significant rainfall events (1:2 year storm event and/or 40 mm rainfall over 24 hours duration)

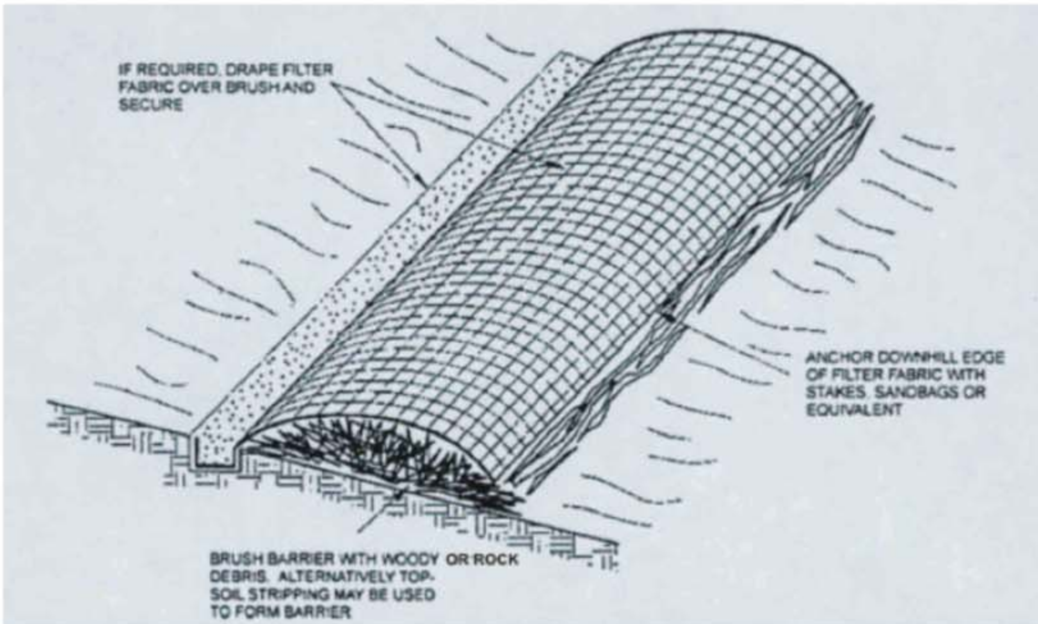
- Reshape berms as needed and replace lost or dislodged rock, brush, and/or filter fabric inspect for sediment accumulation and remove sediment when depths reach approximately one-third the berm height or 300 mm, whichever occurs first
- Inspect for toe undercutting, weathered/deteriorated filter fabric, and end runs and erosion of the filter and repair immediately

SIMILAR MEASURES

- Berms/Barriers
- Check Dams
- Permeable/Synthetic Barriers
- Sand/Gravel Bag Barriers

DESIGN CONSIDERATIONS

- Material properties
  - Rocks
  - Shall consist of hard, durable, clean mineral particles free of organic matter, clay lumps, soft articles, or other substances that might interfere with drainage and filtering properties
  - D50 of 75 mm to 150 mm preferable
- Brush
  - Material shall be less than 150 mm in diameter



NOT TO SCALE

NOTES:

1. EXCAVATE 100 mm X 100 mm TRENCH ALONG UPSTREAM SIDE OF BRUSH OR ROCK FILTER BERM.
2. DRAPE FILTER FABRIC OVER BRUSH OR ROCK FILTER BERM ENSURING UPSTREAM SIDE IS IN TRENCH.
3. BACKFILL AND COMPACT SOIL OVER FILTER FABRIC IN EXCAVATED TRENCH.
4. SECURE FILTER FABRIC OVER BRUSH OR ROCK FILTER BERM BY STAKING ON DOWNSTREAM SIDE OF BERM.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

BRUSH or ROCK FILTER BERMS

BMP 3: ROCK CHECK DAM

EROSION AND SEDIMENT CONTROL

DESCRIPTION AND PURPOSE

- Small dam constructed of rock placed across steep channel
- Decrease flow velocities to reduce erosion caused by storm runoff
- Sediment laden runoff is retained allowing sediment to settle out

APPLICATIONS

- Temporary or permanent measure
- Reduces long steep grade to intervals of gentle grades between successive structures
- Reduces flow velocities and kinetic energy to decrease erosion potential caused by runoff
- Sediment laden runoff is retained behind structure allowing sediment to settle out
- May be used in channels that drain 4 ha (10 ac) or less
- May be used in steep channels where storm water runoff velocity is less than 1.5 m/s (5 fps)

ADVANTAGES

- More effective than straw bales for stabilizing medium to steep gradient ditches as a permanent measure
- Cheaper than using riprap armouring or gabion structures in a ditch
- Easy to construct

LIMITATIONS

- Not appropriate for high flow velocity >1.5 m/sec; (use gabion structures for flow velocity >1.5 m/sec)
- Not appropriate for channels draining areas larger than 4 ha (10 ac)
- Not to be placed in grass lined channels unless erosion is anticipated
    - Susceptible to failure if water undermines or outflanks structure

CONSTRUCTION

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Excavate a trench key a minimum of 0.15 m in depth at the rock check structure location
- Place non-woven geotextile fabric over footprint area of rock check
- Construct structure by machine or hand
- Structure should extend from one side of the ditch or channel to the other

- Structure should be constructed so that centre of the crest is depressed to form a centre flow width which is a minimum of 0.30 m lower than the outer edges
- Height of structures should be less than 0.8 m in height to avoid impounding large volumes of runoff
- Downstream slope of the check dam should be 3H:1V (minimum)
- Upstream slope of the check dam should be 2H:1V (minimum)

CONSTRUCTION CONSIDERATIONS

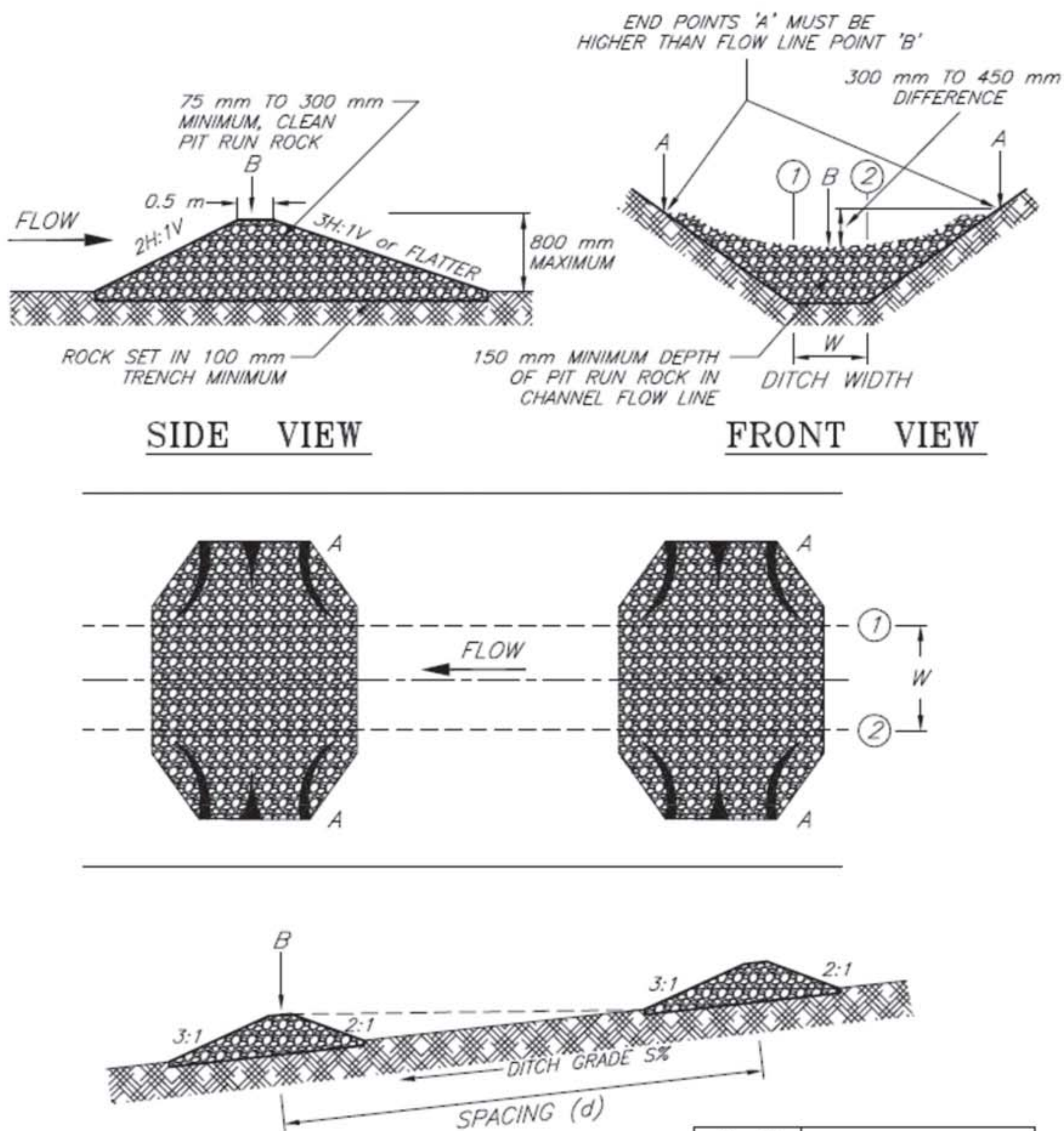
- Height and spacing between structures should be designed to reduce steep channel slope to intervals of flatter gradient
- Rock check structures should be constructed of free draining aggregate
- Aggregate used should have a mean diameter (D50) of between 75 mm and 150 mm and must be large enough to remain in place during high velocity flow situations. Maximum rock diameter should not exceed 150 mm if the structure is to be used as a sediment trap.
- If rock check structures are to be placed in channels with significant high flows, they must be properly designed for stone size and structure spacings.

INSPECTION AND MAINTENANCE

- Inspect barriers at least once a week and before and after each significant rainfall event (more than 25 mm in a 24 hour period)
- Remove sediment build up before it reaches one half the check structure height
- Erosion repairs should be made immediately to prevent failure of the structure
- Replace dislodged aggregate immediately with heavier aggregate or gabion structures

SIMILAR MEASURES

- Sand bag check dam
- Wood check dam
    - Straw bale check dam



D_{50} of ROCK (mm)	MAXIMUM FLOW DEPTH OVER ROCK (mm)
75	50
150	100

SUGGESTED ROCK DIAMETER AND OVERFLOW DEPTHS

NOTES:

1. SUITABLE FOR FLOW VELOCITY $\leq$ 1.5 m/s.
2. SUITABLE FOR DRAINAGE AREA $\leq$ 4 ha.
3. SUITABLE FOR GRADES FROM 5% TO 8%.
4. SPACING (d) AND ROCK SIZE (D_{50}) TO BE DETERMINED BY ENGINEER BASED ON HYDRAULIC CONDITIONS.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

NOT TO SCALE

ROCK CHECK DAM

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BMP 4: AGGREGATE–FILLED SAND BAG CHECK DAM

EROSION AND SEDIMENT CONTROL

DESCRIPTION AND PURPOSE

- Small dam constructed with aggregate filled sand bags
- Decrease flow velocities to reduce erosion caused by storm runoff
- Sediment laden runoff is retained allowing sediment to settle out

APPLICATIONS

- Temporary measure
- May be used in small open channels that drain 2 ha (5 ac) or less
- May be used in steeply graded channels to reduce gradient, especially in highly erodible soils (sand and silt)
- May be used until vegetation is established
- May b used in temporary channels or ditches whe re short service life does not warrant installation of erosion-resistant linings
- Perimeter control

ADVANTAGES

- More effective than silt fences or straw bales for a temporary drop structure and sediment trap for stabilizing major ditches
- Cheaper than armouring entire channel or ditch
- Easily constructed and reusable

LIMITATIONS

- Not appropriate for channels draining areas larger than 2 ha (5 ac)
- Require extensive maintenance following high velocity flows associated with storm events
- No filtering capabilities
- Sand bags need to be placed by hand to avoid ripping bags during placement

CONSTRUCTION

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Place sandbags by hand at check structure location

- Check structure should extend from one side of the ditch or channel to the other
- Structure should be constructed so that centre of the crest is depressed to form a centre flow width which is a minimum of 0.30 m lower than the outer edges
- Height of check structures should be less than 0.8 m to avoid impounding large volumes of runoff
- Downstream slope of the check dam should be 2.5H:1V (minimum)
- Upstream slope of the check dam should be 1.5H:1V (minimum)

CONSTRUCTION CONSIDERATIONS

- Height and spacing of check structures should be designed to reduce channel slope to intervals of flatter gradient
- Sandbags should only be filled ¾ full to allow bag to mould to contours, allowing continuous contact between the bag and the soil

INSPECTION AND MAINTENANCE

- Inspect barriers at least once a week and before and after each significant rainfall event (more than 25 mm in a 24 hour period)
- Remove sediment build up before it reaches one half the check structure height
- Erosion repairs should be made immediately to prevent failure of the structure
- Replace dislodged or damaged bags immediately

SIMILAR MEASURES

- Rock check dam
- Wood check dam
- Straw bale check dam

BMP 5: LOG CHECK DAM

EROSION CONTROL AND SEDIMENT CONTROL

DESCRIPTION AND PURPOSE

- Small dam constructed of wood (logs/timbers)
- Decrease flow velocities to reduce erosion caused by storm runoff
- Used to reduce steeply graded channels to intervals of flatter gradients to reduce erosion flow velocity and energy especially in highly erodible soils (sand and silt)
- Sediment laden runoff is retained allowing sediment to settle out

APPLICATIONS

- Temporary or permanent measure
- Used in small open channels that drain 4 ha (10 ac) or less
- Used in areas where logs/timber is readily available
- Can be economical by reusing suitable timber material salvaged from clearing operations

ADVANTAGES

- More effective than silt fences or straw bales as temporary drop structure and sediment entrapment for stabilizing major ditches
- Cheaper than gabion structures depending on the availability of timber and its proximity to the construction site

LIMITATIONS

- Not appropriate for channels draining areas larger than 4 ha (10 ac)
- Not to be placed in grass lined channels unless erosion is anticipated
- Labour intensive construction
- Undermining and outflanking around the ends may occur if constructed improperly
- Gaps between logs may allow sediment laden runoff to escape
- Logs/timbers will decay and rot with time

CONSTRUCTION

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Embed ends of logs at least 0.5 m into channel or ditch bed

- Ensure there are minimal gaps between logs
- Install horizontal cross brace at top of the downstream side of structure to connect logs together providing integral support
- Structure should extend from one side of the ditch or channel to the other
- Structure should be constructed so that centre of the crest is depressed to form a centre flow width which is a minimum of 0.30 m lower than the outer edges
- To avoid impounding large volumes of runoff, check structures should be less than 0.5 m in height above the base of the ditch.

CONSTRUCTION CONSIDERATIONS

- Height and spacing of structures should be designed to reduce gradient to a flatter grade
- Wood check dams placed in ditches with high anticipated flow velocity should have their spacing and height design according to the anticipated hydraulic condition
- Bracing should be installed to provide support to embedded logs

INSPECTION AND MAINTENANCE

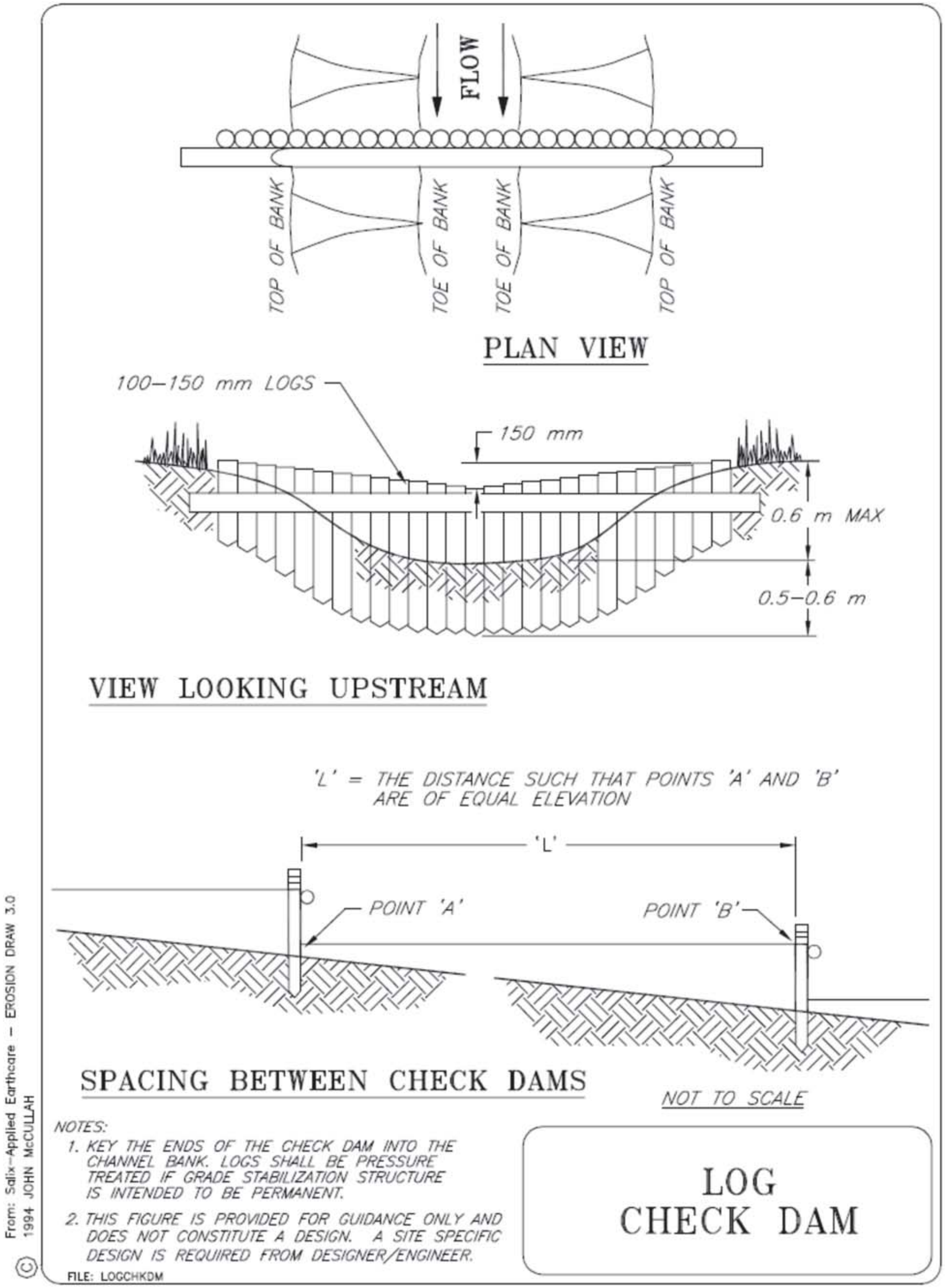
- Inspect barriers at least once a week and before and after each significant rainfall event (more than 25 mm in a 24 hour period)
- Remove sediment build up before it reaches one half the check structure height
- Erosion repairs should be made immediately to prevent failure of the structure
- Replace dislodged, decayed, or damaged wood immediately

SIMILAR MEASURES

- Rock check dam
- Sand bag check dam
- Straw bale check dam

DESIGN CONSIDERATIONS

- Install splash pad (energy dissipater) on downstream side of structure to reduce erosion potential of water overtopping the structure
  - Splash pad can be constructed of gravel, riprap, or bound woody debris


FLOW
TOP OF BANK
TOE OF BANK
TOE OF BANK
TOP OF BANK
PLAN VIEW
100–150 mm LOGS
150 mm
0.6 m MAX
0.5–0.6 m
VIEW LOOKING UPSTREAM
'L' = THE DISTANCE SUCH THAT POINTS 'A' AND 'B' ARE OF EQUAL ELEVATION
'L'
POINT 'A'
POINT 'B'
SPACING BETWEEN CHECK DAMS
NOT TO SCALE
NOTES:
1. KEY THE ENDS OF THE CHECK DAM INTO THE CHANNEL BANK. LOGS SHALL BE PRESSURE TREATED IF GRADE STABILIZATION STRUCTURE IS INTENDED TO BE PERMANENT.
2. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.
LOG CHECK DAM
FILE: LOGCHKDM
From: Salix–Applied Earthcare – EROSION DRAW 3.0
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BMP 6: STRAW BALE CHECK DAM

EROSION CONTROL AND SEDIMENT CONTROL

DESCRIPTION AND PURPOSE

- Small, temporary dam constructed of straw bales as drop structures placed across channels
- Sediment laden runoff is ponded allowing sediment to settle out or is filtered through the straw bale
- Reduce steep grade to intervals of flatter grades between structures
- Decrease flow velocities to reduce erosion potential caused by storm runoff

APPLICATIONS

- Temporary measure
- May be used in small open channels that drain 2 ha (5 ac) or less
- May be used in channels with grade of less than 5%
- May be used for flow velocities of 0.3 m/s or less
- May be used until vegetation is established
- May be used in temporary channels or ditches (offtakes) where short service life does not warrant installation of erosion-resistant linings

ADVANTAGES

- Economical in areas where straw is readily available or within an economical hauling distance
- Biodegradable

LIMITATIONS

- Not appropriate for channels draining areas larger than 2 ha (5 ac)
- Not appropriate for channels graded greater than 5%
- Not appropriate for flow velocities greater than 0.3 m/s as straw bale can be damaged by high flow impacts
- Require extensive maintenance following high velocity flows associated with storm events
- Not as robust as rock, wood, or sand bag check dams
- Susceptible to failure if bale s are not properly trenched and anchored thus allowing water to undermine or outflank the structure
- Service life is short
- Must be installed by hand
- Straw bale check structure should only be a maximum of one straw bale in height or 0.5 m maximum

CONSTRUCTION

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Excavate a trench approximately 0.15 m deep with a width of two straw bales at the straw bale check structure location
- Place two rows of straw bales in excavated trench perpendicular to flow direction ensuring bales are staggered so that no joints are aligned on the upstream and downstream rows.
- Ensure twine or wire is not in contact with the soil
- Infill all joints with straw
- The centre of the crest of the check structure should be a centre flow width at least 0.15 m lower than the outer edges along the channel walls
- Drive two 50 mm square section wooden stakes 1.2 m long through each straw bale, ensuring stake is embedded a minimum of 0.15 m into soil
- Backfill and compact the upstream and downstream edges of the check structure to seat the straw bales into the base of the ditch
- Geotextile wrapping may be specified. The geotextile shall be pinned to the straw bale subgrade.

CONSTRUCTION CONSIDERATIONS

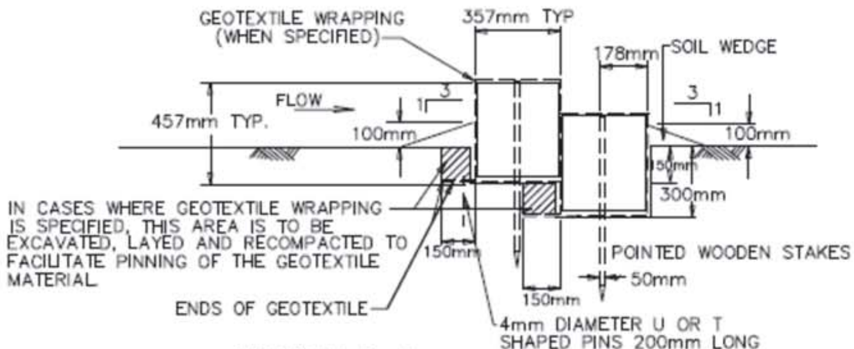
- Height and spacing of structures should be designed to reduce gradient to a flatter grade
- To avoid impounding large volumes of runoff, check structures should be a maximum of one straw bale high
- Straw bales should be:
    - Machine-made
    - Weed free cereal crop straw such as wheat, oats, rye, or barley
    - Tightly compacted and bound with two rows of wire or synthetic string and shall show no signs of weathering
    - No more than year old

INSPECTION AND MAINTENANCE

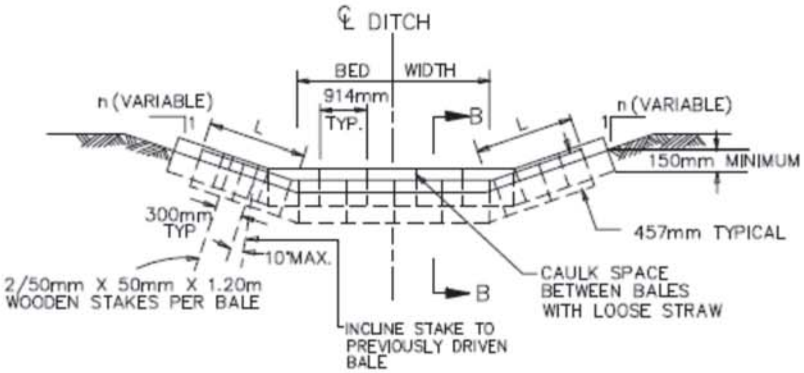
- Inspect barriers at weekly intervals and after each significant rainfall event (1:2 year storm and/or 40 mm rainfall over 24 hour duration)
- Remove sediment build up before it reaches one half the check structure height
- Erosion repairs should be made immediately to prevent failure of the structure
- Replace damaged, decayed, or dislodged straw bales immediately
- Straw bale check structure should be maintained until no longer required

SIMILAR MEASURES

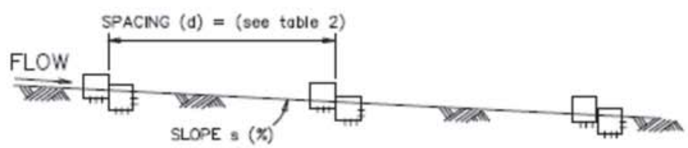
- Rock check dam
- Aggregate filled sand bag check structure
- Log check dam



SECTION B–B



ELEVATION A–A (WOODEN STAKES OMITTED FOR CLARITY)



TYPICAL DITCH BARRIER SPACING

TABLE 1

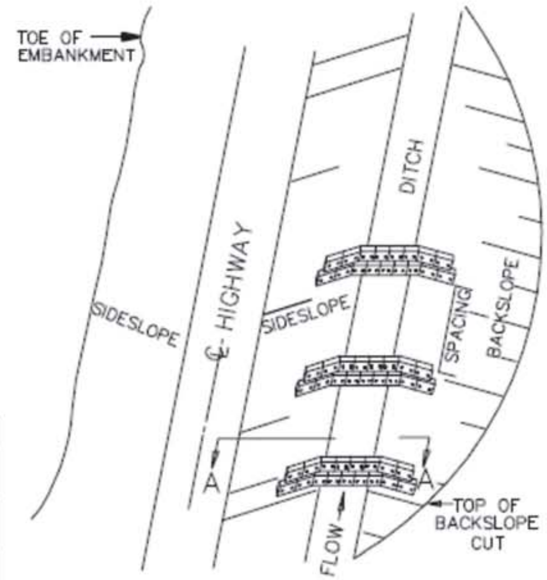
MINIMUM INSTALLATION LENGTH UP SLOPES

SLOPE n	LENGTH L (m)
2	1.0
2.5	1.25
3.0	1.50
3.5	1.65
4	1.80
5	2.35
6	2.75

TABLE 2

SUGGESTED SPACING (d)

S (%)	d (m)
3	40
4	35
5	25



DITCH BARRIER

NOTES:

1. *SUITABLE FOR S < 5% AND HYDRAULIC CONDITIONS NOT SEVERE FOR S > 5%, THE ENGINEER MUST ASSESS USE OF THIS STRUCTURE VERSUS OTHER OPTIONS.*
2. *EMBED BALES 100 TO 150 mm INTO THE SOIL AND "KEY BALES INTO THE CHANNEL BANKS.*
3. *PLACE BALES PERPENDICULAR TO THE FLOW WITH ENDS TIGHTLY ABUTTING.*
4. *BALE HEIGHT SHALL NOT EXCEED 0.5 m.*
5. *INSPECT AFTER EACH SIGNIFICANT STORM, MAINTAIN AND REPAIR PROMPTLY.*
6. *THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.*

STRAW BALE CHECK DAM

BMP 7: ROLLED EROSION CONTROL PRODUCTS (RECPS): CHANNEL AND SLOPE INSTALLATION

EROSION CONTROL

DESCRIPTION AND PURPOSE

- Biodegradable or synthetic soil coverings used for temporary or permanent protection of disturbed soils at slopes and channels
- Categories of Rolled erosion control products (RECP) can be:
    - Erosion control blankets (ECB) (generally biodegradable and temporary)
    - Turf reinforcement mats (TRM)
    - Composite turf reinforcement mats (C-TRM)
- RECP may be manufactured of organic material, synthetic material, or as a composite of organic and synthetic materials
- Protect disturbed soils from raindrop impact and surface runoff erosion, increase water infiltration into soil, retains soil moisture and decreases evaporation loss
- Protect seeds from raindrop impact, runoff, and predators
- Stabilizes soil temperature to promote seed germination and enhance vegetation growth

APPLICATIONS

- Temporary or permanent measure
- May be used to protect disturbed, exposed soils for cut or fill slopes at gradients of 2.5H:1V or steeper
- May be used on slopes where erosion potential is high
    - Silts and sands have higher erosion potential than high plastic clays
- May be used on slopes where vegetation is likely to be slow to develop
- May be used to protect disturbed exposed soils in ditches and channels (with high flow velocities) by providing additional tractive resistance cover in conjunction with a successful high density vegetative growth established

ADVANTAGES

- Degree of erosion protection is higher, more uniform, and longer lasting than for sprayed-on products (e.g. mulches)
- Wide range of commercially available temporary (biodegradable) or permanent products

LIMITATIONS

- Non-performance of RECP may result from the following:
    - Low density vegetation growth (beneath RECP) due to non-favorable weather and growth conditions (i.e. soil type, moisture, storm events at critical times). It is noted that values of tractive resistance of RECP products for vegetative growth may be generally tested in laboratory after a growth period (e.g. 3 months) under greenhouse growth conditions. The effectiveness of RECP, especially along channels , is very dependent on success of vegetation growth on site. It is important that the designer should assess the effectiveness of RECP in accordance with site, soil, terrain and vegetation growth conditions.
    - Hydraulic uplift of RECP and erosion of underlying soils can occur under rapid snow melt conditions when dammed up melt water generates a hydraulic head and high flow velocity generated in constricted snow melt channel. This situation can occur along steep channels interlaced with drop structures and with RECP lining installed in-between the drop structures. Ponding of melt water and non-anchored RECP joint areas allow flow entry beneath the RECP and generate hydraulic heads to uplift the RECP. This can occur along un-anchored edges of RECP at upper edges of ditch when snow melt occurs at tops of ditch and flow beneath the RECP. This is especially critical when underlying soil is easily erodible. (e.g. fine grained non-cohesive silty soils). It is important to trench-in and anchor the edges of the RECP installations and installed anchor pin (staples) at sufficient dense intervals.
    - Ice buildup from groundwater seepage source can uplift and dislocate the RECP and causing flow beneath the RECP to erode the substrate soils. Winter ice accumulation may be related to groundwater regime and investigative design on subsurface drainage by a geotechnical engineer is required.

- Can be labour-intensive to install
- Must be installed on unfrozen ground
- Temporary blankets may require removal before implementation of permanent measures
- Rolled erosion control products (RECP) are not suitable for rocky sites
- Proper surface preparation is required to ensure intimate contact between blanket and soil
- Plastic sheeting can be used at sensitive slopes with precautions:
    - Plastic sheeting RECP product can be easily torn, ripped, non-biodegradable, and should be disposed of in a landfill
    - Plastic sheeting product, if used, results in 100% runoff, thus increasing erosion potential in downslope areas receiving the increased flow volumes
    - Plastic sheeting should be limited to temporary covering of sensitive soil stockpiles or temporary covering of small critical unstable slope areas

CONSTRUCTION (SLOPES)

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- RECP should be installed in accordance with manufacturer's directions
- The following is a general installation method
- Prepare surface and place topsoil and seed
- Surface should be smooth and free of large rocks, debris, or other deleterious materials
- Blanket should be anchored at top of slope in a minimum 0.15 m by 0.15 m trench for the entire width of the blanket
- The blanket should be rolled out downslope
  - Where the blanket roll is not long enough to cover the entire length of the slope, a minimum 0.15 m by 0.15 m check slot should be excavated at the location of the lap, and the downslope segment of blanket anchored in the check slot, similar to the method used for the top of the slope, or (2) when blankets, must be spliced down the slope, place blanket end over end (shingle style with approximately 0.10 m overlap. Staple through overlapped area at 0.3 m intervals.
  - The upslope portion of blanket should overlap the downslope portion of blanket, shingle style, at least 0.15 m with staple anchors placed a maximum 0.3 m apart
  - Adjacent rolls of blanket should overlap a minimum 0.1 m
  - Anchors should be placed along central portion of blanket spaced at 4/m2 minimum (0.5 m spacing) for slopes steeper than 2H:1V and 1/m² (1 m spacing) for slopes flatter than 2H:1V
  - Anchors along splices between adjacent rolls should be placed 0.9 m apart

CONSTRUCTION (CHANNELS)

(For guidance only. A site specific design is required from designer/engineer)

- A Blanket should be installed in accordance with manufacturer's directions
- The following is a general installation method
  - Prepare surface and place topsoil and seed
  - Surface should be smooth and free of large rocks, debris, or other deleterious materials
  - Begin by excavating a minimum 0.15 m deep and 0.15 m wide trench at the upstream end of channel and place end of RECP into trench
  - Use a double row of staggered anchors approximately 0.1 m apart (i.e. 0.2 m linear spacing) to secure RECP to soil in base of trench
  - Backfill and compact soil over RECP in trench
  - Roll centre RECP in direction of water flow on base of channel
  - Place RECP end over end (shingle style) with a minimum 0.15 m overlap downgrade
  - Use a double row of staggered anchors approximately 0.1 m apart to secure RECP to soil
  - Full length edge of RECP at top of sideslopes must be anchored in a minimum 0.15 m deep and 0.15 m wide trench
  - Use a double row of staggered staple anchors a maximum of 0.1 m apart (i.e. 0.2 m linear spacing) to secure RECP to soil in base of trench

  - Backfill and compact soil over RECP in trench
  - Overlap RECP on sideslopes (shingle style down channel) a minimum of 0.1 m over the centre RECP and secure RECP to soil with anchors spaced a maximum of 0.2 m apart
  - In high flow channels, a check slot across the width of the channel is recommended at a maximum spacing of 10 m to anchor the ends of the RECP to the underlying soil
  - Use a double row of staggered staple anchors a maximum of 0.1 m apart (0.2 m linear spacing) to secure RECP to soil in base of check slot
  - Backfill and compact soil over RECP in check slot
  - Anchor terminal ends of RECP in a minimum 0.15 m deep and 0.15 m wide trench
  - Use a double row of staggered anchors a maximum of 0.1 m apart (i.e. 0.2 m linear spacing) to secure RECP to soil in base of trench
  - Backfill and compact soil over RECP in trench

CONSTRUCTION CONSIDERATIONS

- Slopes should be topsoiled and seeded prior to placing RECP
- Ensure blanket is in intimate contact with the soil by properly grading soil, removing rocks or deleterious materials, prior to placing blanket
- In channels, blankets should extend to above the anticipated flow height, with a minimum 0.5 m of free board
- For turf reinforcement mat (TRM), blanket should be placed immediately after topsoiling
- Blanket should be anchored by using wire staples, metal geotextile stake pins, or triangular wooden stakes
  - All anchors should be a minimum of 0.15 to 0.2 m in length
  - For loose soils, use longer anchors
- Blankets should be placed longitudinal to direction of flow, with fabric not stretched but maintaining contact with underlying soil
- It is essential to understand product specifications and follow manufacturer's instructions on installation methods

PRODUCT QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) CERTIFICATION

- RECPs should be certified by the supplier/manufacturer to ensure product performance and compliance with specified property requirements. A certificate for QA/QC testing of manufactured products is required. The performance and QA/QC testing should be carried out by reputable laboratories (e.g. TxDoT – Hydraulic and Erosion Control Laboratory OR equivalent laboratory) to ensure a commonly acceptable QA/QC standard. Dependent on product type and intended performance, the product information certificate should be provided by the product supplier/manufacturer to include the following:
- Manufacturer's Certification
- Performance specification

  - Permissible Tractive Resistance (include testing methods and vegetative growth conditions)
  - Permissible Flow Velocity (if available)
  - Longevity (for biodegradable or non-biodegradable products)

- Minimum Average Roll Values (MARVs) along with specified testing methods for
  - Physical properties
  - Mass per unit area
  - Thickness
  - Tensile strength
  - UV Resistance
  - Other physical properties (for non-woven below Erosion Mat (if specified)
  - Grab tensile strength
  - Grab elongation
  - Puncture strength
  - Trapezoidal tear
  - UV Resistance

INSPECTION AND MAINTENANCE

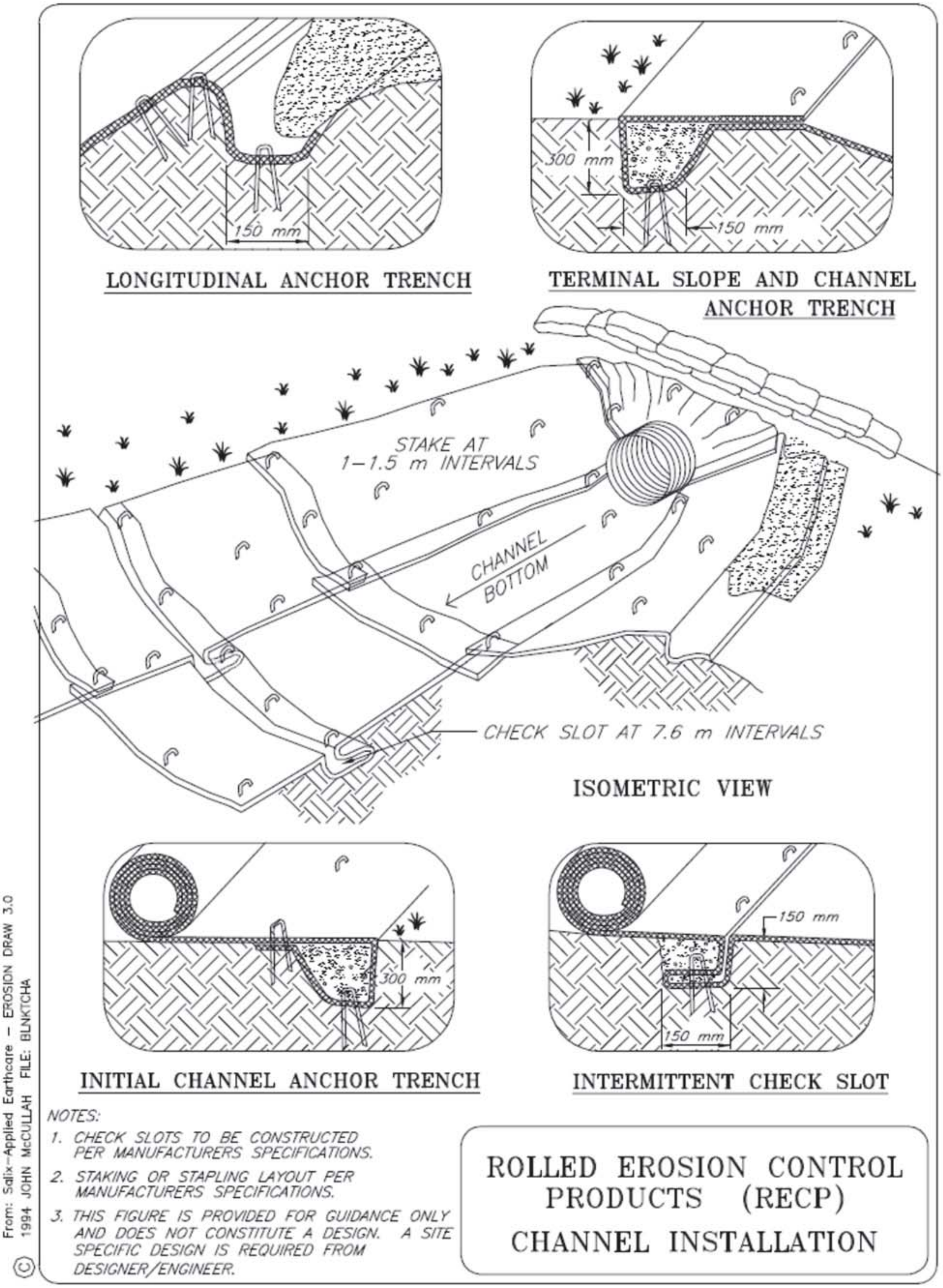
- Area covered with blankets should be regularly inspected/remediated, especially after periods of severe rainfall or storm events, to check for blanket separatio n or breakage
- Any damaged or poorly performing areas should be repaired/remediated immediately. Regrading of the slope by hand methods may be required in the event of rill or gully erosion.
- Inspection and maintenance should continue until dense vegetation is established
- Areas with low vegetation density should be reseeded
- After approximately one year, a top dressing of fertilizer may be applied to improve vegetation cover and assist degradation of temporary blankets

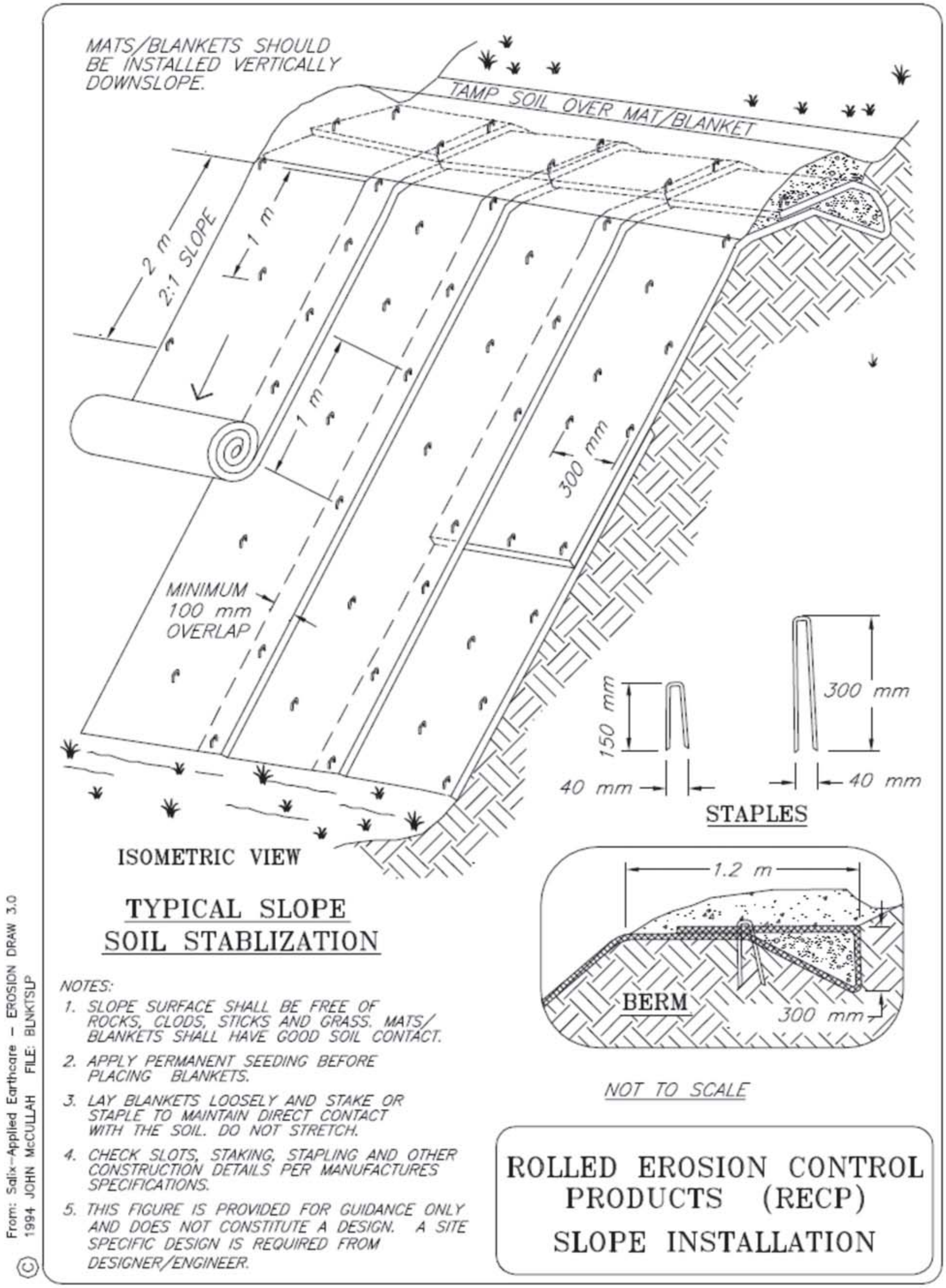
SIMILAR MEASURES

- Mulching (for slopes only)
- Chemical stabilization (for slopes only, e.g. Tackifiers)
- Rip rap (primarily in channels)
- Gabion mattresses (primarily in channels)

DESIGN CONSIDERATIONS

- Assess hydraulic flow conditions and tractive stress on channel
- Assess local soil, weather and growth conditions (favourable/non- favourable) for revegetation (within 3 to 12 months) to allow a determination on use or non-use of RECP as a protective measure. If the revegetation conditions are assessed favourable, the use of RECP can be considered
- Assess suitability of a RECP product using tractive resistance data tested for (i) bare soil, and (ii) vegetated (a specified duration of growth period) condition
- It is noted that tractive resistance data are adopted as selection criteria of RECP and permissible velocity data can be provided for reference.


150 mm
LONGITUDINAL ANCHOR TRENCH
300 mm
150 mm
TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH
STAKE AT 1–1.5 m INTERVALS
CHANNEL BOTTOM
CHECK SLOT AT 7.6 m INTERVALS
ISOMETRIC VIEW
300 mm
INITIAL CHANNEL ANCHOR TRENCH
150 mm
150 mm
INTERMITTENT CHECK SLOT
NOTES:
1. CHECK SLOTS TO BE CONSTRUCTED PER MANUFACTURERS SPECIFICATIONS.
2. STAKING OR STAPLING LAYOUT PER MANUFACTURERS SPECIFICATIONS.
3. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.
ROLLED EROSION CONTROL PRODUCTS (RECP)
CHANNEL INSTALLATION
© 1994 JOHN McCULLAH FILE: BLNKTCHA
From: Salix-Applied Earthcare – EROSION DRAW 3.0


MATS/BLANKETS SHOULD BE INSTALLED VERTICALLY DOWNSLOPE.
TAMP SOIL OVER MAT/BLANKET
2 m
2:1 SLOPE
1 m
1 m
300 mm
MINIMUM 100 mm OVERLAP
150 mm
40 mm
300 mm
40 mm
STAPLES
ISOMETRIC VIEW
1.2 m
BERM
300 mm
TYPICAL SLOPE SOIL STABLIZATION
NOT TO SCALE
NOTES:
1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS/ BLANKETS SHALL HAVE GOOD SOIL CONTACT.
2. APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS.
3. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.
4. CHECK SLOTS, STAKING, STAPLING AND OTHER CONSTRUCTION DETAILS PER MANUFACTURES SPECIFICATIONS.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.
ROLLED EROSION CONTROL PRODUCTS (RECP) SLOPE INSTALLATION
From: Salix–Applied Earthcare – EROSION DRAW 3.0
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BMP 8: ENERGY DISSIPATER FOR CULVERT OUTLET

EROSION CONTROL

DESCRIPTION

- Hard armour (rip rap, gravel, sand bags, concrete) placed at pipe outlets, in channels, and at downstream side of check structures to reduce velocity and dissipate energy of concentrated flows
- Standard Drain Trough Terminal Protection Structure generally used at bridge headslope
-
- Minimizes scour at flow impact location with dissipated flow energy

APPLICATIONS

- Permanent measure
- May be used at outlets of pipes, drains, culverts, conduits, or channels with substantial flows
- May be used at slope drain outlets located at the bottom of mild to steep slopes
- May be used where lined channels discharge into unlined channels
- May be used as splash pad on downstream side of gabions, check structures, berms, barriers, and silt fences to prevent erosion caused by overtopping of structure

ADVANTAGES

- Reduces flow energy in a relatively small area

LIMITATIONS

- Small rocks or stones can be dislodged during high flows
- Grouted rip rap may breakup due to hydrostatic pressure, frost heave, or settlement
- May be expensive if construction materials (rip rap, gravel, or concrete) is not readily available
- May be labour intensive to place and construct
- Extreme flow velocities may require paved outlet structures, stilling basins, plunge pools, drop structures, baffles, or concrete splash pads which will require special design by qualified personnel. Energy dissipaters constructed of rip rap may not be adequate for extreme flow velocities

CONSTRUCTION

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Grade the area to final design grades and elevations
- Sub-excavate energy dissipater location to thickness of energy dissipater

- Place filtration bedding material on base of excavation
    - Bedding can be comprised of well graded sand and gravel or non-woven geotextile
    - Acts as separating filter between fine grained subgrade and riprap size energy dissipater material
- Place energy dissipater material (rip rap, gravel, sand bags, concrete) over filtration bedding material
- Top of energy dissipater should be flush with surrounding grade

CONSTRUCTION CONSIDERATIONS

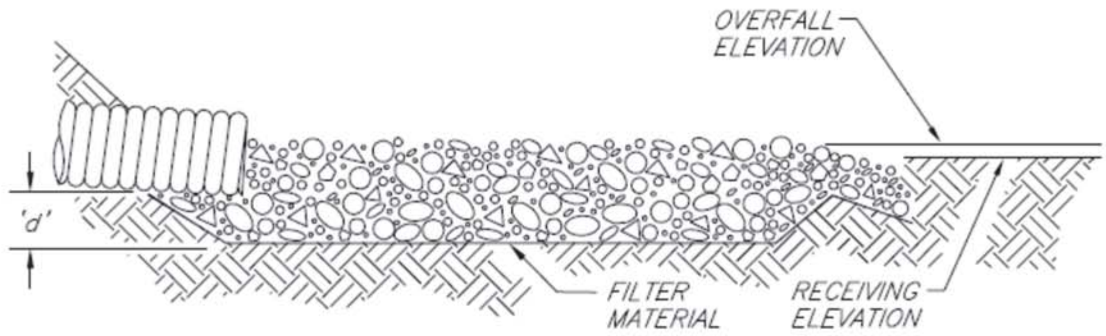
- Length of energy dissipater (La) at outlets shall be of sufficient length to dissipate energy
    - La = 4.5 x D (where D is the diameter of the pipe or channel at the outlet)
    - Energy dissipater should extend upstream of the outlet approximately a minimum distance of 0.5 x D
- Width of energy dissipater (Wa) at outlets shall be of sufficient width to dissipate energy
    - Wa = 4 x D
- Thickness of energy dissipater (da) at outlets shall be of sufficient thickness to dissipate energy
    - da = 1.5 x maximum rock diameter (with a minimum thickness of 0.30 m)
- Energy dissipater (splash pad, apron) shall be set at zero grade and aligned straight, with the direction of flow at the outlet
- Bedding (filtration) layer can comprise either non-woven geotextile or a minimum of 0.15 m well graded sand and gravel layer
- Energy dissipater should be constructed of well- graded rip rap
    - Minimum d50 = 150 mm. Preferable d50 = 300 mm
    - Minimum thickness = a) 1.5 x d50 or b) 0.30 m to 0.45 m thickness. (a or b whichever is greater)
- Energy dissipater shall be designed to accommodate a 10- year peak runoff or the design discharge of the upstream channel, pipe, drain, or culvert, whichever is greater
- The energy dissipater shall be constructed flush with the surrounding grade and shall be directly in line with direction of outlet flow

INSPECTION AND MAINTENANCE

- Periodic inspections to check for damage should occur at least once a month, or after storm events (1:2 year storm and/or 40 mm rainfall over 24 hour duration)
- Any damage should be repaired immediately

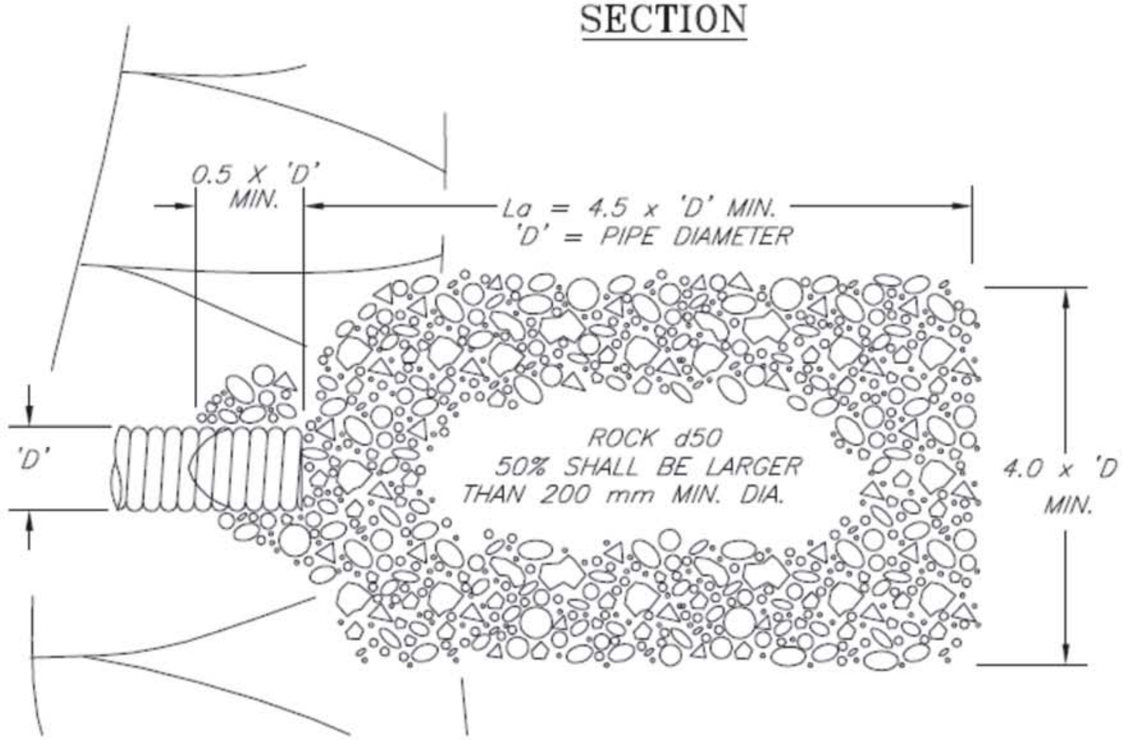
SIMILAR MEASURES

- Gabion mattresses



B) MINIMUM THICKNESS = 300 mm. (i.e. 1.5x D_{50}) FOR D_{50} = 200 mm.

SECTION



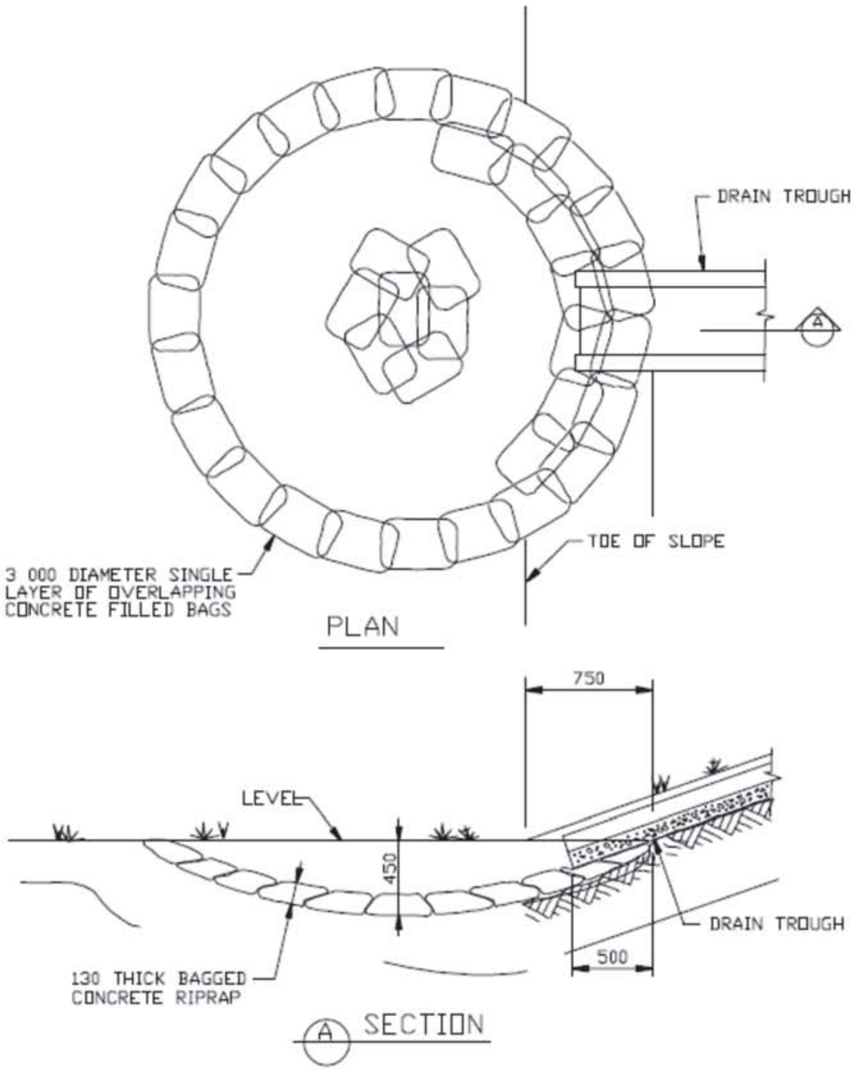
PLAN

NOTES:

1. 'La' = LENGTH OF APRON. DISTANCE 'La' SHALL BE OF SUFFICIENT LENGTH TO DISSIPATE ENERGY.
2. APRON SHALL BE SET AT A ZERO GRADE AND ALIGNED STRAIGHT.
3. FILTER MATERIAL SHALL BE FILTER FABRIC OR 150 mm THICK MINIMUM GRADED GRAVEL LAYER.
4. FOR PIPE DIAMETER > 600 mm, DESIGN BY ENGINEER IS REQUIRED.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

ENERGY DISSIPATOR FOR CULVERT OUTLET

FILE: ENRGYDIS



GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE.
- PLACING OF BAGGED CONCRETE RIPRAP SHALL START AT THE BOTTOM CENTRE OF THE DISHED AREA AND SHALL PROCEED IN A CONTINUOUS SPIRAL FASHION OUTWARD UNTIL THE ENTIRE DISH IS COVERED. EACH CONCRETE FILLED BAG SHALL LAP OVER THE EDGES OF THE PREVIOUSLY PLACED BAGS.

  SOURCE: ALBERTA TRANSPORTATION SPECIFICATIONS FOR BRIDGE CONSTRUCTION DRAWING: S-1410-91

- THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

ENERGY DISSIPATOR

FOR SEMI-CIRCULAR TROUGH DRAIN TERMINAL PROTECTION FOR BRIDGE HEADSLOPE

BMP 9: SLOPE DRAINS (TEMPORARY PIPES)

A) SLOPE DRAIN

B) OVERSIZE DRAIN

DESCRIPTION AND PURPOSE

- Heavy duty, flexible pipe "Big O" that carries water from top to bottom of fill or cut slope to prevent concentrated water flowing downslope and eroding face of slope

APPLICATIONS

- Temporary or permanent measure
- Used on cut or fill slopes where there is a high potential for upslope runoff waters to flow over the face of the slope causing erosion, especially at areas where runoff converges resulting in concentrated runoff flows (e.g. possible breach of low catchwater ditch at top of a cut slope)
- Used in conjunction with some form of water containment or diversion structures, such as diversion channels, berms, or barriers, to convey upslope runoff water and direct water towards slope drain

LIMITATIONS

- Pipes must be sized correctly to accommodate anticipated flow volumes
- Water can erode around inlet if inlet protection is not properly constructed
- Erosion can occur at base if outlet protection or energy dissipater is not constructed
- Slope drain must be anchored securely to face of slope

CONSTRUCTION

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Construct diversion or intercept channel, ditch block, barrier, or other inflow apron structure at crest of slope to channel flow toward the slope drain inlet
- Install slope drain through inlet berm or barrier with a minimum of 0.45 m of soil cover above top of drain pipe to secure the inlet
- Install scour inlet protection (such as rip rap, sand bags)
- Install energy dissipater (such as rip rap, gravel, concrete) at downslope outlet end of slope drain
    - Outlet must not discharge directly onto unprotected soil

- Secure the pipe from movement by tying to steel anchor stakes, hold-down grommets, or other approved anchor method
    - Space anchors on each side of drain pipe at maximum 3 m intervals along entire length of drain pipe

CONSTRUCTION CONSIDERATIONS (FOR GUIDANCE ONLY)

- Use coiled drain pipe for low flows only
- If constructing inflow apron at crest of slope out of sandbags, only fill each sandbag ¾ full, this will allow sandbag to be flexible enough to mould around drain pipe and remain in continuous contact with the ground
- Several slope drains may be required if upslope drainage areas are too large for one drain pipe

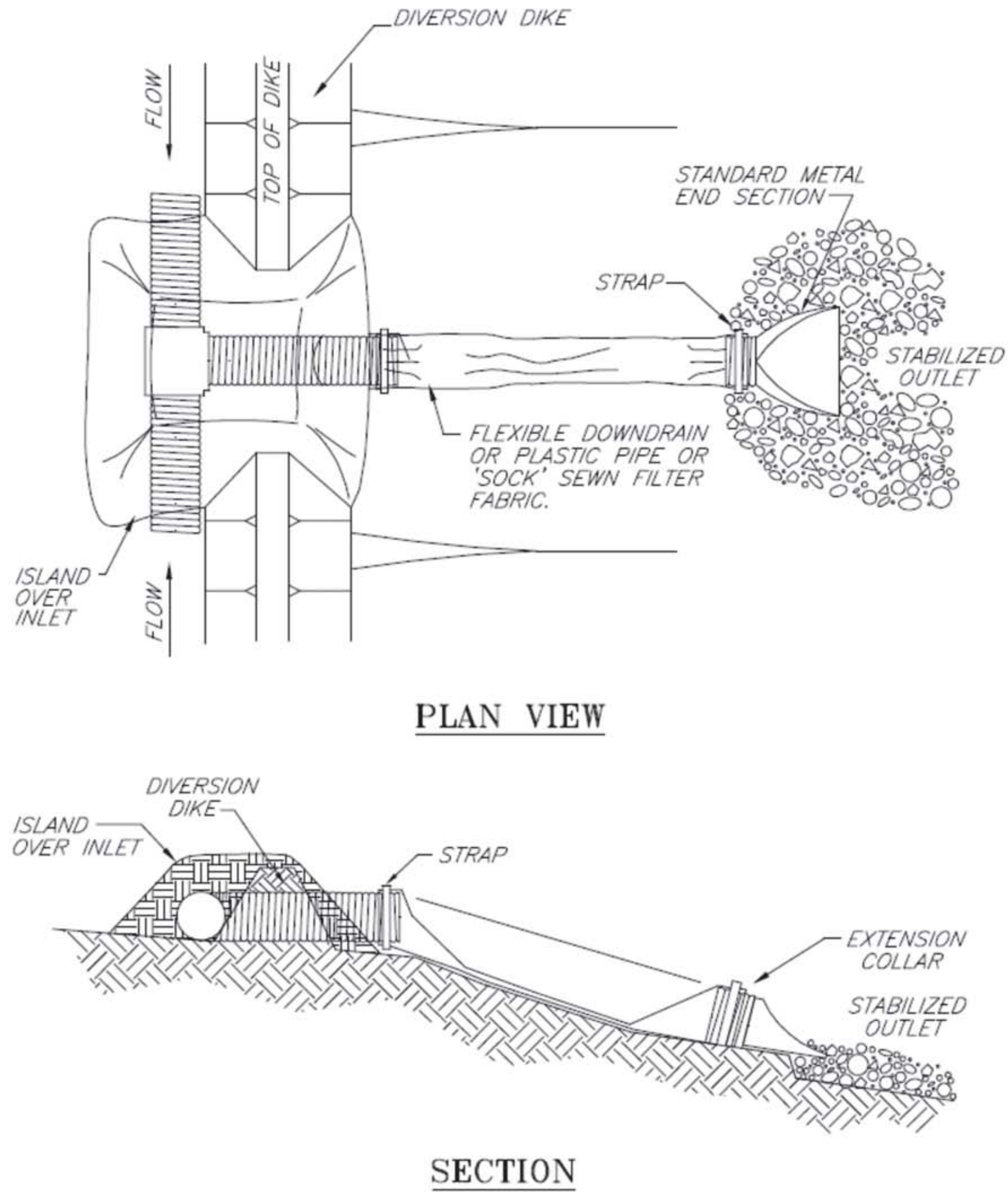
Size of Slope Drain	
Maximum Drainage Area (ha)	Pipe Diameter (mm)
0.2	300
0.6	450
1.0	530
1.4	600
2.0	760

INSPECTION AND MAINTENANCE

- Inspect slope drains at least once per week, or after significant storm events (1:2 year storm and/or 40 mm precipitation in 24 hours)
- Repair any damaged section of pipe immediately
- If evidence exists of pipe movement, install additional anchor stakes to secure and anchor at zones of movement
- Remove sediment from upslope inflow apron area after each storm event otherwise either downslope sediment transport will occur or cause the drainpipe to be plugged which could result in overtopping of inflow apron structure and sheet flow over slope face.

SIMILAR MEASURES

- Rock lined channel
- Permanent Pipe (slope drains)
  - Corrugated steel pipe (CSP) downdrain (AT Drawing No. CB-6 2.4 M17)
  - Half-round corrugated steel (1/2 CSP) downslope drain (AT Drawing No. CB-6 2.4 M4) for low flow areas such as bridge headslopes

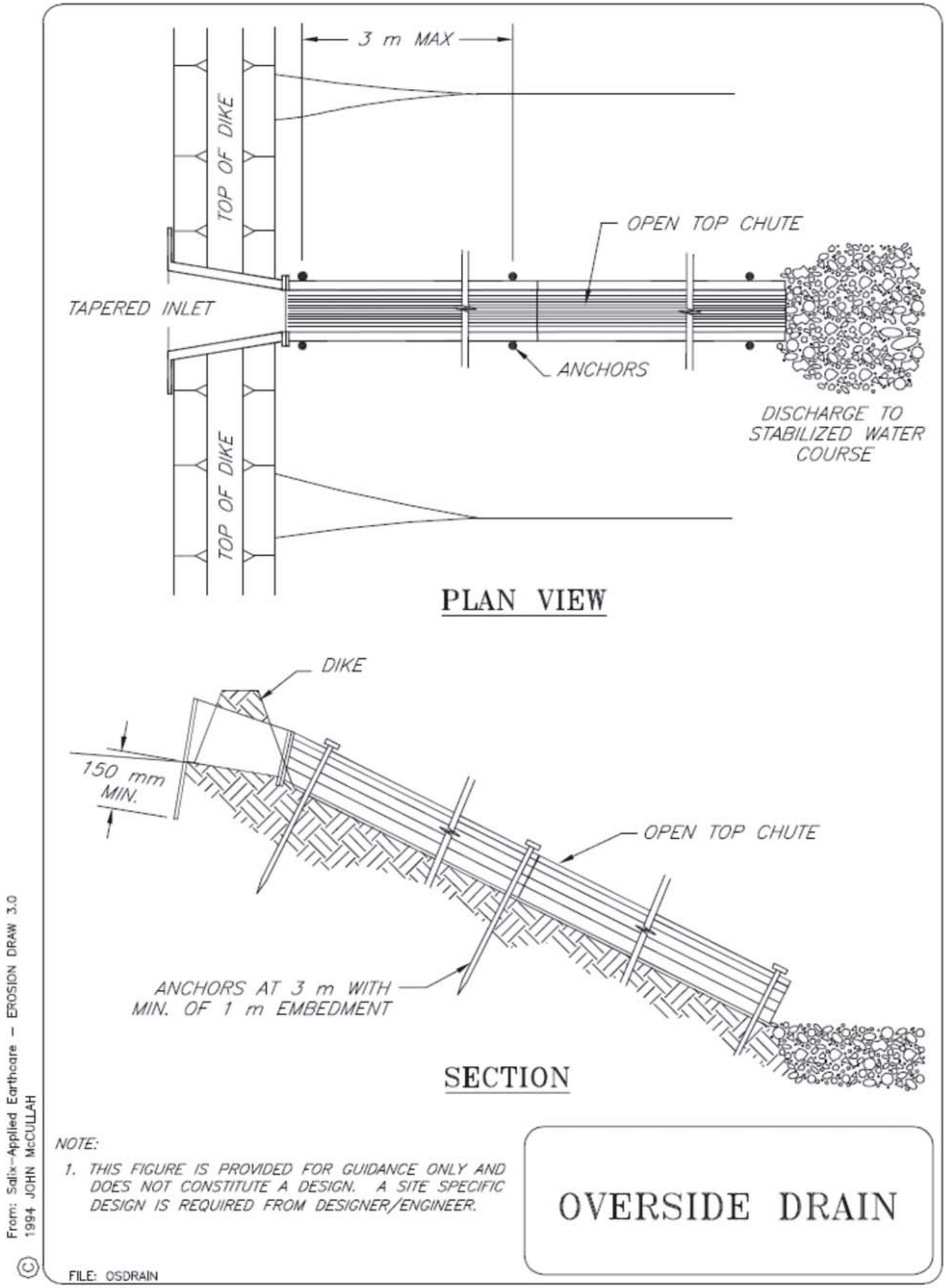


NOTE:

1. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

SLOPE DRAIN

FILE: SLOPEDRN


3 m MAX
TOP OF DIKE
OPEN TOP CHUTE
TAPERED INLET
ANCHORS
DISCHARGE TO STABILIZED WATER COURSE
TOP OF DIKE
PLAN VIEW
DIKE
150 mm MIN.
OPEN TOP CHUTE
ANCHORS AT 3 m WITH MIN. OF 1 m EMBEDMENT
SECTION
From: Salix-Applied Earthcare – EROSION DRAW 3.0
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NOTE:
1. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.
OVERSIDE DRAIN
FILE: OSDRAIN

BMP 10: OFFTAKE DITCH (INTERCEPT DITCH)

EROSION CONTROL

DESCRIPTION AND PURPOSE

- Channels or swales commonly located along the crest of cuts slopes to intercept and convey runoff away from flowing down a newly excavated bare soil slope and to minimize erosion of slope from overland sheet flow
- Can be tied to outfall to slope drains (or downdrains) which carry water from higher slope elevations to lower elevation of a slope

APPLICATIONS

- Permanent measure
- Effective method of intercepting runoff to avoid excessive sheet flow over slope and causing erosion, especially on cut slopes in highly erodible soils (sand and silt)
- Can be used in conjunction with slope drains which was installed down a large cut slope
- May be lined with vegetation, rip rap, erosion control blankets, or some other erosion protection measure, but this requirement may be appropriate only at highly sensitive and high risk environmental areas
- Can be used in conjunction with sediment control measures, such as check structures or permeable synthetic barriers as normal channel design, but this requirement may be appropriate only at highly sensitive and high risk environmental areas

LIMITATIONS

- Ditch may require lining to minimize soil erosion from concentrated flow
- Ditch may require design by qualified personnel if flow velocities and/or volumes are large
- Channel must be graded to maintain adequate depth, positive drainage to avoid ponding and breaching of channel flow, which may lead to overtopping of the channel to result flow to cause in downslope erosion
- Removal of sediment build up and ditch maintenance may be difficult due to limited access space as offtake ditches are commonly constructed at crest of slopes

CONSTRUCTION

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Use backhoe to form ditch a minimum offset distance of 2 m between crest of highway slope and top of offtake ditch side slope, thus providing a dyke width of 1 m

  - Place and compact excavated soil to form a dyke between crest of highway slope and offtake ditch channel to provide adequate depth (1 m) of the offtake ditch
  - The consequence of failure on this dyke will determine the level of compaction effort required
  - Sideslopes of ditch should not be steeper than 2H:1V (depending upon material type)
  - Depth of ditch (from base of ditch to top of embankment) should be a minimum of 1 m in depth; width of ditch should be 1 m minimum
  - Ditch grade should be graded a minimum of 1% to promote positive drainage and outfall

CONSTRUCTION CONSIDERATIONS

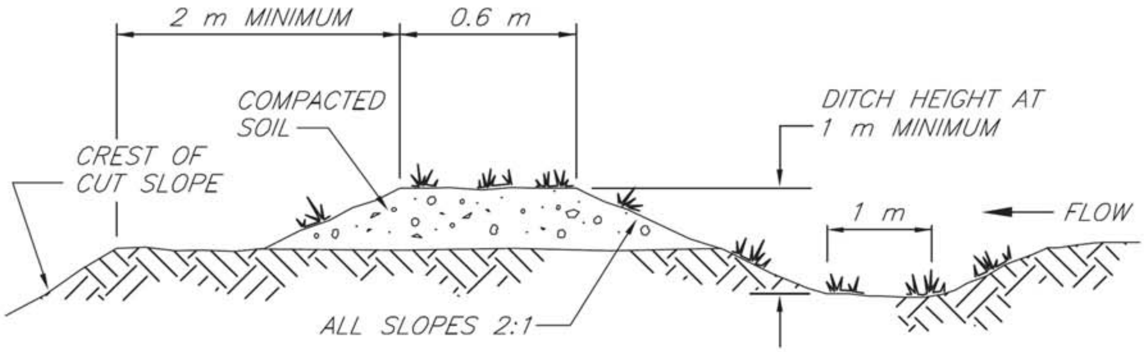
- Channel should be graded towards nearest outfall (draw) or drainage pipe

INSPECTION AND MAINTENANCE

- Inspect ditches at least at biweekly intervals and after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
- Repair any damage to channel immediately

SIMILAR MEASURES

- Berms
- Barriers



TYPICAL OFFTAKE DITCH

NOTES:

1. THE DITCH BEHIND THE DYKE SHALL HAVE POSITIVE GRADE TO A STABILIZED OUTLET.
2. THE DYKE SHALL BE ADEQUATELY COMPACTED TO PREVENT FAILURE.
3. FOR SENSITIVE HIGH RISK AREAS, THE DITCH SHALL BE STABILIZED WITH TEMPORARY OR PERMANENT SEEDING OR RIPRAP.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

OFFTAKE DITCH
(INTERCEPT DITCH)

FILE: TEMPDIKE

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BMP 11: PLANTING TREES AND SHRUBS

A) LIVE STAKING
B) BRUSH LAYERING

DESCRIPTION AND PURPOSE

- Consists of installing woody plantings (trees and shrubs) to develop a root matrix within the soil, increasing subsurface soil strength and stabilizing slopes with deeper root systems than grasses
- Reduces erosion potential of slopes and channel banks

APPLICATIONS

- Temporary or permanent measure
- May be used on slopes stable enough to support vegetation; however, there is a low success rate for steep slopes and channel banks with gradients greater than 1H:1V
- May be used on slopes and channel banks with adequate sunlight, moisture, and wind protection to support vegetation
- May be used as bio-engineering stabilization of historical shallow slope instability soil movements on eroded slopes and gullies
- May be used along channels to provide higher channel roughness to reduce flow velocity and in sedimentation ponds to provide higher sedimentation duration of runoff impoundment

ADVANTAGES

- Promotes development of organic mat
- Dense leaves and large diameter plant stalks increases channel roughness and reduces flow velocities in channel thus decreasing erosion potential
- Traps sediment laden runoff and stabilizes soil
- Aesthetically pleasing once developed
- Grows stronger with time as root structure develops
- Usually has deeper root penetration than grass with greater depth of stabilization
- Manual planting may be attempted on steep slopes that are sensitive to machinery disturbance or represent an area of high erosion potential

LIMITATIONS

- Can be labour intensive to install

- Some level of uncertainty as success of plant growth is dependent on various unknown site parameters (i.e. moisture, soil, terrain, weather, seeding conditions, etc.)
- Revegetated areas are susceptible to erosion until vegetation develops; and should be used in conjunction with hydroseeding and/or mulching
- Plants may be damaged by wildlife
- Potential for low success rate
- Few precedents as this measure is generally not used on AT construction projects

CONSTRUCTION

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Live Staking
  - Used on cut or fill slopes or in ditches/channels
  - Comprised of willow or poplar stakes inserted into the ground; other indigenous plants may be acceptable
  - Individual dormant willow or poplar stakes should be cut to a minimum length of 0.5 m using pruning shears
  - Cuts should be made at a 45° angle a minimum of 0.05 m (5 cm) below a leaf bud
  - All side shutes should be trimmed to within 0.05 m of the main stem
  - Install live stakes in a 1 m by 1 m grid
  - Make a pilot hole a minimum of 0.3 m in depth to insert live stake into
  - Use iron bar, broom handle or other tool to make pilot hole
  - Insert live stake into pilot hole and lightly tamp soil around live stake
  - A minimum of two leaf buds should remain above grade

- Brush Layers
  - Used on cut or fill slopes or on channel/ditch walls susceptible to erosion
  - Comprised of layers of live branches placed on terraces on slopes
  - Excavate terraces perpendicular to direction of slope spaced approximately 1 m apart across entire width of slope to be protected
  - Slope terraces at an angle of 108 upwards from the back of the terrace towards the slope face
  - Place layers of branches on the terrace
  - Use Individual dormant willow or poplar branches a minimum length of 1 m and a minimum diameter of 0.025 m (25 mm)
  - Place brush layer approximately 0.1 to 0.2 m thick
  - Ensure a minimum length of 0.1 to 0.2 m of the branch is protruding from face of slope
  - Backfill and tamp soil over brush layer

CONSTRUCTION CONSIDERATIONS

- Successful installation requires the use of freshly cut branches or stakes

  - Storage time of cut branches/stakes on-site prior to installation should be kept to as short a time period as possible

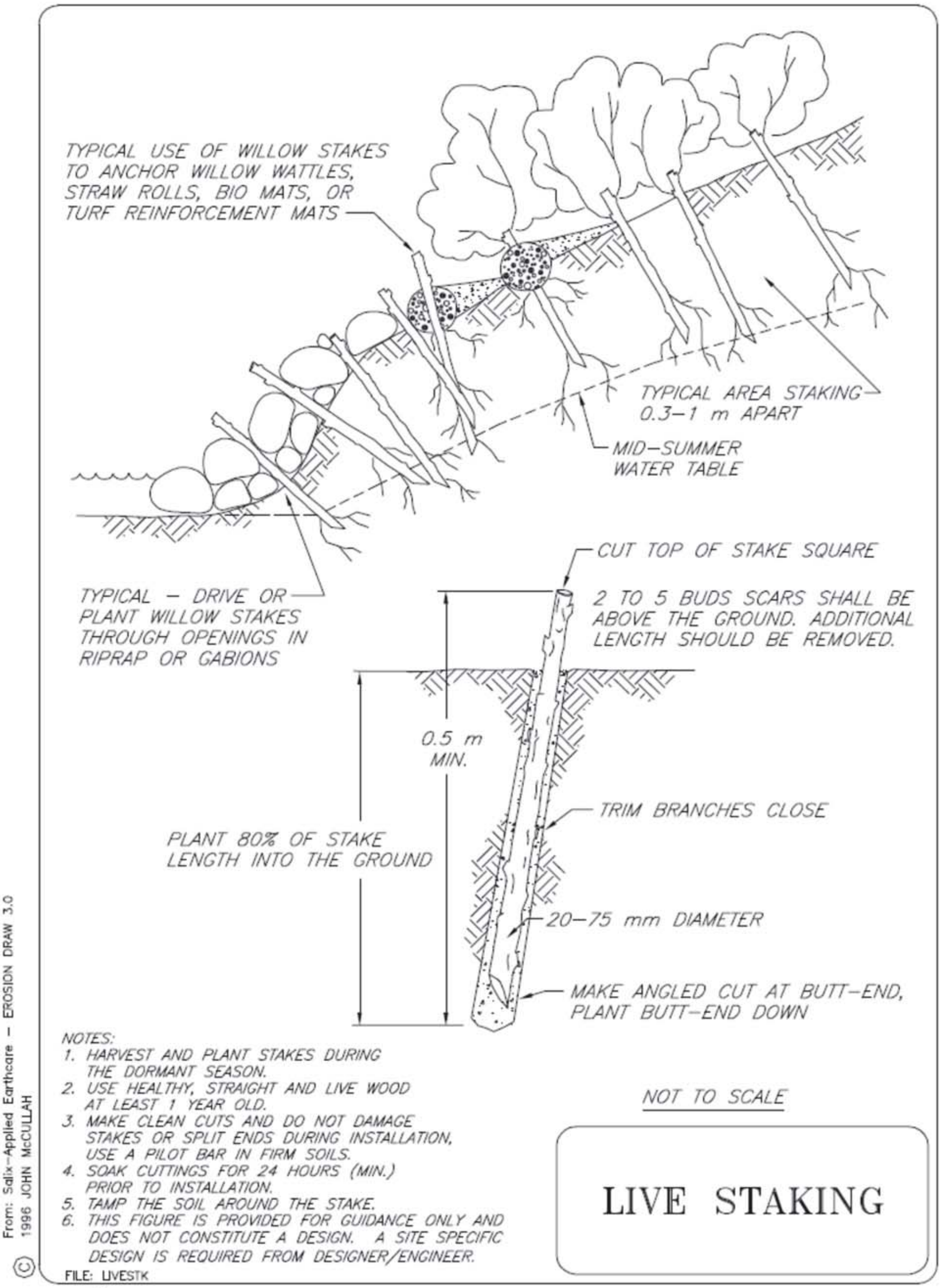
- Successful growth dependent on soil moisture and rainfall conditions
- Consultation with agrologist, greenhouse growers, local expertise can be beneficial in selecting and procuring appropriate species for planting

INSPECTION AND MAINTENANCE

- Inspect planted areas at least twice per year or after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
  - Areas damaged by washout or erosion rilling should be replanted immediately
- Additional stormwater control measures should be considered for severe rilling areas damaged by runoff
- Watering plants is required for first one to two months after planting

SIMILAR MEASURES

- Seeding
- Mulching
- Hydroseeding-hydromulching
- Rolled erosion control products (RECP)


TYPICAL USE OF WILLOW STAKES TO ANCHOR WILLOW WATTLES, STRAW ROLLS, BIO MATS, OR TURF REINFORCEMENT MATS
TYPICAL AREA STAKING 0.3–1 m APART
MID–SUMMER WATER TABLE
TYPICAL – DRIVE OR PLANT WILLOW STAKES THROUGH OPENINGS IN RIPRAP OR GABIONS
CUT TOP OF STAKE SQUARE
2 TO 5 BUDS SCARS SHALL BE ABOVE THE GROUND. ADDITIONAL LENGTH SHOULD BE REMOVED.
0.5 m MIN.
TRIM BRANCHES CLOSE
PLANT 80% OF STAKE LENGTH INTO THE GROUND
20–75 mm DIAMETER
MAKE ANGLED CUT AT BUTT–END, PLANT BUTT–END DOWN
NOTES:
1. HARVEST AND PLANT STAKES DURING THE DORMANT SEASON.
2. USE HEALTHY, STRAIGHT AND LIVE WOOD AT LEAST 1 YEAR OLD.
3. MAKE CLEAN CUTS AND DO NOT DAMAGE STAKES OR SPLIT ENDS DURING INSTALLATION. USE A PILOT BAR IN FIRM SOILS.
4. SOAK CUTTINGS FOR 24 HOURS (MIN.) PRIOR TO INSTALLATION.
5. TAMP THE SOIL AROUND THE STAKE.
6. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.
NOT TO SCALE
LIVE STAKING
FILE: LIVESTK
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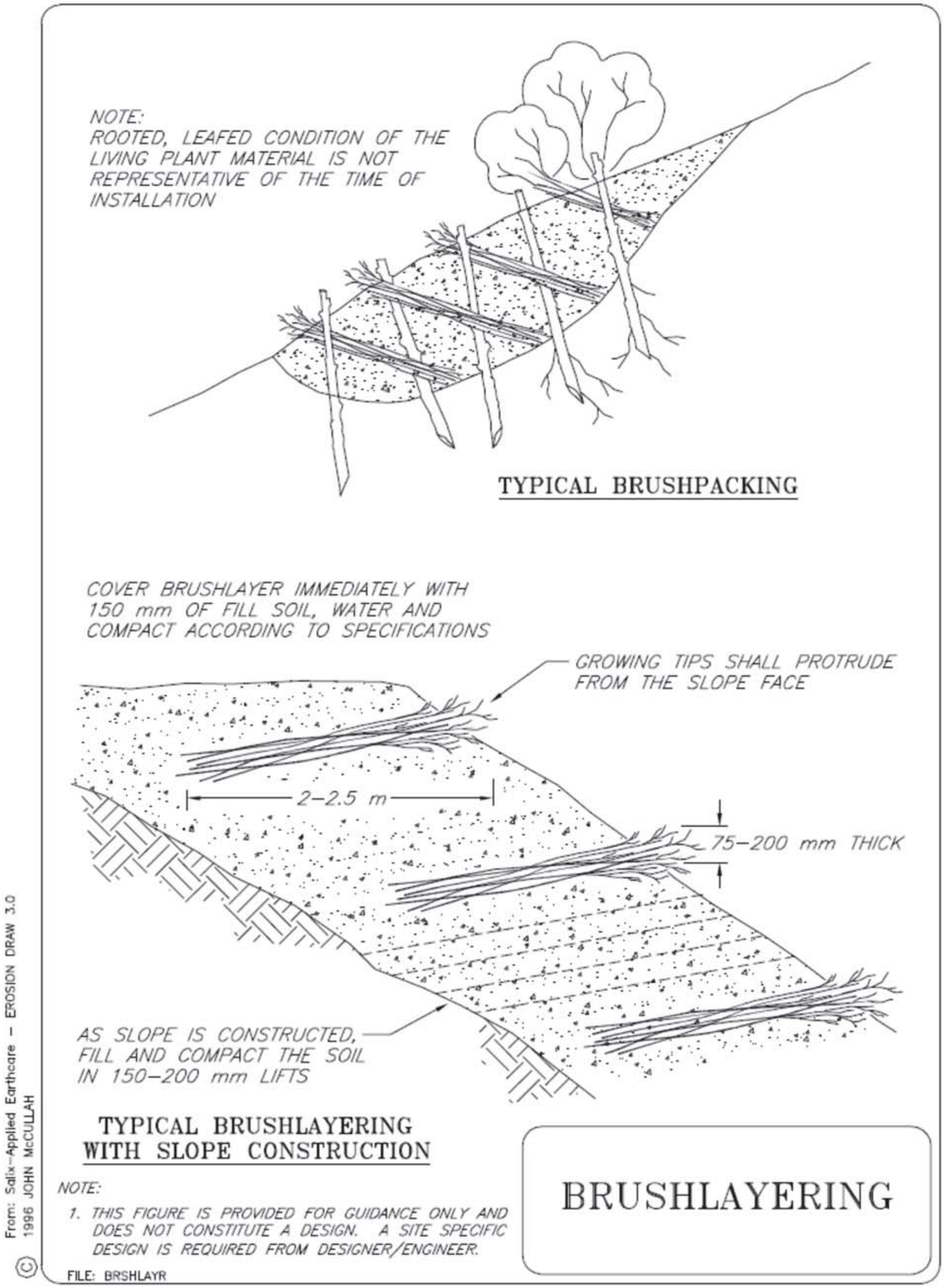
NOTE:
ROOTED, LEAFED CONDITION OF THE LIVING PLANT MATERIAL IS NOT REPRESENTATIVE OF THE TIME OF INSTALLATION
TYPICAL BRUSHPACKING
COVER BRUSHLAYER IMMEDIATELY WITH 150 mm OF FILL SOIL, WATER AND COMPACT ACCORDING TO SPECIFICATIONS
GROWING TIPS SHALL PROTRUDE FROM THE SLOPE FACE
2–2.5 m
75–200 mm THICK
AS SLOPE IS CONSTRUCTED, FILL AND COMPACT THE SOIL IN 150–200 mm LIFTS
TYPICAL BRUSHLAYERING WITH SLOPE CONSTRUCTION
NOTE:
1. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.
FILE: BRSHLAYR
BRUSHLAYERING
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BMP 12: RIPARIAN ZONE PROTECTION

SEDIMENT CONTROL AND EROSION CONTROL

DESCRIPTION AND PURPOSE

- Protection of existing plants and trees adjacent to all natural water bodies (riparian zones) adjacent to construction areas
- Existing vegetation acts as an effective vegetative buffer strip as a form of erosion and sediment control measure

APPLICATIONS

- Permanent measure
- Existing established vegetation acts as an effective sediment control and erosion control buffer strip barrier to slow down flows and allow sedimentation filtration to occur
- May be used along property boundaries to minimize sediment transport off construction site despite non-presence of watercourse adjacent

ADVANTAGES

Existing dense vegetation is more effective than any man- made structures or devices for sediment or erosion control, however, other forms of sediment and erosion control measures may be required on construction sites in addition to preserved riparian zones

- Any denuding of vegetation along steep valley slope with highly erodible soil will be detrimental and inductive to long-term sedimentation yield; it is important only to strip necessary areas along the footprint of construction. Preservation of riparian zone is mandatory along river valley slopes and along the edge corridor of waterbodies

LIMITATIONS

- Preservation of riparian zones may interfere with construction efficiency
- Careful planning is required to work around preserved riparian zones

CONSTRUCTION

(Waiver: For guidance only. A site specific design is required from designer/engineer).

- It is highly important to preserve an established vegetative buffer as freshly planted vegetation generally require substantial growth periods before they are as effective as established riparian zones

- Wherever possible, retain as much existing vegetation as possible between construction areas and sensitive zones (wetlands, marshes, streams, floodplains, etc.) to entrap sediment and to minimize sediment transport off of the construction site into the sensitive zones
- Define and delineate riparian zones to be preserved in Environmental Construction Operations Plan (ECO Plan) prior to commencement of construction
- Clearly mark riparian zones to be preserved in the field (with construction fencing, survey flagging, or other highly visible measure) so all personnel involved with construction operations can identify areas to be preserved

CONSTRUCTION CONSIDERATIONS

- Riparian zones must be fenced off immediately to minimize trespassing and to ensure effectiveness of riparian zone is maintained
- Do not allow equipment to enter areas not necessary to construction

INSPECTION AND MAINTENANCE

- Maintain fence protecting riparian zones from trespassing.

BMP 13: SCHEDULING

SEDIMENT CONTROL AND EROSION CONTROL

DESCRIPTION AND PURPOSE

- Scheduling the sequence and timing arrangement of construction activities (1) to efficiently maximize the amount of erosion protection installed (such as top-soiling and seeding) as soon as a portion of grade construction is completed, and (2) to limit the portion of land disturbance (construction) compatible with the efficient rate of construction of erosion control measures achievable
- Incorporating erosion and sedimentation control concerns during the scheduling phase will minimize the amount and duration of bare soil exposure to erosion elements and ensure erosion and sedimentation control measures are implemented at an appropriate time
- Scheduling may be designed during planning stages by the contractor and altered during construction to suit actual conditions encountered

APPLICATIONS

- Temporary measure

ADVANTAGES

- Ensures erosion and sedimentation control issues are identified during the planning stage by the Contractor
- May be used to minimize bare soil exposure and erosion hazard with careful planning and utilization of equipment in construction projects

LIMITATIONS

- May be more costly as erosion control measures (such as top-soiling and seeding) have to be implemented immediately after completion of each phase or a short section of construction

IMPLEMENTATION

- Incorporate a schedule with erosion protection perspective to form part of the overall construction plan
- Determine sequencing and timetable for the start and end of each item, such as clearing, grubbing, stripping, etc.
- Incorporate installation of appropriate erosion and/or sediment control measures in construction schedule
- Allow sufficient time before rainfall begins to install erosion and/or sediment control measures
- Whenever possible, schedule work to minimize extent of site disturbance at any one time

- Incorporate staged top-soiling and re-vegetation of graded slopes as work progresses
    - Don't leave all top-soiling and re-vegetation until the very end of the project

INSPECTION AND MAINTENANCE

- Routinely verify that construction activities and the installation of erosion and sediment control measures is progressing in accordance with schedule
    - If progress deviates from schedule, take corrective action
- When changes to the project schedule are unavoidable, alter the schedule as soon as practicable to maintain control of erosion

BMP 14: ROLLED EROSION CONTROL PRODUCTS (RECP) ON SLOPES

EROSION CONTROL

DESCRIPTION

- Biodegradable or synthetic soil coverings used to protect exposed soils from erosion.

PURPOSE

- To prevent detachment and entrainment of sediment by raindrops and runoff
- To protect seed from raindrop impact, predation and runoff
- Enhance soil moisture and moderate soil temperatures to improve plant germination and growth

APPLICATIONS

- Effective temporary erosion control measure.
- Wide variety of products allow for the use of RECPs across a range of slope and soil conditions.
- May be used to protect disturbed and exposed soils on slopes 2.5H:1V and steeper
- May be used on slopes where erosion potential is high (i.e., silts and sands).
- May be used on slopes where vegetation may be slow to develop.

LIMITATIONS

- Ultimate erosion control comes from vegetation
  - May be ineffective if a vegetation cover does not develop
- Successful installation requires site preparation to ensure intimate contact between RECP and soil.
  - Poor installation can result in erosion under the RECP
- Must be installed by hand labor. May be labor-intensive and expensive to install.
- RECPs are not suitable for rocky soils.

INSTALLATION

- Site preparation
  - Essential step in successful use of RECPs
  - Grade and shape slopes and apply topsoil if available or specified
  - Soil surface should be relatively smooth (no sharp depressions or hummocks).
  - Prepare seed bed by loosening top 50 to 75 mm of soil.

- All rocks, soil clods, exposed vegetation or other materials that may prevent the intimate contact of the RECP with the soil surface must be removed.
- Incorporate soil amendments into soil (i.e., fertilizer, lime, etc.)
- Seed area before RECP installation.

- Installation requirements
  - Follow manufacturer's installation specifications
  - If manufacturer's installation specifications are not available, the following general installation method may be used:

- General installation method on slopes
  - Excavate anchor trench 0.3 m deep x 0.2 wide approximately 1m back from the crest of slope along the length of slope to be protected.
  - Insert the leading edge of the RECP roll into the trench and backfill and compact soil. Insert anchors at 0.3 m intervals along the edge of the anchor trench.
  - Roll RECP out downslope making sure the RECP is not stretched or under tension.
  - The entire RECP must be loose and be in intimate contact with the underlying soil
  - The edges of adjacent parallel rolls must be overlapped 50 to 75 mm and be stapled every 0.9 m.
  - When RECPs must be spliced down the slope, place RECPs end over end (shingle style with the upslope RECP on the top) with 0.2 m overlap. Staple through overlapped area at 0.3 m intervals.
  - Blankets shall be stapled sufficiently to anchor RECP and maintain contact with the soil.
  - Staple the central portion the RECP at 4 staples/m^2 minimum (0.5 m spacing) for slopes.

INSPECTION AND MAINTENANCE

- All RECP and mats should be inspected periodically.
- Inspect installation after significant rainstorms to check for erosion and undermining.
  - Any separation in the RECPs or RECP damage should be repaired immediately.
  - Rills must be filled or smoothed out so the RECP can be re-anchored in contact with the soil.

- Inspection and maintenance should continue until vigorous vegetation cover is established.
- Reseeding of the RECPs may be required if a vigorous vegetation cover does not develop.
- After one year, a top dressing of fertilizer may be applied to enhance vegetation growth and promote RECP decomposition.

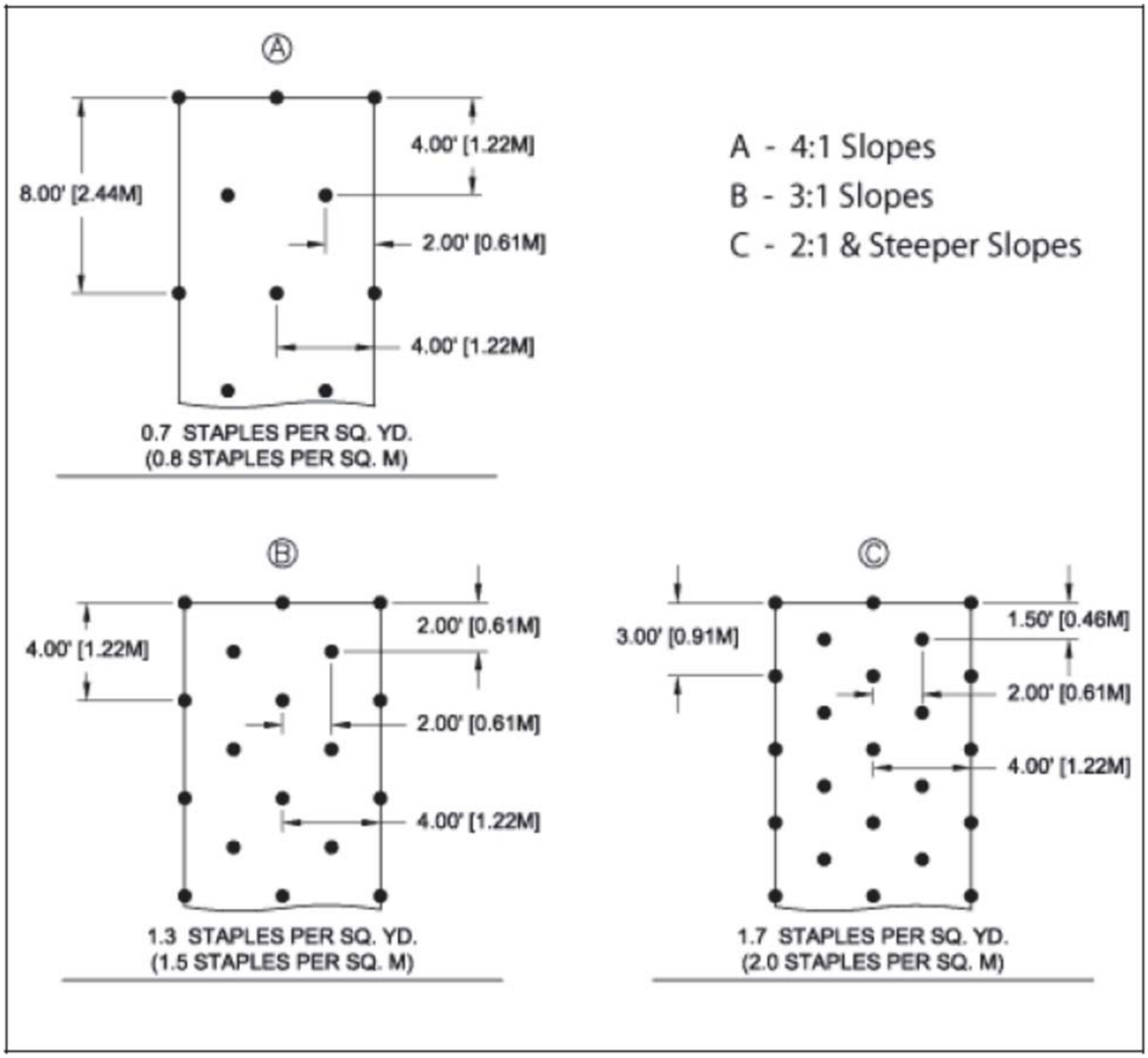


Figure EC BMP #4.1. Rolled Erosion Control Products: Examples of Staple Patterns for Slope Installation

Figure EC BMP #4.2. Rolled Erosion Control Products: Slope Installation

Figure EC BMP #4.3. Rolled Erosion Control Products

BMP 15: WATER BARS AND ROLLING DIPS

EROSION CONTROL

DESCRIPTION

- To minimize the volume of runoff on a road.
- To minimize slope length and the potential for erosion.
- To direct runoff and sediment into a designation treatment site.
- Water bars should be installed where frequent vehicle passage is not required
  - Water bars are narrow, gently sloping cross-grade drainage structures.
- Rolling dips should be installed where vehicle passage is required.
  - Rolling dips are very wide gently sloping cross-grade drainage structures.

APPLICATIONS

- Utility access roads and resource extraction roads.
- During subgrade construction.
- Temporary roads on construction sites.

LIMITATIONS

- May require maintenance to remain effective.
- Effectiveness may decrease as structures fill with sediment.
- Vehicle traffic through structures can degrade structures.
- Will cause erosion if runoff is directed onto unstable fill slopes.
- Can direct potentially deleterious sediment into watercourses if location of water bars and rolling dips is poorly chosen.

INSTALLATION

- Install as road is being constructed
- Minimum depth 0.5 m (as measured from base of water bar or rolling dip to original road elevation).
- Side slopes should be 3H:1V or flatter.
  - Rolling dip side slopes should be much gentler for easy vehicle passage.
- Minimum cross- road gradient is 2%.
- Water bars and rolling dips should form an angle between 30 and 45° downslope as measured from a line perpendicular to the center line of the road.
- Stabilize rolling dips and water bars with gravel or small rock if necessary.

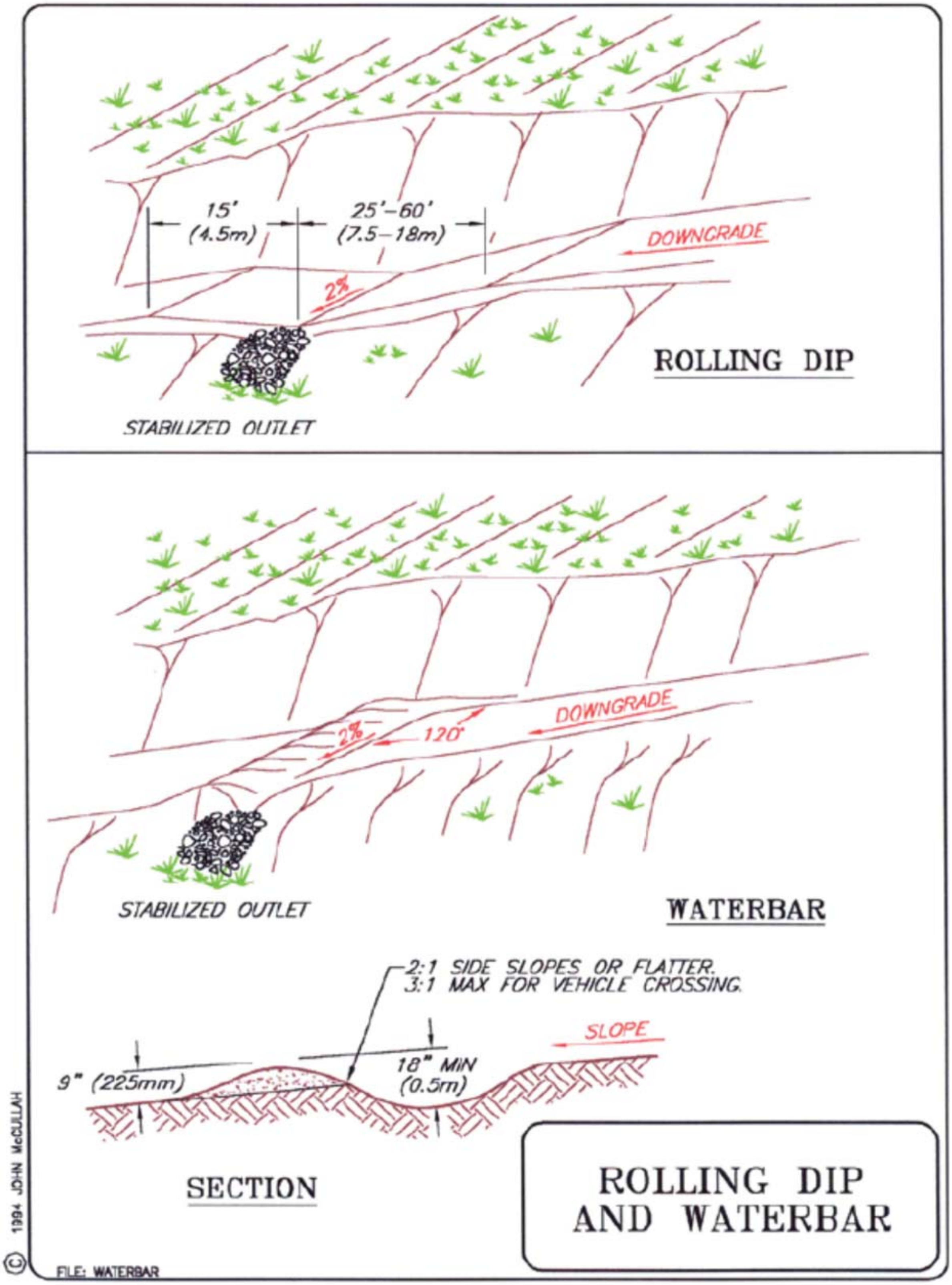
- Runoff from water bars and rolling dips must be directed into a natural or constructed stabilized outlet.
  - Direct water onto a rock pad to dissipate energy.
  - Suggested spacing for water bars and rolling dips:

Road Slope (%)	Spacing (m)	High Erosion Potential Spacing (m)
<5	38	30
5 – 10	31	23
10 – 20	23	15*
20 – 35	15*	7.5*
>35	7.5*	7.5*
* Configuration of rolling dips prohibits their construction at these roads slopes.		

- Structure spacing should be adjusted in the field to ensure drainage is directed into stabilized outlets.

INSPECTION AND MAINTENANCE

- Inspect periodically and after intense or sustained rainfall events.
- Removal accumulated sediment.
- Ensure erosion is not occurring at outlet areas.
- Regrade water bars and rolling dips to ensure they remain functional.


15' (4.5m)
25'–60' (7.5–18m)
DOWNGRADE
2%
ROLLING DIP
STABILIZED OUTLET
DOWNGRADE
2%
120°
STABILIZED OUTLET
WATERBAR
2:1 SIDE SLOPES OR FLATTER.
3:1 MAX FOR VEHICLE CROSSING.
SLOPE
9" (225mm)
18" MIN (0.5m)
SECTION
ROLLING DIP AND WATERBAR
© 1994 JOHN McCULLAH
FILE: WATERBAR

BMP 16: POLYETHYLENE SHEETING

EROSION CONTROL

DESCRIPTION

- Impermeable material in sheet form applied over soils or placed to temporarily collect and direct concentrated flows.

PURPOSE

- To prevent sediment detachment by raindrops and runoff.
- To convey concentrated runoff.
- Where an effect temporary soil cover or ditch lining is required

APPLICATIONS

- Cover material stockpiles.
- Cover erodible disturbed soils.
- Lining materials in ditches and channels
- Temporary flumes on cut or fill slopes

LIMITATIONS

- Minimum polyethylene sheeting thickness should be 6 mil (6/1000 of an inch).
- Use of this BMP can be quite costly
    - Materials must be installed by hand labour.
    - Requires frequent inspection and maintenance
- Very susceptible to displacement by water and wind.
    - Anchoring is critical for successful implementation
    - Penetrating anchors decrease erosion control effectiveness.
- Prevents infiltration of runoff into soil.
- Concentrates runoff increasing erosion potential at base of slope.
- No benefit if runoff results from groundwater exfiltration.
- Other mulch materials may be as effective, easier to install and require less maintenance.

INSTALLATION

Soil Surfaces

- Site preparation
    - Grade and shape the area of disturbed and exposed soil.
    - Soil surface should be relatively smooth (no sharp depressions or hummocks).
    - All large rocks and organic debris that may puncture sheeting and prevent close contact between the sheeting and the soil must be removed.
    - Ensure other required ESC measures are in place before placing sheeting.
- Installation requirements
    - Excavate anchor trench 300 mm deep x 200 mm wide approximately 1m back from the crest of slope along the length of slope to be protected.
    - Insert the leading edge of the poly sheeting into the trench and backfill and compact soil or anchor with sandbags in trench.
    - Roll out poly sheeting downslope making sure the sheeting is loose and lies as much as possible on the soil surface.
    - Excavate 300 mm deep x 200 mm trench down the slope to anchor edges of polyethylene sheeting and where adjacent rolls of sheeting will be overlapped.
        - Wind can easily get under and displace sheeting if there is not continuous perimeter anchoring.
    - Overlap adjacent parallel rolls 50 to 75 mm and place in excavated slots. Backfill slots with soil and compact.
        - Minimize overlapping by using the widest sheeting available.
    - Avoid splices in poly sheeting part way down a slope.
        - Poly sheeting is available in long lengths and it should be possible to avoid splices part way down a slope
        - If poly sheeting must be spliced down the slope, place sheeting end over end (shingle style with the upslope sheet on the top) with 200 mm overlap. Sufficient anchors must be placed to prevent displacement by wind.
    - Sheeting shall be anchored with surface weights to ensure sheeting maintains contact with the soil and resists displacement by wind.
    - Poly sheeting must extend minimum 2m past the toe of slope and must be securely anchored.
    - Runoff collected at the bottom of the sheeting must be either:
        - Directed into stable, vegetated area.
        - Be directed and conveyed through the construction site or off the construction site without causing erosion (runoff should be clear and should not require treatment in sediment control structure).

- Anchoring
  - Anchors must be non-penetrating.
  - Non-penetrating surface anchors should be attached to one another otherwise they will slide down the poly sheeting.
  - Surface anchors should extend 1 to 2m back from the crest of the slope.
  - Surface anchors that minimize puncturing the sheeting during placement should be selected.
    - Rocks, concrete and other heavy, hard materials should not be used.
  - Commonly used anchors include partially filled sandbags linked together with rope and used tires linked together with rope.
  - Place anchors at minimum of 0.5 anchor/m^2 (1 anchor for every 2 m^2 surface area).
    - Each line of anchors must be securely fastened at the top of slope to prevent sliding.
    - One of the anchors can be placed in a sufficiently deep hole followed by backfilling and compaction.
    - Attach the anchor line to a minimum 50 mm x 50 mm wooden stake or 25 mm steel rod driven into the ground. Secure anchor line at the base of the stake or rod.

Ditch or Channel Liner

- Site Preparation
  - Grade and shape ditch.
  - Soil surface should be relatively smooth (no sharp depressions or hummocks).
  - All large rocks and organic debris that may puncture sheeting must be removed.
- Installation Requirements
  - Use sufficiently wide sheeting to eliminate longitudinal joints down the channel.
  - Puncture resistance of the poly sheeting is greatly enhanced if a continuous non-woven geotextile blanket is placed under the sheeting.
  - Excavate anchor trench 300 mm deep x 300 mm wide across the channel at the upstream end of project.
  - Excavate 300 mm deep x 300 mm check slots across the channel at 10 m intervals along the channel.
  - Excavate 100 mm x 100 mm longitudinal anchor slots along both sides of the channel to bury edges of sheeting.
    - Extend sheeting 50 to 75 mm above the crest of channel side slopes, if possible.
    - Alternatively, sheeting should extend above the anticipated flow height with a minimum 0.5 m of freeboard.
  - Beginning at the upstream end and in the center of the channel, place the initial end of the first roll of sheeting in the anchor trench and secure with partially filled sandbags (sheeting will initially be upside down in anchor trench).
  - Stop at next check slot or up channel terminal anchor trench.

- Fold and secure poly sheeting into all transverse check slots. Lay sheeting in the bottom of the slot then fold back against itself. Anchor with partially filled sandbags.
- Any joints in the sheeting should be at the transverse check slots.
  - Overlap sheeting by 300 mm.
- Place edges of poly sheeting in previously excavated longitudinal slots and backfill and compact soil or anchor with sandbags in trench.
- Anchor downstream end of sheeting with partially filled sandbags in a 300 mm deep x 300 mm terminal trench.
- Avoid placing rocks or other hard materials on the sheeting to prevent puncturing.

INSPECTION, MAINTENANCE AND REMOVAL

- All sheeting should be inspected the at least once per week and more frequently during windy or high runoff conditions.
- Inspect installation after significant rainstorms to check for erosion and undermining.
  - Any separation in the sheeting should be repaired immediately.
  - Rills must be filled or smoothed out prior to re-anchoring sheeting.
- Polyethylene sheeting is a temporary erosion control measure. Ultimately disturbed soils and channels must be stabilized using other methods.


8. 26. 2003

APPENDIX V. AVALANCHE MITIGATION STRATEGY

Alpine Solutions Avalanche Services, 2013. Avalanche Mitigation Strategy for Selwyn Project. Rev. A. Project Memorandum. Prepared for Selwyn Chihong Mining Ltd. by Alpine Solutions Avalanche Services, Squamish, BC.

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e-mail : bgould@avalancheservices.ca

PROJECT MEMORANDUM

Date : February 28, 2013
To : Alistair Kent, Manager, Technical Services, Selwyn Chihong Mining Ltd.;
From : Brian Gould, P. Eng;
Re : Avalanche mitigation strategy and costs for Selwyn Project. Rev. A

1.0 Introduction

This memorandum summarizes options for avalanche mitigation for the proposed Selwyn Project located in the Yukon and NWT. Locations where avalanche management may be required are reviewed, and both passive and active avalanche hazard management strategies are discussed and compared. A table comparing four different options for avalanche mitigation is provided in Appendix A, and a preliminary estimate of costs for various components of mitigation measures is included as Appendix B.

2.0 Limitations

The avalanche hazard management options described in this memorandum are intended to provide an overview of potential measures to reduce risk to workers and facilities for the Selwyn Project. Information contained within this memorandum is based on a preliminary layout of facilities described in Alpine Solutions (2013), and the project requirements and limitations as provided by Selwyn Chihong Mining Ltd. and its consultants.

Initial cost estimates for various levels of avalanche management are provided in this memorandum. There are several factors which may change these initial estimates. These include, but are not limited to:

- Price adjustments from manufacturers of avalanche control equipment;
- change in exchange rates which would impact imported products;
- changes to the General Arrangement of facilities and/or access routes; and
- adjustments in the Consumer Price Index, which may impact labour rates.

3.0 Avalanche Hazard Locations

3.1 XY Pad

As indicated in Alpine Solutions (2013), very low frequency (100 to 300 year return period) avalanches may run in close proximity to the northwestern edge of the XY pad. During avalanche season (October thru May), potential avalanche risk at the edge of the pad may be reduced by an active avalanche conditions monitoring and control program. Mitigation may include temporary evacuation and explosive control measures during periods where very large avalanches may be expected. If facilities such as camps, offices, or other vulnerable buildings are located at the northwestern edge, an avalanche zoning plan may be required, and/or fixed mitigation measures be considered. Alternatively, ensuring these facilities are located away from the northwestern margin would eliminate the need for these measures.

3.2 Roads

Roads that are affected by avalanches include Haul and Service Roads in the Don Valley (Alpine Solutions, 2013), and the Howards Pass Access Road (HPAR) as indicated in Alpine Solutions (2010). Several of the avalanche paths that affect the roads are estimated to be high frequency (reach the roadway at least once per year), and is expected to result in intermittent road blockage and delays to traffic flow.

Typically avalanche mitigation for roads incorporate an avalanche management program (described in greater detail in Section 4.0), which may include ongoing avalanche condition monitoring and explosive control. Avalanche conditions monitoring may require the installation of remote weather stations in strategic locations. Explosive control would normally be accomplished by way of helicopter explosive control. If there is limited tolerance to temporary road closures, advanced measures such as pneumatic cannons (avalaunchers), and remote avalanche control systems installed in starting zones of high frequency avalanche paths may be warranted.

4.0 Avalanche Mitigation Methods

Both passive and active mitigation may be considered for the project. The type and level of mitigation depends on the tolerance for extended delays and road closures. The following two sections describe passive and active mitigation for the project.

4.1 Passive Mitigation

Passive mitigation involves determining when threshold snowpack depth for avalanching has been reached in the fall or early winter, and evacuating the exposed areas until avalanche hazard no longer exists in the spring. This option is considered as a base case in Appendix A, but unless winter closure of the road (150 days minimum) is an option, this method alone is considered impractical.

4.2 Active Avalanche Hazard Management Program (Basic)

The overall strategy of an active avalanche hazard management program is to provide continuous monitoring of avalanche conditions (during winter and spring months), and controlled release of avalanches when hazard is high. Although explosive control is a commonly used mitigation method, preventative closure of roads and exposed areas during periods of high avalanche hazard (and waiting for conditions to stabilize) may be acceptable if long term delays and closure are acceptable.

Monitoring of avalanche hazard is accomplished by way of ongoing snowpack analysis and evaluation of weather conditions by experienced Avalanche Technicians. Controlled release of avalanches is accomplished by using explosive control measures, which may initiate from fixed exploders (described in Section 4.2) or from charges delivered by helicopters or avalauncher. The following three sections describe key components of a basic active avalanche management program and a table in Appendix A compares and summarizes four different levels of avalanche management.

4.2.1 Avalanche Personnel

Experienced Avalanche Technicians are required for avalanche monitoring and control, especially considering the challenging forecasting conditions associated with a dry continental snowpack. Depending on the project demands, and whether 24/7 monitoring and control is required, avalanche management will require from one to four full time avalanche staff during avalanche season (the period when avalanches may affect facilities). Two technicians would allow for reasonably efficient control during many storm conditions, although a team of four would allow for 12 hour shifts for 2 two-person teams during extended storm cycles. Costs for avalanche personnel are indicated in Appendix A, and they are based on typical industry wage rates plus 10% to account for travel to and from site.

4.2.2 Weather Stations

Snow and weather observation sites generally include:

- High-elevation remote weather stations for monitoring wind and temperature.
- Mid-elevation remote weather stations for monitoring temperature, precipitation and snow depth.
- Low-elevation manual weather stations for monitoring snowfall and weather trends.
- Snow profile observation sites in sheltered locations near treeline to monitor snowpack development.

Remote weather stations provide the ability for technicians to continually monitor snow and weather at specific elevations and locations during storms or changing conditions, in order to increase avalanche hazard forecasting accuracy. An example of a remote weather station is provided in Figure 4-1. Two remote weather stations located along the HPAR and one located near XY portal and Associated Facilities Pad would be expected to increase efficiency of the avalanche hazard management program, and decrease road closure time. A cost estimate for the three weather stations is included in Appendix A.

Figure 4-1 – Example of a Remote Weather Station

4.2.3 Explosive Avalanche Control

Helicopter avalanche control, cornice control, case charging, and other explosive methods will be required to trigger avalanches during periods of high hazard (Figure 4-2). Conventional explosive materials are readily available and include ammonium nitrate, dynamite, gels, and other 'high explosives'. Although these explosive control methods form an effective avalanche control option, with the exception of case charging, they require good visibility and as a result are not effective if control is required at night or during severe storms. During November to February, this can lead to significant challenges to complete avalanche control missions, and may result in extended delays and closure during larger storms.

Figure 4-2 - Helicopter Explosive Control and Case Charging

Costs for avalanche explosive control include direct costs of explosives, transportation and storage of explosives, and helicopter costs.

4.3 Active Avalanche Hazard Management Program (Advanced)

Advanced avalanche hazard management may be considered if high efficiency is required, and longer term road closures are not tolerated. Considering the latitude of the project, daylight hours are short during November through January, and a helicopter explosive control program will be limited to only a few hours each day. Advanced methods allow for avalanche control during periods of reduced visibility (during storms and reduced daylight).

4.3.1 Pneumatic Cannons (Avalaunchers)

Manufactured pneumatic cannons are a commonly used avalanche control device which provides a means to deliver explosives to avalanche starting zones during storms, nightfall, and periods of reduced visibility. Commonly referred to as 'avalaunchers' they use compressed gas to launch explosives to avalanche starting zones from a safe location (see Figure 4-3). Although they are capable of transporting explosives 1000 m or more, explosive size is small and accuracy is limited. As a result they are generally limited to small and medium size avalanche paths, which include many of the paths near Howards Pass, as well as near the central section of the HPAR road.

If 24/7 avalanche control capability is required, two avalaunchers should be incorporated on the Howards Pass Access Road. The avalaunchers would be mounted on trailers, and used to supplement helicopter explosive control and RACS.

Figure 4-3 - Avalauncher

4.3.2 Remote Avalanche Control Systems

Remote avalanche control systems (RACS) utilize fixed infrastructure installed in or near avalanche starting zones. Systems are designed to deploy explosive charges and trigger avalanches anytime day or night, via a remote communications link. Although remote systems generally have high initial cost, this may be offset by costs savings due to reduced operational delays.

Types RACS include gas exploders, sophisticated remote control mortar systems, and other remote devices which can transport explosives to starting zones. At times when avalanche control is required, an avalanche technician establishes a communications link between the infrastructure and a control computer, and a firing sequence is initiated.

Remote control gas exploders are currently the most prominent type of remote systems in use today. In addition to hundreds of operations in Europe and Asia, several highways, parks, and ski areas in North America, and some mining operations in South America, rely on them for effective control in highly active areas. Remote control gas exploders are often desired due to their reliability, efficiency, and elimination of problems associated with using conventional explosive charges. These problems include misfires, disposal of duds, and the build-up of explosive residue compounds in the environment which can occur with widespread use of conventional explosives (USGS, 2005).

Remote control gas exploders operate by creating a gas explosion directed at the snowpack mantle. Gases used are propane and oxygen, and they are normally supplied by a proximal control shelter which houses gas bottles, radio telemetry, and the electronics required to initiate the blast sequence. The control shelter allows the gas exploder to be initiated remotely by an avalanche technician several times during storm cycles.

Examples of two different types of RACS are illustrated in Figure 4-4 and 4-5. Figure 4-4 illustrates a single remote control gas exploder and associated control shelter (which would support an array of exploders). Figure 4-5 illustrates a mortar based system.

Figure 4-4 – Gas Exploder (left) and Control Shelter (right)


Figure 4-5 – Mortar Based RACS

5.0 Discussion

The avalanche hazard management options discussed in this memorandum are based on typical mitigation methods used for industrial roads in Canada. Installation of permanent fixed mitigation (including tunnels, sheds, and extensive structural support fencing or earthworks) is not usually justified unless there is very high frequency of avalanches and high traffic volumes.

If an active avalanche management program is chosen, the level of management (basic or advanced) would be based on the reliability requirements for the roads. An advanced program would typically keep closures shorter than 4 to 6 hours. It should be noted that an active avalanche control program for a transportation corridor such as the HPAR should expect at least one long closure (e.g. 48 hours) each winter, regardless of control measures. This is usually due to a combination of severe storm conditions, and snow removal challenges.

6.0 Closure

This document was prepared by Alpine Solutions Avalanche Services for the account of Selwyn Chihong Mining Inc. The material in it reflects Alpine Solutions best judgment in light of the information available to Alpine Solutions at the time of preparation. Any use which a third party makes of this document, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Alpine Solutions accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions, based on this document.

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Yours Sincerely,
Alpine Solutions Avalanche Services
Per:

Brian Gould, P. Eng.
Avalanche Specialist

References

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Appendix A – Avalanche Mitigations Options Table

Table A1 – Avalanche Mitigation Options

Type		Description	Resources		Effect to Operations (closures)	Estimated CAPEX	Estimated OPEX
			Equipment	Avalanche Personnel			
PASSIVE		Evacuation of affected zones once avalanche threshold reached	None required.	0	Significant in winter; Estimated >150 days per year of road closure.	0	0
ACTIVE	**Basic**	Basic Avalanche Conditions Monitoring and Preventative Closures. No helicopter on site.	Weather Stations; Road Signage; Avalanche PPE; One truck	1	Approximately 30 to 60 days per year of closure along the HPAR, and in some areas in Don Valley.	$200K (weather stations, signage)	$100K (wages and maintenance)
	Basic with helicopter	As above with helicopter explosive control.	As above with helicopter, explosives, and magazine, and 2nd truck.	2	Average 10 to 15 days of closure per year, some multi-day closures to 5 days.	$250K	$275K
	Advanced	As above with Remote Avalanche Control Systems along the HPAR, and avalaunchers.	As above with Remote Avalanche Control Systems and 2 avalaunchers.	3-4	1 to 4 hour road delays, 10 to 20 times per year. One 24 to 48 hour closure per year.	$3.5M	$300K-$350K

Appendix B

Estimated Costs for Active Avalanche Management

(not included)

APPENDIX VI. GEOCHEMICAL TEST RESULTS FOR HPAR BORROW SITE SAMPLES

pHase Geochemistry Inc. (2015). Geochemical Test Results for HPAR Borrow Site Samples, Selwyn Project. Memorandum prepared for Selwyn Chihong Mining Ltd. by pHase Geochemistry.

Memorandum

1032 Keith Rd W., North Vancouver BC, V7P 1Y5
604-764-0854 (cell), sshaw@phase-geochemistry.com (email)

To: Jenifer Hill (Selwyn Chihong Mining)

Cc: Doug Reeve (Selwyn Chihong Mining)

From: Shannon Shaw (pHase Geochemistry Inc.)

Andrea Samuels (pHase Geochemistry Inc.)

Date: May 29, 2015

Re: Geochemical Test Results for HPAR Borrow Site Samples, Selwyn Project.

Introduction

pHase Geochemistry Inc. (pHase) has been providing on-going geochemical characterization assistance to Selwyn Chihong Mining Ltd. (SCM) for the Selwyn Project. One of the recent tasks has been to manage and interpret screening level geochemical tests from potential sources at granular borrow sites collected by others along the Howard's Pass Access Road (HPAR). Interpretation of screening results has been related to regional geology and the risk of acid generation and metal leaching for road construction on that basis is discussed.

Sample Program

A total of forty-three (43) samples were sent to SGS by Steven Bartsch with Associated Engineering (AE) representing potential borrow sites along the Howard's Pass Access Road (HPAR). Sample details were provided by AE and included here as Attachment A. Sample IDs were denoted by distance from km 4.2 to km 69.9 and three to four grab samples were collected at each location. A map showing road chainage (by kilometer) is provided in Figure 1. Figure 2 provides the sample locations with respect to regional geology.

Test Methods

All 43 samples were submitted for total sulphur and total carbon analyses by IR Combustion method code CSA06V (Leco Furnace) as well as total inorganic carbon by Coulometry method code CSB02V (screening results). In addition, 16 samples were selected as a subset and submitted for more detailed testwork; including modified acid base accounting, metal analysis by aqua regia digestion (and ICP-MS finish) and 24-hour nanopure water leach extraction testing using a 3:1 water to solid ratio. All testing was done at SGS Canada Inc. in Burnaby BC, Canada.

All duplicate analyses were within the $^{+}/_{-}$ 20% guideline and analyses on standard reference materials were all within the tolerance levels of expected values. QA/QC results are provided in Attachment B and lab data is provided in Attachment C.

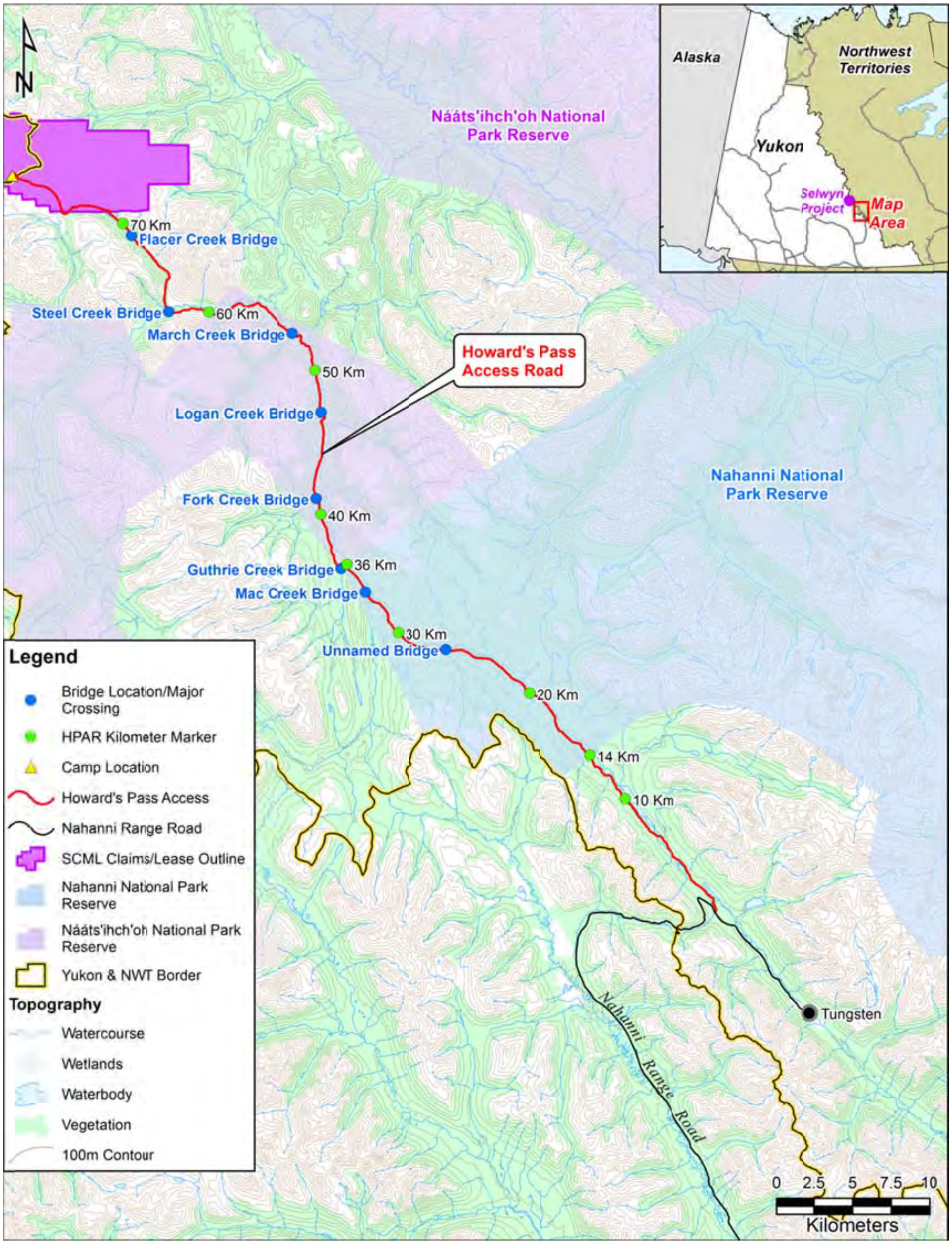
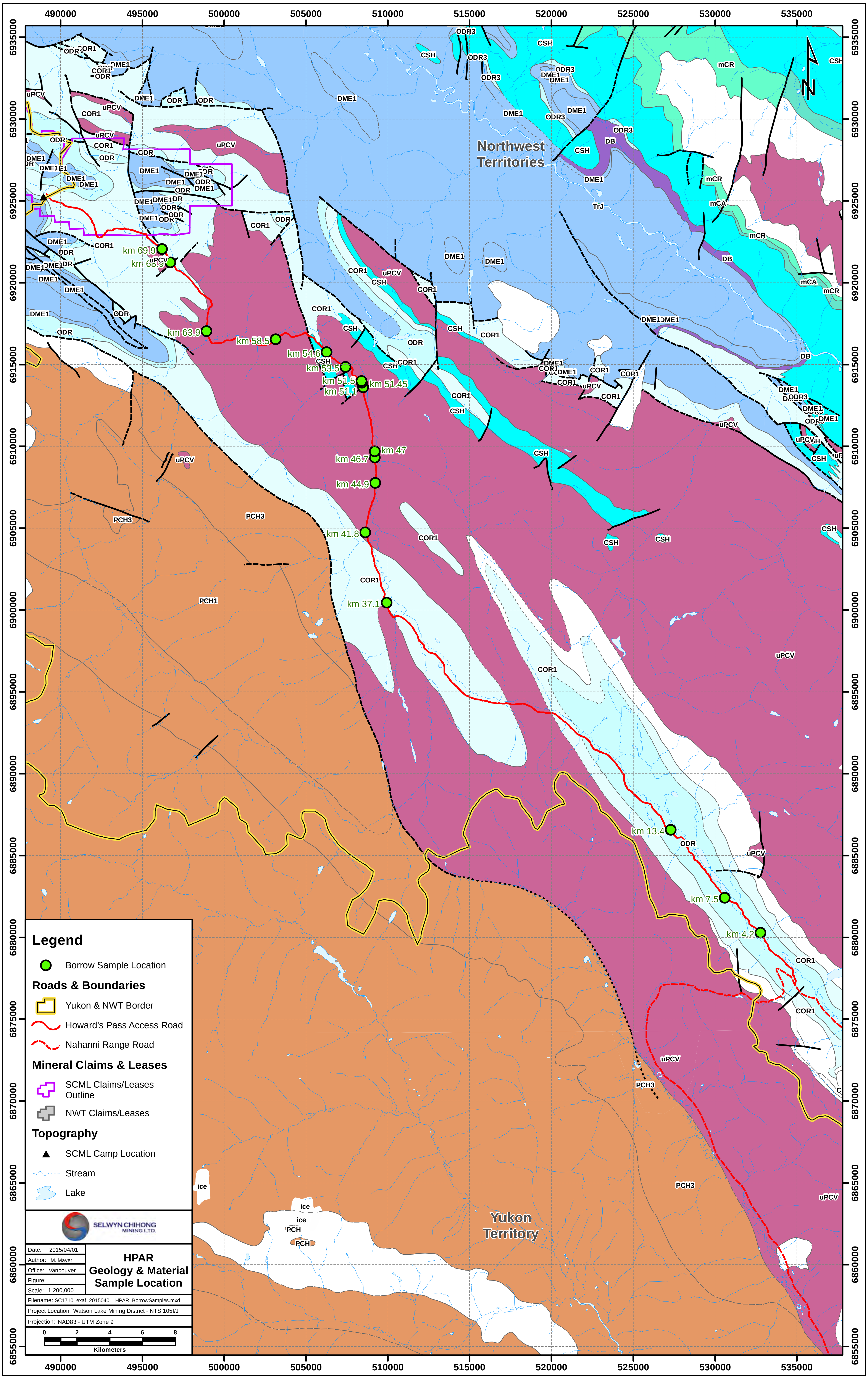


Figure 1. Map of Howard's Pass Access Road.



Legend
Borrow Sample Location
Roads & Boundaries
Yukon & NWT Border
Howard's Pass Access Road
Nahanni Range Road
Mineral Claims & Leases
SCML Claims/Leases Outline
NWT Claims/Leases
Topography
SCML Camp Location
Stream
Lake
SELWYN CHIHONG MINING LTD.
Date: 2015/04/01
Author: M. Mayer
Office: Vancouver
Figure:
Scale: 1:200,000
HPAR Geology & Material Sample Location
Filename: SC1710_exaf_20150401_HPAR_BorrowSamples.mxd
Project Location: Watson Lake Mining District - NTS 105I/J
Projection: NAD83 - UTM Zone 9
0 2 4 6 8
Kilometers
Northwest Territories
Yukon Territory
km 69.9
km 68.9
km 63.9
km 58.5
km 54.6
km 53.5
km 51.5
km 51.1
km 51.45
km 47
km 46.7
km 44.9
km 41.8
km 37.1
km 13.4
km 7.5
km 4.2
490000
495000
500000
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6935000
6930000
6925000
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6915000
6910000
6905000
6900000
6895000
6890000
6885000
6880000
6875000
6870000
6865000
6860000
6855000

Legend

Geology

MID-CRETACEOUS

mKgS: SELWYN SUITE: resistant, blocky, fine to coarse grained equigranular to porphyritic (K-feldspasr) biotite quartz monzonite and granodiorite and minor quartz diorite; minor leuco-quartz monzonite and syenite (Selwyn Suite)

MIDDLE TO UPPER TRIASSIC

TrJ: JONES LAKE: brown to buff weathering, calcareous fine grained sandstone, argillite and shale; extensive ripple cross-lamination and bioturbation; massive,light grey weathering, fine crystalline, dark grey limestone; minor orange weathering platy limestone (Jones Lake)

DEVONIAN AND MISSISSIPPIAN

DME1: EARN: thin bedded, laminated slate with thin to thickly interbedded fine to medium grained chert-quartz arenite and wacke; thick members of chert pebble conglomerate; black siliceous siltstone; nodular and bedded barite; rare limestone (Earn Gp., Portrait Lake and Prevost)

UPPER LOWER TO LOWER MIDDLE DEVONIAN

DB: GRIZZLY BEAR: limestone, white grey weathering, cliff forming, blocky partings, massive, fine to medium crystalline; scattered corals, brachiopods, bryozoans and twin canal echinoderm ossicles (Grizzly Bear)

MIDDLE DEVONIAN

DH4: HUME: buff-orange weathering thin to medium bedded silty limestone (Funeral)

ORDOVICIAN TO LOWER DEVONIAN

ODR: ROAD RIVER - SELWYN: black shale and chert (1) overlain by orange siltstone (2) or buff platy limestone (3); locally contains beds as old as Middle Cambrian (4); correlations with basinal strata in Richardson Mountains include: ODR1 with CDR2 (upper part) and ODR2 with CDR4 (Road River Gp.)

ODR3: ROAD RIVER - SELWYN: blue-grey weathering, black limestone; tan, buff, or dark grey weathering platy, silty limestone (Sapper)

UPPER CAMBRIAN TO SILURIAN

CSH: HAYWIRE: undivided medium to thick bedded, white to dark-grey dolostone, locally cherty; rare amygdaloidal basalt and tuff; basal member of grey-white dolostone, quartz arenite, and maroon mudstone (Haywire)

UPPER CAMBRIAN AND ORDOVICIAN

COR1: RABBITKETTLE: thin bedded, wavy banded, silty limestone and grey lustrous calcareous phyllite; limestone intraclast breccia and conglomerate; massive to laminated, grey quartzose siltstone and chert and rare black slate; local mafic flows, breccia, and tuff (Rabbitkettle)

MIDDLE CAMBRIAN

mCA: AVALANCHE: light grey, buff, yellow, and orange weathering, crypto grained dolostone, silty dolostone, dolomitic siltstone and dolomitic mudstone; (Avalanche)

mCR: ROCKSLIDE: recessive, dark grey weathering, laminated, platy calcareous shale and silty, dark grey fine- to crypto-grained limestone; minor thin beds of light brown to grey weathering platy dark crypto-grained limestone and rare bands of buff dolostone (Rockslide)

LOWER CAMBRIAN

lCG1: GULL LAKE: shale, siltstone and mudstone, locally bioturbated, with minor quartz sandstone; rare green-grey chert; local basal limestone and limestone conglomerate; phyllite to quartz-muscovite-biotite schist (garnet sillimanite staurolite andalusite) (Gull Lake)

lCS: SEKWI: limestone, locally wavy bedded and nodular; limestone conglomerate slope breccia; massive grey dolostone; medium- to thick-bedded quartz sandstone; purple siltstone; bright orange weathering, fine crystalline dolostone (Sekwi)

UPPER PROTEROZOIC TO LOWER CAMBRIAN

uPCV: VAMPIRE: dark brown weathering. thin-bedded, argillaceous fine-grained sandstone and siltstone, minor interbedded medium- to coarse grained white to light grey orthoquartzite; phyllite, slate, and argillite (Vampire)

PCH: HYLAND: consists upwards of coarse turbiditic clastics (1), limestone (2) and fine clastics typified by maroon and green shale (3); may include younger (4) units; includes scattered mafic volcanic rocks (5) (Hyland Gp.)

PCH1: HYLAND: thin to thick bedded, brown to pale green shale, fine to coarse grained quartz-rich sandstone, grit, and quartz pebble conglomerate; minor argillaceous limestone; phyllite, quartzofeldspathic and micaceous psammite, gritty psammite and minor marble (Hyland Gp., Yusezyu)

PCH2: HYLAND: grey weathering, dark grey to grey white, thin to thick bedded, very fine crystalline limestone, locally sandy; calc-silicate and marble; may locally include carbonate members within (1) or (4) (Hyland Gp., Algae Lake , limestone member of Yusezyu)

PCH3: HYLAND: distinctive, recessive, maroon weathering, interbedded maroon and apple-green slate; "Oldhamia" trace fossils; rare grey chert; locally basal member and interbeds of quartz siltstone, sandstone and quartz-pebble conglomerate (Hyland Gp., Narchilla , Senoah , Arrowhead Lake)

PCH4: HYLAND: quartzose clastic rocks as described in (1); mostly(?) equivalent to (1) but may include younger units (Hyland Gp., mostly(?) Yusezyu)

ice

Contact

Defined

Approximate

Assumed

Extrapolated

Fault

Defined

Approximate

Assumed

Extrapolated

Results

Screening Tests

Total carbon results ranged from 0.12 to 49% (median of 0.58%) while total inorganic carbon values ranged from 0.01 to 8.4% (median 0.01%). Figure 3 provides a plot of total inorganic carbon versus total carbon which indicates that some of the samples have significant organic carbon content. As a result total inorganic carbon values were used to calculate carbonate neutralization potential in units of kg $CaCO_3$/t ($CaCO_3$ NP).

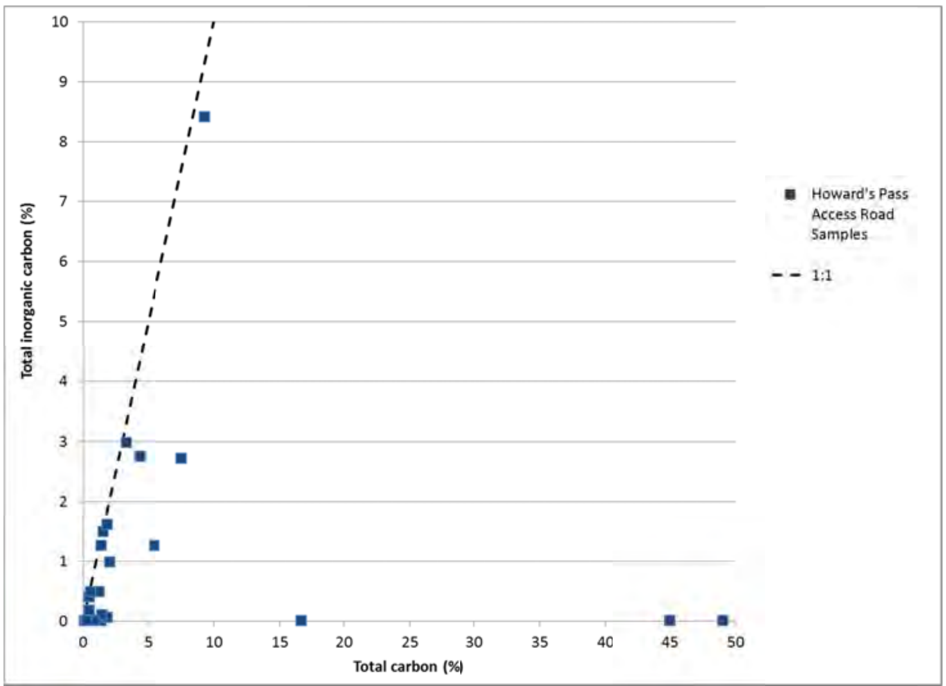


Figure 3. Total carbon versus total inorganic carbon for HPAR samples.

Total sulphur values ranged from 0.007 to 1.1% (median of 0.026%). Acid potential (AP) values were calculated based on total sulphur and compared to carbonate NP (Figure 4). As a preliminary assessment, samples were defined as potentially acid generating (PAG) if the $CaCO_3$ NP/AP ratio was less than 2 and non-PAG if greater than 2 based on guidelines from MEND 2009 (Figures 5 and 6). It should be noted that without additional geological or mineralogical information it is difficult to assess whether or not this guideline is an appropriate means of defining these specific samples as PAG or non-PAG.

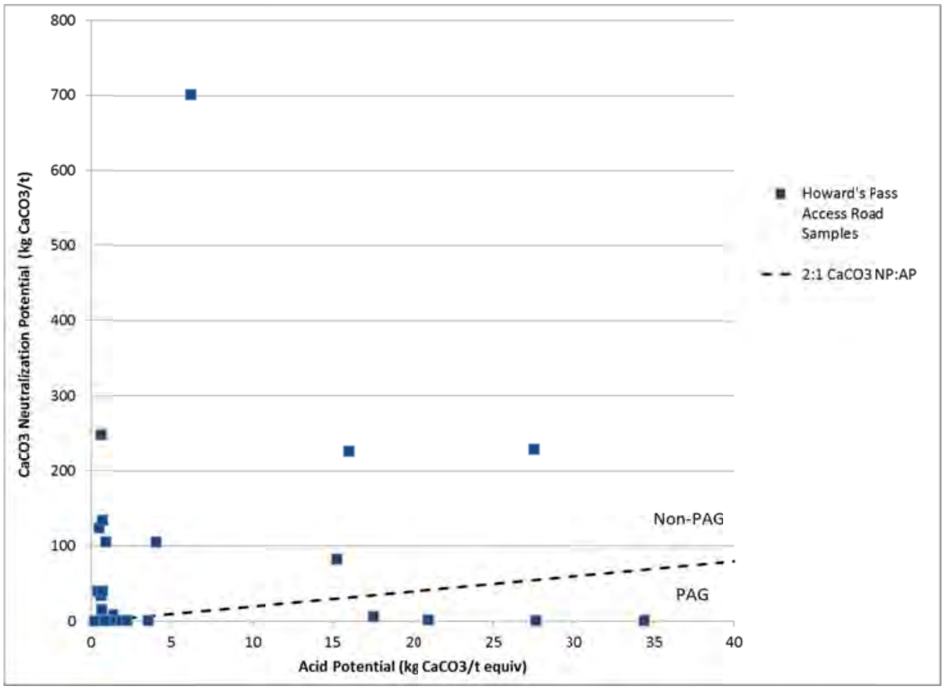


Figure 4. Acid Potential versus Carbonate Neutralization Potential for HPAR samples.

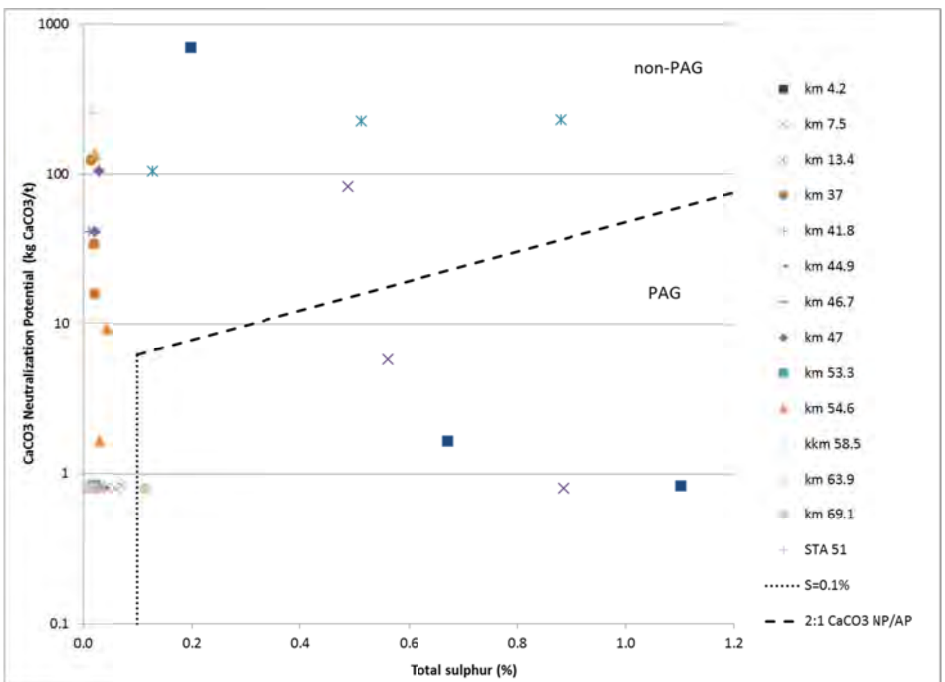


Figure 5. Total Sulphur versus Carbonate NP for HPAR samples.

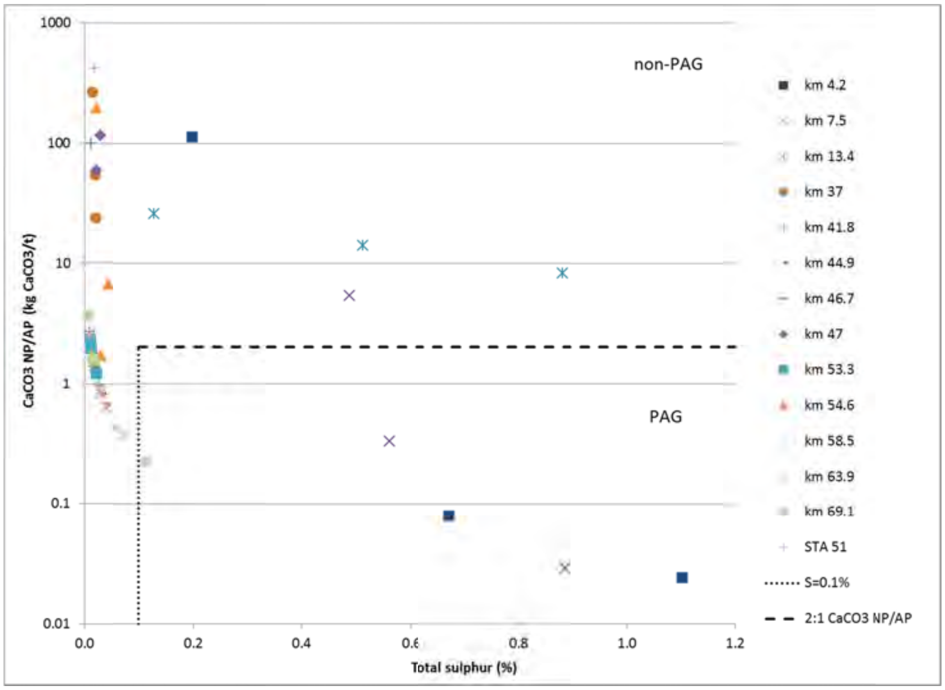


Figure 6. Total Sulphur versus Carbonate NP/AP for HPAR samples.

Acid Base Accounting

Modified acid base accounting (ABA) analyses were completed on a subset of 16 samples generally representing one sample at each chainage post as described for the screening tests above. These analyses included measurement of paste pH, total inorganic carbon (and calculated carbonate neutralization potential ($CaCO_3$ NP)), total sulphur, sulphate sulphur (and calculated sulphide sulphur and associated acid potential (AP)), modified Sobek neutralization potential (by titration) and resulting calculated net NP and ratios of NP to AP. Results are provided in Attachment C and summarized in Table 1 below.

In general, paste pH values ranged from 5.3 to 8.5, with the lowest paste pH values reported for samples from kilometer 4.2 and 7.5. Total inorganic carbon values were often below method detection limits (0.01%) up to values of 3.0% which represents a carbonate NP of approximately 250 kg $CaCO_3$/t. Total sulphur values ranged from 0.01% to 1.1%, with an average for all samples of 0.17%. Sulphate sulphur was below method detection for all but one sample suggesting that nearly all sulphur is present as sulphides. Corresponding acid potential (AP) values ranged from 0.3 to 34 kg $CaCO_3$/t equivalent with the highest values being from those samples collected from kilometer 4.2, 7.5 and 13.4 dropping off to very low values from kilometer post 37 onwards.

Table 1. Summary of Modified Acid Base Accounting Results.

Classification	Number of Samples	Proportion of Sample Set	Comment
Potentially Acid Generating (PAG): $CaCO_3$ NP/AP<2 and Sulphide Sulphur >0.1%	2	13%	Negligible neutralization potential and sulphide sulphur content at levels that could produce acidity.
Limited Potential for Acid Generating (PAG-Low): $CaCO_3$ NP/AP<2 and Sulphide Sulphur <0.1%	8	50%	Negligible neutralization potential and negligible sulphide content, acid generation considered unlikely and if present then very localized and limited.
Non-Potentially Acid Generating (Non-PAG): $CaCO_3$ NP/AP>2	6	38%	Neutralization potential considered moderate and sulphide content negligible.

Metals

Solid metal analyses by aqua regia digestion (and ICP-MS finish) were also completed on the subset of 16 samples generally representing one sample at each chainage post. Results are provided in Attachment C with selected parameters summarized in Table 2. Elemental values were compared to ten times average crustal abundances as a qualitative assessment to indicate the potential for anomalously high metals (Figure 7).

On this basis, those metals that would be considered elevated in the HPAR borrow site samples include barium in two samples collected from kilometer 4.2 and 7.5 with values exceeding the detection limit of 10,000 pm. This may suggest the presence of barite in the rock at these locations. Sulphur from acid-insoluble sulphate minerals such as barite report to the sulphide sulphur analysis and therefore if barite is present the AP in these two samples may be slightly over predicted. Marginally elevated silver was also identified in one sample from kilometer 13.4 with slightly higher sulphur content (0.5% S) than the majority of samples analyzed along the HPAR.

All other metals of potential concern were generally low with values below ten times average crustal abundances for shales.

Table 2. Summary of Solid Metals Content.

Sample ID	Ag ppm	As ppm	Ba ppm	Cd ppm	Cu ppm	Fe %	Hg ppm	Mn ppm	Mo ppm	Ni ppm	Pb ppm	S %	Sb ppm	Se ppm	Zn ppm
10x Crustal Avg.[1]	0.7	130	5800	3	450	47.2	4	8500	26	680	200	2.4	15	6	950
KM 4.2-1	0.36	24	**10000**	1.6	54.3	4.38	0.11	116	12.1	64.7	8.2	0.08	4.48	4	185
KM 7.5-1	0.34	18	**10000**	0.5	35.5	3.31	0.15	49	10.7	36.1	6.9	0.09	4.09	5	144
KM 13.4-2	0.77	55	161	1.31	51	1.79	0.11	271	9.68	54.1	30.9	0.58	5.09	3	165
KM 37 - 1	0.06	16	49	0.19	20.6	3.99	*0.01*	566	3.41	35.2	23.2	0.02	0.27	*1*	92
KM 41.8-3	0.09	20	32	0.23	28.2	3.82	*0.01*	543	3.46	24.2	49	*0.01*	0.08	*1*	81
KM 44.9-3	0.05	9	27	0.1	18	4.6	*0.01*	382	2	23.9	17.8	0.03	0.07	*1*	86
KM 46.7-2	0.06	8	26	0.04	14.2	5.45	*0.01*	526	1.26	16.3	21.7	0.03	0.05	*1*	85
KM 47-3	0.09	23	56	0.31	26.5	3.55	*0.01*	504	4.72	32.1	14	0.03	0.37	*1*	85
KM 53.3-3	0.08	23	70	0.33	26.9	4.4	0.01	463	4.48	41.6	18.8	0.02	0.48	*1*	104
KM 54.6-3	0.05	8	40	0.08	16.2	2.63	*0.01*	218	3.28	22.4	15.9	0.03	0.12	*1*	41
KM 58.5-3	0.04	8	28	0.05	15.1	4.58	*0.01*	451	1.9	25	9.9	0.03	0.09	*1*	92
KM 63.9-3	0.1	35	68	0.46	36.3	4.87	0.03	736	3.18	89.7	16.7	*0.01*	0.46	1	157
KM 69.1-2	0.06	54	94	0.25	20.3	4.58	*0.01*	373	2.8	39.4	24.9	0.01	0.71	*1*	109
STA 51+100-1	0.11	8	61	0.27	17.6	2.84	0.04	371	4.62	22.8	16.3	0.02	0.45	*1*	73
STA 51+450	0.08	14	74	0.3	21.9	4.39	*0.01*	1700	4.8	36	15.4	0.02	0.28	*1*	90
STA 51+500-1	0.08	23	54	0.32	27.2	4.41	*0.01*	469	3.94	37.6	15.5	0.02	0.48	*1*	104

Notes:
[1] Average crustal abundance for shales.
Brown italics = value less than laboratory detection limit. Detection limit shown.
Blue bold = value greater than laboratory detection limit. Detection limit shown.
Complete metals analysis results provided in Att. C3.

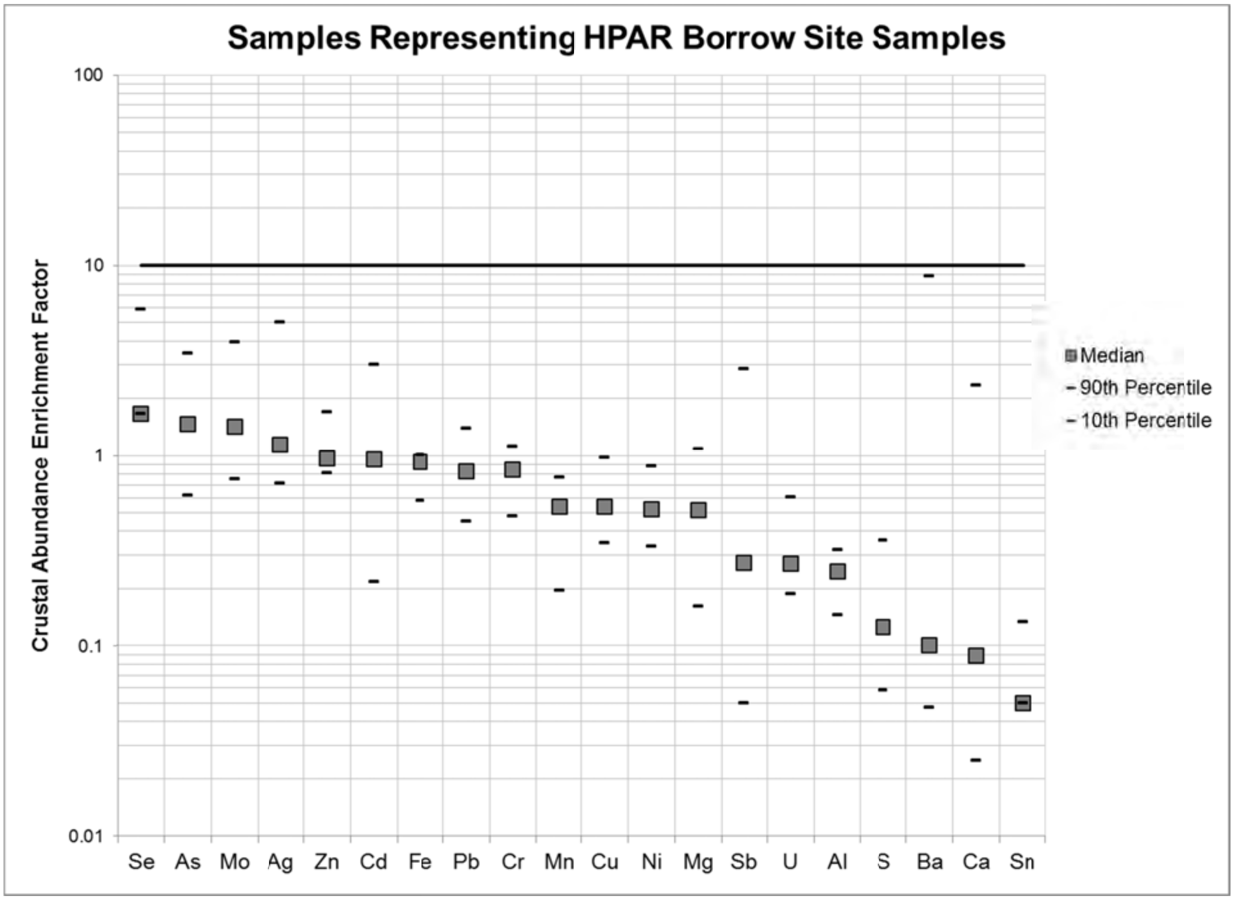


Figure 7. Crustal Abundance Enrichment Factor for Selected Parameters.

Leach Extraction Tests

Leach extraction tests were conducted on a subset of 16 HPAR samples to assess the portion of each sample that is readily extractable or soluble when exposed to distilled water and quantification of metal concentrations in extracted leachate. Selected parameters are summarized in Table 3 below and complete results are provided in Attachment C.

The leach extraction tests indicate that the HPAR samples were generally buffered with a pH range from 6.2 to 7.7, with the lowest pH value reported for the sample from kilometer 4.2. Concentrations of sulphate were generally low with values typically <10 mg/L. Two exceptions included a sample from kilometer 13.4 (235 mg/L SO_4) and kilometer 54.6 (94 mg/L SO_4) with higher soluble sulphate than the other samples, albeit still relatively low.

Table 3. Summary of Leach Extraction Test Results.

Sample ID	pH	SO4	Al	Sb	As	Ba	Cd	Cu	Fe	Pb	Mn	Mo	Ni	Se	Zn
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
KM 4.2-1	6.24	15	0.15	*0.0002*	0.0003	0.18	0.0033	0.0014	*0.007*	0.00007	0.18	0.00021	0.033	0.00079	0.163
KM 7.5-1	6.92	6	0.078	*0.0002*	*0.0002*	0.45	0.00096	0.0018	*0.007*	0.00008	0.083	0.00008	0.013	0.00060	0.040
KM 13.4-2	7.47	235	0.0025	0.0009	*0.0002*	0.017	0.000059	0.00033	*0.007*	*0.00001*	0.018	0.0052	0.0005	0.012	*0.001*
KM 37 - 1	7.73	3	0.13	0.0002	0.0019	0.0075	0.000048	0.0040	0.14	0.00052	0.053	0.00065	0.0007	0.00031	0.001
KM 41.8-3	7.72	*2*	0.099	0.0003	0.0021	0.0032	0.000006	0.0045	0.13	0.00061	0.013	0.00066	0.0011	0.00040	*0.001*
KM 44.9-3	7.54	2	0.10	*0.0002*	0.0013	0.0057	0.00028	0.0028	0.15	0.00091	0.10	0.00014	0.0050	0.00025	0.003
KM 46.7-2	7.43	3	0.037	*0.0002*	0.0004	0.0025	0.000012	0.0013	0.071	0.00020	0.012	0.00005	0.0012	0.00007	*0.001*
KM 47-3	7.53	*2*	0.097	0.0002	0.0011	0.0025	*0.000003*	0.0010	0.016	0.00002	0.00089	0.0018	*0.0001*	0.00012	*0.001*
KM 53.3-3	7.49	2	0.16	0.0006	0.0008	0.011	0.000055	0.0035	0.18	0.00027	0.041	0.014	0.0011	0.00032	0.002
KM 54.6-3	7.41	94	0.035	0.0007	0.0015	0.0071	0.000012	0.013	0.063	0.00019	0.035	0.0034	0.0037	0.00021	0.001
KM 58.5-3	7.44	2	0.21	0.0005	0.0007	0.0024	0.000012	0.0038	0.19	0.00025	0.016	0.0012	0.0015	0.00028	0.002
KM 63.9-3	7.17	2	0.12	0.0004	0.0017	0.0072	0.000044	0.0023	0.11	0.00019	0.038	0.00070	0.0036	0.00025	0.001
KM 69.1-2	7.24	7	0.17	0.0015	0.0073	0.029	0.000055	0.0067	0.41	0.00078	0.096	0.00053	0.0024	0.00057	0.003
STA 51+100-1	7.68	*2*	0.15	0.0004	0.0006	0.013	0.000019	0.0020	0.079	0.00019	0.0045	0.00075	0.0004	0.00026	0.005
STA 51+450	7.71	2	0.042	0.0003	0.0005	0.0082	0.000026	0.00407	0.10	0.00024	0.019	0.00043	0.0007	0.00019	0.001
STA 51+500-1	7.17	3	0.18	0.0003	0.0007	0.017	0.000093	0.0028	0.16	0.00032	0.23	0.00013	0.0036	0.00019	0.002

Notes:
Brown italics = value less than laboratory detection limit. Detection limit shown.
Complete metals analysis results provided in Att. C4.

Elevated soluble metals included barium from the two samples at kilometer 4.2 and 7.5 that reported significantly high solid barium content, as well as marginally elevated barium at kilometers 53.3, 69.1, STA 51+100-1 and STA 51+500-1. Elevated soluble cadmium, nickel and zinc were also reported in the samples from kilometers 4.2 and 7.5 relative to the other samples, as well as selenium at kilometer 13.4. All three of these samples, located near the start of the HPAR, reported slightly higher total sulphur (~0.5-1%) than the rest of the samples along the HPAR.

Most other parameters of concern were low and would be expected to remain low while buffered to near neutral pH values.

Discussion

Guidelines suggest that on the basis of the $CaCO_3$ NP/AP ratio, samples with values less than 2 would be classified as potentially acid generating (MEND 2009). In this case, many of those samples plot near the intercept on the AP vs NP plot (Figure 4) with very low values of both parameters ($CaCO_3$ NP and AP) and many are collected from the same chainage or kilometer markers. Figures 5 and 6 provide a better representation of the proportion and distribution of potentially acid generating and non-acid generating samples. Plotted on both of these figures is a sulphur criterion of 0.1%. For this evaluation, this sulphur value has been selected as a value below which acid generation would not be expected or would be very limited. Considering both the $CaCO_3$ NP/AP ratio and a lower bounding sulphur value, only 5 samples (or roughly 10% of the sample set) might be considered PAG. Four of these are from two locations; kilometer 4.2 and 7.5 respectively. This suggests that there may be a spatial influence on the results.

Considering the spatial distribution along the road, the results suggest that beyond kilometer post 13.4, most samples have either sufficient carbonate neutralization potential to balance any potential acid generation or have negligible sulphide content thereby classifying samples as non-potentially acid generating or with negligible potential for acid generation.

Based on the geological map as shown in Figure 2, samples that classify as PAG are largely from within the ODR unit or the Ordovician Road River unit; whereas those that are non-PAG with very low sulphur are from within the uPCV unit or the Upper Proterozoic to Lower Cambrian Vampire unit. The ODR unit is described as black shale and chert (1) overlain by orange siltstone (2) or buff platy limestone (3). The uPCV unit is described as dark brown weathering, thin-bedded, argillaceous fine-grained sandstone and siltstone, minor interbedded medium- to coarse grained with to light grey orthoquartzite, phyllite, slate and argillite. Based on this sample set, it appears that the ODR unit can have sulphides in amounts that could generate acidity whereas the uPCV unit has lesser sulphide content and therefore a lessened potential for ARD.

Metals analysis indicated high barite values in the samples at kilometer 4.2 and 7.5, also within the ODR unit. Leach extraction results also indicated the potential for metal leaching of some trace metals (possibly barium, cadmium, nickel, zinc) at neutral pH from samples within the ODR unit. Other soluble metals from samples within the ODR unit as well as the uPCV unit were at low concentrations and would be expected to remain low at neutral pH conditions.

Conclusions and Recommendations

The proposed HPAR upgrades will widen and increase the load capacity of the road. It is expected that the cut and fill volumes are close to being balanced with a surplus of cut on the lower half of the road and close to being balanced on the upper half and a need for borrow for road surfacing with volumes on the order of 200,000 m^3 (J. Hill, pers. comm.).

This screening program suggests that potential sources of granular borrow material beyond the Ordovician Road River unit ending at approximately kilometer 21 are predominantly non-acid generating, and that some of the samples collected at kilometers 4.2 and 7.5 could be potentially acid generating.

The preferred method to manage the risk associated with potentially acid generating rock is to reduce the likelihood of exposing or using potentially acid generating or metal leaching (PAG/ML) rock in road construction. Given that the volumes of rock are small, if some PAG/ML rock is exposed, the potential effects on the receiving environment are likely local in extent and small in magnitude.

A two phased approach is recommended for the material characterization program moving forward.

Phase 1 – During feasibility level design

- Avoid borrow materials at kilometers 4.2 and 7.5. Conduct additional material sampling and testing for borrows in the first 21 kilometers where still required in the design.

Phase 2 – During detailed design, prior to tendering

- In order to verify results, once borrow sites are identified and road design is at a level where cut and fill quantities are known, additional sampling and verification testing at those specific locations along the road should be undertaken (i.e. at borrow sites and areas of any large cuts).

- It is also noted that the road alignment crosses the COR1 geological unit in two sections of the road (see Figure 2), which is the Upper Cambrian and Ordovician Rabbitkettle unit defined as a thin bedded, wavy banded, silty limestone and grey lustrous calcareous phyllite. This unit was not well represented in this program and should be included in a verification sampling and characterization program once road construction details are known.
- These screening results suggest that the uPCV unit is likely a better candidate with respect to geochemical behaviour than the ODR unit. This geological relationship should be verified during borrow siting and development with additional sampling and characterization.

We trust that these results and corresponding discussion herein meet your current needs. If you require any additional clarification or support please don't hesitate to contact the undersigned.

pHase Geochemistry Inc.

Report written by:

"original signed"

Shannon Shaw, M.Sc., P.Geo (NWT)
pHase Geochemistry Inc.

Reviewed by:

"original signed"

Andrea Samuels, P.Geo (BC)
pHase Geochemistry Inc.

References

MEND (2009). Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. MEND Report 1.20.1, December 2009.

ATTACHMENT A

SAMPLE DETAILS PROVIDED BY ASSOCIATE ENGINEERING

HPAR Borrow Source Sites									
Location	Latitude			Longitude			Elevation	Notes	Sample Dates	Sample Method
km 4.2	62	3	11.61	128	22	22.362	1180.19		18-Mar-14	Excvated pit and manully shoveled into bucket or bag
km 7.5	62	4	21.342	128	24	51.474	1121		18-Mar-14	Excvated pit and manully shoveled into bucket or bag
km 13.4	62.000	6.000	36.426	128.000	28.000	36.312	1158.300		18-Mar-14	Excvated pit and manully shoveled into bucket or bag
km 37.1								Used at Km 26.5, Mac Creek, Guthrie Creek and Fork Creek	12-Mar-14	Excvated pit and manully shoveled into bucket or bag
km 41.8	62.000	16.000	27.042	128.000	50.000	0.990	1053.190		12-Mar-14	Excvated pit and manully shoveled into bucket or bag
km 44.9	62.000	18.000	4.752	128.000	49.000	18.354	1000.800		12-Mar-14	Excvated pit and manully shoveled into bucket or bag
km 46.7	62.000	18.000	54.516	128.000	49.000	19.758	1018.500	Used at Km 47	12-Mar-14	Excvated pit and manully shoveled into bucket or bag
km 53.5	62.000	21.000	53.736	128.000	51.000	23.190	931.200	Used at March Creek	29-Mar-14	Excvated pit and manully shoveled into bucket or bag
km 54.6									12-Mar-14	Excvated pit and manully shoveled into bucket or bag
km 58.5									12-Mar-14	Excvated pit and manully shoveled into bucket or bag
km 63.9	62.000	23.000	4.752	129.000	1.000	14.436	965.500	Used at Steel Creek	12-Mar-14	Excvated pit and manully shoveled into bucket or bag
km 68.9									12-Mar-14	Excvated pit and manully shoveled into bucket or bag
km 69.9								Used at Placer Creek	12-Mar-14	Excvated pit and manully shoveled into bucket or bag
km 47								3 separate samples	27-Oct-14	Excvated pit and manully shoveled into bucket or bag
STA 51+100									2-Oct-14	Excvated pit and manully shoveled into bucket or bag
STA 51+450									2-Oct-14	Excvated pit and manully shoveled into bucket or bag
STA 51+500									2-Oct-14	Excvated pit and manully shoveled into bucket or bag

ATTACHMENT B

QUALITY CONTROL/QUALITY ASSURANCE ANALYSES

QA/QC

Sample ID	TIC %	C(T) %	S(T) %
Method Code	CSB02V	CSA06V	CSA06V
LOD	0.01	0.01	0.01
KM 7.5-2	0.99	2.04	0.488
KM 7.5-2	1.02		
Relative Percent Difference	-3.0%		
KM 13.4-3	1.26	5.46	0.129
KM 13.4-3	1.27		
Relative Percent Difference	-0.8%		
KM 37-1	0.19	0.472	0.021
KM 37-1	0.18		
Relative Percent Difference	5.4%		
KM 37-2	1.49	1.51	0.015
KM 37-2		1.52	0.014
Relative Percent Difference		-0.7%	6.9%
KM 44.9-1	*0.01*	0.189	0.038
KM 44.9-1		0.182	0.041
Relative Percent Difference		3.8%	-7.6%
QC			
GTS-2A		1.97	0.327
Expected Values		2.01	0.341
Tolerance +/-		0.150	0.030
RTS-1			1.67
Expected Values			1.66
Tolerance +/-			0.08
502-491-1001		11.7	11.1
Expected Values		11.44	11.16
Tolerance +/-		0.58	0.57
SY-4	0.91		
Expected Values	0.95		
Tolerance +/-	0.06		
CaCO3	11.8		
Expected Values	12.0		
Tolerance +/-	1.2		
TIC-L1	0.13		
Expected Values	0.1325		
Tolerance +/-	0.02		

Note:

ATTACHMENT C
ANALYTICAL RESULTS

CLIENT **: pHase Geochemistry**
PROJECT **: Selwyn (HPAR Borrow)**
SGS Project # **: 0679**
Test **: Carbon, Sulphur Assays**
Date **: March 5, 2015**

Sample ID	**TIC %**	**CaCO3 NP**	**C(T) %**	**S(T) %**
Method Code	CSB02V	Calc.	CSA06V	CSA06V
LOD	0.01	#N/A	0.01	0.01
KM 4.2-1	0.01	0.8	1.29	1.1
KM 4.2-2	8.42	701.7	9.3	0.198
KM 4.2-3	0.02	1.7	1.04	0.672
KM 7.5-1	<0.01	<0.8	1.38	0.884
KM 7.5-2	0.99	82.5	2.04	0.488
KM 7.5-3	0.07	5.8	1.84	0.561
KM 13.4-1	2.75	229.2	4.37	0.88
KM 13.4-2	2.72	226.7	7.53	0.512
KM 13.4-3	1.26	105.0	5.46	0.129
KM 37-1	0.19	15.8	0.472	0.021
KM 37-2	1.49	124.2	1.51	0.015
KM 37-3	0.41	34.2	0.468	0.02
KM 41.8-1	0.01	0.8	0.228	0.01
KM 41.8-2	<0.01	<0.8	0.326	0.011
KM 41.8-3	0.49	40.8	1.21	0.013
KM 44.9-1	<0.01	<0.8	0.189	0.038
KM 44.9-2	<0.01	<0.8	0.124	0.014
KM 44.9-3	<0.01	<0.8	0.142	0.031
KM 46.7-1	0.01	0.8	0.581	0.019
KM 46.7-2	<0.01	<0.8	0.204	0.026
KM 46.7-3	<0.01	<0.8	0.777	0.017
KM 47-1	0.49	40.8	0.578	0.022
KM 47-2	<0.01	<0.8	0.137	0.02
KM 47-3	1.26	105.0	1.35	0.029
KM 53.3-1	<0.01	<0.8	0.179	0.011
KM 53.3-2	<0.01	<0.8	0.177	0.013
KM 53.3-3	0.01	0.8	0.331	0.022
KM 54.6-1	0.11	9.2	1.41	0.044
KM 54.6-2	1.61	134.2	1.83	0.022
KM 54.6-3	0.02	1.7	0.258	0.031
KM 54.6-4	<0.01	<0.8	0.164	0.015
KM 58.5-1	<0.01	<0.8	16.6	0.06
KM 58.5-2	0.01	0.8	49	0.072
KM 58.5-3	<0.01	<0.8	0.594	0.029
KM 63.9-1	<0.01	<0.8	0.316	0.031
KM 63.9-2	<0.01	<0.8	0.186	0.04
KM 63.9-3	<0.01	<0.8	0.306	0.01
KM 69.1-1	<0.01	<0.8	45	0.114
KM 69.1-2	<0.01	<0.8	0.816	0.016
KM 69.1-3	<0.01	<0.8	0.162	0.007
STA 51+100-1	2.98	248.3	3.27	0.019
STA 51+450	<0.01	<0.8	0.153	0.026
STA 51+500-1	<0.01	<0.8	0.257	0.027
Duplicates				
KM 7.5-2	1.02			
KM 13.4-3	1.27			
KM 37-1	0.18			
KM 37-2			1.52	0.014
KM 44.9-1			0.182	0.041
QC				
GTS-2A			1.97	0.327
Expected Values			2.01	0.341
Tolerance +/-			0.150	0.030
RTS-1				1.67
Expected Values				1.66
Tolerance +/-				0.08
502-491-1001			11.7	11.1
Expected Values			11.44	11.16
Tolerance +/-			0.58	0.57
SY-4	0.91			
Expected Values	0.95			
Tolerance +/-	0.06			
CaCO3	11.8			
Expected Values	12.0			
Tolerance +/-	1.2			
TIC-L1	0.13			
Expected Values	0.1325			
Tolerance +/-	0.02			

Note:

CLIENT : **pHase Geochemistry**
PROJECT : **Selwyn (HPAR Borrow)**
SGS Project # : **0679**
Test : **Modified Acid-Base Accounting**
Date : **May 4, 2015**

Sample ID	**Paste pH**	**TIC %**	**CaCO3 NP**	**S(T) %**	**S(SO4) %**	**S(S-2) %**	**AP**	**NP**	**Net NP**	**Fizz Test**
Method Code	Sobek	CSB02V	Calc.	CSA06V	CSA07V	Calc.	Calc.	Modified	Calc.	Sobek
LOD	0.2	0.01	#N/A	0.01	0.01	#N/A	#N/A	0.5	#N/A	#N/A
KM 4.2-1	5.42	0.01	0.8	1.1	<0.01	1.1	34.4	-2.1	-36.5	None
KM 7.5-1	5.30	<0.01	<0.8	0.884	<0.01	0.884	27.6	-2.3	-29.9	None
KM 13.4-2	7.96	2.72	226.7	0.512	0.03	0.482	15.1	224.0	208.9	Slight
KM 37 - 1	7.61	0.19	15.8	0.021	<0.01	0.021	0.7	14.5	13.8	Slight
KM 41.8-3	7.72	0.49	40.8	0.013	<0.01	0.013	0.4	41.9	41.5	Slight
KM 44.9-3	7.02	<0.01	<0.8	0.031	<0.01	0.031	1.0	-0.6	-1.6	None
KM 46.7-2	6.76	<0.01	<0.8	0.026	<0.01	0.026	0.8	0.5	-0.3	None
KM 47-3	8.60	1.26	105.0	0.029	<0.01	0.029	0.9	104.7	103.8	Moderate
KM 53.3-3	6.79	0.01	0.8	0.022	<0.01	0.022	0.7	1.6	0.9	None
KM 54.6-3	7.75	0.02	1.7	0.031	<0.01	0.031	1.0	2.8	1.8	None
KM 58.5-3	6.46	<0.01	<0.8	0.029	<0.01	0.029	0.9	-0.9	-1.8	None
KM 63.9-3	7.03	<0.01	<0.8	0.01	<0.01	0.01	0.3	1.5	1.2	None
KM 69.1-2	6.65	<0.01	<0.8	0.016	<0.01	0.016	0.5	-0.2	-0.7	None
STA 51+100-1	8.47	2.98	248.3	0.019	<0.01	0.019	0.6	244.6	244.0	Slight
STA 51+450	7.45	<0.01	<0.8	0.026	<0.01	0.026	0.8	0.4	-0.4	None
STA 51+500-1	6.90	<0.01	<0.8	0.027	<0.01	0.027	0.8	0.2	-0.6	None
Duplicates										
KM 4.2-1	5.39							-2.8		None
KM 53.3-3					<0.01					
QC										
PD-1					4.07					
NBM-1								40.5		Slight
Expected Values					4.27			42.0		Slight
Tolerance +/-					0.51			4.0		

Note:

CLIENT : pHase Geochemistry
PROJECT : Selwyn (HPAR Borrow)
SGS Project # : 0679
Test : Metals by Aqua Regia Digestion with ICP-MS Finish
Date : May 4, 2015

Sample ID	Ag	Al	B	Ba	Ca	Cr	Cu	Fe	K	Li	Mg	Mn	Na	Ni	P	S
	ppm	%	ppm	ppm	%	ppm	ppm	%	%	ppm	%	ppm	%	ppm	ppm	%
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.01	0.01	10	5	0.01	1	0.5	0.01	0.01	1	0.01	2	0.01	0.5	50	0.01
KM 4.2-1	0.36	3.81	<10	>10000	0.06	35	54.3	4.38	0.14	5	0.05	116	0.01	64.7	0.047	0.08
KM 7.5-1	0.34	2.18	<10	>10000	0.02	43	35.5	3.31	0.11	3	0.03	49	0.01	36.1	0.032	0.09
KM 13.4-2	0.77	0.91	20	161	6.92	43	51	1.79	0.43	13	2.19	271	0.01	54.1	0.255	0.58
KM 37 - 1	0.06	1.96	<10	49	0.76	89	20.6	3.99	0.12	61	0.74	566	0.03	35.2	0.055	0.02
KM 41.8-3	0.09	1.74	<10	32	1.87	93	28.2	3.82	0.11	63	0.65	543	0.02	24.2	0.039	<0.01
KM 44.9-3	0.05	2.15	<10	27	0.08	74	18	4.6	0.12	79	0.77	382	0.02	23.9	0.04	0.03
KM 46.7-2	0.06	2.71	<10	26	0.05	66	14.2	5.45	0.11	103	1.05	526	0.02	16.3	0.051	0.03
KM 47-3	0.09	1.69	<10	56	4.46	99	26.5	3.55	0.15	55	0.78	504	0.03	32.1	0.087	0.03
KM 53.3-3	0.08	2.31	<10	70	0.47	102	26.9	4.4	0.21	58	0.75	463	0.06	41.6	0.089	0.02
KM 54.6-3	0.05	1.06	<10	40	0.22	64	16.2	2.63	0.23	23	0.43	218	0.01	22.4	0.074	0.03
KM 58.5-3	0.04	2.3	<10	28	0.09	74	15.1	4.58	0.08	64	0.92	451	0.02	25	0.048	0.03
KM 63.9-3	0.1	2.42	<10	68	0.21	93	36.3	4.87	0.1	66	0.94	736	0.02	89.7	0.095	<0.01
KM 69.1-2	0.06	1.9	<10	94	0.18	74	20.3	4.58	0.1	77	0.62	373	0.02	39.4	0.069	0.01
STA 51+100-1	0.11	1.26	<10	61	5.89	77	17.6	2.84	0.12	42	3.46	371	0.02	22.8	0.087	0.02
STA 51+450	0.08	1.99	<10	74	0.11	112	21.9	4.39	0.11	62	0.82	1700	0.02	36	0.053	0.02
STA 51+500-1	0.08	1.92	<10	54	0.14	91	27.2	4.41	0.11	62	0.78	469	0.02	37.6	0.084	0.02
Duplicates																
KM 58.5-3	0.04	2.3	<10	27	0.09	75	14.1	4.59	0.08	65	0.93	448	0.02	25.3	0.047	0.03
QC																
CH4	2.29	1.89	<10	304	0.59	108	2080	4.64	1.45	13	1.2	314	0.07	50.7	0.065	0.75
Expected Values	2.13	1.85	#N/A	293	0.61	103.8	2000	4.79	1.43	12.6	1.18	324	0.06	49.57	0.072	0.73
Tolerance (%)	10.9	11.35	#N/A	14.3	14.1	12.4	10.1	10.52	11.74	29.84	12.3	11.5	50.3	12.52	27.4	13.4

Sr	Ti	V	Zn	Zr	As	Be	Bi	Cd	Ce	Co	Cs	Ga	Ge	Hf	Hg	In	La
ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
0.5	0.01	1	1	0.5	1	0.1	0.02	0.01	0.05	0.1	0.05	0.1	0.1	0.05	0.01	0.02	0.1
19.9	<0.01	26	185	11	24	0.4	0.24	1.6	24.5	11.2	1.19	3.1	<0.1	0.27	0.11	0.02	10
14.6	<0.01	22	144	14.5	18	0.2	0.19	0.5	29	4.1	1.16	2.1	<0.1	0.39	0.15	0.04	15
65.5	<0.01	178	165	14.5	55	0.9	0.14	1.31	22.6	7.7	2.23	2.2	<0.1	0.41	0.11	0.02	12.1
22	0.01	19	92	3.9	16	0.5	0.34	0.19	45.3	15.2	1.21	5.3	<0.1	0.05	<0.01	<0.02	21.8
38.7	<0.01	11	81	5.9	20	0.4	0.66	0.23	31.9	10	0.63	4.4	<0.1	0.14	<0.01	0.04	15.2
7.3	<0.01	16	86	3.3	9	0.3	0.27	0.1	41.8	11.9	0.51	5.3	<0.1	0.08	<0.01	<0.02	12.9
9.6	<0.01	17	85	8.6	8	0.4	0.42	0.04	67.9	7.7	0.66	7.1	<0.1	0.21	<0.01	<0.02	31.9
135	0.01	22	85	6.4	23	0.5	0.3	0.31	38.1	12.8	1.5	4.8	<0.1	0.16	<0.01	<0.02	18.7
32.1	0.03	28	104	5.4	23	0.6	0.37	0.33	46.1	15.6	1.57	6.3	<0.1	0.11	0.01	<0.02	20.9
29.1	0.01	8	41	5.6	8	0.4	0.37	0.08	68.8	12.6	0.96	2.9	<0.1	0.14	<0.01	<0.02	30.3
6	0.02	20	92	2.3	8	0.3	0.37	0.05	29	10.3	0.81	6.7	<0.1	<0.05	<0.01	<0.02	14.9
11.5	<0.01	42	157	5.7	35	0.7	0.3	0.46	230	36.4	0.87	7.6	0.3	0.14	0.03	<0.02	135
12.4	<0.01	20	109	4	54	0.4	0.35	0.25	65.2	16.8	0.48	5.4	<0.1	0.08	<0.01	<0.02	32.2
45	<0.01	60	73	4.8	8	0.4	0.2	0.27	31.6	9.6	1	3.2	<0.1	0.1	0.04	<0.02	15.7
8.7	0.01	20	90	4	14	0.3	0.31	0.3	55.3	13.7	0.74	5.7	<0.1	0.08	<0.01	<0.02	29.5
11.4	<0.01	22	104	4.4	23	0.3	0.33	0.32	52.5	15.7	1	5.3	<0.1	0.08	<0.01	<0.02	25.5
5.9	0.02	19	88	2.2	8	0.3	0.35	0.06	27.6	10.4	0.8	6.6	<0.1	<0.05	<0.01	<0.02	14.2
9.7	0.21	81	199	13.1	8	0.1	0.48	1.14	27.9	22.5	2.59	9.3	0.3	0.32	<0.01	0.09	13.5
9.38	0.21	79.27	189.4	11.7	8.14	0.11	0.51	1.17	28.18	23.56	2.6	8.72	0.21	0.29	#N/A	0.1	14
23.3	23.3	13.2	11.3	17.7	13.1	241.3	19.7	12.1	16.1	11.1	14.8	12.9	127.4	52.8	#N/A	62.1	11.8

Lu	Mo	Nb	Pb	Rb	Sb	Sc	Se	Sn	Ta	Tb	Te	Th	Tl	U	W	Y	Yb
ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
0.01	0.05	0.05	0.2	0.2	0.05	0.1	1	0.3	0.05	0.02	0.05	0.1	0.02	0.05	0.1	0.05	0.1
0.16	12.1	0.09	8.2	8.7	4.48	2.8	4	<0.3	<0.05	0.21	0.06	4.7	1.06	2.1	0.5	4.31	0.4
0.14	10.7	<0.05	6.9	6.5	4.09	2	5	0.3	<0.05	0.18	0.06	4.9	0.27	2.14	0.2	3.1	0.4
0.24	9.68	0.05	30.9	17.2	5.09	4.1	3	0.3	<0.05	0.66	0.09	4	0.23	3.9	<0.1	25.6	1.6
0.05	3.41	0.27	23.2	7.3	0.27	2.2	<1	<0.3	<0.05	0.27	<0.05	8.8	0.07	0.56	0.2	3.77	0.3
0.03	3.46	0.11	49	4.6	0.08	1.5	<1	<0.3	<0.05	0.2	<0.05	8.5	0.03	1.36	<0.1	2.33	0.2
0.03	2	<0.05	17.8	4.5	0.07	1.8	<1	<0.3	<0.05	0.25	<0.05	11.2	0.03	0.52	<0.1	3.7	0.3
0.07	1.26	<0.05	21.7	4.6	0.05	2.3	<1	<0.3	<0.05	0.44	<0.05	15.6	0.03	0.87	<0.1	7.82	0.6
0.07	4.72	0.16	14	9.1	0.37	2.6	<1	<0.3	<0.05	0.31	<0.05	7.7	0.09	0.83	0.1	5.99	0.5
0.06	4.48	0.51	18.8	13.4	0.48	2.9	<1	1.3	<0.05	0.34	<0.05	11.6	0.13	1.07	0.4	5.94	0.4
0.06	3.28	0.3	15.9	8.3	0.12	1	<1	<0.3	<0.05	0.47	<0.05	15.6	0.05	1.88	0.1	5.51	0.4
0.03	1.9	0.55	9.9	4	0.09	2	<1	<0.3	<0.05	0.23	<0.05	13	0.03	0.94	0.2	4.15	0.3
0.17	3.18	0.14	16.7	4.2	0.46	3.9	1	<0.3	<0.05	1.58	<0.05	17.4	0.06	2.31	2.8	25.9	1.3
0.04	2.8	0.1	24.9	4.2	0.71	1.7	<1	1.3	<0.05	0.33	<0.05	12.4	0.04	0.86	<0.1	3.71	0.3
0.07	4.62	0.17	16.3	5	0.45	1.6	<1	<0.3	<0.05	0.29	<0.05	7.6	0.12	1.24	0.2	6.06	0.5
0.08	4.8	0.14	15.4	4.4	0.28	2.9	<1	<0.3	<0.05	0.48	<0.05	11.1	0.05	0.93	0.3	8	0.6
0.06	3.94	0.19	15.5	4.8	0.48	2	<1	<0.3	<0.05	0.34	<0.05	12.1	0.1	0.91	<0.1	5.48	0.4
0.03	1.92	0.55	9.5	3.9	0.09	2	<1	<0.3	<0.05	0.22	<0.05	12.4	0.03	0.9	0.2	4.07	0.3
0.06	3.26	0.22	9	71.6	0.35	7.5	2	0.6	<0.05	0.25	0.44	2	0.39	0.27	2.6	5.38	0.4
#N/A	3.05	0.19	8.24	67	0.34	8.53	1.57	0.6	0.3	0.27	0.42	2.2	0.4	0.29	2.15	5.66	#N/A
#N/A	14.1	75	16.1	10.7	47.3	13.1	169.6	134.5	51.7	28.4	39.6	21.2	22.6	52.9	21.6	12.2	#N/A

CLIENT : pHase Geochemistry
PROJECT : Selwyn (HPAR Borrow)
SGS Project # : 0679
Test : 24 Hour Nanopure Water Leach Extraction Test at 3:1 Liquid to Solid Ratio
Date : May 4, 2015

Leachate Analysis

Sample ID			KM 4.2-1	KM 7.5-1	KM 13.4-2	KM 37 - 1	KM 41.8-3	KM 44.9-3	KM 46.7-2	KM 47-3
Parameter	**Method**	**Units**								
Volume Nanopure Water		mL	750	750	750	750	750	750	750	750
Sample Weight		g	250	250	250	250	250	250	250	250
pH	meter		6.24	6.92	7.47	7.73	7.72	7.54	7.43	7.53
Redox	meter	mV	314	284	301	281	294	278	293	326
Conductivity	meter	uS/cm	108	35	534	78	119	27	14	93
Acidity (to pH 4.5)	titration	mg CaCO3/L	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Total Acidity (to pH 8.3)	titration	mg CaCO3/L	6.5	4.6	5.6	4.4	6.0	4.5	3.8	4.5
Alkalinity	titration	mg CaCO3/L	1.9	2.3	43.0	29.2	58.4	4.4	3.4	49.3
Sulphate	Turbidity	mg/L	15	6	235	3	<2	2	3	<2
Ion Balance										
Major Anions	Calc	meq/L	0.35	0.17	5.75	0.65	1.17	0.13	0.13	0.99
Major Cations	Calc	meq/L	0.78	0.24	5.44	0.81	1.26	0.22	0.12	0.99
Difference	Calc	meq/L	-0.43	-0.06	0.32	-0.16	-0.09	-0.09	0.01	0.00
Balance (%)	Calc	%	-38.0%	-15.9%	2.8%	-11.2%	-3.5%	-26.0%	4.4%	-0.1%
Dissolved Metals										
Hardness CaCO3		mg/L	35.2	9.7	270	37.0	60.1	7.5	3.9	47.8
Aluminum Al	ICP-MS	mg/L	0.152	0.0783	0.0025	0.126	0.0987	0.101	0.0371	0.0970
Antimony Sb	ICP-MS	mg/L	< 0.0002	< 0.0002	0.0009	0.0002	0.0003	< 0.0002	< 0.0002	0.0002
Arsenic As	ICP-MS	mg/L	0.0003	< 0.0002	< 0.0002	0.0019	0.0021	0.0013	0.0004	0.0011
Barium Ba	ICP-MS	mg/L	0.184	0.449	0.0166	0.00754	0.00315	0.00570	0.00249	0.00248
Beryllium Be	ICP-MS	mg/L	0.000029	0.000011	< 0.000007	0.000017	0.000016	0.000020	0.000007	< 0.000007
Bismuth Bi	ICP-MS	mg/L	< 0.000007	< 0.000007	< 0.000007	0.000022	0.000017	0.000009	< 0.000007	< 0.000007
Boron B	ICP-MS	mg/L	0.0095	0.0072	0.0086	0.0070	0.0065	0.0092	0.0092	0.0019
Cadmium Cd	ICP-MS	mg/L	0.00328	0.000959	0.000059	0.000048	0.000006	0.000278	0.000012	< 0.000003
Calcium Ca	ICP-MS	mg/L	13.3	3.47	80.8	14.0	21.9	2.51	0.85	17.7
Chromium Cr	ICP-MS	mg/L	< 0.00003	< 0.00003	0.00008	0.00021	0.00011	0.00016	0.00005	0.00004
Cobalt Co	ICP-MS	mg/L	0.00910	0.00280	0.000218	0.000326	0.000125	0.00457	0.00123	0.000043
Copper Cu	ICP-MS	mg/L	0.00141	0.00175	0.00033	0.00404	0.00452	0.00284	0.00130	0.00103
Iron Fe	ICP-MS	mg/L	< 0.007	< 0.007	< 0.007	0.138	0.125	0.145	0.071	0.016
Lead Pb	ICP-MS	mg/L	0.00007	0.00008	< 0.00001	0.00052	0.00061	0.00091	0.00020	0.00002
Lithium Li	ICP-MS	mg/L	0.000797	0.000447	0.00118	0.000151	0.000952	0.000895	0.000376	0.00160
Magnesium Mg	ICP-MS	mg/L	0.472	0.261	16.6	0.518	1.33	0.310	0.423	0.846
Manganese Mn	ICP-MS	mg/L	0.184	0.0825	0.0182	0.0534	0.0125	0.101	0.0121	0.00089
Mercury Hg	ICP-MS	ug/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Molybdenum Mo	ICP-MS	mg/L	0.00021	0.00008	0.00517	0.00065	0.00066	0.00014	0.00005	0.00184
Nickel Ni	ICP-MS	mg/L	0.0326	0.0132	0.0005	0.0007	0.0011	0.0050	0.0012	< 0.0001
Phosphorus P	ICP-MS	mg/L	< 0.003	< 0.003	< 0.003	0.021	0.021	0.010	0.012	< 0.003
Potassium K	ICP-MS	mg/L	0.990	0.635	0.910	0.754	0.462	1.26	0.657	0.523
Selenium Se	ICP-MS	mg/L	0.00079	0.00060	0.0120	0.00031	0.00040	0.00025	0.00007	0.00012
Silicon Si	ICP-MS	mg/L	9.62	4.78	1.38	1.58	1.41	1.00	1.01	1.26
Silver Ag	ICP-MS	mg/L	< 0.000002	< 0.000002	< 0.000002	0.000011	0.000010	0.000010	< 0.000002	< 0.000002
Sodium Na	ICP-MS	mg/L	0.38	0.10	0.30	0.63	0.52	0.35	0.41	0.18
Strontium Sr	ICP-MS	mg/L	0.146	0.0688	0.0571	0.0577	0.0737	0.0111	0.00521	0.0482
Sulphur (S)	ICP-MS	mg/L	5.4	1.9	84.4	0.9	< 0.1	0.5	0.4	< 0.1
Thallium Tl	ICP-MS	mg/L	0.00121	0.000436	0.000040	< 0.000005	< 0.000005	< 0.000005	< 0.000005	< 0.000005
Tin Sn	ICP-MS	mg/L	0.00006	0.00008	0.00004	0.00013	0.00005	0.00005	0.00004	0.00005
Titanium Ti	ICP-MS	mg/L	0.00012	< 0.00005	< 0.00005	0.00207	0.00071	0.00182	0.00012	0.00024
Uranium U	ICP-MS	mg/L	0.000042	0.000021	0.000331	0.000049	0.000972	0.000129	0.000048	0.000222
Vanadium V	ICP-MS	mg/L	0.00007	0.00006	0.00005	0.00017	0.00018	0.00011	0.00004	0.00007
Zinc Zn	ICP-MS	mg/L	0.163	0.040	< 0.001	0.001	< 0.001	0.003	< 0.001	< 0.001
Zirconium Zr	ICP-MS	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002

CLIENT : pHase Geochemistry
PROJECT : Selwyn (HPAR Borrow)
SGS Project # : 0679
Test : 24 Hour Nanopure Water
Date : May 4, 2015

Leachate Analysis

Sample ID			KM 53.3-3	KM 54.6-3	KM 58.5-3	KM 63.9-3	KM 69.1-2	STA 51+100-1	STA 51+450	STA 51+500-1	Blank
Parameter	**Method**	**Units**									
Volume Nanopure Water		mL	750	750	750	750	750	750	750	750	750
Sample Weight		g	250	250	250	250	250	250	250	250	-
pH	meter		7.49	7.41	7.44	7.17	7.24	7.68	7.71	7.17	6.41
Redox	meter	mV	299	320	281	312	323	313	300	311	-
Conductivity	meter	uS/cm	15	269	15	15	37	105	26	9	2
Acidity (to pH 4.5)	titration	mg CaCO3/L	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	-
Total Acidity (to pH 8.3)	titration	mg CaCO3/L	4.0	4.7	4.1	4.1	5.2	4.8	3.3	3.9	-
Alkalinity	titration	mg CaCO3/L	5.5	24.1	5.1	3.9	12.2	56.0	14.0	3.1	-
Sulphate	Turbidity	mg/L	2	94	2	2	7	<2	2	3	-
Ion Balance											
Major Anions	Calc	meq/L	0.15	2.44	0.15	0.12	0.40	1.12	0.32	0.13	#N/A
Major Cations	Calc	meq/L	0.19	2.65	0.17	0.17	0.44	1.16	0.30	0.12	#N/A
Difference	Calc	meq/L	-0.03	-0.21	-0.02	-0.05	-0.04	-0.04	0.03	0.01	#N/A
Balance (%)	Calc	%	-10.0%	-4.1%	-7.1%	-16.7%	-4.9%	-1.7%	4.2%	2.4%	#N/A
Dissolved Metals											
Hardness CaCO3		mg/L	7.2	128	4.9	6.2	16.9	56.0	13.2	2.3	-
Aluminum Al	ICP-MS	mg/L	0.155	0.0346	0.206	0.117	0.170	0.145	0.0417	0.175	-
Antimony Sb	ICP-MS	mg/L	0.0006	0.0007	0.0005	0.0004	0.0015	0.0004	0.0003	0.0003	-
Arsenic As	ICP-MS	mg/L	0.0008	0.0015	0.0007	0.0017	0.0073	0.0006	0.0005	0.0007	-
Barium Ba	ICP-MS	mg/L	0.0109	0.00711	0.00243	0.00721	0.0294	0.0134	0.00821	0.0165	-
Beryllium Be	ICP-MS	mg/L	0.000011	< 0.000007	0.000015	0.000017	0.000022	< 0.000007	< 0.000007	0.000012	-
Bismuth Bi	ICP-MS	mg/L	< 0.000007	0.000021	0.000009	< 0.000007	0.000029	< 0.000007	< 0.000007	< 0.000007	-
Boron B	ICP-MS	mg/L	0.0160	0.0110	0.0108	0.0122	0.0093	0.0067	0.0079	0.0079	-
Cadmium Cd	ICP-MS	mg/L	0.000055	0.000012	0.000012	0.000044	0.000055	0.000019	0.000026	0.000093	-
Calcium Ca	ICP-MS	mg/L	2.10	30.2	0.80	2.03	5.70	16.1	3.55	0.64	-
Chromium Cr	ICP-MS	mg/L	0.00028	< 0.00003	0.00030	0.00015	0.00036	0.00014	0.00020	0.00022	-
Cobalt Co	ICP-MS	mg/L	0.000440	0.000464	0.00101	0.000735	0.000916	0.000188	0.000309	0.00374	-
Copper Cu	ICP-MS	mg/L	0.00346	0.0127	0.00379	0.00227	0.00673	0.00202	0.00407	0.00283	-
Iron Fe	ICP-MS	mg/L	0.178	0.063	0.189	0.113	0.412	0.079	0.101	0.162	-
Lead Pb	ICP-MS	mg/L	0.00027	0.00019	0.00025	0.00019	0.00078	0.00019	0.00024	0.00032	-
Lithium Li	ICP-MS	mg/L	0.000321	0.00665	0.000587	0.000528	0.000682	0.000582	0.000367	0.000872	-
Magnesium Mg	ICP-MS	mg/L	0.475	12.7	0.712	0.282	0.653	3.81	1.05	0.169	-
Manganese Mn	ICP-MS	mg/L	0.0408	0.0350	0.0155	0.0377	0.0961	0.00451	0.0187	0.228	-
Mercury Hg	ICP-MS	ug/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-
Molybdenum Mo	ICP-MS	mg/L	0.0137	0.00343	0.00115	0.00070	0.00053	0.00075	0.00043	0.00013	-
Nickel Ni	ICP-MS	mg/L	0.0011	0.0037	0.0015	0.0036	0.0024	0.0004	0.0007	0.0036	-
Phosphorus P	ICP-MS	mg/L	0.015	0.014	0.022	0.008	0.055	0.014	0.012	0.011	-
Potassium K	ICP-MS	mg/L	0.214	2.78	0.368	0.231	0.894	0.336	0.220	0.395	-
Selenium Se	ICP-MS	mg/L	0.00032	0.00021	0.00028	0.00025	0.00057	0.00026	0.00019	0.00019	-
Silicon Si	ICP-MS	mg/L	2.34	1.29	1.10	1.44	1.47	1.21	1.95	1.55	-
Silver Ag	ICP-MS	mg/L	0.000007	0.000011	0.000004	0.000007	0.000031	0.000004	0.000011	0.000004	-
Sodium Na	ICP-MS	mg/L	0.24	0.44	0.62	0.37	0.70	0.33	0.37	0.61	-
Strontium Sr	ICP-MS	mg/L	0.00885	0.0428	0.00204	0.0107	0.0224	0.0249	0.0148	0.00523	-
Sulphur (S)	ICP-MS	mg/L	0.4	29.9	0.2	< 0.1	1.2	0.1	0.5	0.3	-
Thallium Tl	ICP-MS	mg/L	< 0.000005	< 0.000005	< 0.000005	< 0.000005	0.000015	< 0.000005	< 0.000005	0.000011	-
Tin Sn	ICP-MS	mg/L	0.00010	0.00007	0.00005	0.00001	0.00004	0.00005	0.00004	0.00001	-
Titanium Ti	ICP-MS	mg/L	0.00080	0.00118	0.00122	0.00042	0.00220	0.00033	0.00027	0.00097	-
Uranium U	ICP-MS	mg/L	0.000122	0.000139	0.000229	0.000407	0.000185	0.000393	0.000039	0.000149	-
Vanadium V	ICP-MS	mg/L	0.00017	0.00012	0.00019	0.00012	0.00064	0.00024	0.00010	0.00012	-
Zinc Zn	ICP-MS	mg/L	0.002	0.001	0.002	0.001	0.003	0.005	0.001	0.002	-
Zirconium Zr	ICP-MS	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	-

APPENDIX VII. SAMPLE QUARRY OPERATIONS PLAN (2014)

Summit Environmental Consultants (2014). Selwyn Chihong Mining Ltd. Howard's Pass Access Road Quarry Operations Plan, Parks Canada Application. Prepared for Selwyn Chihong Mining Ltd. by Summit Environmental Consultants Inc.

Selwyn Chihong Mining Ltd.

Howard's Pass Access Road
Quarry Operations Plan

Parks Canada Application

July 2014

Table of Contents

1 Project Background

The Quarry Development Areas are located at various points along the Howards Pass Access Road (HPAR). A total of 22 potential aggregate sources, required for upgrades and maintenance of the HPAR, were identified in a desktop study completed by Summit Environmental Consultants. Of the 22 areas, 8 were identified as high priority for development due to their strategic location and material deposit characteristics. This Quarry Operations Procedures Manual applies to the single quarry location under Parks Canada jurisdiction and as indicated in the development permit.

Existing permits applicable to the proposed quarry development permit include:

- Existing Land Use Permit 2009-L01 (expires June 8, 2015)

The area of the site is 0.4 hectares which is restricted to the current 50' right of way. Details for the site are found in Table 1 in Section 2.1 below. At this time, no geotechnical or field verification has been completed on any of the proposed sites. The information presented in the application and operation plan is based on air photo interpretation of the sites. Prior to development, it is proposed field verifications and/or geotechnical testing will be undertaken to update the proposed pit operations, layout and footprints. Upon updating, we would submit updated site sketches and quarry information to the permitting agencies for their information.

The volume of material to be extracted from the quarry area has been based on the estimated volume required for ongoing maintenance of the Howard's Pass Access Road. Excavation depth will range from 1 to 5 meters. Estimated volumes for each deposit are found in Table 1 in Section 2.1 below. Blasting of rock or crushing of rock will not be undertaken for the proposed quarry operations.

The proposed quarry area is adjacent to the existing HPAR, therefore, no access road are required to source the material. The proposed site will require clearing, grubbing and stripping to access aggregate material.

No camp will be required at this site for quarry operations.

2 Quarry Sites and Aggregate Sources

2.1 QUARRY SITE DETAILS

A summary of the details of the proposed quarry area is found below in Table 1 below. Additional information on the site can be found in Appendix A.

Table 1 – Details of identified possible quarry sites.

SITE NO.	LOCATION	QUARRY MATERIAL	Volume for Permit (m3)	Total Estimate Resource Area (ha)	Working Area for Permit (ha)	ADDITIONAL DETAILS OF DEPOSIT
9	19+375 to 19+700	Sand and gravel	15,000	2.3	0.4	Adjacent to HPAR

2.2 CLEARING

All proposed quarry areas will require clearing, stripping and grubbing prior to processing and extraction of aggregate materials. All trees greater than 125 mm in diameter at the base will be salvaged and cut into 2 to 3 meter lengths and stockpiled on site. All additional clearing material will be chipped into piles along the site perimeter or in location shown on sketches and used for future reclamation. All grubbing and stripping material will be stockpiled in windrows along the site perimeter or location shown on sketch and used for future reclamation.

2.3 TEMPORARY CAMP

No camp is required.

2.4 EQUIPMENT

Equipment to be used for quarrying operations has not been finalized at this time. The following is a list of typical equipment expected:

- One (1) to Three (3) Tracked Dozer(s) for clearing, grubbing, stripping, grading and general site preparation.
- One (1) to Three (3) Rubber Tired Loader(s) for moving materials on site, loading crusher and loading haul trucks.
- One (1) to Three (3) Tracked Excavator(s) for excavating materials on site, loading crusher and loading haul trucks.
- One (1) Rock Crusher unit for aggregate production.
- Two (2) to Six (6) Haul Trucks for transporting material.
- Temporary camp to house workers.
- Fuel storage containers.
- Pickup trucks.
- Service vehicles.
- Miscellaneous small equipment.

2.5 DUST CONTROL

During quarry operations, best efforts will be made to manage dust control. The quarry operator will follow standard industry practice to mitigate the amount of dust produced by material hauling and aggregate production.

2.6 SENSITIVE AREAS

The quarry areas were located as best as possible outside of riparian zones. The quarry operator will work with the necessary regulation bodies to identify all sensitive areas within the quarry boundaries. These areas may include, but are not limited to, species at risk and sensitive habitat features and water bodies.

The quarry operator will avoid impacting any areas identified as sensitive. A 30 m no-work zone will be established adjacent to any creeks having a defined channel.

2.7 SLOPE STABILITY AND DRAINAGE

The quarry operator will maintain slopes in the area no greater than 2:1 horizontal to vertical. The quarry operator will excavate the area to maintain a positive drainage profile. Sedimentation control structures will be installed as required in drainage areas.

3 Closure and Reclamation Plan

3.1 CAMP RECLAMATION

No camp reclamation will be required.

3.2 QUARRY ABANDONMENT

Upon completion of quarry operations the quarry operator will grade the site to facilitate proper drainage. The site shall contain no slopes greater than 2:1 horizontal to vertical. Standard industry practice sedimentation control structures will be placed in required areas. All stockpiled overburden material will be spread over cleared quarry area to facilitate remediation. All equipment will be removed from site and the quarry area will be left in a tidy state.

3.3 STOCKPILE REMOVAL

Stockpiled material remaining after quarry operations cease and once road upgrades are complete will not be removed from quarry area. The material will be sloped to facilitate positive drainage and will remain onsite for future maintenance work.

3.4 ROAD CLOSURES

No road closures are expected to take place as a result of quarry operations. The HPAR is located in a remote region and any delays to road traffic as a result of quarry operations will not affect the general public.

3.5 CONTAMINATED SOIL REMEDIATION

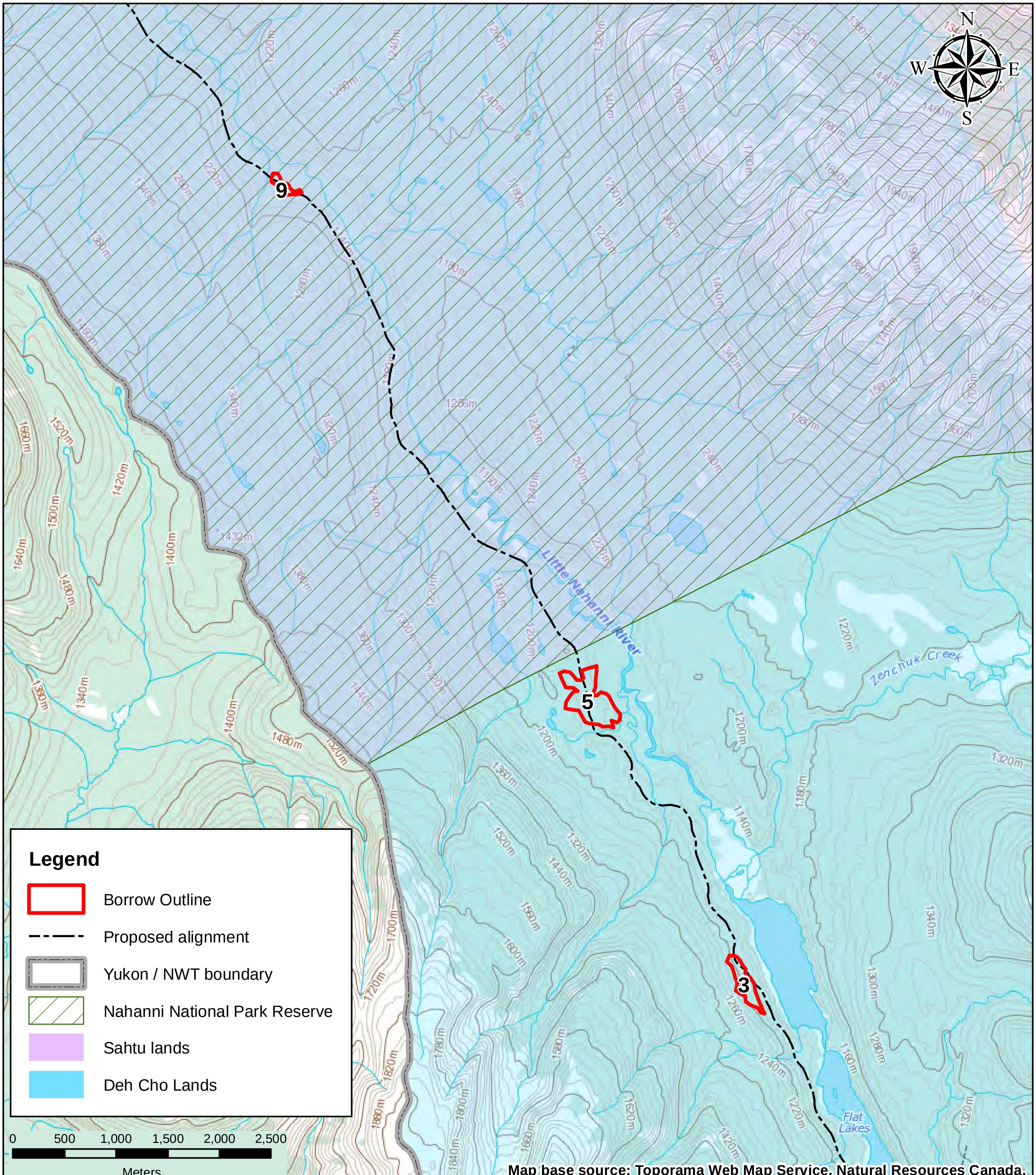
SCML's Spill Response Plan for NT Operations will be accessible on the quarry site at all times in order to satisfy the Land Use Permit. All employees of the quarry operator will be trained in fuel spill containment and remediation practices. In the event of a fuel spill, the quarry operator will notify the Government of Northwest Territories (GNWT) office of Environment & Natural Resources and Park Canada representatives. All contaminated soil will be removed from site and disposed of at an authorized facility.

The cleanup must satisfy a Parks Canada inspection. The spill area will then be remediated in the same manner as the rest of the quarry as specified above.

Appendix A - Maps and Figures

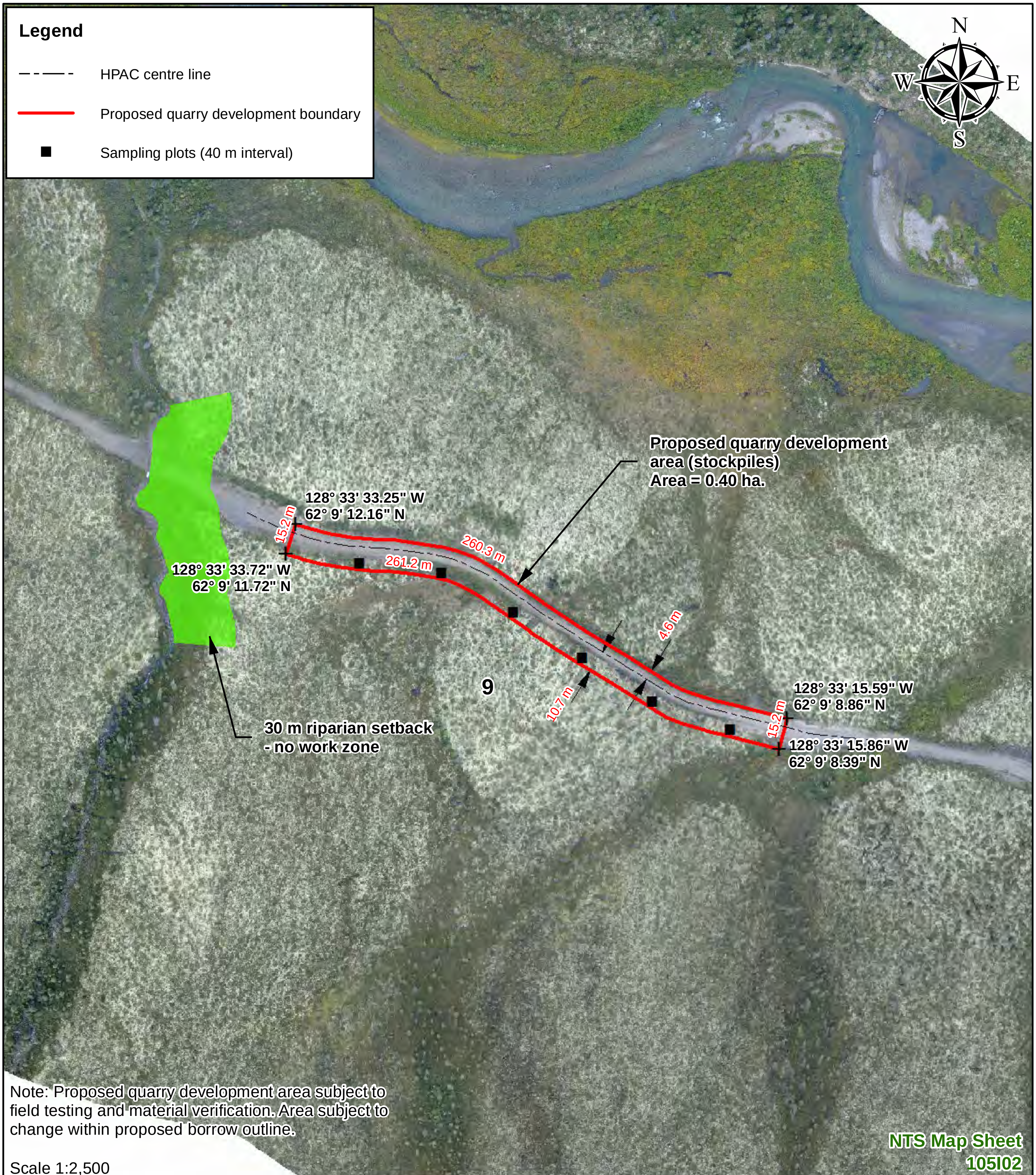
Table 3: HPAR "Target Aggregate Deposits"

Unit No.	Approximate Road Chainage	Deposit Type	Inferred Texture/Quality	Drainage Conditions	Permafrost/ Ground ice	Location re: HPAR	Access Requirements	Footprint Area of Deposit (ha)	Permit Application Working Area (ha)	Estimated Workable Thickness (m)	Estimated Volume (1000s m^3)	Permit Application Working Volmue and Type (m3)	Borrow Type	Deposit Ranking	Reclamation Potential	Land Tenure
9	19+375 to 19+700	Small outwash hills	Silt, sand, gravel, boulders	Likely well drained	None observed	Beside road, previous borrow.	None - Directly off HPAR	2.3	0.4	2 - 5	50 - 150	15000	Gravel/Stone	High	Medium	Deh Cho Nahanni National Park



SUMMIT
ENVIRONMENTAL CONSULTANTS INC.
A Member of the Associated Engineering Group of Companies

PROJECT:	**SELWYN CHIHONG NT AGGREGATE INVENTORY**
PROJECT NO.: **2013-2520**	**FIGURE 1: OVERVIEW MAP - SITES 3, 5, & 9**
FILE: **nts.mxd**	
DATE: **May 2014** / DRAWN BY: **BdJ**	
PREPARED FOR: **Associated Engineering**	



SUMMIT ENVIRONMENTAL CONSULTANTS INC.

A Member of the Associated Engineering Group of Companies

PROJECT:	SELWYN CHIHONG NT AGGREGATE INVENTORY
PROJECT NO.:	2013-2520
FILE:	sketches.mxd
DATE:	July 2014
DRAWN BY:	BdJ
	SITE 9
PREPARED FOR:	Selwyn Chihong Mining Ltd.

APPENDIX VIII. WILDLIFE MITIGATION AND MONITORING PLAN

SCML (2015). Wildlife Mitigation and Monitoring Plan for the Howard's Pass Access Road (Draft for Discussion). Prepared by Selwyn Chihong Mining Ltd., Vancouver, BC.

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Wildlife Mitigation and Monitoring Plan

for the

Howard's Pass Access Road

(Draft for Discussion)

Revision Date: June 22, 2015

SELWYN CHIHONG MINING LTD.

Wildlife Mitigation and Monitoring Plan

for the

Howard's Pass Access Road

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1. INTRODUCTION

1.1 Purpose and Objectives of the Wildlife Mitigation and Monitoring Plan

Selwyn Chihong Mining Ltd. (SCML) has prepared this Wildlife Mitigation and Monitoring Plan (the Plan) to provide the framework for wildlife protection along the Howard's Pass Access Road (HPAR) corridor during the planned road upgrading (construction phase) and use of the road during mine development and operation (operational phase), which together comprise the HPAR Upgrade Project. The Plan is designed to be in accordance with requirements of the *Mackenzie Valley Resource Management Act* and the Northwest Territories *Wildlife Act*. It covers the scope outlined in the Draft Wildlife and Wildlife Habitat Protection Plan (WWHP) and Wildlife Effects Monitoring Program (WEMP) Guidelines (NWT ENR, 2014). Separate versions of these plans could be produced, and a shortened version could also be produced for use by staff and contractors.

This plan's mitigation and monitoring measures are currently more fully developed for the construction phase (widening of the HPAR) than for the operational phase (use of the HPAR during mine construction and operation, including as a haul road). Aspects of the plan that are related to regional-scale wildlife effects monitoring are conceptual. The plan will be further developed as planning and design for the Selwyn Mine Project and for the use of the HPAR during mine operations progress. Further development of the plan will include:

- Additional consultation with First Nations, Parks Canada, and other federal and territorial agencies with related jurisdiction
- Cooperative arrangements for monitoring and research to develop programs to improve understanding of regional-scale impacts on wildlife that may be affected by the use of the HPAR during mine construction and operations
- Adaptive management techniques: the plan will evolve based on periodic assessment of effectiveness of mitigation, adequacy of available information, changes in use and conditions along the HPAR, and unexpected events or responses of wildlife to HPAR operations

The objectives of the plan are to ensure that wildlife continue to use habitat in areas adjacent to the HPAR, and to reduce the risk of injury or mortality from HPAR operations during all seasons of use.

To achieve these objectives, the plan provides mitigation measures and plans for monitoring to assess effectiveness and to provide the information needed for the adaptive management of SCML's NWT road operations. The plan draws on environmental baseline studies carried out since 2007 by SCML, regional studies conducted by government agencies and researchers, as well as traditional knowledge provided by First Nations, primarily through community consultations.

1.2 SCML's Environmental Policy

SCML is committed to the responsible exploration and development of mineral resources. Our commitment is demonstrated by our responsible approach to social, economic, and environmental performance that is aligned with the evolving priorities of our communities of interest.

SCML is committed to:

- seeking to minimize the impact of our operations on the environment through all stages of exploration and development;
- seeking to prevent accidental release of pollutants into the environment; and
- practicing continuous improvement through the application of new technology, innovation and reasonable best practices in all facets of our operation.

1.3 Guiding Philosophy

The HPAR passes through the Sahtu Settlement Area and Dehcho Traditional Territory, as well as Kaska traditional lands. In so doing, all staff and contractors to SCML must respect the natural laws of the land, including respect for fish, wildlife and their habitats.

1.4 Implementing the Plan

1.4.1. Distribution

This Plan (or a suitable version containing pertinent information and procedures) is to be distributed to all staff (casual and permanent) and all contractors prior to undertaking work on the land.

Adherence to this Plan is a requirement of employment and contractor agreements. Staff and contractors will review this Plan, and must acknowledge that they have read and understood it.

A copy of this Plan must be kept at centres of operations at the Selwyn Project and at the Corporate Office.

1.4.2. Training and Enforcement

Site staff and contractors will be informed of Plan requirements during the site induction program. Non-conformance with the Plan will be followed up with corrective actions as necessary, including, but not limited to, notices of non-compliance, follow-up actions, additional training, reminders, tracking and integration into meetings.

1.5 Measures, Conditions and Developer Commitments Concordance Table

A concordance table will be added at the permitting stage. A list of mitigation measures is in Section 4.1.

1.6 Engagement

SCML has a Memorandum of Understanding with Parks Canada and Co-operation Agreements with the Tulita District (Tulita Land Corporation, Fort Norman Metis Land Corporation and Norman Wells Land Corporation) in the Sahtu and the Naha Dehé Dene Band in the Dehcho. All of these agreements have requirements for review of SCML's management plans and for ongoing consultation.

The agreements with Sahtu and the Dehcho communities include commitments on environmental management and monitoring, and on culture and traditional knowledge. SCML has, in addition, entered into an Interim Measures Agreement with all Kaska communities, and is working with them to establish a formal agreement. While this primarily pertains to the Selwyn Mine Project in the Yukon, it is also relevant to the HPAR Upgrade Project.

A Community Engagement Plan to explain the HPAR Upgrade Project and elicit input on perspectives, knowledge and advice from the affected communities was prepared and implemented in 2014 and 2015 (Sidena Consulting Inc., 2014). The results of this community engagement program contributed to development of this Wildlife Mitigation and Monitoring Plan. In addition, draft mitigation measures for the HPAR Upgrade Project were reviewed by the Naha Dehé Dene Band (Nahanni Butte) and their advice has been taken into account in development of this plan.

1.7 Associated Operational and Management Plans

Table 1 presents a summary of relevant plans for both the construction and operational phases of the HPAR Upgrade Project.

Table 1: Summary of Related Plans

Plan Name or Description	Phase Related to	Status and Description
Community Engagement Plan	Pre-Construction	Implemented. Includes plans for engagement with Sahtu, Dehcho and Kaska communities on the HPAR Upgrade Project. The Consultation was carried out in the first half of 2015. (Sidena Consulting Ltd., 2014)
Erosion and Sediment Control Plan	Construction	Draft. The main issues around erosion control are for the construction phase, and this plan is specific to construction. For operations, erosion and sediment control planning will be included in the Road Operations Plan. (EDI, 2015)
Quarry Operations Plan	Construction	To be developed. This plan will be required as part of permitting. It will include site-specific revegetation plans for the borrow pits to be developed in consultation with Parks Canada.

Plan Name or Description	Phase Related to	Status and Description
Waste Management Plan for the Howard's Pass Access Road	Construction	Draft. During the operational phase, wastes will not be generated or stored along the HPAR. For minor exceptions to this, e.g. waste disposal associated with the staffed check point at the start of the road, procedures will be included in the Road Operations Plan. (SCML, 2015b)
Spill Contingency Plan for the Northwest Territories	Construction (current plan) Operational (to be developed)	Final. The plan will be revised to include contingency planning related to operations, including for potential concentrate spills, fuel spills, and spills of reagents being transported to the mine site. (SCML, 2015c)
Construction camp site revegetation plans	Construction	Site-specific plans to be developed in consultation with Parks Canada during the pre-construction and construction period.
Road Operations Plan	Operational, Decommissioning	This integrated plan will be developed so that it can come into effect following the construction period and will be updated prior to use of the road for hauling concentrates. The plan will bring together the plans and procedures needed for road operations during mine operation, including wildlife mitigation measures related to road operations. It will also capture management practices and procedures not covered elsewhere, such as waste management, and revegetation of any areas that might be cleared during operations. The purpose is to have all the essential procedures, guidance and information in one place for reference by staff and contractors. The plan will be reviewed annually and revised as needed.
Access Management Plan	Operational	As the HPAR is a public road, access management needs to be developed collaboratively between SCML, regulators and road users. SCML will work closely with Parks in developing the plan. It is anticipated that the plan will come into effect prior to the road being put into operations. (Access management during construction will be handled through the checkpoint at Km 3 Camp.)
Safety and Emergency Response Plan	Operational	Will be developed so that it can come into effect following the construction period.
Air Quality Management Plan (for mine and haul road operations)	Operational	Will be developed. Trigger for plan release is prior to the start of mine operations and use of the HPAR as a haul road.
Temporary Closure and Decommissioning Plans	Temporary closures, decommissioning	Plans for temporary closures will be developed early in the operational phase. The plan for final decommissioning will be developed and will be built on the measures outlined in this report, and in consultation with Parks Canada.

2. PROJECT DESCRIPTION

2.1 Overview

The HPAR is a 79 km gravel road located in southwestern NWT (

Figure 1). It was originally built in the late 1970s to access the zinc-lead deposit that straddle the Yukon-NWT border at Howard’s Pass in the Selwyn Mountains. When mineral exploration activity declined in the 1980s, the road fell into disuse and gradually deteriorated. Renewed interest in the Howard’s Pass mineral deposit since 2005 has also renewed the need for access to this potential mine site, both for exploration and mine development, and as part of a route for transporting ore concentrates to market when the mine is operational. SCML, a Vancouver-based mineral exploration and development company, is currently conducting pre-feasibility studies for a proposed zinc-lead mine on the Yukon side of Howard’s Pass, referred to as the Selwyn Project.

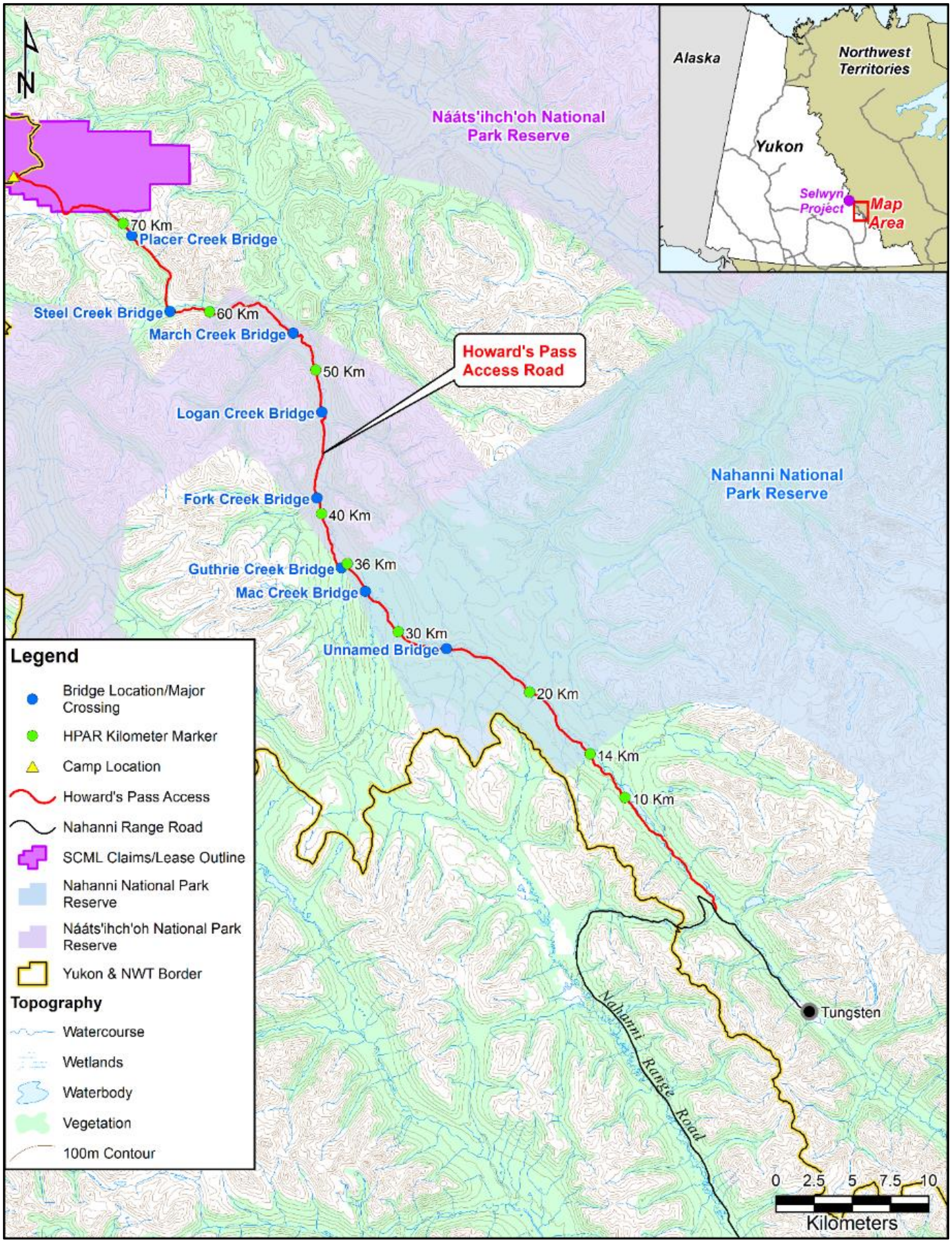
The HPAR was used as a winter road for bringing equipment to the Selwyn Project in 2010/11, and it was rehabilitated in 2014 to a single-lane road for use year-round. As part of this reconstruction, new bridges and culverts were installed. SCML is now applying to upgrade the HPAR to a two-lane road that is suitable for commercial use, and to use the access road to support mine operations at Howard’s Pass, including the bulk haul of mine concentrates.

While the mine is under development, the upgraded HPAR would be used for transportation of equipment and supplies. Once the mine is in operation, the zinc and lead ore concentrate would be hauled by truck and trailer from the mine along the HPAR to the road’s beginning near Tungsten, NWT, then southwest along the Nahanni Range Road and the Robert Campbell Highway, joining the Alaska Highway near Watson Lake, Yukon. The trucks would then travel south along Highway 37 through northern British Columbia to port facilities at Stewart, British Columbia, a distance of about 1,000 km from Howard’s Pass.

Current plans indicate that, when the mine is in operation, about 100 trucks per day would be travelling on the HPAR in each direction. This includes trucks hauling zinc and lead concentrates to port, and trucks hauling equipment, fuel and other supplies to the mine. About 12 of these trucks per day would be hauling liquefied natural gas to power the mine generators. Mine personnel will generally use air travel to access the site.

The HPAR branches off the Nahanni Range Road northwest of Tungsten. From km 14 to km 36 the road is within the Nahanni National Park Reserve, and from km 36 to km 60 it is within the Nááts’ihah’oh National Park Reserve. These sections are subject to federal laws and regulations. Remaining sections (km 0–14 and km 60–79) are subject to the jurisdiction of the Government of the Northwest Territories. The HPAR transects Dehcho Traditional Territory (km 0–36) and the Sahtu Settlement Area (km 36–79). In addition, the road passes through Kaska Dena Traditional Territory.

Figure 1 Howard's Pass Access Road



2.2 Ecological Setting, Wildlife Habitat and Wildlife along the HPAR Corridor

The HPAR corridor is at the edge of the Taiga Cordillera Ecozone (ESTR Secretariat, 2011), and within the Greater Nahanni Ecosystem, the ecological region used by Parks Canada for assessment purposes (Parks Canada, 2015). Under the NWT ecological classification system (Ecosystem Classification Group, 2010), the HPAR is within the Mid-Boreal Ecoregion, which is characterized by short, wet summers and cold, snowy winters, with mean annual temperatures from minus 4°C to minus 6°C. With an average annual precipitation of 400–600 mm, this is one of the wettest areas of the NWT. The area is underlain by discontinuous permafrost.

Terrestrial ecosystem mapping was completed for a 2 km-wide corridor along the HPAR in 2011, showing a diversity of habitats over an elevation range. The corridor has four broad ecological zones: subalpine, parkland, upland and lowland. Nearly 60% of the corridor is within the upland ecological zone, which occurs on lower mountain slopes, typically with a cover of open forests of white spruce and subalpine fir. Approximately 30% of the HPAR corridor is meadow ecosystems. Wetlands account for about 1% of the road corridor, while five lakes plus a number of ponds cover about 2% of the corridor.

Wildlife occurrences near the HPAR and in the vicinity of the proposed mine at Howard's Pass have been documented through systematic wildlife surveys, as well as through incidental wildlife observations. Species found in proximity to the HPAR include woodland caribou, northern mountain population (*Rangifer tarandus caribou*), moose (*Alces americanus*) and grizzly bear (*Ursus arctos*), as well as furbearer, small mammal, and bird species. Terrestrial ecosystem mapping conducted in 2011 was used to assess habitat suitability for several species, including caribou, moose, grizzly bear, wolverine (*Gulo gulo*), beaver (*Castor canadensis*) and marten (*Martes americana*).

Interviews conducted for a traditional knowledge study with Sahtu people from Tulita indicate that regions in the vicinity of the HPAR were used in the past for traditional pursuits, but the current level of use is low. However, wildlife species that frequent the area, however, are important to First Nations on a regional basis. In particular, the woodland caribou that utilize favourable habitat within the HPAR corridor winter along the South Nahanni River and are important culturally and as a source of meat for people of the Naha Dehé Dene of Nahanni Butte.

2.3 Regulatory Setting and Status

Wildlife protection in the Northwest Territories is governed by the Northwest Territories *Wildlife Act* (2014), the Canadian *Species at Risk Act* (2002) and Migratory Birds Convention Act (1994) and Regulations. The Sahtu Land Use Plan also specifies wildlife management requirements under the Conformity Requirements provisions of the Plan. Similar provisions under the Dehcho Final Draft Land Use Plan will guide land use activities with respect to protection of wildlife and other valued community objectives when it comes into force.

The first draft of this Plan was prepared to accompany the HPAR Upgrade Project Description Report (SCML, 2015), and in support of land use permit and water licence applications to the Mackenzie Valley Land and Water Board (MVLWB) and Parks Canada (June, 2015). The applications to the MVLWB apply to two HPAR sections, km 0–14 and km 60–79, and to the two temporary construction camp locations in those sections. The applications to Parks Canada apply to the HPAR section km 14–60 and to the two temporary construction camps located near km 37.

These permits would enable the work of upgrading the HPAR to proceed, which would allow for the long-term use of the road for commercial purposes as the Selwyn Project advances, both for mine re-supply and for hauling ore concentrate. SCML held authorizations from the MVLWB and Parks Canada that permitted the 2014 rehabilitation of the road back to its original condition, including the completion of bridges. SCML also holds a Licence of Occupation for the HPAR, securing the company's access rights for a period of 30 years on the road outside the Nahanni National Park Reserve. The company is currently seeking a similar tenure instrument for the road within Nahanni National Park Reserve. The HPAR is a legacy land use under the definition of the Sahtu Land Use Plan, and an existing use as defined in the draft Dehcho Land Use Plan.

3. POTENTIAL IMPACTS

3.1 List of Potential Impacts to Wildlife and Wildlife Habitat

A. Direct loss of habitat

- Known **long-term loss of habitat** through road upgrading. Direct loss of habitat is incremental. The HPAR is an existing road, built in the 1970s. There will be additional loss of habitat through widening the road from 4 m to 8.5 m, with wider sections in some locations, such as for pull-out areas near bridges or avalanche zones, and realignment in some sections to improve the road.
    - The use of the road to supply the mine and as a haul road for ore concentrates will not result in further direct loss of habitat.
- Potential **loss of nesting, roosting or denning sites** in the areas cleared for road widening, which is especially significant for species at risk.
- Known **short-term loss of habitat** for temporary construction camp sites and borrow pits during the construction phase.

B. Indirect loss of habitat

- Possible **loss of effective habitat** when wildlife avoid parts of the road corridor. Avoidance can be related to sensory disturbances, including noise, dust, vehicle emissions, and lights from vehicles at night. During road construction, activities will be concentrated on specific road sections, and wildlife disturbance will be of short duration, intermittent and localized. The potential for avoidance of the road corridor would be greater during the operational phase, when traffic is heavier and of longer duration. This effect may be temporary or sporadic (as some animals may initially avoid areas and then become habituated), and it may only apply to some species.

C. Alteration of habitat

- Risk of **introduction of invasive species**, with consequent changes in vegetation communities. Once they have become established along roadsides, invasive species may spread through wind and water pathways. This is mainly a concern for the operational phase, with increased traffic increasing the risk of introduction of invasive plant species.

- Potential for **loss of quality of forage vegetation** from dust deposition near the road.
- Potential for **contamination of soils and vegetation** by metals or toxic substances, through fugitive dust, leakage or spills. Although localized effects could occur from spills during construction, this is primarily related to the use of the road for hauling zinc and lead ore concentrates.
- Risk of **damage to riparian, stream, wetland and lake habitat** for wildlife (including for waterfowl and marsh birds) from spills or, less directly, through bank instability, erosion and sedimentation, with consequent effects on aquatic food webs.

D. Increased mortality

- Risk of mortality from **vehicle collisions** on the road. This applies to both construction and operational phases, but is a greater risk during the operational phase, as the volume of traffic is much greater.
- Potential for **increased hunting pressure** due to increased access. This is a potential effect over both construction and operational phases, and also a consideration for road decommissioning.

E. Changes in wildlife populations, health and behaviour patterns

- Potential to **alter wildlife movement patterns**, through avoidance of the road corridor or through restrictions in movements across the road. This is mainly relevant to the operational phase.
- Potential for wildlife attractants at construction camps to lead to wildlife encounters and habituation to camp scavenging (specifically for bears and wolverines).
- Potential for **disturbance-related stress** to wildlife resulting in changes to behaviour, health or reproductive success
- Potential changes in **predator-prey dynamics** if use of the road corridor by predators leads to increased predation on ungulates

3.2 Summary of Selected Wildlife Species

3.2.1. Species selection

The following species may be present in the project area and are either traditionally important and/or are considered as species at risk (SAR). The list incorporates input from traditional knowledge studies and consultations in Sahtu, Dehcho and Kaska communities. Sightings or encounters with any of these animals will be noted in the wildlife log (Appendix A), where feasible, during the construction and operational phases.

Mammals

- Woodland caribou (SAR; traditionally important)
- Moose (traditionally important)
- Dall sheep (traditionally important)
- Mountain goat (traditionally important)
- Grizzly bear (SAR, strong spirit powers)
- Black bear (traditionally important)
- Wolves (traditionally important)

- Wolverine (SAR; traditionally important)
- Fox, lynx, marten (fur-bearers; traditionally important)
- Otter and mink (strong spirit powers)
- Beaver (traditionally important)
- Muskrat (traditionally important)
- Gopher (arctic ground squirrel; traditionally important)
- Hoary marmot (traditionally important)
- Woodchuck (traditionally important)
- Porcupine (traditionally important)
- Other (snowshoe hare, red squirrel, flying squirrel, chipmunks, voles (traditionally important)

Birds

- Peregrine falcon (SAR)
- Rusty blackbird (SAR)
- Ptarmigan (all species; traditionally important)
- Grouse (blue/dusky, willow/spruce; traditionally important)
- Trumpeter swan (sacred)
- Great horned owls (sacred)
- Eagles (bald and golden; sacred)
- Hawk owl (omen of hunting success)
- Dabbling ducks, bluebills (scaup) and geese (traditionally important)
- Snow buntings (traditionally important)
- Sandhill crane (traditionally important)

Wildlife is identified as a Valued Ecosystem Component (VEC) owing to the potential for interaction with activities associated with the project, and because wildlife is considered by SCML, First Nations, the public, the scientific community and other technical specialists, and government agencies to have ecological, aesthetic, recreational, economic, and cultural importance.

Table 2 provides an overview of proposed wildlife VEC species that provide additional focus to planning mitigation and monitoring. This is a preliminary list that may be expanded or contracted based on future consultation, project refinements and needs identified through adaptive management. These wildlife VEC species were selected to represent groups of foraging guilds or ecological niches and based on the following criteria:

- Occurrence and use of habitats in the HPAR vicinity
- Potential sensitivity to Project effects
- Assessment and listing status under SARA, the Committee on the Status of Wildlife in Canada (COSEWIC) and the NWT Species at Risk Committee
- Ecological importance
- Importance to First Nations

Table 2: Selected Wildlife Species (VECs) and their Assessment and Listing Status

Name	Occurrence in the HPAR Vicinity	COSEWIC Status(1) (last COSEWIC assessment)	SARA Schedule 1 Status(2) and SARA plans	NWT GS Rank(3)
Woodland caribou, northern mountain population, Nahanni caribou herd	Occurrence known	Special Concern (2014, reassigned)	Special Concern (management plan in place since 2012)	Secure
Grizzly bear, Western population	Occurrence known	Special Concern (2012, reassigned)	(under consideration)	Sensitive
Wolverine	Occurrence known	Special Concern (2014, reassigned)	(under consideration)	Sensitive
Little brown and northern myotis	May occur	Endangered (2013, no change for little brown myotis)	Endangered	May Be At Risk
Olive-sided Flycatcher	Recorded occurrence along HPAR	Threatened (2007, new designation)	Threatened (recovery strategy to be completed 2015)	At Risk

(1) COSEWIC (2015)

(2) SARA Registry (Government of Canada, 2015)

(3) Working Group on the General Status of NWT Species (2011)

3.2.2. Overview of Potential Impacts for Selected Wildlife VECs

Woodland Caribou (Nahanni Caribou Herd)

- Mortality risk from vehicle collisions (particularly during use of the HPAR as a haul road).
- Mortality risk from improved hunter access to the HPAR corridor and surrounding areas.
- Alteration of habitat use and movement through the area due to sensory disturbance. Studies indicate that linear developments can influence the distribution, movement, and behaviour of caribou (e.g., Polfus et al., 2011 for northern mountain caribou; James and Stuart-Smith, 2000 for boreal woodland caribou; Boulanger et al., 2012 for barren-ground caribou). Disturbance stimuli can result in short-term behavioural responses or avoidance of portions of seasonal range (Johnson and Russell, 2014). The ability to predict the response over time of the caribou to sensory disturbance along the HPAR, however, is low, as there are few studies and results are variable.
- Increased vulnerability to predators when caribou are on and near the HPAR. Linear corridors, including roads, may be attractive to some predators, such as wolves, owing to easier travel, and may affect predator-prey dynamics (Environment Canada, 2012; James and Stuart-Smith, 2000). Road widening and measures to improve sight lines for vehicle drivers may also increase sight lines for predators, which may increase predator efficiency (DeCesare, 2012).

Grizzly Bear

- Mortality risk from vehicle collisions.
- Mortality risk from improved hunter access to the HPAR corridor and surrounding areas.
- Mortality risk from increased human–bear interactions, for example, at camps during the construction period.
- Habitat fragmentation leading to changes in demography from avoidance of the road corridor. Grizzly bears are known to avoid areas with high habitat value because of disturbance from human activity (COSEWC, 2012).

Wolverine

- Mortality risk from vehicle collisions.
- Mortality risk from increased vulnerability to hunting and trapping because of increased access.
- Risk from attraction to food sources at construction camps, leading to mortality or the need for relocation.
- Avoidance of the road corridor because of noise and traffic. As this effect depends on traffic level (Species at Risk Committee, 2014), the main potential for impact is during the use of the road as a haul road.

Bats (Little Brown Myotis and Northern Myotis)

- Loss of day and night roosting habitat, as well as foraging habitat, from vegetation clearing during construction. Little brown myotis and northern myotis summer roosting sites include tree cavities and under the bark of trees (COSEWC, 2013; Nagorsen and Brigham 1993).

Olive-sided Flycatcher

- Disturbance of breeding habitat through vegetation clearing, especially during construction. Nests are typically in tall coniferous trees by an open area (e.g., forest edges or rivers) (Government of Canada, 2015).
- Indirect loss of habitat along the road—decreases in bird species diversity and bird abundance near roads are well documented. Reasons for this are not well understood, with some studies indicating that noise is not an important factor (e.g., Summers et al., 2011), and others indicating that it may be significant (e.g., McClure et al., 2013; Bayne et al. 2008).

4. MITIGATION MEASURES

4.1 Overview of Wildlife and Wildlife Habitat Mitigation Measures

Mitigation measures are summarized in Table 3 in relation to potential impacts identified in Section 3.1.

Table 3: Mitigation Measures

A. Minimize direct habitat loss

Objective	Mitigation Measures	Additional Information[1]
Reclaim habitat cleared for construction process.	Progressive reclamation (including revegetation) of some areas cleared during construction, including camp sites and borrow pits.	Measures described in the PDR.
Reclaim habitat within road footprint following closures.	Reclamation measures (including revegetation) for closures (temporary and permanent).	Measures outlined in the PDR and to be developed further in closure plans (subject to decisions through consultation).
Prevent loss of nesting, roosting or denning sites during construction.	1. Pre-construction surveys to identify bear dens, nest sites and sites of importance for bats; modification of construction activities where possible to avoid their loss. 2. Vegetation clearing planned to be completed outside of seasonal restriction of nesting period for migratory birds: May to mid-August for Zone B8 (Environment Canada, 2014). 3. If vegetation clearing is required within nesting season: pre-clearing nest surveys and no-work zones for identified active nesting sites.	1. See Table 6. 2. and 3. See the PDR for details of the scheduling of vegetation clearing for each year of construction.

B. Minimize indirect habitat loss from sensory disturbance

Objective	Mitigation Measures	Additional Information[1]
Keep frequency of disturbance as low as possible during use as a haul road.	1. Keep number of haul truck trips to a minimum through optimizing ore concentrate truck hauling. 2. Use two-truck convoys during periods of the year critical to caribou.	Section 4.3, woodland caribou.
Reduce noise where possible.	Noise reduction measures: use of industry-standard muffling equipment; regular maintenance of equipment and vehicles, and adherence to best practices and standard operating procedures.	Information in the PDR for both phases; for the operational phase, more detailed measures will be in the Road Operations Plan.

Objective	Mitigation Measures	Additional Information[1]
Keep dust levels low.	1. Reduction of dust sources during construction. 2. Dust suppression during construction and operational phases.	1. Information in the PDR. 2. Preliminary plans in the PDR for both phases; developed plans will be in the Quarry Operations Plan, Road Operations Plan and Air Quality Management Plan.
Minimize vehicle emissions.	Emission reduction measures for both construction and operational phases.	Information in the PDR. The Road Operations Plan and Air Quality Management Plan will include measures on emission reduction.

C. Minimize alteration of habitat

Objective	Mitigation Measures	Additional Information[1]
Prevent introduction of invasive species.	1. Annual surveys during the operational phase and removal of any invasive plants found. 2. All revegetation with native plant species only.	2. More information is in the PDR; the Quarry Operations Plan will include revegetation measures; site-specific revegetation plans will be developed with Parks Canada.
Prevent damage to vegetation from dust deposition.	Dust reduction and dust suppression measures (described in Table B above).	
Prevent contamination of soils and vegetation from metals.	Measures to reduce risk of contamination from ore concentrates, including design of haul trucks and load-out facilities at the mine.	Measures are presented in the PDR and will be further developed in conjunction with detailed mine planning.
Prevent damage to riparian, stream, wetland and lake habitat.	Mitigation measures include erosion and sediment control, bank stabilization and spill contingency planning.	Measures are summarized in the PDR and in the Erosion and Sediment Control and Spill Contingency plans.

D. Prevent significant increased wildlife mortality

Objective	Mitigation Measures	Additional Information[1]
Prevent significant mortality from vehicle collisions.	Measures to minimize wildlife collisions (construction and operational phases) include road access management, orientation and training, signage, speed limits, maintenance measures to reduce attraction of wildlife to the road, and reporting and notification of wildlife presence.	Section 4.2. To be further developed as needed for the Road Operations Plan.
Prevent significant increase in hunting pressure.	1. No-hunting policy for staff and contractors. 2. Access management in both construction and operational phases.	Section 4.2. To be further developed as needed for the Road Operations Plan and (2.) through the Access Management Plan, in consultation with Parks Canada.

E. Prevent changes in wildlife populations, health and behaviour patterns

Objective	Mitigation Measures	Additional Information[(1)]
Reduce barriers to wildlife crossing the road.	1. Protocols for wildlife encounters on the road (“wildlife have the right of way”). 2. In winter, snow banks kept low and escape points plowed out for wildlife crossing.	Section 4.2. To be further developed as needed for the Road Operations Plan.
Prevent attraction of wildlife to construction camps for human safety and to minimize associated wildlife mortality.	1. Minimizing attractants for bears and other scavengers, including food waste, fuel containers and other refuse. 2. Training of staff and contractors to reduce bear encounters and wildlife attractants in and around camps.	1. Protocols in the Waste Management Plan, and SCML’s Standard Operating Procedure for Worksite Cleanliness. 2. Section 4.2 and Appendix C.

[(1)] The PDR is the Project Description Report for the HPAR Upgrade Project (SCML, 2015). Plans referred to are listed in Table 1.

4.2 Mitigation Measures for Road Operations

4.2.1. Introduction

SCML is committed to maintaining the HPAR as a resource road with controlled access. HPAR design criteria include:

- Design speed of 70 km/h, with reduced speed sections of 50 km/h required in some locations where the road geometry is constrained by steep slopes or watercourses.
- Design minimum sight distance of 110 m for 70 km/hr zones and 65 m for 50 km/hr zones.
- Clearing width of 3 m beyond limit of cut and fill.

Two-way traffic during the operational phase will be mainly concentrate haul trucks, LNG transport trucks and service vehicles. It is estimated that traffic volume will consist of approximately 200 vehicles/day (travelling north and south). On average, a loaded or unloaded truck would pass any given point along the road once every seven minutes.

The Road Operations Plan will bring together the information and procedures needed for road operations during mine operation, including wildlife mitigation measures. The plan will include monitoring and reporting requirements. Mitigation measures in this section are relevant to the operational phase and will form part of the Road Operations Plan. Most of these measures are also relevant to the construction phase and will be applied to mitigate effects of increased traffic during construction.

4.2.2. Access Management

During construction, the main point of access control to the HPAR will be the construction camp at km 3.

An Access Management Plan will be developed in consultation with Parks Canada to address issues related to public and worker safety. This plan will also contain provisions to minimize adverse effects on wildlife. The plan will include operation of a staffed gate at or near the start of the HPAR to monitor haul trucks and other traffic. This checkpoint will be staffed on a 24-hour basis, all year round. Options for operation of this checkpoint to enhance public safety and Park visitor experience, and for monitoring harvest, will be explored in consultation with Parks Canada, GNWT and First Nations.

Road access control protocols will be developed and updated once per year and aligned with the intended level of activity for that year. It is anticipated that the level of knowledge regarding the environment of the road corridor and wildlife use (e.g., through identification of mineral licks, dens, nests, and rare plant locations), as well as knowledge about public use aspects of the area, will expand with time. The annual review and revision to road access control protocols will be a necessary adaptive management step to ensure their relevance and applicability.

4.2.3. Training

Staff transporting goods to and from the Selwyn mine site will be trained according to GNWT Department of Transportation requirements and will also have training in spill response, hazardous materials safety and SCML's spill contingency, emergency response, road and traffic management plans and Standard Operating Procedures.

Wildlife awareness training will be provided, so that drivers and equipment operators are familiar with the large mammal species that may be on or near the road, and to promote stewardship of the HPAR corridor's wildlife and habitat (see Appendix B). Specific training on managing wildlife encounters will be included (Section 4.2.5).

4.2.4. Signage

SCML will post the following signage along the roadway to remind road users of their responsibilities:

General Information Sign: Placed at a visible location at the Mac Creek Bridge (the bridge nearest Flat Lakes, beyond those portions of the road that are legally accessed by cabin owners at Flat Lakes), the sign will include the following information:

- Project Operator name and contact information
- Public access restrictions
- Warning of narrow road and large vehicle use
- Radio controlled road requirements
- List of road use conditions
- Condition to report all wildlife sightings and procedure for reporting

Speed Limit Signs: Travel speeds along the roadway will be restricted to no more than 70 km/hr. Sections along the road will be posted with a 50 km/hr speed limit.

Wildlife Warning Signs: Symbol-based signs will be placed at strategic locations along the roadway to remind drivers to watch for wildlife. Signs will be posted near identified sensitive areas as they become known, to warn of potential wildlife presence and to instruct drivers to reduce speeds, watch for wildlife, stop if wildlife is visible, and wait until any danger of striking wildlife has passed before proceeding. These signs will include a reminder to report wildlife sightings.

Kilometre Marker Signs: Each kilometre will be marked with a visible sign to allow road users to identify locations of wildlife sightings and/or identify their location to Project operations as required.

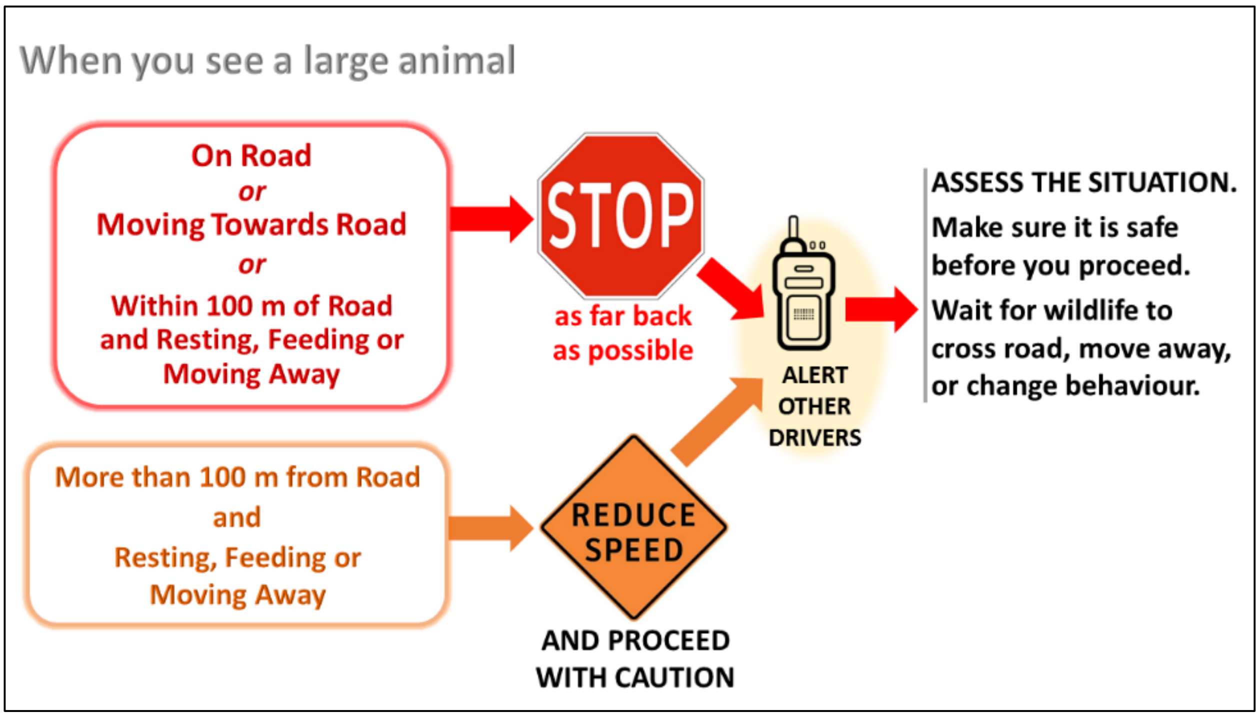
4.2.5. Wildlife Encounters

SCML will implement a “**Wildlife has the Right-of-Way**” policy to avoid potential collisions and disturbance between wildlife and vehicles. Vehicle operators will receive training in wildlife encounter procedures and will adhere to the conditions in Figure 2 and the following protocols:

- ✓ Be vigilant and watch for wildlife near roads, particularly during periods of low light, and take all reasonable actions to avoid wildlife collision.
- ✓ Stop when wildlife is observed on or moving towards the road.
- ✓ Allow groups of animals standing on the road to move off the road unalarmed.
- ✓ Wildlife sightings will be recorded and catalogued (see template in Appendix A and identification notes in Appendix B).
- ✓ No personnel will carry or discharge firearms for the purpose of hunting wildlife. Only company-designated personnel, with a permit, may use a firearm for managing dangerous human-wildlife conflicts if required.
- ✓ Do not feed wildlife. Feeding wildlife can lead to habituation for some species such as bears, and to dangerous human-wildlife conflicts.
- ✓ Do not purposefully attract (e.g., feed), harass, harm or handle any wildlife encountered.

“Safety in Grizzly and Black Bear Country” (Appendix C) provides additional measures for bear avoidance and self-protection that will be followed.

Figure 2: Road Operations Wildlife Encounter Decision-Making Flowchart



Adapted from “Wildlife and Road Operation Decision Matrix” (Wildlife Monitoring and Mitigation Plan, Casino Project YESAB Proposal, Appendix 23A)

4.2.6. Communications: Wildlife Encounter Alerting System

During construction and operational phases, the HPAR will be managed through radio control calling up and down at kilometre markings. SCML will enforce radio use with its employees, contractors and visitors. All vehicles will be expected to adhere to radio call procedures that include wildlife encounter alerts. Specific wildlife precautions will be communicated to drivers using the HPAR.

SCML is also investigating the use of GPS technology to enhance the standard radio-control-based system described above. This would involve implementing a GPS-based monitoring system in trucks that includes a “geo-fencing” feature that allows drivers to report caribou and other large mammal sightings by pressing a button. Through an automated system, temporary speed control zones are then set and other trucks are immediately informed of these reduced-speed zones. This feature will also provide systematic monitoring of presence of wildlife along the road and a record of interactions with traffic.

4.2.7. Maintenance

SCML is committed to maintaining the HPAR for the life of the Project. The HPAR will be maintained to ensure project-related traffic can travel when the site is operational. General maintenance will be completed seasonally as required project. The following ongoing maintenance measures apply to all phases of operation of the road, and will contribute to mitigation of impacts on wildlife and wildlife habitat:

1. During winter, snow clearing will be completed regularly as required. Snow banks will be maintained at less than 1 m high (until snowpack levels exceed that depth) and escape routes will be plowed at intervals so that caribou and other wildlife can cross or depart the HPAR easily.
2. Salt will not be applied to the road or to equipment on the HPAR. Road salts are known to be an attractant to wildlife that lead to vehicle collisions. Traction management will consist of untreated sand and gravel use only.
3. During summer, roadside vegetation will be cleared and maintained well back to reduce edge habitat (new-growth browse preferred by some wildlife) and improve visibility.
4. Debris on the road surface that hinders safe road navigation will be removed promptly. Drivers encountering debris they cannot remove will report the location and material type on the roadway through radio communication to SCML personnel to arrange for immediate removal.
5. Road dust will be minimized using water sprays or other approved products as necessary to maintain safe driving conditions. Drivers will relay dust conditions to SCML personnel by vehicle operators travelling the roadway.
6. Any spills will be dealt with promptly in accordance with SCML’s Spill Contingency Plan.
7. Respecting the handling of waste or other materials that may attract wildlife, SCML requires that there will be no waste or garbage disposed along the length of the roadway. All waste will be disposed of at approved waste disposal facilities. The staffed access control point near the start of the HPAR will have a trailer. Waste from that facility, including sewage and domestic waste, will be stored and disposed of following provisions to be included in the Road Operations Plan.
8. SCML will ensure that there is no damage to nests or disruption of migratory bird nesting through maintenance activities.

4.2.8. Annual assessment

Annual assessment review of the effectiveness of the road operation mitigation measures should include:

- Snowbank management assessment.
- Traffic volumes analysis.
- Public access statistics.
- Incidental wildlife observations.
- Wildlife incidents and near-miss reporting.
- Identification of sections of the road where wildlife mostly occur in order to update signage.

4.3 Mitigation in Relation to VEC Wildlife Species

Woodland Caribou

Many of the mitigation measures in the previous section are of particular relevance to minimizing impacts on caribou, including measures to reduce collisions with wildlife, reduce sources of sensory disturbance, provide access points through snow berms in winter, prohibit hunting by staff and contractors, and manage road access.

Measures have been developed specifically to address potential effects on the Nahanni caribou herd during the use of the HPAR as a haul road. Many of these measures, which will be further developed through the evolution of this Plan, will also mitigate impacts on other wildlife in the HPAR corridor and vicinity. Most of these measures are included in the sections above, but are presented here for easy reference.

1) Operate a staffed gate at or near the start of the HPAR to monitor haul trucks and traffic. This checkpoint would be staffed on a 24-hour basis, all year round. Options for operation of this checkpoint for monitoring harvest will be explored in cooperation with Parks Canada, GNWT and First Nations. This measure in part responds to community concerns about documenting the type of non-mine-related traffic on the road, in relation to the potential for increased harvest pressure on caribou.
2) Optimize ore concentrate hauling with the aim of having as few truck trips as possible. This is part of ongoing mine planning, and includes consideration of increasing haul truck capacity and decreasing volume of concentrate hauled through increasing its purity.
3) Reduce truck speeds to 50 km/hour maximum during times of limited visibility.
4) Use two-truck convoys during critical periods of the year (caribou calving/post calving in spring and early summer, and post-rut in the fall) to increase the time intervals between traffic.
5) Operate a GPS-based monitoring system in trucks that includes a “geo-fencing” feature that allows drivers to report caribou (and other wildlife) sightings by pressing a button. Through an automated system, temporary speed control zones are then set and other trucks are immediately informed of these reduced-speed zones. This feature will also provide systematic monitoring of presence of caribou along the road and a record of interactions with traffic.

6) Conduct ongoing herd monitoring, as well as monitoring of impacts from the Selwyn mine and the HPAR on caribou, and adapt mitigation measures based on the results (Section 5).
7) Participate in regional studies on caribou in order to monitor and mitigate potential cumulative effects (Section 8).

Grizzly Bear

Attractants at construction camps will be managed to reduce human/grizzly bear interactions. Mitigation measures to reduce human-bear encounters also include bear-awareness training of staff and contractors, and reporting of bear sightings with real-time notification of other road users. Measures taken for caribou (listed above) to reduce the level of sensory disturbance along the HPAR may also be beneficial to grizzly bears. Access management of the road will reduce the risk of added mortality from increased hunting or human-bear encounters.

Wolverine

Mitigation of the potential effects of the HPAR on wolverine focuses on mitigating for mortality risk associated with increased road traffic during construction and use of the HPAR, and decreasing wildlife attractants at temporary construction camps. Access management of the road will reduce the risk of added mortality from increased hunting or trapping.

Bats

Since endangered species of bats (little brown myotis and northern myotis) may occur in the HPAR corridor, beneficial management practices may need to be implemented. An evaluation of the potential for bat hibernacula and/or bat roosts will be undertaken to determine their potential presence or likely presence. Should these bats be confirmed as occurring along the HPAR corridor, additional mitigation measures will be implemented to reduce potential impacts. Mitigation measures may include accounting for the loss of roosting habitat through the installation of specifically designed tools (e.g., Brandenburg et al., 2013).

Olive-sided Flycatcher

Vegetation clearing along the HPAR is scheduled to be completed each year prior to the bird nesting season. Should vegetation clearing be required in the breeding season, pre-clearing nest surveys will be undertaken and no-work zones will be established where active nesting sites are located.

SCML will implement appropriate beneficial management practices for bird species listed as threatened under SARA. Prior to road construction, breeding bird surveys will be undertaken to confirm presence along the corridor, and to assess the scope of potential loss of nesting habitat.

5. MONITORING

5.1 Planned and Ongoing Monitoring

Monitoring measures are summarized in Table 4. SCML anticipates developing further monitoring approaches to provide the information needed to evaluate success of mitigation measures. Monitoring will be adjusted and new programs may be developed through the process of adaptive management.

With the exception of the incidental wildlife observations (Section 5.2) and the ungulate surveys (Section 5.3), details of monitoring programs have not been fully developed or finalized, and will be added at a later stage.

Table 4: Monitoring Approaches

Monitoring Approach	Objective of Monitoring	Relevant Mitigation Measures
Ungulate surveys (Section 5.3)	Detect changes in seasonal distribution of ungulates in relation to the road.	Mitigation measures to reduce the frequency and extent of sensory disturbance along the HPAR, especially during the period of use as a haul road.
	Monitor broader-scale effects on caribou, including from combined activity with the Selwyn mine and other pressures, and including over the range of the Nahanni caribou herd.	Mitigation measures to prevent impacts on caribou at the regional scale and population level.
Periodic inspections of revegetated areas.	Evaluate success of revegetation.	Revegetation of areas cleared for temporary use during construction, and areas reclaimed as part of closures.
Dust monitoring.	Monitor dust levels to adjust mitigation measures as needed.	Dust reduction and abatement measures for health and safety and for reduction of damage to vegetation and of sensory disturbance to wildlife.
Surveys for invasive species (annual).	Detect presence of invasive species before they become established.	Manual removal of any invasive species found.
Monitoring of metals in soils and in vegetation along the HPAR.	Detect signs of elevation of metals to test effectiveness of mitigation.	Haul truck design and measures at the mine site to prevent loss of ore concentrate in transit.
Monitoring program to review road operations annually (Section 4.2.8).	Evaluate success of mitigation measures and provide information for adjustment of mitigation.	Measures to reduce the risk of vehicle collisions with wildlife, measures to provide escape and crossing points through snow banks in the winter, and others.
Incidental wildlife observations documentation.	Provide warning of unexpected impacts; improve knowledge of large mammal distribution along the road corridor, including high use areas.	

5.2 Incidental Wildlife Observations

Incidental observations have been recorded since 2007 and have provided useful background and supplemental information on species presence and absence, as well as limited information on distribution. Observations to date were compiled in 2014 (EDI, 2014) and summarized in the Project Description Report.

Throughout the construction and operational phases, this program will be continued and will be augmented with observations by road users.

A professional environmental monitor will be present during HPAR upgrade construction work to ensure that mitigation measures are carried out effectively and that wildlife encounters are minimized. Wildlife monitors from community organizations will be utilized during construction activities as appropriate. The monitors will also document observations of wildlife to add to the knowledge base about wildlife and habitat use in the HPAR corridor.

The use of GPS technology in trucks during the operational period will further enhance record-keeping, especially for caribou sightings. The system can be adapted to include a button to record a sighting, which will provide a reliable record of location and time.

5.3 Ungulate Surveys

SCML's ungulate monitoring program (Table 5) includes surveys over the range of the Nahanni caribou herd, surveys over the Regional Study Area for the Selwyn mine (the area over which effects will be assessed) plus control areas, and has included surveys of the HPAR corridor since 2012. The program is designed to provide information on caribou and moose seasonal use patterns in the general area and over the range of the Nahanni caribou herd. This monitoring will continue, adapted as needed, throughout the life of the Project.

Table 5: Baseline Ungulate Surveys, 2007–2014

Year	Caribou Calving	Caribou Post-calving	Caribou Rut	Ungulate Post-rut	Ungulate Late winter	Total Hours of Flight Time
2007	3.5[1]	3.7/6.2[1/3]	3.6[1]	-	-	17.0
2008	2.9[1]	7.9[3]	3.7[1]	-	-	14.5
2009	-	6.9[3]	-	-	-	6.9
2010	1.2[1]	7.5[3]	-	-	-	8.7
2012	3.8[2/4]	7.5[3/4]	4.6[1]	3.0/2.0[1/4]	10.2[4]	31.1
2013	-	10.4[3/4]	-	2.8[2]	2.0[4]	15.2
2014		10.5[3/4]	8.9[5]	-	5.0[4]	24.4
2015					6.0[2]	6.0
Total	11.4	60.1	20.8	7.8	17.2	123.3

[1]Regional Study Area; [2]Regional Study Area & HPAR; [3]Regional Study Area and Controls; [4]HPAR; [5]Range-wide

5.4 Baseline Surveys

SCML has conducted surveys to provide information on wildlife and wildlife habitat for use in planning the HPAR Upgrade Project. Baseline information is also needed to interpret the results of the monitoring conducted during construction and operation of the HPAR. Changes detected in comparison to the baseline levels are an indication that mitigation may need to be altered or other measures may be needed.

Table 6 summarizes wildlife- and habitat-related baseline information about the HPAR corridor that has been established through surveys, or that is planned prior to upgrading of the road.

Table 6. Summary of Baseline Wildlife and Wildlife Habitat Information

Baseline Information	Survey Work Conducted/Planned	Status
Mapping of ecosystems along the HPAR corridor and assessment of habitat suitability for selected species.	Terrestrial Ecosystem Mapping and habitat suitability analysis for woodland caribou, moose, grizzly bear, wolverine, marten, beaver, Trumpeter Swan and Gyrfalcon.	Completed (Madrone Environmental Services Ltd., 2011).
Mapping, description and classification of aquatic habitat.	Aquatic habitat and fish assessment for streams crossing the road and streams and water bodies adjacent to the road, including lakes and wetlands. The study focused on fish and fish habitat, but is relevant to other wildlife.	Completed (Triton Environmental Consultants, 2014).
Levels of metals in vegetation.	Analyses of lichen, forb and shrub species selected because of forage value, at points along the HPAR.	Completed (Madrone Environmental Services Ltd., 2013).
Snow pack characteristics (relevant to ungulate distribution).	Snow course surveys at 10 stations along the HPAR, since 2012.	Ongoing.
Abundance and seasonal distribution of ungulates.	Surveys designed around annual cycles (e.g., calving and rut periods), for a range of study areas, with the HPAR being added in 2012.	Ongoing (Farnell, 2013)
Animals sighted along the road corridor.	Incidental wildlife sightings records.	Compiled up to 2014 (EDI, 2014), and ongoing.
Grizzly bear dens.	Survey conducted spring, 2015.	Completed.
Amphibian distribution.	Baseline survey.	Planned for 2015.
Beaver habitat use, including location of lodges.	Baseline survey.	Planned for 2015.
Small mammals present, in particular species at risk (bats, pikas).	Baseline survey.	Planned for 2015.
Wolverine and martin distribution and abundance.	Baseline survey.	Planned for 2015 (winter).
Supplementary baseline information on areas near to the HPAR and alpine ecosystems (above the HPAR elevation).	Surveys on wildlife and wildlife habitat in the area around the Selwyn mine project at Howard’s Pass.	Some surveys completed and others ongoing.

6. ADAPTIVE MANAGEMENT

This Plan will evolve and will be updated annually based on an analysis of monitoring data in wildlife logs, annual ungulate survey data and other monitoring results. Mitigation measures will be appropriately revised if measures are shown to be ineffective or if unexpected effects arise.

Adaptive management links monitoring results with management responses. The use of action levels based on monitoring metrics will help determine when action will be taken, and which actions will be taken (Table 7). At lower action levels, appropriate responses might include increasing monitoring intensity or modification of mitigation measures. Revised mitigation measures could include adjusting the timing, schedule, or method of tasks in order to protect or reduce risk to wildlife, particularly during sensitive life stages such as during breeding, nesting and while young are being reared. At higher action levels, further investigations into sources of the problem and implementation of more intensive mitigation measures may be required (NWT ENR, 2014).

Table 7: Adaptive Management Worksheet

This worksheet will be developed as project engineering and mitigation design progress. Contents are provided as examples.

Objective	Monitoring Approach	Metrics	Action Levels	Management Responses
Minimize direct habitat loss.	Monitor success of revegetation where undertaken.	Degree of revegetation success.	Action levels might include revisiting in a year or proceeding to remedial work.	Site work to improve revegetation success/ reseeding.
Minimize effects of sensory disturbance (avoidance of road corridor) in particular by caribou.	Monitor distribution of ungulates in relation to the road.	Change in distribution from baseline and control conditions.	Action levels set by degree and nature of change observed.	Responses could include improved or added monitoring, review of measures to reduce disturbance sources, review of potential to reduce frequency of disturbance.
Prevent introduction of invasive species.	Annually survey for invasive species.	Presence and extent of invasive species.	Level 1: few plants occur.	Complete removal.
			Level 2: substantive or recurring presence of invasive plants.	Re-evaluation/ improvement of measures to prevent introduction of invasive species.
Prevent contamination of soils and vegetation with metals.	Monitor metals levels.	Significant increase above background range in one or more metals.	Level 1: few high readings.	Resample.
			Level 2: (level based on extent of and consistency of increase).	Investigate source of contamination so that it can be eliminated.

Objective	Monitoring Approach	Metrics	Action Levels	Management Responses
Prevent mortality from vehicle collisions.	Monitoring of collisions and near misses, as well as wildlife sightings.	Numbers of collisions and near misses for all species.	Action levels set based on species and numbers.	Responses would be based on investigation of details of collisions, and could include, e.g., changes in signage, further driver training, seasonal speed limits at areas of frequent wildlife encounters.

7. REPORTING PROTOCOLS

- All wildlife emergencies shall be reported to 867-695-7433 in the Dehcho region and 867-587-2422 in the Sahtu region.
- All poachers should be reported to the Northwest Territories Department of Environment and Natural Resources, report a poacher line 1-866-762-2437.

Wildlife observation logs (Appendix A) will be collated and analysed in conjunction with annual ungulate survey data. A report will then be prepared that reviews the observed impacts, success of mitigation measures, and recommendations for revisions to the mitigation measures used during the construction phase. Any proposed revisions to mitigation measures as a result of these analyses will be discussed between SCML management and responsible persons at Parks Canada, Sahtu Renewable Resources Board and NWT Department of Environment and Natural Resources, prior to implementation. The resulting report with supporting data and any updates to the plan will be submitted annually (by March 31 of each year) to Parks Canada, Sahtu Renewable Resources Board, and NWT Department of Environment and Natural Resources.

Further reporting procedures related to permitting will be included in this section.

8. WILDLIFE EFFECTS MONITORING PROGRAM

A Wildlife Effects Monitoring Program (WEMP) encompasses effects at a scale that is beyond the direct footprint of the project (NWT ENR, 2014). It provides a framework for monitoring and assessing these larger-scale potential effects, especially those that may be cumulative with other pressures on wildlife and wildlife habitat.

Key objectives of the Wildlife Effects Monitoring Program for the HPAR are:

1. Testing and verifying effects predictions.
2. Monitoring effectiveness of mitigation measures or remedial measures for effects that extend beyond the direct footprint of the project.
3. Collaborating on population-level, range-level, and/or multi-scale monitoring of VECs to evaluate cumulative effects with the Selwyn mining project.
4. Supporting monitoring, research programs or regional-scale cumulative effects management initiatives led by government agencies through continued contribution of in-kind support, specifically for caribou.

A collaborative approach is essential for achieving these objectives. The lands through which the HPAR passes include National Park Reserves, Sahtu Settlement Area, and Dehcho and Kaska Traditional Territories. While many of the projected effects from the HPAR Upgrade Project are short-term and localized, there is the potential for effects that extend beyond the project zone of influence and interact with other natural and anthropogenic pressures to affect wildlife at a regional scale. The most important of these is the potential for the use of the HPAR during mine operations to act cumulatively with effects from the Selwyn mine and from other sources, including harvest pressure, to lead to effects at the scale of the herd. SCML is committed to working with Parks Canada, the governments of Yukon and the Northwest Territories, the Sahtu Renewable Resources Board and the Naha Dehé Dene Band to monitor and address these potential impacts and interactions at the regional scale. This includes collaboration on tracking and limiting harvest pressure.

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10. APPENDICES

Appendix A

Wildlife Log Template

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SELWYN PROJECT WILDLIFE LOG

				Wildlife							Weather[2]			Comments[3] (e.g., habitat, behavior of animal, reaction to disturbance, and other relevant information)
						No. Adults								
Date (d/m/y)	Time (24 hr)	Observer Initials	Location[1]	Species	Total No. Animals	Fem.	Male	Unk.	Juv.	Wildlife Activity[4]	Temp. (ºC)	Wind	Precip.	

[1] Location: GPS coordinate, km along road or associated with site infrastructure (e.g., tailings facility, mill site, mine portal, camp, landfill, etc)

[2] Weather Codes – Wind: N (none), L (light), M (moderate), S (strong); Precipitation – N (none), M (misty rain), LR (light rain), HR (heavy rain), S (snow)

[3] Comments – include information on habitat (e.g., what type of environment was the animal seen), animals behaviour, reaction to disturbance (e.g., did the animal run away?), or other useful information

[4] Wildlife Activity Codes: W (walking), R (running), F (foraging or feeding), S (swimming), R (resting or bedded down), FL (flying), N/D (on nest or in den), O (other activity, specify in comments)

Appendix B

HPAR Wildlife Identification Guide

This section is an early draft to provide examples for discussion.

Bird, bat and small mammal species will be added.

This guide could potentially be developed as a pocket-sized roadside field guide to serve as a tool for identification, as a means of educating staff, contractors and visitors, and to promote stewardship by all users of the road.

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Identification of Key Large Mammals
(contact environmental staff for more information on identification)

Species	Life Stage Notes	Photo
Caribou	Mother caribou and calf – post calving	 Photo credit: Rick Farnell
	Females and calves – post calving	 Photo credit: Rick Farnell
	Fall Caribou Both males and females have antlers. The antlers of the female are smaller than those of the male, but they are carried for a longer period of time. Caribou start growing their antlers each spring and they normally grow until August. Male caribou shed their antlers in November or December, after mating, while females will often carry them until June, after they have given birth. (Canadian Geographic, 2014)	 Photo credit: Steve Krassmann

Species	Life Stage Notes	Photo
Moose	Cow moose	 Photo credit: Steve Krassmann
	Cow moose and calves	 Photo credit: Steve Krassmann
	Young bull moose Moose shed their antlers from mid-December to end of January. Young males carry small, unbranched antlers. Maximum antler size is reached at age 5 to 12.	 Photo credit: Steve Krassmann

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Species	Life Stage Notes	Photo
Grizzly bear	Male and female grizzly are difficult to tell apart. Males usually are solitary and females will stay with their cubs for 2-3 years.	 Photo credit: Steve Krassmann
	Mother grizzly and cub	 Photo credit: Steve Krassmann

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Appendix C: Safety in Grizzly and Black Bear Country

Government of the Northwest Territories Brochure

Deterrents...

- Include 12 gauge cracker shells, air horns, flares and chemical repellents such as pepper spray.
- Are not completely effective against every bear in every situation.
- Should not make you less careful to avoid bear conflicts.
- Are potentially dangerous so use with extreme caution.
- If you are using a chemical repellent, try to stay upwind of the bear before using.

If a Bear Charges...

- Many charges are bluffs. The bear will often veer to the side at the last minute.
- Use a chemical repellent only at close range.
- If you have a firearm and contact appears unavoidable, shoot to kill.
- Play dead only during a grizzly bear attack. Lie on your side, curl into a ball with your legs tight to your chest and hands clasped behind your neck.

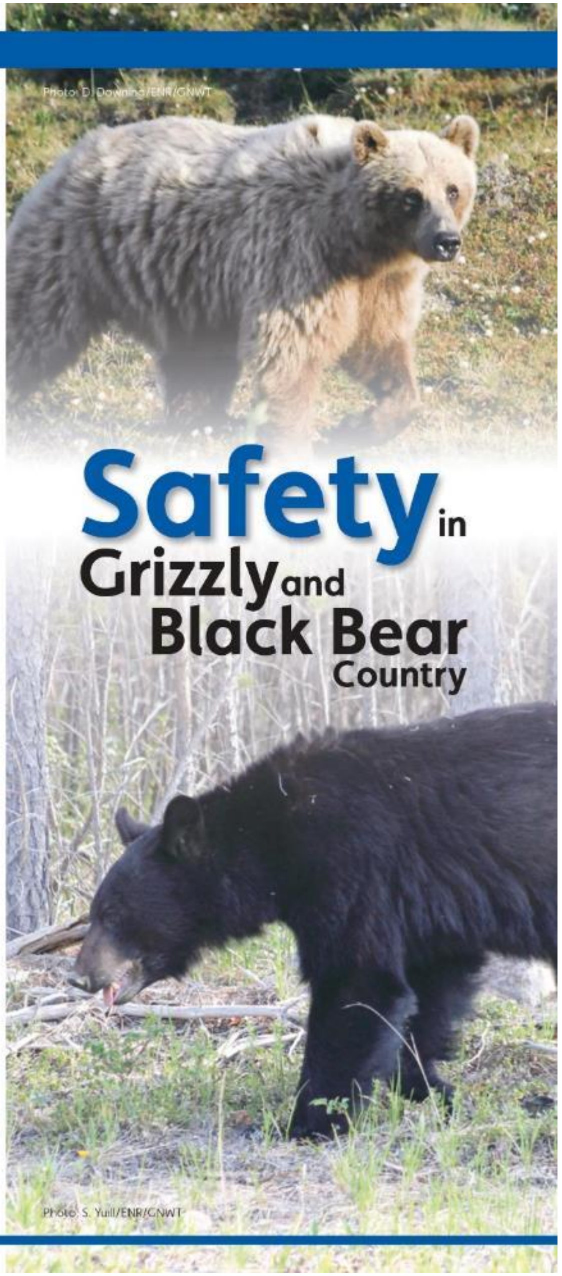
If you must shoot a bear in self-defence, report the kill to a Renewable Resource Officer as soon as possible and provide an explanation of the incident, the date and location of the incident, and any other information requested by an Officer. You may not keep any part of a bear killed in self-defence.

For More Information...

Aklavik	867-978-2248
Deline	867-589-3421
Fort Good Hope	867-598-2271
Fort Liard	867-770-4300
Fort McPherson	867-952-2200
Fort Providence	867-699-5002
Fort Resolution	867-394-4596
Fort Simpson	867-695-7433
Fort Smith	867-872-6400
Hay River	867-875-5550
Inuvik	867-678-6670
Lutsel K'e	867-370-3141
Norman Wells	867-587-3500
Behchokǫ̀	867-392-6511
Tsiigehtchic	867-953-3055
Tulita	867-588-3441
Tuktoyaktuk	867-977-2350
Ulukhaktok	867-396-4505
Yellowknife	867- 873-7181

Northwest Territories Environment and Natural Resources

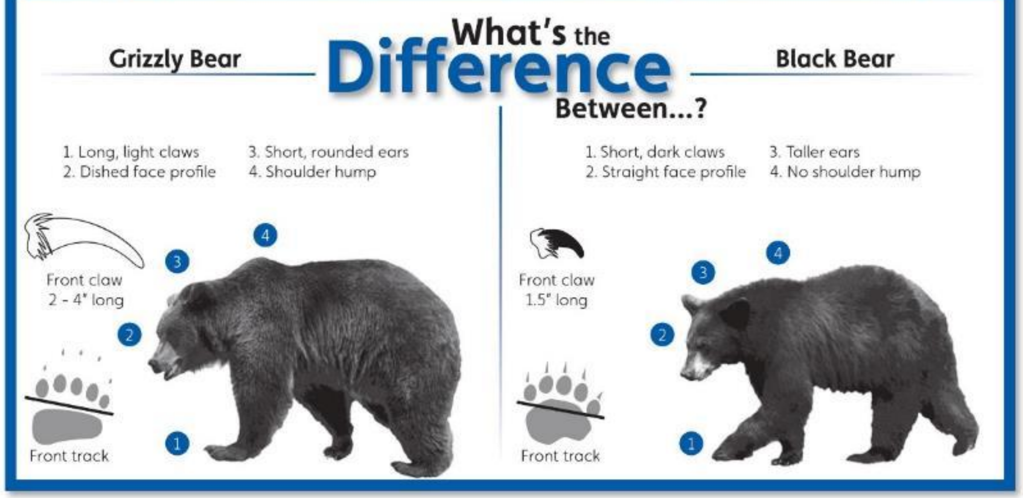
May 2015



Safety in Grizzly and Black Bear Country

Welcome to Bear Country

Grizzly and black bears can be found throughout the Northwest Territories. They are an important part of the northern ecosystem. Northerners are committed to maintaining healthy populations of all wildlife, including grizzly and black bears. Treat bears with respect. Remember, you are in a bear's territory.



While You are Travelling...

- Always be alert.
- Travel in groups.
- Travel only during daylight.
- Avoid carry strong smelling foods.
- Make noise where visibility is limited.
- Avoid bear feeding areas such as flood plains, berry patches and areas rich in horsetails and other grasses.
- Avoid bear travel areas, including shorelines, trails, along the water or near berry patches.
- Watch for fresh bear droppings and tracks.
- Carry bear deterrents.

If You are Camping...

- Avoid camping in areas frequented by bears.
- Always sleep inside a shelter (tent, cabin, etc.).
- Don't keep food in tents or areas of your camp other than the cook tent or kitchen/cooking area.
- Keep a clean camp. Wash all dishes and utensils after every meal.
- Avoid cooking greasy foods.
- Burn all garbage every day or take it to a bearproof disposal site. ***Burying garbage does not eliminate odours.***
- If you are going to leave campsite:
  - Bearproof your camp. Store food and other attractants (dish detergent, toothpaste, dog food, etc.) in an inaccessible place.
  - Let someone know where you are going.
  - Take a partner and bear deterrents with you.

If You Are Fishing...

- Be cautious near streams or lakes. Bears frequent these areas.
- Clean fish away from camp and store them underwater.
- Burn fish guts away from camp.
- Don't wear clothes that smell like fish to bed.

If You are Hunting...

- Avoid hunting late in the day and returning to your camp in the dark.
- Stay alert when dressing game or handling meat and make sure you are away from your camp.
- Avoid shooting more than your party can pack out in a single load.
- If you must leave meat in the field, leave it near a visible landmark with a clear approach route and cover it with a tarp to discourage scavengers.
- Don't keep bloodied clothes in your tent.

If You Encounter a Bear...

- Remember the 3 S's... Stop, Stand still, Stay calm.
- Make sure others know a bear is in the vicinity.
- Do not run.
- Leave the bear an open avenue of escape.

...at a DISTANCE

- Alert the bear to your presence by speaking in low tones and slowly waving your arms.
- Quietly walk backwards the way you came or make a wide detour.
- Keep an eye on the bear.
- Stay downwind.
- Consider using warning shots, noisemakers.

...that is NEARBY

- Do not shout or make sudden movements.
- Avoid direct eye contact.
- Back away slowly.
- Climb at least four metres up a tree to escape a grizzly. (This does not work against black bears).

Appendix D

Wildlife Mitigation and Monitoring Plan Revision Tracking