ACCESS

PROJECT PROPOSAL SUBMISSION TO THE

YUKON ENVIRONMENTAL AND SOCIO-ECONOMIC ASSESSMENT BOARD (YESAB)

SÄ DENA HES MINE: POST-RECLAMATION PHASE

October 2014

Prepared for:

TECK RESOURCES LIMITED

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ACKNOWLEDGEMENTS

This Project Proposal was prepared on behalf of Teck Resources Limited for submission to the Yukon Environmental and Socio-economic Assessment Board (YESAB).

This proposal was authored by Access Consulting Group, with contributions from Lauren Haney, Scott Keesey, Nicole Scotney and Catherine Henry. Key supporting documents were developed by Azimuth Consulting Group Partnership and SRK Consulting, and the authors wish to acknowledge both firms for their key contributions to this Project Proposal.

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EXECUTIVE SUMMARY

The Sä Dena Hes (SDH) mine is a lead/zinc mine located 45 km north of Watson Lake in southeastern Yukon within the Traditional Territory of the Kaska First Nation. The SDH mine operated for 16 months beginning in August of 1991. Approximately 700,000 tonnes of ore were mined and processed onsite during that time. The mine has not operated since December 1992.

Teck Resources Limited (Teck), on behalf of the Sä Dena Hes Operating Corporation, is currently undertaking decommissioning, closure and reclamation activities to permanently close the SDH mine in accordance with the licenced and approved Detailed Decommissioning and Reclamation Plan (DDRP). These activities commenced in 2013 and will be complete by the expiry of the mine's production licences at the end of 2015.

Teck is applying to renew its Type A Water Use Licence (QZ99-045) and Quartz Mining Licence (QML-0004), both of which expire on December 31, 2015, for the 25-year post-reclamation phase (the Project). During the post-reclamation phase, Teck proposes:

- **to undertake post-reclamation monitoring and adaptive management, inspections and maintenance of constructed/engineered structures;**
- **to continue to discharge neutral mine drainage; and**
- **to decommission the Main Access Road.**

Development of the DDRP has always been and continues to be a collaborative, iterative process. The DDRP was first compiled in 2000 after extensive consultation with regulators and First Nations. Despite the fact that the property remained in temporary closure, the DDRP was updated in January 2006, 2010, 2012 and most recently in 2013, in accordance with regulatory requirements and based on the findings of the ongoing closure studies undertaken for the site. Among the numerous studied conducted to support closure, Teck has commissioned Human Health and Ecological Risk Assessments that have been rigorously reviewed by regulators and Liard First Nation (LFN).

The scope of the assessment includes consideration of potential significant environmental and/or socio-economic effects associated with the post-reclamation activities listed above. Notably, potential impacts on water quality and aquatic resources are evaluated through water quality predictions based on 23 years of monitoring data. The assessment also considers environmental and socio-economic implications of the post-reclamation conditions of the SDH mine site on terrestrial resources and land and resource use, supported by the Human Health and Ecological Risk Assessments undertaken to inform development and implementation of the DDRP.

The decommissioning, closure and reclamation activities themselves are not included within the scope of the assessment, because they are already licenced and approved activities and will be complete by the time the post-reclamation period begins.

Comprehensive environmental monitoring and adaptive management is key to addressing potential adverse effects during the post-reclamation period. Preliminary environmental monitoring plans for surface water, groundwater and aquatic resources have been developed to support this assessment. Plans for terrestrial resources have also been drafted. An Adaptive Management Plan framework has been put forward to effectively address potential impacts.

Teck has collaborated closely with LFN on refinement and implementation of the DDRP. In particular, LFN has had extensive involvement in development of the Human Health and Ecological Risk Assessments that support closure and reclamation. Teck and LFN have discussed measures beyond the identified closure and reclamation options to reduce potential risks to human health through their traditional land and resource use of the area during the post-reclamation period, including installation of signage to warn of possible risks. Teck and LFN will continue to work together to ensure effective, functional measures are implemented.

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List of Acronyms

ACR	Acute-to-Chronic Ratio
CCME	Canadian Council of Ministers of the Environment
CEAA	*Canadian Environmental Assessment Act*
DDRP	Detailed Decommissioning and Reclamation Plan
DIAND	Department of Indian Affairs and Northern Development
EARPGO	Environmental Assessment Review Process Guidelines Order
EPS	Environmental Protection Services
ERA	Ecological Risk Assessment
HHRA	Human Health Risk Assessment
IPCC	Intergovernmental Panel on Climate Change
IPL	Interim Protected Land
ISQG	Interim Sediment Quality Guideline
LFN	Liard First Nation
PEL	Probable Effects Level
QML	Quartz Mining Licence
ROCs	Receptors of Concern
RRDC	Ross River Dena Council
SDH	Sä Dena Hes
WQL PAL	Water Quality Guidelines for the Protection of Aquatic Life
WUL	Water Use Licence
YEAA	*Yukon Environmental Assessment Act*
YESAA	*Yukon Environmental and Socio-economic Assessment Act*
YESAB	Yukon Environmental and Socio-economic Assessment Board
YG	Yukon Government

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1 INTRODUCTION

The Sä Dena Hes (SDH) mine is a lead/zinc mine located 45 km north of Watson Lake in southeastern Yukon within the Traditional Territory of the Kaska First Nation, specifically Liard First Nation (LFN) (see Figures 1-1 and 1-2). Teck Resources Limited (Teck), on behalf of the Sä Dena Hes Operating Corporation, is currently undertaking decommissioning, closure and reclamation activities to permanently close the SDH mine in accordance with the licenced and approved Detailed Decommissioning and Reclamation Plan (DDRP, Appendix A). These activities have been underway since 2013, and will be complete by the end of 2015.

Teck is applying to renew its Type A Water Use Licence (QZ99-045, Appendix B) and Quartz Mining Licence (QML-0004, Appendix C), both of which expire on December 31, 2015, for the proposed 25 year post-reclamation phase (the Project)[1]. During the post-reclamation phase, Teck proposes:

- **to undertake post-reclamation monitoring and adaptive management, inspections and maintenance of constructed/engineered structures;**
- **to continue to discharge neutral mine drainage; and**
- **to decommission the Main Access Road.**

The SDH mine was constructed in 1991 and operated between August 1991 and December 1992 by Curragh Resources Inc. under Water Licence IN90-002 pursuant to the *Northern Inland Waters Act*. Approximately 700,000 tonnes of ore were mined and processed onsite during the 16-month operation of the mine. The mine has not been in operation since that time.

In 1994, the Sä Dena Hes Operating Corporation purchased the property and undertook active care and maintenance under Water Licence IN90-002, which was subsequently re-licenced pursuant to the Yukon *Waters Act* as Water Use Licence (WUL) QZ97-025. A condition of QZ97-025 required that Teck submit a decommissioning plan for the site. In February 2000, Teck submitted the first DDRP, which was incorporated into the Water Use Licence (QZ99-045) and Quartz Mine Licence (QML-0004) issued in 2002 and 2001, respectively. In 2005 and again in 2009, Teck applied for amendments to the WUL and QML to extend the term of Temporary Closure. Closure security provisions are held by Yukon Government (YG) under the QML to ensure that site liabilities are addressed as part of implementing the DDRP.

After 14 years in Temporary Closure, on January 26, 2012, Teck informed the YG of its intention to enter the SDH mine into permanent closure and begin to implement the approved DDRP on January 29, 2013. Teck intends to complete site decommissioning, closure and reclamation as per the licenced DDRP by the WUL and QML expiry date, December 31, 2015. The company wishes to renew the WUL and QML for 25 years to undertake post-reclamation monitoring, inspections and maintenance; to continue to discharge neutral mine drainage; and to maintain and eventually decommission the Main Access Road.

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[1] This Project Proposal uses the term "post-reclamation" to describe the phase that will commence upon completion of the implementation of the SDH Detailed Decommissioning and Reclamation Plan in January 2016. Other documentation provided with this submission may refer to "post-closure"; these two terms are synonymous.

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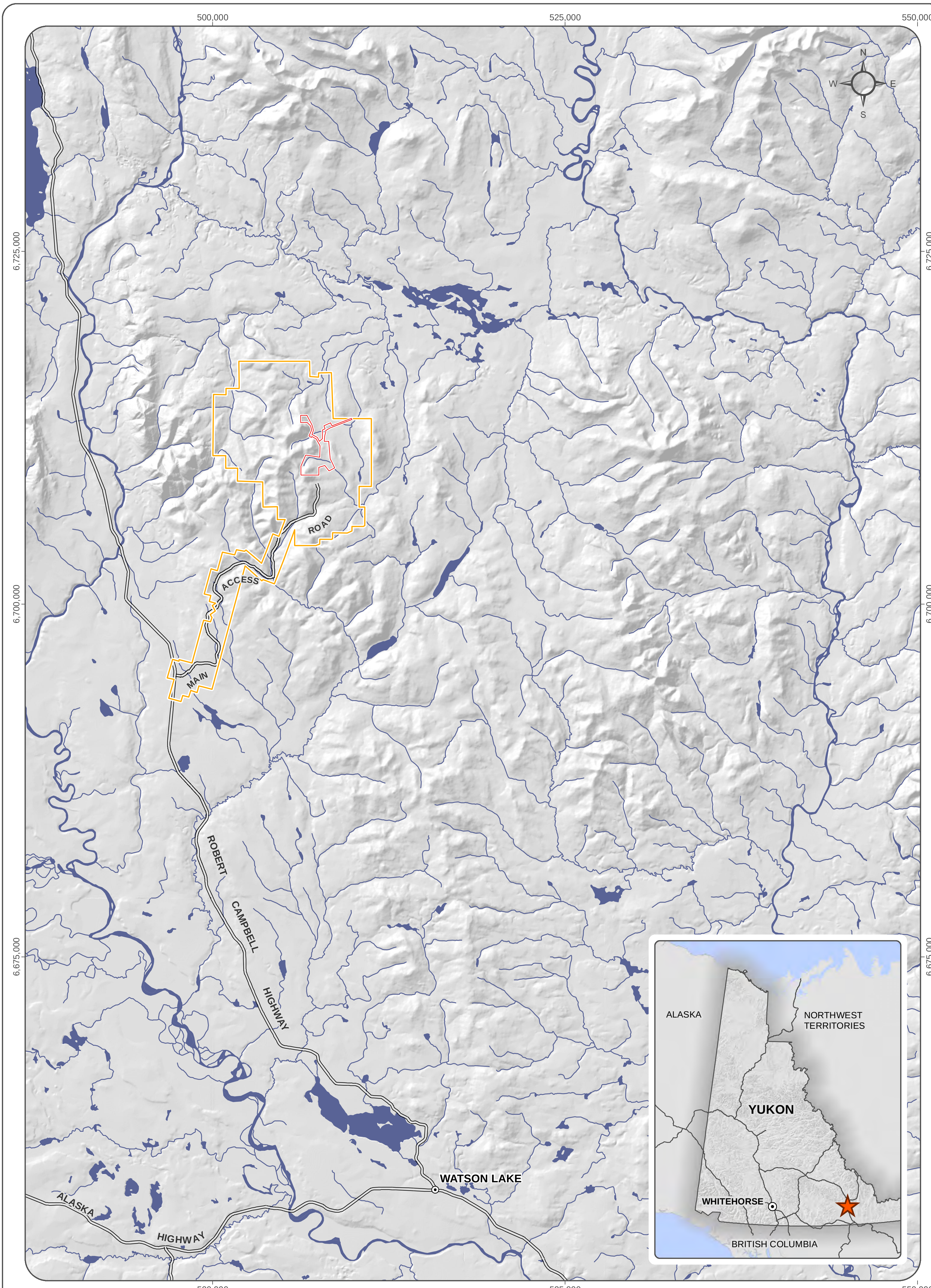

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Kilometers

Sä Dena Hes Mine Lease Boundary

Quartz Claim Boundary

Teck

SÄ DENA HES MINE
POST-RECLAMATION PHASE

FIGURE 1-1

PROJECT LOCATION

National topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:250,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada. Land Lease and Claim boundary obtained from SRK, August 2014.
Main Map Datum: NAD 83; Projection: UTM Zone 9N.

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Sä Dena Hes Mine Land Lease
Perrenial Stream
Ephemeral Stream

Teck

SÄ DENA HES MINE
POST- RECLAMATION PHASE

FIGURE 1-2
PRE-RECLAMATION MINE SITE OVERVIEW

Datum: NAD 83; Projection: UTM Zone 9N

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1.1 CORPORATE PROFILE

The SDH mine is currently owned by a joint venture between Teck (50% ownership) and Korea Zinc (50% ownership). The Joint Venture purchased the Sä Dena Hes lead/zinc property in March 1994. Teck is the operator under the joint venture agreement.

Teck is a diversified resource company committed to responsible mining and mineral development with business units focused on copper, steelmaking coal, zinc and energy. Teck is also a significant producer of specialty metals such as germanium and indium and actively explores for copper, zinc and gold in the Americas, Asia Pacific, Europe and Africa. Teck is headquartered in Vancouver, Canada, and owns or has an interest in 12 operating mines in Canada, the United States, Chile and Peru, as well as one large metallurgical complex in Canada.

At Teck, the pursuit of sustainability guides the company's approach to business. Teck's Code of Sustainable Conduct is presented in Appendix D.

The Company has significant experience in exploration and mining, particularly in the north, in Canada, Alaska and Greenland. Exploration crews have been working in the north since the 1920's with successful results. Teck's northern mines past and present include:

- Con, Yellowknife, NWT – Con was the first gold mine in the NWT, beginning production in 1937. The mine was sold in 1986 and continued to operate under several different owners until it was permanently closed in 2003.

- Pine Point, Pine Point, NWT – This open pit lead-zinc mine operated between 1965 and 1988. It is located near the south shore of Great Slave Lake. Forty-eight deposits containing approximately 64 million tonnes of ore were mined. The Pine Point mine site was decommissioned in accordance with the standards of the day. The Crown agreed to accept the return of the land leases upon completion of the decommissioning and reclamation program with the exception of the tailings impoundment area which Teck continues to lease and manage.

- Black Angel, Greenland – The Black Angel lead-zinc underground mine operated between 1973 and 1990, although not under Cominco ownership from 1986 onwards. It was located at 73°N in extremely rugged terrain, approximately 500 kilometres north of the Arctic Circle on Greenland's west coast.

- Polaris, NWT – The Polaris zinc-lead underground mine began production in 1981 and ceased production in 2002 producing 1 million tonnes of ore per year. It was the world's most northerly base metal mine, located at 75°N on Little Cornwallis Island approximately 100 km northwest of Resolute, NWT. Post-closure reclamation is completed and final demobilization from the site occurred in September 2011. Teck continues to provide on-going site monitoring.

- Red Dog, Alaska – The Red Dog zinc-lead open pit mine began producing in 1990 and has a projected mine life of at least another 40 years. It is one of the world's largest zinc mines. The mine is located 145 kilometres north of Kotzebue. Red Dog is a joint venture between Teck and the North Alaska Native Association (NANA) Regional Corporation Inc. Teck is the operator of the mine.

1.2 PROJECT HISTORY AND ASSESSMENT AND REGULATORY CONTEXT

In 1962, Francis River Syndicate discovered a zinc-lead-silver showing and conducted geochemical and geophysical surveys along with some initial diamond drilling. Cima Resources Ltd. and Canadian Natural Resources Ltd. carried out additional diamond drilling (approximately 3,000 m in 72 holes) between 1979 and 1982 and outlined an estimated 250,000 tonnes of zinc and lead mineralization.

Canamax purchased the property in 1984 and conducted additional geological exploration. By the end of 1988, Canamax had completed 23,333 mof drilling in 193 holes and estimated a zinc-lead-silver mineral inventory of over five-million tonnes in a number of zones.

In 1989, the Mount Hundere Joint Venture (Curragh Resources Ltd. - 80%, and Hillsborough Resources Ltd. - 20%) purchased the property from Canamax and completed 29,000 metres of diamond drilling in 150 holes in order to upgrade reserves in the Jewelbox Hill and North Hill areas. Proven-plus-probable mineable reserves of 3.9 million tonnes at 11.5% zinc (Zn), 3.8% lead (Pb), and 53 grams/tonne silver (Ag) were identified.

Kilborn Ltd. completed a development plan for the Mount Hundere Joint Venture in 1990 with a mine production and mill processing rate of 1,500 tonnes per day. An environmental assessment was completed for the Project by Department of Indian and Northern Affairs (DIAND) under the *Environmental Assessment Review Process Guidelines Order* (EARPGO). The assessment was based on a six volume Initial Environmental Evaluation report. The EARPGO determined that the Mount Hundere Joint Venture proposal met section 12(c) of EARPGO and could proceed through the regulatory process with mitigation identified in the screening report. An EARPGO Decision Report was issued on January 29, 1990. Water Use Licence IN90-002 was subsequently issued by the Water Board with a licence expiry of September 15, 2000.

The property was put into production in August 1991. Some 700,000 tonnes of ore were mined and processed during a 16 month production period with approximately 120,000 tonnes of zinc and 54,000 tonnes of lead concentrates produced (grade of 59% zinc and 77% lead). The concentrates were trucked in covered containers to Skagway for shipment to European and Asian smelters with the first concentrates shipped in September 1991.

The mine was forced to shut down in December 1992 due to poor metal process, at which time the property was put on a care and maintenance basis. In consultation with LFN and the Kaska Dena, the property name was changed from Mount Hundere to Sä Dena Hes, which means Ancient Peoples' Mountain.

In 1993, Curragh Resources sought and received Court protection under the Corporations and Creditors Arrangement Act and in September 20, 1993, Coopers & Lybrand Ltd. was appointed by the court as Receiver and Manager of the Sä Dena Hes property. The Sä Dena Hes Operating Corporation (SDHOC), a joint venture owned between Teck Cominco (50% ownership) and Pan Pacific Metal Mining Corp. (50% ownership), a wholly owned subsidiary of Korea Zinc, purchased the Sä Dena Hes lead/zinc property through the Receiver according to a Court Order in March 1994. Teck Resources is the current operator under the joint venture agreement.

Water Use Licence IN90-002 was amended by the Sä Dena Hes Operating Corporation in August 1997 to address changes to the mine operations and monitoring procedures and submission of a decommissioning plan for the site. A *Canadian Environmental Assessment Act* (CEAA) screening of the amendment requests was completed in November 1997 and determined that the WUL could be amended with appropriate mitigation. Amended WUL (QZ97-025) was subsequently issued in March 1998 and required the company to submit a DDRP for the site. The licence expiry date remained September 15, 2000.

The company submitted a final DDRP in February 2000 after extensive consultation with various interested parties. A WUL renewal application was also filed (QZ99-045) in February 2000 to renew and extend the existing licence and this application triggered an environmental assessment pursuant to CEAA. Two further amendment requests (QZ00-047) and (QZ00-048) were made to the Water Board to request an extension to the licence expiry date to ensure completion of the CEAA review. In addition, the company also submitted an application for a QML pursuant to the *Yukon Quartz Mining Act* which also required a CEAA review and submission of a cumulative effects assessment since this was not completed during the initial project EARPGO assessment.

The CEAA Comprehensive Screening was completed in June 2001 while the property was still under temporary closure and included a detailed assessment of the DDRP (See Appendix E for the CEAA Screening Report). The CEAA screening enabled the issuance of both the WUL (QZ99-045) and QML (QML-0004) with specific terms and conditions relating to temporary closure and maintenance of the site. Section 5.1, Scope of the Project, of the CEAA Screening Report explicitly addresses implementation of the DDRP, including post-closure monitoring:

> "The scope also includes the implementation of the DDRP, including environmental monitoring and inspection done once all closure measures have been implemented. The DDRP discusses monitoring planned for 5 years immediately following completion of the reclamation work but notes that monitoring may need to be continued based on the results of monitoring done and regulatory requirements in effect at the time.
>
> The temporal scope of the project is the time involved in continuing to maintain the site in standby mode, or to resume and conduct operations, or to decommission and reclaim the site, including post-reclamation monitoring."

The 2000 DDRP that underwent assessment under CEAA and was subsequently licenced and approved under QZ99-045 additionally included consideration of ongoing waste deposit associated with discharge from the Main Zone 1380 Portal (Sections 3.2.2.2; and Appendix B), Burnick 1200 Portal (Section 3.2.3.1; and Appendix B), and the tailings impoundment (Sections 3.3; and Appendix B). The geochemistry and potential environmental effects of these discharges have been studied on an ongoing basis, and recent findings are incorporated in the 2013 DDRP and associated closure studies, and will inform final closure and reclamation plans.

The 2000 DDRP also addressed decommissioning of the Main Access Road (Section 3.6.1.2).

In 2005, the company requested an amendment to WUL QZ99-045 and QML-0004 to extend the temporary closure provision of the SDH mine for a further four year period. The temporary closure period for the current licences was to expire on January 28, 2006. The requested extension would allow temporary closure of the site to continue until January 28, 2010. As part of the amendment requests, the company committed to submitting an update of a previously approved site DDRP to the Water Board by January 28, 2006. A *Yukon*

Environmental Assessment Act (YEAA) Environmental Assessment was completed in September 2005 with a determination that the Project could proceed (see Appendix F for the YEAA Screening Report). Water Use Licence QZ99-045 was subsequently amended (Amendment 1) on September 23, 2005 enabling the site to remain in temporary closure and included the requirement to submit an updated DDRP by January 2006.

In 2009, Teck again applied for amendments to the WUL and QML to extend the term of Temporary Closure. The following was stated in the 2009 amendment request letter (Amendment #2, QZ09-093):

> *The purpose of this amendment application is to request a five year period of Temporary Closure for the mine beginning January 28, 2010 and continuing until the WUL expiry of December 15, 2015. This is consistent with the current expiry date of the Quartz Mining Production Licence and with the date being requested for the end of Temporary Closure in the Quartz Mining Production Licence. As the requirement for an update to the DDRP is every four years, this would time the submission to be one year prior to expiry of the Water Use Licence. <u>This timing ensures that current information related to decommissioning and reclamation activities is available when consideration for renewal of the Water Use Licence (and Production Licence) is sought by the proponent.</u>*

In 2012, the company advised regulatory authorities that the Sä Dena Hes Mine was going into permanent closure and that the DDRP would be implemented. The property has been kept on care and maintenance except for a brief period in the winter of 1998 when the company began preparations for reopening, however mine re-opening was suspended after a re-evaluation of metal prices. No new development activities have been undertaken at the site since the Project was originally assessed and licenced. All required care and maintenance activities have been completed by the company. The site will be closed and reclaimed as it was always contemplated.

The company is presently in the process of implementing the DDRP. During Temporary Closure, the site had a full time, onsite caretaker until the active decommissioning began in May 2014. The caretaker provided security for the site, conducted daily checks of the mill and the general area, the Tailings Management Facility, and conducted monthly and quarterly environmental sampling in accordance with licence requirements.

In the spring and summer of 2014 most of the decommissioning was completed including removing all buildings and assets from site and reducing the liability remaining on site. Access to the site via the Main Access Road will be limited once the work is completed in October and restarts in 2015. As such, a caretaker will not be on site for the 2014/2015 winter months and monitoring will be conducted by an environmental consultant accessing the site via helicopter. Geotechnical inspections of the tailings management facility are conducted in accordance with the Water Use and Quartz Mining Licences and any recommendations resulting from these inspections have been implemented by the company. Any required licence studies, inspection and monitoring programs have been completed and submitted to YG and the Water Board. Details of the current state of all facilities are provided in later sections of this report.

1.3 Past and Current Studies

Since the early 1990s, numerous detailed studies have been undertaken at the site. These studies have included initial geotechnical surveys and engineering studies to support mine and mill designs and tailings disposal, geochemical studies and environmental baseline surveys in support of the initial environmental evaluation and permitting for the Project. As the Project has been in a state of temporary closure since late 1992, the majority of the studies conducted at the site have included regulatory inspections of mine and tailings facilities, reclamation investigations and environmental monitoring. All WUL and QML inspection and monitoring reports have been reported to the Yukon Water Board and YG Energy Mines and Resources (EMR), as per licence requirements.

In recent years in support of the detailed decommissioning and reclamation plan, studies have been undertaken to document current site conditions, implement the closure plan, assess human health and ecological risks and establish long term site monitoring for an adaptive management plan. These studies support the environmental assessment for this Project Proposal.

Appendix G provides a listing of the past studies, plans, inspection and monitoring activities that have occurred at the site to date. This table also identifies the studies' purpose including corporate documents; environmental assessment; geotechnical and engineering design; water use applications, licences, inspections and reporting; environmental monitoring; operating plans; and closure plans and studies. The table identifies which studies have been selected for inclusion with this submission, because they are relevant to the Project scope. Additional reports can be made available upon request.

1.4 ENVIRONMENTAL AND SOCIO-ECONOMIC SETTING

Table 1-1 provides an overview of the environmental setting information for the project area. More information on existing conditions are provided in Sections 4 (Aquatic Resources), 5 (Terrestrial Resources), and 8 (Socio-economic Resources).

Table 1-1 Project Setting Overview

Component	Detail
Region	Yukon
Topographic Map Sheets:	NTS 105 A/6, 105 A/7, 105 A/10, 105 A/11
Geographic Location Name Code	Mt. Hundere
Latitude	60° 42' 21" (max.) 60° 18' 31" (min.)
Longitude	129° 11' 38" (max.) 128° 34' 08" (min.)
Drainage Region:	Mackenzie River
Significant Watersheds	False Canyon Creek, Tom Creek, Frances River, Liard River
Nearest Community:	Watson Lake, Yukon, approx. 70 km south by road at the Alaska/Campbell Highway intersection
Access	25 km long Main Access Road located at km 47 of the Robert Campbell Highway
First Nations Traditional Territory:	Kaska First Nation (Liard First Nation and Ross River Dena Council)
Surrounding Land Status	Federal Crown Land & First Nation Interim Protected Lands
Special Designation	None
Planning Region	Kaska Dena Planning Region
Ecoregion	Liard Basin
Project Area Elevation	671-1579 m. (2200-5180 ft.)
Site Climate	Mean annual temperature of -6.6°C. Mean annual total precipitation is 630 mm
Vegetation Communities	White and black spruce, lodgepole pine, aspen, larch, alpine fir, paper birch, alder, rose, mountain ash, Labrador tea, crowberry, bunchberry, toadflax,

Component	Detail
	bearberry, ligonberry, bunchberry, kinnikinnick, buck brush/willow. Discontinuous permafrost is present on site.
Wildlife Species	Moose, caribou, stone sheep, grizzly and black bears, beaver, muskrat, mink, otter, marten, weasel, wolverine, lynx, coyote, fox, wolf, red squirrel. Bird species include: spruce grouse, ruffed grouse, ptarmigan, golden eagle, bald eagle, Harlan's hawk, waterfowl species, and a variety of smaller birds
Fish Species	In False Canyon Creek: Arctic grayling, round whitefish, Northern pike, burbot, Dolly Varden and Arctic char. In Tom Creek: Arctic grayling, burbot, Dolly Varden and slimy sculpin. In the Frances River: Arctic grayling, burbot, and slimy sculpin.

2 PROJECT AND ASSESSMENT SCOPE

The scope of the proposed Project includes the following activities to be conducted during the SDH mine post-reclamation phase, following implementation of the DDRP:

- Post-reclamation environmental monitoring and associated adaptive management activities; inspections and maintenance of constructed/engineered structures;
- Continued discharge from underground mine workings and tailings dam seepage; and
- Decommissioning of the Main Access Road.

2.1.1 Environmental Monitoring, Inspections and Maintenance

Post-reclamation environmental monitoring, physical/geotechnical inspections, and maintenance of constructed/engineered structures will be undertaken throughout the terms of the renewed WUL and QML. Post-reclamation monitoring and inspection plans are dependent on the final closure and reclamation measures implemented for the site, and will be refined through the re-licencing processes, in collaboration with regulators, LFN and their respective technical third-party reviewers. Final monitoring, inspection and maintenance requirements will be reflected in the renewed WUL and QML.

2.1.1.1 Environmental Monitoring and Adaptive Management

Environmental monitoring and adaptive management are key to effectively identifying and addressing potential effects that could occur during the post-reclamation period. Details of the proposed post-reclamation environmental monitoring plans are presented in Section 7. Section 7 also outlines the linkages between the monitoring programs and adaptive management responses.

Monitoring and inspection events will generally involve one to two day site visits by small crews (two to four people) conducted one to four times per year depending on the monitoring/inspection requirements. The Access Road will remain open in the snow free months and maintained as a four wheel drive road for at least the first five years of the post-reclamation phase, until the success of the site closure and reclamation measures can be determined. During that time, monitoring and inspections personnel will access the site using four wheel drive vehicles in the snow free months via the Access Road or via helicopter. Once the Access Road is decommissioned, crews will access the site via helicopter.

2.1.1.2 Inspections and Maintenance

Physical/geotechnical inspections and maintenance of constructed/engineered structures remaining at the site will be conducted throughout the post-closure phase. Geotechnical monitoring, inspections and maintenance is outlined in Appendix H. The focus of the inspections include the North Dam, the Sediment retaining structure (SRS) and spillway, soil covers, diversions and waste rock dumps.

Geotechnical monitoring and inspections will be undertaken by Qualified Professionals. Inspection reports will be submitted to the Water Board, YG Energy, Mines and Resources Mineral Resources Branch and Mining Inspections as per the requirements of the WUL and QML. If any issues requiring response are identified during an inspection, Teck will submit a plan for addressing the issue(s) to regulatory authorities within 45 days of receiving the inspection report.

Additionally, the Main Access Road will be routinely inspected and maintained for four-wheel drive access until it is decommissioned (see Section 2.1.3 below). Maintenance activities may include: debris removal, drainage re-establishment, embankment re-stabilization, surface compaction, and general culvert maintenance (debris removal, bank re-stabilization, erosion and sediment control, etc.).

The signage to be installed at certain locations on the site to warn land and resources users of potential Health & Safety risks will also be routinely inspected and maintained.

2.1.2 Mine Water Discharge

Two portals at the SDH mine site are expected to continue to discharge water from the mine workings to ground through post-reclamation: the Main Zone 1380 Portal and the Burnick 1200 Ventilation Portal. Additionally, seepage from the Tailings Management Facility is expected to continue to discharge to the environment.

The 2013 DDRP (Appendix A) includes consideration of ongoing waste deposit associated with discharge from the Main Zone 1380 Portal (specifically Sections 3.2.2.2 and 3.6.3.1) and Burnick 1200 Portal (specifically, Section 3.2.3.2). Additionally, relevant baseline conditions and potential effects associated with ongoing mine water discharge are addressed in this Project Proposal in Section 4; proposed monitoring and adaptive management to address potential significant adverse effects are outlined in Section 7.

2.1.3 Main Access Road Decommissioning

Decommissioning the Main Access Road is the sole decommissioning and reclamation activity that will not be completed by the expiry of QZ99-045 (Appendix A, Section 3.7.1.2, p. 3-75). Teck intends to maintain the road as a four wheel drive access road until it is established that the reclamation/revegetation program at the site has been successful and that the physical structures are stable. Monitoring and inspection crews in the snow free months will also use the Main Access Road to access the site until it is decommissioned.

The 22 km long road has numerous culverts that will require removal (there are no bridges). Culvert removal work will be conducted in the late summer/early fall when flows are low or non-existent. Culvert removals and bank re-contouring works at locations where there is still flow will include pump around or flow diversions to ensure that work is done in the dry and silt loads are not added to stream systems. Regrading/contouring the roads will ensure that runoff sheds off the road surface. The road surfaces are not expected to require seeding, only surface scarification to encourage natural revegetation.

Removing culverts crossing fish-bearing streams is of primary concern. At these stream crossings, the roadbed would be cut down to the culvert and original streambed elevation with side slopes brought back to

2H:1V. Material displaced during culvert removal will be spread loosely on adjacent road surface to promote revegetation. The stream channel would be stabilized as required and slopes revegetated.

The disturbed footprint of the Access Road occupies only a portion of the cleared right-of way. Vegetation should re-establish itself naturally in the right-of-way. The preferred methodology is to encourage natural revegetation to occur, after first preparing the road surface by recontouring and scarifying. Temporary sediment management measures such as silt fencing will be installed as required in order to minimize sediment transport during establishment of a vegetative cover.

2.2 SCOPE OF THE ASSESSMENT

The Project triggers evaluation under the *Yukon Environmental and Socio-economic Act* (YESAA), Part 9, item 12, at the Designated Office level.

The proposed scope of the assessment includes consideration of potential effects associated with the activities described above and explained further in this report.

Previous water quality loading models have been reviewed and updated based on approximately 25 years of actual site monitoring data. Long term water quality predictions are presented to support the Aquatic Resources Effects Assessment. Refer to Section 4 and 7.

The Effects Assessment also incorporates the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) approach applied to development of the DDRP, as described above, in order to consider the environmental and socio-economic implications of the post-reclamation conditions of the SDH mine site. The impact of the post-reclamation state of the SDH mine site on terrestrial resources, and on land and resource use is considered. Refer to Sections 5, 7.4 and 8.

The temporal scope of the assessment begins at the commencement of the post-reclamation phase in January 2016 and spans the proposed 25 year term of the WUL and QML renewals. The geographic scope of the assessment is dependent on the Valued Component and is specified in the Effects Assessments presented in Sections 4, 5 and 8.

2.3 OUTSIDE THE SCOPE OF ASSESSMENT

The already licenced decommissioning, closure and reclamation activities being undertaken through to December 31, 2015 are not within the scope of the Project, nor this assessment. As described in the next section (Section 3.1), the currently licenced and approved DDRP has undergone several reviews and updates in collaboration with territorial and federal regulators, LFN and their respective third-party technical reviewers. Numerous technical studies have been conducted by a multitude of technical specialists to inform development of the DDRP. Through this rigorous review and iterative refinement process, the selected closure and reclamation options have been determined by regulatory authorities and LFN to be sufficiently protective of environmental and socio-economic resources. **It is thus understood by Teck, LFN and the Decision Body that no proposed changes to the selected closure options may result from this assessment.** Rather, it is intended that the primary purpose of this assessment process will be to further refine the post-reclamation monitoring, inspection and maintenance plans, and adaptive management responses, in order to mitigate potential significant adverse effects on environmental or socio-economic resources through the post-reclamation phase.

3 DECOMMISSIONING, CLOSURE AND RECLAMATION

Teck's closure philosophy is described in the DDRP, Section 1.1. In keeping with this philosophy, the following objectives have guided development and implementation of the DDRP:

- Protection of public health and safety;
- Implementation of environmental protection measures that minimize adverse environment impacts;
- Ensuring land use commensurate with surrounding lands;
- Post-reclamation monitoring of the site to assess effectiveness of closure measures for the long term; and
- Passive post-reclamation monitoring and management of the site where applicable.

The DDRP has been approved under QZ99-045 and QML-0004 and is currently being implemented in collaboration with regulators and LFN. The temporal scope of the proposed Project includes activities associated with the post-reclamation phase of the SDH mine, which commences in January 2016. The decommissioning, closure and reclamation activities being undertaken through to December 31, 2015 are not within the scope of the Project, nor this assessment. It is necessary, however, to understand the closure and reclamation plans and the DDRP development process in order to provide the context for the post-reclamation conditions of the SDH mine site and to consider long term implications for environmental and socio-economic resources.

Details of the decommissioning, closure and reclamation plans for the SDH mine are presented in the DDRP (Appendix A)and the additional direction from YG (Appendix I[2]). A summary is presented in Section 3.2.

3.1 DEVELOPMENT OF THE DDRP

Development of the DDRP has always been and continues to be a collaborative, iterative process. The DDRP was first compiled in 2000 after extensive consultation with regulators and First Nations, and as explained above in Section 1.2, the DDRP was assessed under CEAA and subsequently approved and licenced under the Type A WUL QZ99-045 and QML-0004. Despite the fact that the property remained in temporary closure, the DDRP was updated in January 2006, January 2010, and January 2012, in accordance with regulatory requirements and based on the findings of the numerous ongoing closure studies undertaken for the site. The most recent version of the DDRP was released for review by regulators and LFN in July 2013.

Teck began to implement the DDRP on January 29, 2013. Through engagement with LFN, regulators[3] and third-party reviewers, Teck and their technical consultants have undertaken several more closure studies to

[2] Note that the amendment to include the requested changes described in this letter will not be submitted by November 1, 2014. Teck is involved in ongoing discussion with YG about this matter.

guide the final closure and reclamation plans. Teck and the various interested parties continue to use the findings of new and ongoing studies to inform decision-making about the most appropriate, sufficiently protective site closure and reclamation measures. As explained below, the HHRA and ERA and their supporting studies have played a key role in guiding site closure and reclamation.

Teck has worked closely with LFN on the refinement and implementation of the DDRP. To support their collaboration and cooperation, the two parties formed the Sä Dena Hes Project Working Group to provide strategic guidance to Teck and LFN on the advancement of the site closure and remediation. Further, Teck and LFN established a Communication and Engagement Plan to facilitate cooperative implementation of the DDRP.

After Teck's decision to put the SDH mine into permanent closure, additional site assessment and studies were conducted through 2012 to provide additional information to refine the DDRP. The most recent March 2013 update of the DDRP incorporates the studies completed to date, addresses comments raised by regulators and LFN and was used to implement closure activities in 2013.

The 2013 DDRP notes that, in certain cases, the final closure measures will be determined based on the results of further sampling and studies. Results of those studies and analyses continue to be collected and submitted for review. A final version of the DDRP will be submitted to regulatory authorities and LFN in 2015, based on review of the results of the Risk Assessments and other closure studies by Teck, regulators, LFN and third-party technical reviewers.

3.1.1 Human Health and Ecological Risk Assessments

The Yukon Mine Site Closure and Reclamation Policy (YG Energy, Mines & Resources, 2006) formally recognizes that "risk management may be utilized in the development of the reclamation and closure plan by the mine operator. This approach should take into consideration ecological, human health, socioeconomic considerations and engineering factors and be designed to enable the mine operator and Yukon government agencies to fully understand the likelihood and consequence of failure in order to assess reclamation and closure options and to ensure that risks associated with implementing the mine DDRP are addressed to the satisfaction of the Yukon government."

The HHRA and ERA commissioned by Teck have played a key role in guiding closure and reclamation planning. A comprehensive, collaborative approach to development of the Risk Assessments has been taken, involving Teck and their technical consultants, LFN and several YG departments/branches, and their third-party reviewers. Numerous additional studies have been and continue to be undertaken to support the Risk Assessments

Figure 3-1 depicts the DDRP development and implementation process in the context of the HHRA and ERA.

---

[3] *Several territorial and federal regulatory agencies have been involved in the DDRP development and implementation process, including YG Energy, Mines & Resources (Mineral Resources Branch, Mining Inspections), Environment Yukon (Environmental Affairs, Water Resources, Environmental Programs), Water Board Secretariat; Environment Canada.*

Note that the Risk Assessments have been undertaken to support development and refinement of the DDRP and closure and reclamation implementation. While they have been referenced in this submission to support certain aspects of the Effects Assessment, that is not their primary or intended purpose.

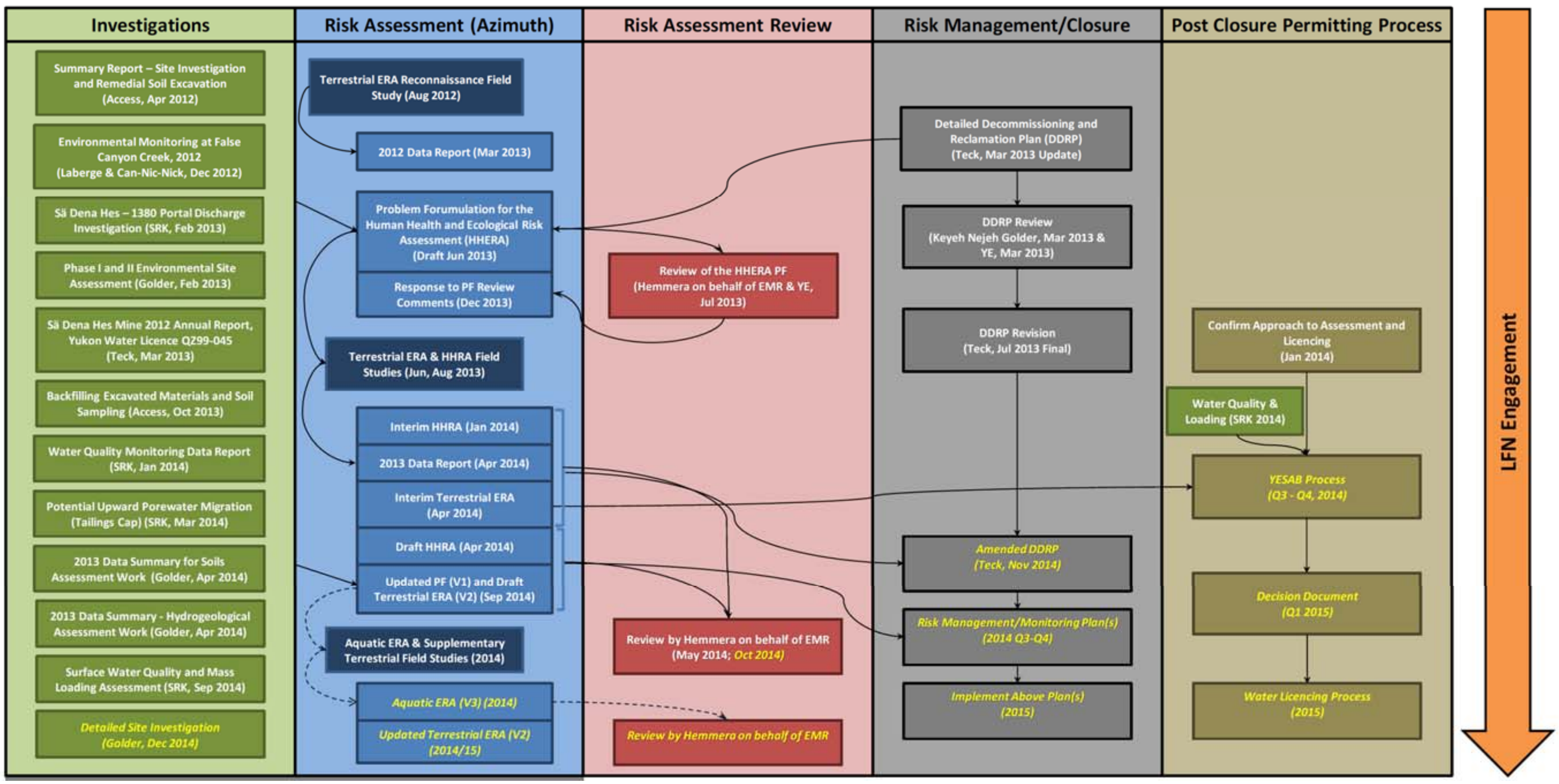


Figure 3-1 Overall Risk Assessment and Risk Management Process for the SDH Mine Site

3.2 *C*LOSURE AND RECLAMATION OVERVIEW

Figure 1-2 shows the main features of the SDH mine site. The site includes underground workings and open pits associated with three ore bodies: the Main Zone and Jewelbox ore bodies located adjacent to each other, on the south end of the site and immediately west of the Mill Site; the Burnick ore body located in the northwestern corner of the site. The Mill Site is located in the southern portion of the site, southwest of the Tailings Management Facility. The Facility comprises the Main Tailings Pond and associated North and South Dams, and the Reclaim Pond and Dam. Camp Creek is diverted around the Reclaim Pond. The main Borrow Source and Landfill Area is located in the northern portion of the site. The 22 km long Main Access Road connects the SDH mine site to the Robert Campbell Highway; there is a network of minor roads throughout the site.

Although decommissioning is, with the exception of decommissioning of the Main Access Road, outside the scope of assessment, Table 3-1 summarizes the decommissioning, closure and reclamation plans detailed in the DDRP in order to provide an overall picture of the post-reclamation conditions of the SDH mine site. These plans are also shown in Figure 3-2, taken from the DDRP.

In general, the plans include decommissioning all buildings and other infrastructure on the site; draining and capping the tailings ponds; breaching the South and Reclaim dams; sealing portals; re-contouring waste rock dumps and re-sloping pit walls; as well as remediation and natural revegetation. Decommissioning and reclamation commenced in 2013 and will be completed by the end of 2015 (with the exception of decommissioning of the Main Access Road, as described in Section 2.1.3).

Table 3-1 Summary of Closure and Reclamation Measures

Mine Site Feature	Closure and Reclamation Overview
Jewelbox Ore Body	• Seal the 1408 and 1250 portals. *Neither portal discharges*. • Re-slope to stabilze open pit walls; fill base of pit with coarse waste rock. • Re-contour waste rock dump; decompact and revegetate where possible.
Main Zone Ore Body	• Seal 1380 portal; direct drainage through drainage channel. *The fate and potential environmental effects of portal discharge addressed in Section 3.6.3 of the DDRP and Section 4 of this Project Proposal*. • Re-slope to stabilze open pit walls; fill base of pit with coarse waste rock. • Re-contour waste rock dump; decompact and revegetate where possible.
Burnick Ore Body	• Seal the 1200 portals (2) and 1300 portal. *No significant environmental effects predicted for drainage from the 1200 ventilation portal; the other two portals do not discharge.* • Re-contour 1200 level waste rock dump; decompact and revegetate where possible. • Conduct geotechnical stability asssesment to determine closure measures for 1300 level waste dump.
Tailings Management Facility	• Drain and cap North and South tailings ponds. • Drain and cap Reclaim Pond.* • Remove South Dam and Reclaim Dam. • Dismantle and remove or bury associated infrastructre (e.g., decanter tower, pipelines).

Mine Site Feature	Closure and Reclamation Overview
Camp Creek Diversion	• Redirect Camp Creek back to its original channel. • Contour diversion to provide natural drainage.
Buildings and Infrastructure	• Dismantle and salvage non-hazardous materials, or bury non-hazardous materials *in situ* or in the site landfill facility; remove hazardous materials from site in accordance with applicable regulations. • Cap, scarify, recontour and revegetate disturbed areas. • Remove North Creek dyke and culverts; re-contour and armour the drainage channel to stabilize.
Main Access Road, Site Access Roads and Trails	• Remove safety berms and culverts; scarify, decompact and recontour to promote natural revegetation. • Stabilize trails where required.
General	• Risk manage hydrocarbon-contaminated areas: remove from or remediate contaminated soils in discrete areas (e.g., settling ponds) in accordance with applicable regulations. • Conduct Ecological Restoration through reclamation, and natural and active revegetation.

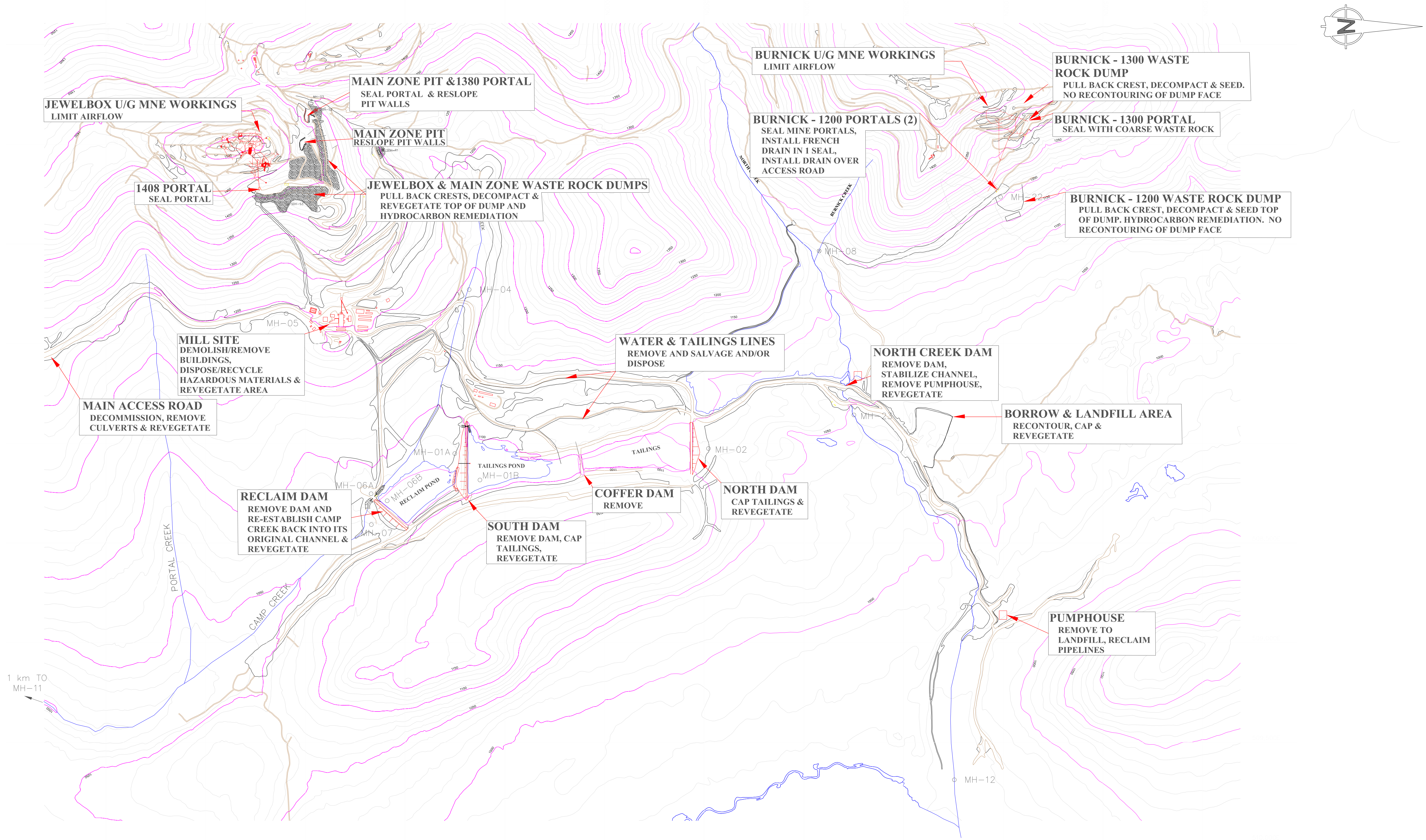
*Note: * Re-location of the Reclaim Pond tailings to the main tailings pond was considered and reflected in the DDRP; however, it was decided to darin and cap the Reclaim Pond.*

In response to the findings of the Ecological and Human Health Risk Assessment undertakings and their supporting studies, YG has required that some additional measures be undertaken to manage the potential risks[4] (Appendix I):

- Waste rock from the Jewelbox and Main Zone dumps must be characterized after they are re-contoured and stabilized to determine final remediation measures.
- Further site characterization must be undertaken for the Jewelbox/ Main Zone 1380 Gully and the results used to refine the risk management plan for the area.
- The Tailings Management Facility must be capped at a minimum 50 mm depth (30 mm cap previously proposed).
- The Mill Yard/ Camp area must be capped at a minimum 20 mm depth (depth not previously specified).

With respect to physical hazards, YG also recommended that a notification system, such as signage or fencing, will be established for any areas that have residual unstable rock faces or have the potential for surface subsidence. Teck has discussed this with the primary users of the area, LFN, and the most appropriate options will be selected through 2015.

[4] *Note that the HHRA and the Ecological Risk Assessment findings have been used to inform refinement of the closure and reclamation options. In some cases, measures to protect ecological resources also protect human health & safety, and vice versa.*



LEGEND

WASTE ROCK DUMPS

EXPLORATION TRAILS

HAUL ROADS

CLEARED AREA

CONTOUR INTERVAL=10m

NOTE
BASE TOPOGRAPHY FROM NORTH AMERICAN DATUM 1983
ALL SURFACE FACILITIES AND BOUNDARIES HAVE BEEN ADJUSTED FROM NAD 1927

Teck

Sä DENA HES DRAFT DETAILED DECOMMISSIONING AND RECLAMATION PLAN

GENERAL ARRANGEMENT PLAN CLOSURE MEASURES

DRAWN BY: BJD	CHECKED BY: BJD	FIGURE NO. 3-2	REV. 1
Revised: February 1, 2013	PROJ. NO.		

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3.2.1 Landfill Facility

The Landfill Facility is highlighted here because LFN has expressed concern about materials being buried in the onsite Landfill Facility (location shown in Figure 1-2) and its associated potential environmental impacts. The landfill is administered by the QML-0004 and a Solid Waste Management permit. No hazardous materials were placed in the landfill, a minimum 1 m cap will be placed, shaped to shed surface water and re-vegetated. Figure 3-3 presents the conceptual design of the Landfill Facility.

In addition to address LFN's concerns regarding potential environmental impacts from the landfill, Teck retained Golder Associates in August 2014 to conduct an environmental assessment of the landfill area, including an evaluation of groundwater quality. The report is currently underway and development of an adaptive management program may be implemented based on the results of the environmental assessment. As discussed with LFN, Teck has agreed to install signage at the landfill warning of any potential hazards.

Final cover is to achieve the following objectives:

1. Prevent exposure of humans and/or wildlife to waste material
2. Control infiltration of precipitation
3. Limit erosion and release of sediment to surrounding surface waters

Surface water management works will be designed to:

1. Convey and direct surface water runoff away from the landfill footprint to minimize surface water contact with waste
2. Minimize potential for on-site erosion

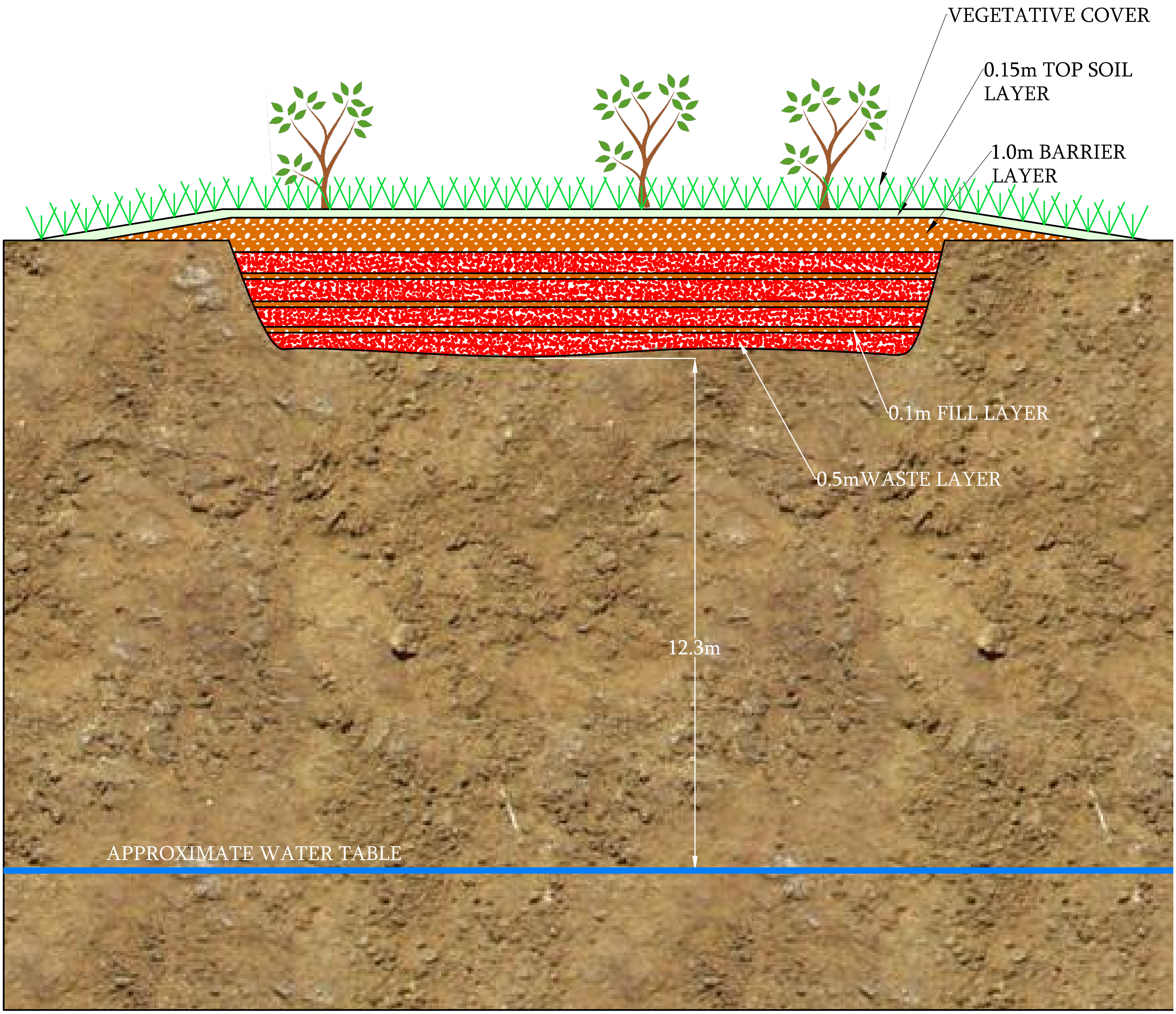

Figure 3-3 Conceptual Design of Landfill Facility

4 AQUATIC RESOURCES EFFECTS ASSESSMENT

This section addresses the implications for aquatic resources associated with the post-reclamation phase of the SDH mine. Existing conditions are detailed for aquatic resources and presented in Section 4.1; potential positive and negative effects are characterized in Section 4.2.

4.1 EXISTING CONDITIONS

4.1.1 Meteorology

The SDH mine property is located in the upper basin of the Liard River, some 40 km north of Watson Lake. The climate is dictated by a number of factors, mainly altitude, latitude and distance to mountain barriers. The property is in the rain shadow of the Coast and St. Elias Mountains. These two mountain ranges form an effective barrier against Pacific influences and allow a continental climate to exist over most of the Yukon. The Cassiar Mountains to the west cause a secondary rain shadow effect.

A complete climate characterization is presented in the DDRP (specifically; Appendix B of the DDRP) and includes precipitation, snowpack, temperature and evaporation estimates for the site. These values were largely inferred from the data of regional climate stations, using data up to 2005 (see Figure 4-1 for stations locations). The following sections will present more recent data where available.

4.1.1.1 Precipitation

The precipitation estimate for the site was based on the corrected Watson Lake mean annual precipitation (MAP) of 490 mm from the 1961-1990 normals, to which the regional precipitation gradient of 48 mm per 100 m of ascent was applied, yielding an estimated MAP of 690 mm. The more recent Watson Lake climate normals for the periods 1971-2000 and 1981-2010 are not significantly different from the 1961-1990 normals for MAP (404.4 mm and 416.4 mm respectively, compared to 413.8 mm for 1961-1990 before correction), and therefore do not warrant a revision of the estimated site MAP for the mine site.

4.1.1.2 Snowpack

The site snowpack was characterized using data from Environment Yukon's regional snow survey stations. Six stations are located within the Liard River basin, three of which have elevations similar to that of the mine site (Tintina Airstrip, Pine Lake Airstrip and Ford Lake), and judged to be indicative of the snowpack conditions likely experienced at the mine site (see Figure 4-1). Nine more years of data has been collected since the last climate characterization, and the average snow water content for that nine-year period is compared to the average for the entire period of record (which ranges from 26 to 49 years depending on stations) in Figures 4-2 to 4-4 for March, April and May respectively.

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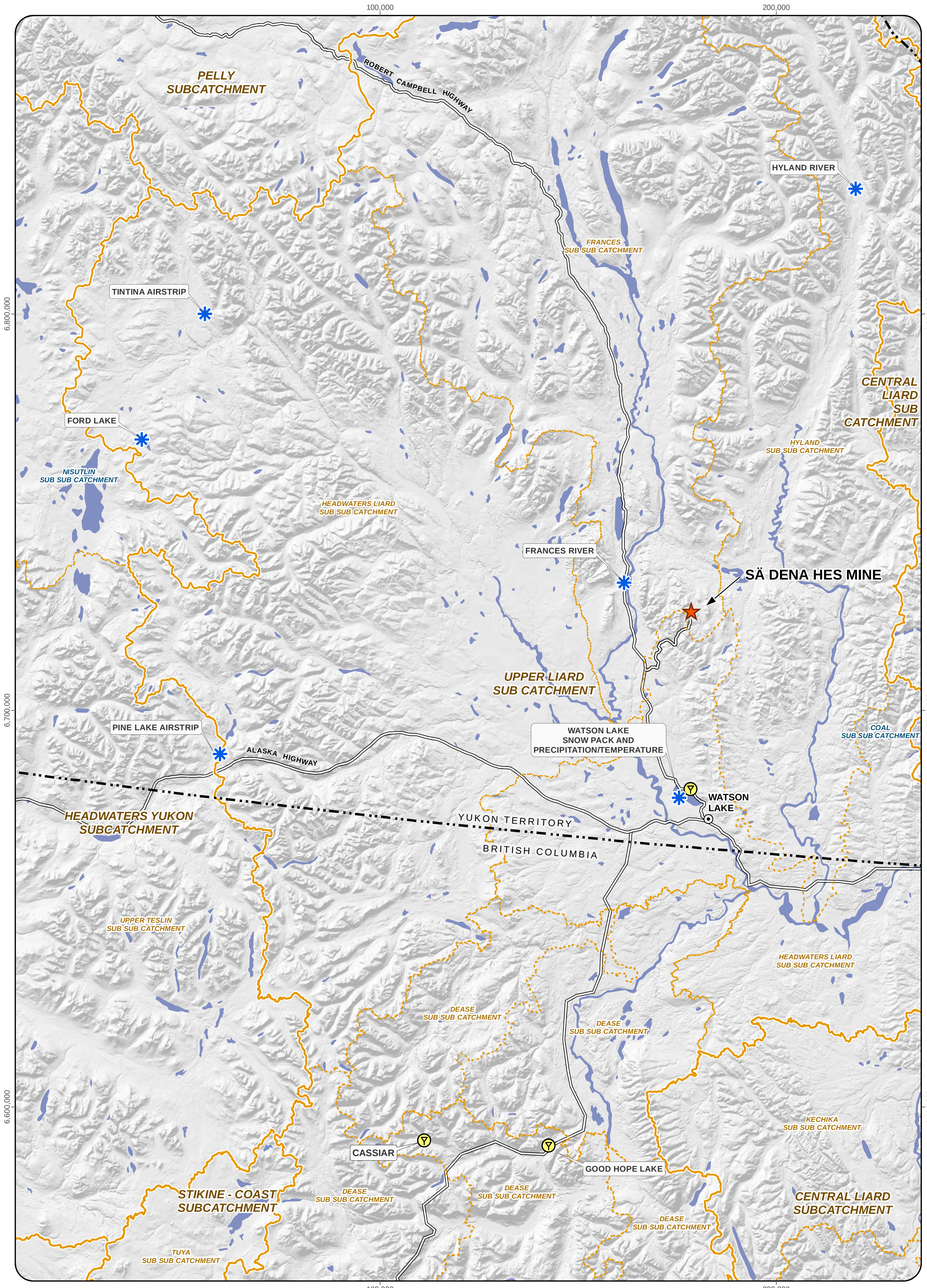

0 20 40
Kilometers

Catchment Outlines

- Water Survey of Canada Sub Catchments
- Water Survey of Canada Sub Sub Catchments

Meteorological Stations

- Precipitation/Temperature
- Snowpack

SÄ DENA HES MINE POST-RECLAMATION PHASE

FIGURE 4-1

REGIONAL METEOROLOGICAL AND SNOW SURVEY STATIONS

National topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Stations coordinates obtained from Environment Yukon website. Shaded relief obtained from Geogratis, Natural Resource Canada.
Datum: NAD 83; Projection: UTM Zone 9N

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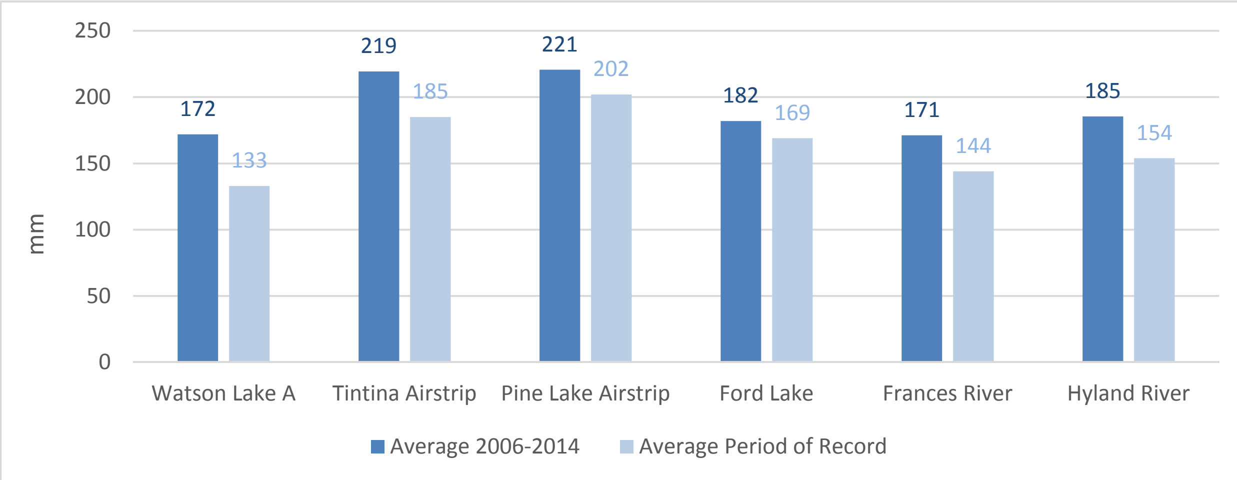


Figure 4-2 March Snow Water Content

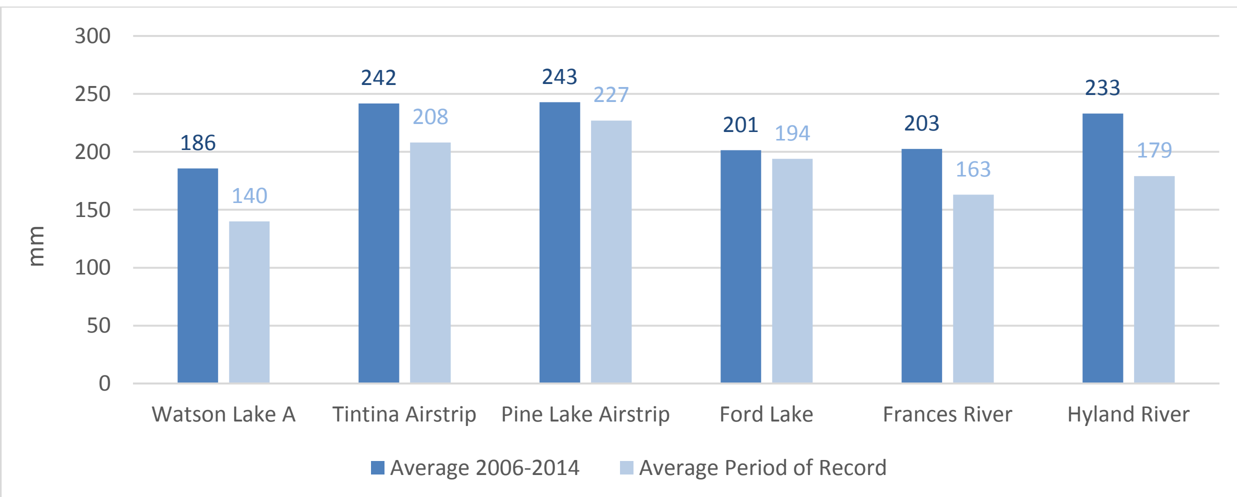


Figure 4-3 April Snow Water Content

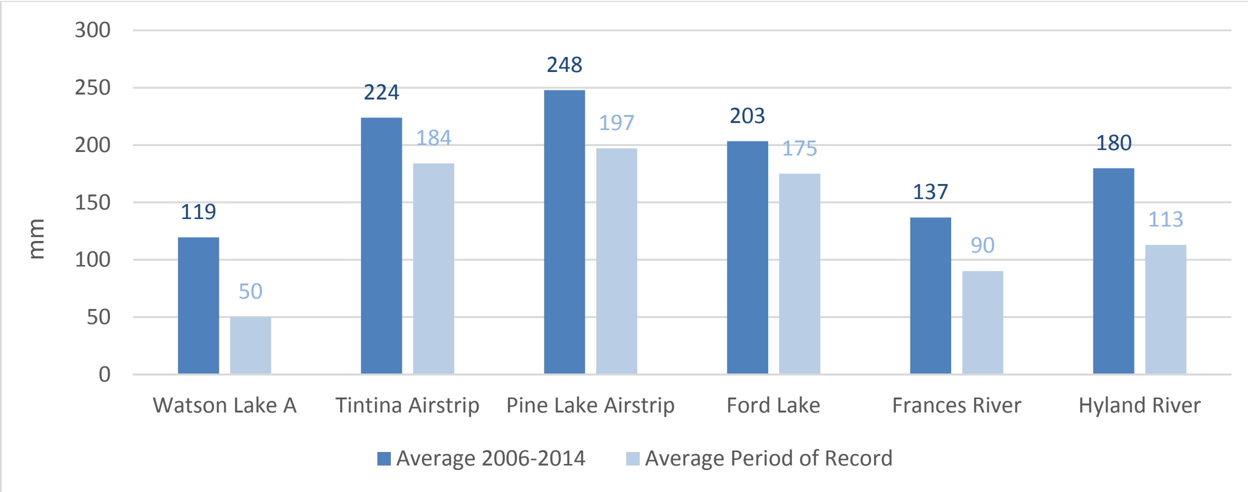


Figure 4-4 May Snow Water Content

Figures 4-2 to 4-4 show that the average water content was on average higher for all months in the recent years (2006-2014) when compared to the entire period of record. The difference is greater in May (average difference of 50 mm across all stations), followed by April (33 mm) and March (27 mm). When considering only the three stations that have similar elevations to that of the mine site, the same trend is observed but the difference is of smaller magnitude. The average difference is of 40 mm in May, of 19 mm in April and of 22 mm in March.

4.1.1.3 Temperature

The site mean annual temperature was estimated by first deriving a temperature gradient as a function of altitude, and then applying it to the elevation difference between the Watson Lake airport and the mine site to extrapolate the site's mean annual temperature from the Watson Lake A 1961-1990 climate normals.

The two MSC stations used to derive the temperature gradient of -0.0084°C/m were Cassiar and Good Hope Lake (see Figure 4-1). These two stations are discontinued and do not have new data since the last characterization, so the temperature gradient will not be revised. New climate normal are however available for Watson Lake A for the periods 1971-2000 and 1981-2010, and the mean annual temperatures were -2.9°C and -2.4°C for these two periods respectively, compared to -3.1°C for 1961-1990, indicating a warming trend. Applying the temperature gradient to the most recent climate normal value, we obtain a predicted mean annual temperature of -5.8°C at the mine site.

Applying the same temperature gradient to daily mean, maximum and minimum temperatures from the 1981-2010 Watson Lake climate normals, the mean monthly values presented in Table 4-1 are obtained.

Over the 59 years of record at Watson Lake A, the extreme minimum temperature recorded was -58.9°C in January 1947 and the extreme maximum was 35.4°C in July 2009. These can be used as an indication of the extremes that could be experienced at the mine site.

4.1.1.4 Evaporation

The evaporation rate at the mine site was approximated using the Thornthwaite Method (Gray, 1973), an empirical formula that uses average monthly air temperature and latitude to calculate potential evapotranspiration. Because the monthly temperatures were updated using more recent climate normals from Watson Lake A, associated monthly evaporation was also updated as shown in Table 4-1. The resulting total annual evaporation estimated from this method is 428 mm, which is not significantly different from the value of 430 mm presented in the 2013 DDRP.

Table 4-1 Estimated Mean Monthly Climatic Parameters for the SDH Mine Site

	Average Daily Min Temp (°C)	Average Daily Max Temp (°C)	Mean Daily Temp (°C)	Evaporation (mm)
Jan	-30.9	-20.9	-25.9	0
Feb	-26.9	-13.8	-20.4	0
Mar	-20.7	-5.2	-13.0	0
Apr	-10.2	3.6	-3.3	0
May	-2.1	10.6	4.2	53.7
Jun	3.4	16.2	9.8	111.6
Jul	5.6	18.1	11.9	126.5
Aug	3.5	15.7	9.6	93.9
Sept	-1.2	9.4	4.1	42.5
Oct	-8.1	0.3	-3.9	0
Nov	-22.7	-13.4	-18.1	0
Dec	-29.0	-19.4	-24.2	0
Year	-11.6	0.1	-5.8	428.2

4.1.2 Hydrology

The SDH mine is located in the drainage basin of False Canyon Creek which has a total catchment area of 492 km^2 and discharges approximately 55 km above the Frances River and Liard River confluence. Access to the mine development is from the south across the drainage basin of Tom Creek, a left bank tributary of the Liard River.

The open pits, underground workings and waste rock dumps associated with the Jewelbox ore zones are located near the drainage divide between Tom and False Canyon Creeks. All drainage from the Jewelbox development is directed to Camp Creek, a steep-gradient tributary of False Canyon Creek that drains the eastern flank of Mount Hundere. The mill site is also located in the catchment of Camp Creek. The Burnick development is entirely confined in the headwaters of another False Canyon Creek tributary, which has been designated Tributary D. The tailings impoundment is constructed in a saddle that lies along the drainage divide between Camp Creek and Tributary E.

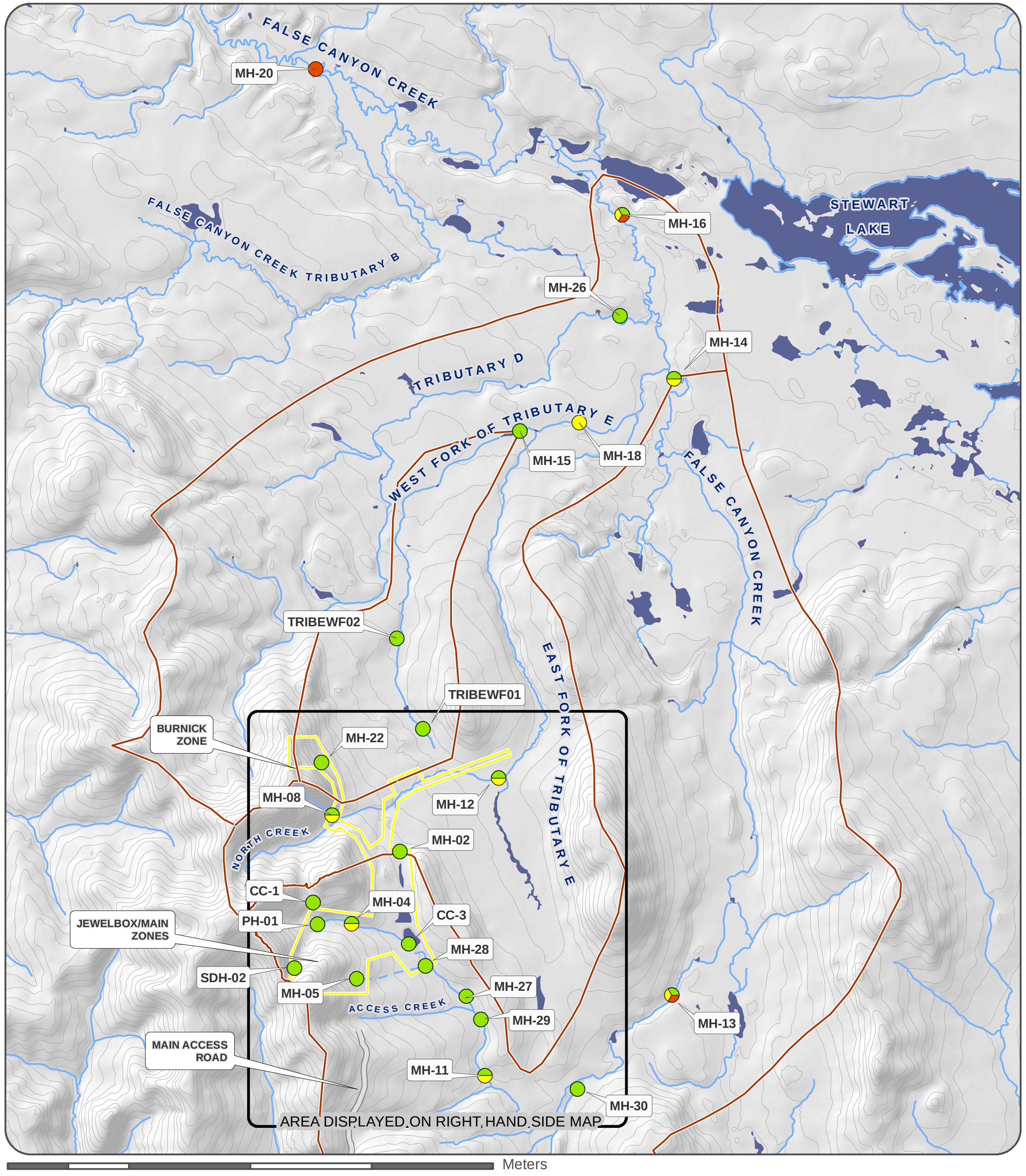
The most recent hydrology update was developed by SRK in 2013 in support of the water and load balance model for predicting post-reclamation surface water quality downslope of the SDH mine. Details can be found in the DDRP (Appendix A) while the summary below is taken from the Post-Closure Water Quality Predictions (Appendix J).

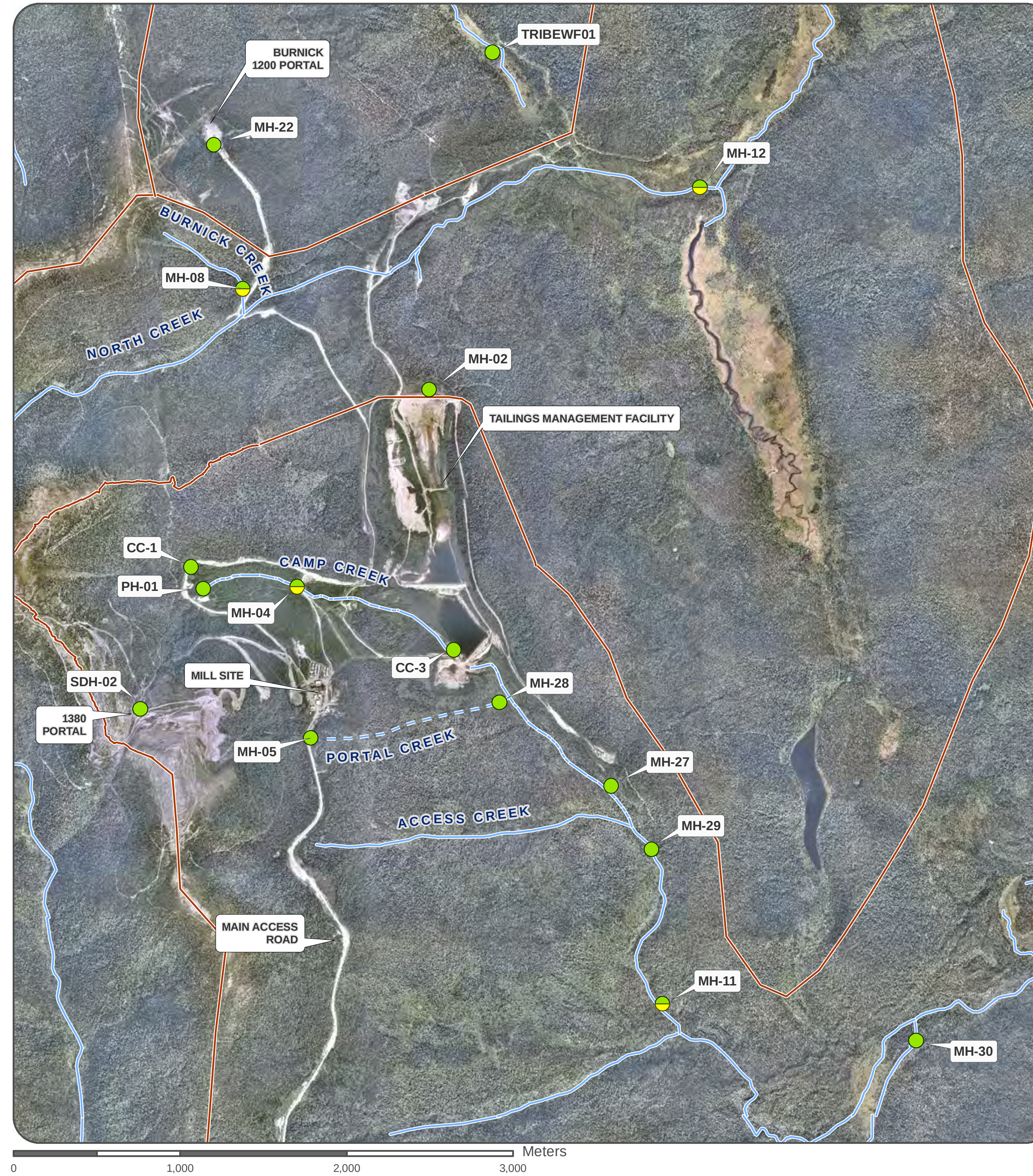
Average monthly and low flow conditions were estimated for water sampling stations relevant to the water and load balance model (see Figure 4-5 for station locations), specifically:

- MH-04: Lower Camp Creek immediately above the West Interceptor Ditch;
- MH-08: Burnick Creek, a small drainage upgradient of the North Tailings Dam that contributes to the upper end of the East Fork of Tributary E;
- MH-11: Upper False Canyon Creek 1 km downstream of the Portal Creek confluence;
- MH-12: North Creek to West fork of Tributary E approximately 2 km downgradient (via groundwater) of the North Tailings Dam;
- MH-13: False Canyon Creek approximately 10 km downstream of the Reclaim Pond and upstream of a tributary that flows north from a small lake;
- MH-14: False Canyon Creek, 20km downstream of Reclaim Pond, upstream of Tributary E confluence
- MH-16: False Canyon Creek approximately 22 km downstream of the Reclaim Pond and downstream of the confluence with Tributary D; and
- MH-18: Tributary E just upstream of its confluence with False Canyon Creek.

The estimated flows are based on estimation techniques described previously (SRK 1990, Teck 2000 and SRK 2005). Some modifications were made to the techniques to accommodate the longer streamflow records that are now available at regional Water Survey of Canada stations and the new site flow data collected since 2005.

Variables estimated were mean annual runoff (MAR) as an average flow and as an equivalent runoff depth; mean monthly flows for average conditions and the two low flow statistics (7Q20a and 7Q20s). The resulting flow estimates for post-reclamation conditions are shown in Table 4-2.





Datum: NAD 83; Map Projection: UTM Zone 9N

Monitoring Stations / Type and Location

- Water Quality Monitoring
- Hydrology Monitoring
- Aquatic Monitoring

- Catchment Boundaries
- Perrenial Stream
- Ephemeral Stream

SÄ DENA HES MINE - POST-RECLAMATION PHASE

FIGURE 4-5
CATCHMENTS AND SELECTED PRE-RECLAMATION SURFACE WATER MONTORING STATIONS

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Table 4-2 Estimated Flows for Key Locations in the Receiving Environment

Station	MH-04	MH-08	MH-11	MH-12	MH-13	MH-14	MH-16	MH-18
Catchment area (km^2) =	2.07	2.773	9.5	10	34.5	74.4	144	30.06
Catchment median elevation (m) =	1301	1327	1135	1064	1081	990	986	996
MAR (mm) =	342	353	267	236	243	203	201	205
Average Monthly Discharge (L/s)								
Jan	5	7	16	14	52	89	171	37
Feb	4	6	14	12	43	73	140	30
Mar	4	5	12	11	40	70	134	29
Apr	4	5	18	19	66	133	257	54
May	45	59	207	210	733	1467	2827	596
Jun	83	117	264	231	836	1388	2654	571
Jul	49	68	166	150	539	936	1794	384
Aug	24	33	77	68	246	417	798	171
Sep	19	26	68	63	224	402	772	165
Oct	17	23	63	60	212	390	749	159
Nov	10	14	35	32	116	207	398	85
Dec	6	9	22	20	71	127	243	52
Average Annual Discharge (L/s)	22	31	81	75	266	477	916	195
7Q20s (L/s)	4.2	5.6	19	20	70	151	292	61
7Q20a (L/s)	0.7	0.9	3.0	3	10.9	23	45	9

4.1.3 Surface Water Quality

Water quality monitoring at the site has been ongoing since 1991, initially as part of a baseline sampling program and subsequently as required under the Water Licence, however data prior to 1999 was excluded from this analysis due to a lack of confidence in the lab results and (often) elevated method detection limits (MDLs) relative to more recent data. In accordance with the DDRP submitted in July 2013, a more extensive water quality monitoring program was implemented to provide data to support the HHRA and ERA, water quality loading assessment and post-reclamation monitoring plan development. Data collected after April 2014 is not considered representative of existing conditions at site as it was impacted by the closure/reclamation activities and as such, was not included in this analysis. Details of water quality data analysis are presented in the Water Quality Characterization Report (Appendix K) while key results are summarized below.

For the purposes of this assessment, water quality monitoring stations were grouped as reference stations, Camp Creek to False Canyon Creek stations, Tributary E drainage stations, and downstream stations. Results were compared to the Canadian Council of Ministers of the Environment (CCME) *Water Quality Guidelines for the Protection of Aquatic Life* (WQG PAL), which are summarized in Table 4-3 for the parameters of interest. In the Camp Creek to False Canyon Creek drainage, focus is given to station MH-13 as it is the station located the nearest from the mine site where seasonal fish presence was detected (slimy sculpin was the only species observed at this site). See Figure 4-5 for the locations of the monitoring stations.

Table 4-3 CCME Water Quality Guideline for the Protection of Aquatic Life (in mg/L)

Analyte	Long Term	Short Term
Aluminum (total)	0.005 if pH <6.5, otherwise 0.100	None
Ammonia (as NH_3)	pH and temperature dependent	None
Arsenic	0.005	None
Cadmium	0.00004 if hardness < 17; ($10^{0.83\ [\log10\ (hardness)]\ -2.46}$)/1000 from hardness 17 to 280; 0.00037 at hardness > 280	0.00011 at hardness < 5.3; ($10^{1.016[\log10\ (hardness)]\ -1.71}$)/1000 from hardness 5.3 to 360; 0.0077 at hardness > 360
Chromium	0.001 (CrVI); 0.0089 (CrIII) The Cr(VI) number is used and applied to measurements of total chromium. According the CCME factsheet for chromium, Cr(VI) is the principal species found in surface waters while Cr(III) is more prevalent in mildly reducing environments such as sediments and wetlands.	None
Copper	0.002 at hardness < 82; ($e^{0.8545[\ln(hardness)]-1.465*0.2}$)/ 1000 at hardness 82 to 180; 0.004 at hardness > 180	None
Iron (total)	0.3	None
Lead	0.001 at hardness 60 or less; ($e^{1.273[\ln(hardness)]-4.705}$)/1000 at hardness > 60 and less than 180; 0.007 at hardness > 180	None
Nitrate (as N)	3	None
pH	6.5 to 9.0	None
Selenium	0.001	None
Silver	0.0001	None
Zinc	0.03	None

After an initial screening of results for all surface stations, a total of 12 parameters had at least one case where the CCME guidelines were exceeded. When considering station MH-13 specifically, eight parameters had at least one case where the CCME guidelines were exceeded. The exceedance rate for aluminum and zinc is very low with only one exceedance for each parameter, representing 2.5% and 1.7% of samples respectively. Other parameters that occasionally exceed the CCME guidelines at MH-13 include cadmium, chromium, copper, iron, lead and selenium. Basic summary statistics are presented in Table 4-4 for parameters of interest, while more detailed statistics as well as complete data tables are available in the Water Quality Characterization report (Appendix K).

In addition, summary statistics for two seep monitoring stations (MH-02 and SDH-S2) are presented at the end of Table 4-4, to provide information on existing conditions at these two stations, as they will be part of the post-closure monitoring program (see Section 7). Comparison to CCME WQG PAL is however not relevant for seep stations, so only count and mean are presented here.

Table 4-4 Water Quality Summary Statistics for Parameters of Interest (1999-2013)

Group	Station	Statistics	pH (field) pH units	Hardness (dissolved) mg/L	Al (total) mg/L	NH_3-N (total) mg/L	As (total) mg/L	Cd (total) mg/L	Cr (total) mg/L	Cu (total) mg/L	Fe (total) mg/L	Pb (total) mg/L	NO_3-N mg/L	Se (total) mg/L	Ag (total) mg/L	Zn (total) mg/L
Reference	CC-1	Count	0	16			2	2		2	2	2		2	2	2
		Mean	NA	122			3.45E-04	8.30E-05		2.60E-04	7.05E-03	3.90E-04		2.55E-04	2.00E-05	5.00E-03
		Count > Guideline	NA	NA			0	0		0	0	0		0	0	0
	MH-26	Count	38	81	4	4	10	10		10	10	10		10	3	10
		Mean	8.32	158	2.70E-02	3.72E-02	4.36E-04	8.97E-05		1.79E-03	2.81E-01	1.57E-03		6.64E-04	2.00E-05	8.70E-03
		Count > Guideline	0	NA	0	0	0	0		1	4	1		0	0	0
	MH-29	Count	0	17			2	2	1	2	2	2		2	2	2
		Mean	NA	166			7.72E-04	1.28E-04	1.70E-04	9.00E-04	6.66E-02	1.65E-03		5.00E-04	1.25E-05	1.18E-02
		Count > Guideline	NA	NA			0	0	0	0	0	0		0	0	0
	MH-30	Count	0	17			2	2	1	2	2	2		2	2	2
		Mean	NA	111			2.77E-04	1.49E-04	1.40E-04	1.38E-03	3.55E-01	2.65E-03		3.44E-04	1.30E-05	8.86E-03
		Count > Guideline	NA	NA			0	1	0	0	2	1		0	0	0
Camp Creek to False Canyon Creek	PH-01	Count	0	24			3	3		3	3	3		3	3	3
		Mean	NA	151			5.90E-04	6.73E-04		3.77E-04	2.06E-02	2.39E-03		1.22E-03	2.00E-05	1.32E-02
		Count > Guideline	NA	NA			0	3		0	0	0		3	0	0
	MH-04	Count	301	479	40	40	33	65	4	39	66	65	3	33	27	66
		Mean	8.22	162	4.04E-02	1.33E-02	4.00E-04	5.48E-03	2.25E-03	1.29E-03	5.35E-02	8.15E-02	2.37E-01	7.40E-04	2.00E-05	9.77E-03
		Count > Guideline	NA	NA	2	0	0	36	3	1	1	5	0	1	0	3
	CC-3	Count	0	8			1	1		1	1	1		1	1	1
		Mean	NA	153			4.40E-04	1.75E-04		9.60E-04	8.02E-02	1.59E-03		5.80E-04	2.00E-05	5.10E-03
		Count > Guideline	NA	NA			0	0		0	0	0		0	0	0
	MH-05	Count	53	66	8	8	2	10	3	4	10	10	1	2	2	6
		Mean	8.11	161	6.44E-01	9.88E-03	1.31E-03	5.28E-03	4.33E-03	4.81E-03	1.02E+00	4.26E-01	3.62E+00	2.53E-03	2.00E-05	2.94E-02
		Count > Guideline	NA	NA	3	0	0	8	3	2	3	5	1	2	0	3
	MH-28	Count	0	33			4	4	1	4	4	4		4	4	4
		Mean	NA	192			7.20E-04	1.34E-04	1.30E-04	6.89E-04	1.16E-01	2.11E-03		8.13E-04	1.63E-05	1.16E-02
		Count > Guideline	NA	NA			0	1	0	0	1	1		1	0	0
	MH-27	Count	0	81			10	10	1	10	10	10		10	10	10
		Mean	NA	172			5.99E-04	1.61E-04	1.00E-04	8.54E-04	1.11E-01	8.64E-03		8.19E-04	1.85E-05	1.79E-02
		Count > Guideline	NA	NA			0	0	1	0	0	0		0	0	0
	MH-11	Count	952	1225	127	126	71	164	16	89	171	164	6	70	54	171
		Mean	8.22	197	1.07E-01	1.23E-02	5.61E-04	1.14E-03	3.09E-03	1.73E-03	1.88E-01	2.53E-02	1.55E-01	7.10E-04	2.62E-05	3.11E-02
		Count > Guideline	NA	NA	11	1	0	37	14	6	14	36	0	0	2	33
	MH-13	Count	288	415	40	40	25	57	5	30	58	58	2	25	17	58
		Mean	8.12	198	3.64E-02	2.95E-02	4.03E-04	3.77E-03	2.02E-03	1.73E-03	2.78E-01	4.70E-02	2.00E-02	7.64E-04	1.91E-05	8.36E-03
		Count > Guideline	NA	NA	1	0	0	5	3	2	14	4	0	3	0	1

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Group	Station	Statistics	pH (field) pH units	Hardness (dissolved) mg/L	Al (total) mg/L	NH_3-N (total) mg/L	As (total) mg/L	Cd (total) mg/L	Cr (total) mg/L	Cu (total) mg/L	Fe (total) mg/L	Pb (total) mg/L	NO_3-N mg/L	Se (total) mg/L	Ag (total) mg/L	Zn (total) mg/L
Tributary E Drainage	TRIBEWF01	Count	0	8			1	1		1	1	1		1	1	1
		Mean	NA	156			2.14E-03	1.92E-04		1.44E-03	8.46E-01	3.38E-03		9.30E-04	2.00E-05	3.22E-02
		Count > Guideline	NA	NA			0	0		0	1	0		0	0	1
	TRIBEWF02	Count	0	16			2	2		2	2	2		2	2	2
		Mean	NA	145			1.07E-03	1.10E-05		2.00E-04	2.60E-01	2.00E-04		7.15E-04	2.00E-05	5.00E-03
		Count > Guideline	NA	NA			0	0		0	0	0		0	0	0
	MH-14	Count	309	433	42	42	25	60	8	31	60	60		25	17	60
		Mean	8.01	208	7.60E-02	1.90E-02	3.84E-04	3.58E-03	2.89E-03	1.81E-03	3.03E-01	2.46E-02		8.24E-04	2.15E-05	7.21E-03
		Count > Guideline	0	NA	4	1	0	2	5	2	19	3		3	0	0
	MH-15	Count	0	17			2	2	1	2	2	2		2	2	2
		Mean	NA	195			4.35E-04	1.40E-05	1.00E-04	2.56E-04	1.92E-01	2.10E-04		4.98E-04	1.30E-05	3.18E-03
		Count > Guideline	NA	NA			0	0	0	0	0	0		0	0	0
	MH-08	Count	875	1150	115	114	75	152	10	84	159	152		74	54	159
		Mean	8.27	149	9.40E-02	1.25E-02	1.24E-03	6.32E-04	4.04E-03	1.79E-03	1.41E-01	2.59E-03		7.56E-04	1.99E-05	1.54E-02
		Count > Guideline	0	NA	13	0	0	9	6	8	14	8		8	0	13
	MH-12	Count	0	17			2	2	1	2	2	2		2	2	2
		Mean	NA	155			1.23E-03	5.95E-05	3.60E-04	6.89E-04	1.71E-01	9.90E-04		6.27E-04	1.40E-05	4.48E-03
		Count > Guideline	NA	NA			0	0	0	0	1	0		0	0	0
Downstream Environment	MH-16	Count	256	355	37	37	17	52	5	22	52	52		17	9	52
		Mean	8.20	207	4.19E-02	1.24E-02	4.10E-04	6.03E-03	3.02E-03	1.40E-03	2.26E-01	5.07E-03		6.74E-04	1.83E-05	7.50E-03
		Count > Guideline	0	NA	1	0	0	2	4	1	4	3		0	0	1
Seeps	MH-02	Count	147	166	157	165	84	161	99	168	168	163	35	77	77	168
		Mean	7.74	557	3.30E-02	8.84E-02	4.81E-03	6.76E-04	1.62E-03	2.71E-03	8.95E-01	1.06E-02	2.78E-02	2.11E-04	2.63E-05	1.24E-01
	SDH-02*	Count	1	1	1	1	1	1	1	1	1	1		1	1	1
		Mean	6.96	138	<0.003	1.70E-02	<0.0001	7.36E-02	<0.001	2.00E-04	6.00E-03	3.97E-02		2.78E-03	<0.00002	7.97

* *Only dissolved parameters are available for this station*

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Analysis of water quality data indicates that cadmium, lead and zinc are the main parameters of concern, as they frequently exceed the CCME *Water Quality Guidelines for the Protection of Aquatic Life*. MH-13 is the station where fish presence has historically been reported (seasonally) located nearest to the mine site and the exceedance rate of the CCME WQG PAL at this site is 9%, 7% and 2% for cadmium, lead and zinc, respectively. Although the exceedance rates are not substantial, the fact that concentrations are on average higher at MH-13 than at reference stations for these parameters is suggestive of the influence of mine-related or natural sources of metals between MH-04 and MH-11 and MH-13. Parameters for which exceedances of the CCME guidelines were observed at reference stations include copper, iron, lead and cadmium, indicating that they may be naturally elevated in this region.

4.1.4 Groundwater

Appendix L presents the results of the Hydrogeological Assessment completed in 2013. Post-reclamation groundwater monitoring is addressed in Section 0. A complete Hydrogeological Assessment Report will be completed in 2015 to support final closure and reclamation measures and will be submitted to LFN and regulators.

4.1.5 Fish/ Fish Habitat and Benthos

The information summarized in the following sections is taken from the DDRP (specifically Appendix B of the DDRP) with additional updates where more recent data were available.

4.1.5.1 Fisheries

Baseline fisheries investigations of drainages within the SDH mine study area were completed by Environmental Sciences Ltd. (ESL) on the False Canyon Creek drainage in June and September of 1989 as a component of the Initial Environmental Evaluation for the Mt. Hundere Development. ESL also conducted fish surveys on the Tom Creek drainage as well as on a tributary to Francis River, where grayling and slimy sculpin were captured. A summary of the results from this investigation are provided in Chapter 2.5 of the report entitled *Mt. Hundere Development Initial Environmental Evaluation, Volume IV Biophysical Evaluation of Project Site* (SRK, 1990).

It was subsequently required that fisheries monitoring be conducted every two years under the terms of the Water License, beginning in 1992. Detailed results can be found in the respective annual reports. A variety of techniques were used during the investigations: electro-shocker (gas and battery operated), minnow trapping, seine netting, gill netting, angling and visual observations. All of the existing fisheries data on the

False Canyon Creek drainage have been summarized and are presented in Table 4-5. Locations of the fish monitoring stations[5] are provided in Figure 4-5.

Table 4-5 Summary of Fish Species Captured in the False Canyon Creek Drainage

Species	Sample Site	Average Annual Catch (1992 to 2010)*	Total Annual Catch 2012
Slimy Sculpin	MH-13	21.8	21
	MH-16	12.3	11
	MH-20	14.9	13
Arctic Grayling	MH-13	0	0
	MH-16	2.9	6
	MH-20	4.7	0
Burbot	MH-13	0	0
	MH-16	1.0	0
	MH-20	0.5	4
Lake Chub	MH-13	0	0
	MH-16	0	0
	MH-20	0	1

** Note: MH-16 was not sampled in 1992 or 1994*

Pre- and post-development fish sampling indicate that fish production capabilities in the upper False Canyon Creek drainage are relatively low. The most productive area within the system appears to be the lower reaches of False Canyon Creek near the confluence with the Frances River.

Four species of fish were found within the False Canyon Creek drainage since 2000: slimy sculpin (*Cottus cognatus*), Arctic grayling (*Thymallus arcticus*), round whitefish (*Prosopium cylindraceum*), and burbot (*Lota lota*). One exception is the unusual capture of a single lake chub at site MH-20 in 2012, a species that has not previously been recorded in the False Creek Canyon drainage. Slimy sculpin continue to be the most abundant species captured, followed by Arctic grayling.

The sites MH-13 and MH-20 were monitored during each of the 11 surveys. Only slimy sculpin were captured at MH-13 although several fishing methods were employed. This site is a beaver/wetland complex with low velocity flow. The slimy sculpin population however, continued to be stable and the habitat supports all life history stages of this species.

Arctic grayling and slimy sculpin dominated the catch at MH-20 with incidental occurrences of whitefish and char. This site displays suitable fish habitat with stable banks and gravel substrate, and good riffle/pool ratio.

[5] The Licence prescribes the location of monitoring stations in False Canyon Creek, but some locations are inaccessible by helicopter, which has necessitated sampling at alternate, more accessible locations. MH-18, MH-19 and MH-24, although prescribed, have never been sampled due to lack of access and MH-14 was submerged from 1996 to 2006, and the alternate site MH-16, located two kilometers downstream, had been used for those studies. The present sampling location at MH-14 is no longer flooded, however in the pursuit of consistency, MH-16 was again used as the sample site rather than MH-14.

The fisheries data was generally consistent with the past studies. While the absolute number of fish captured varies from year to year, the fish assemblage in the catch is consistent and is itself an indication of stability in the fish community. Slimy sculpin continued to be the dominant species captured throughout the drainage, and the only species present at MH13. The presence of Arctic grayling and whitefish were again confirmed in the False Canyon Creek drainage however no whitefish were captured or observed in 2012. A single lake chub was captured in the study area in 2012; the first documented occurrence since the commencement of monitoring.

During a late June 2014 survey of the aquatic environment of Camp Creek and North/Burnick creeks by Azimuth, these watercourses were examined for physical habitat features, sediment chemistry, aquatic macrophytes, amphibians, benthic invertebrates and fish. A single location was examined on North/Burnick Creek at MH-12 and five locations on Camp Creek at MH-04, CC-3 (upstream of Reclaim Pond adjacent to culvert protection), MH-28a (upstream of Portal Creek), MH-27 upstream of Access Creek, and MH-29 within Access Creek. Electrofishing efforts and visual observation produced no fish at any of the sites, which was expected given the season, gradient, substrate, numerous falls/barriers downstream and previous fisheries surveys.

4.1.5.2 Benthic Invertebrates

Two baseline benthic invertebrate investigations were conducted within the SDH mine study area prior to mine development. In September 1989, ESL collected baseline benthic invertebrates from 23 sites. Samples from only three of these sites were identified and analyzed, and the remaining 20 were archived. A discussion of this study was provided in the report entitled *Mt. Hundere Development Initial Environmental Evaluation, Volume IV Biophysical Evaluation of Project Site* (SRK, 1990). In July 1990, Environmental Protection Services (EPS) of Whitehorse, Yukon, conducted baseline biological monitoring at ten sites, four of which lie within the False Canyon Creek drainage. Details of this study are reported in the *Mount Hundere Baseline Study, June 1988 and June 1990, Data Report No. 94-02* (Environmental Protection Branch, 1994).

Biological monitoring programs have continued according to water license specifications, every two years since 1992 and detailed results can be found in the respective annual reports. The Licence prescribes the location of monitoring stations in False Canyon Creek, but some locations are inaccessible by helicopter, which has necessitated sampling at alternate, more accessible locations, namely MH-13, MH-16 and MH-20, which are shown in Figure 4-5. MH-18, MH-19 and MH-24, although prescribed, have never been sampled due to lack of access and MH-14 was submerged from 1996 to 2006, and the alternate site MH-16, located two kilometers downstream, had been used for those studies. The present sampling location at MH-14 is no longer flooded, however in the pursuit of consistency, MH-16 was again used as the sample site rather than MH-14. Regular water samples are, however, collected quarterly at MH-14. MH-16 is also a quarterly water quality station and is located on the main stem of False Canyon Creek. This area is presently unaffected by beaver activity and is representative of a more stable environment than MH-14. Standard methodology for sample collection and analysis was used for all sampling events to allow comparison of the results.

Data collected from False Canyon Creek since 1992 have been summarized and compiled in Table 4-6. Population densities were greatest in 1998 at MH-13 and in 2010 at MH-16 and MH-20 (Figure 4-6). The population at MH-13 has fluctuated considerably over time which probably reflects the variable hydrology and water quality of this site.

Table 4-6 Summary of Benthic Invertebrate Data in the False Canyon Creek Drainage

Site	Year	Total Abundance	Diversity	Density (# of organisms/m²)	Dominant Taxa	Total # of Sensitive Taxa
MH-13	1992	1562	25	5605	Diptera	0
	1994	7631	37	27380	Ephemeroptera & Diptera	9
	1996	3682	57	13211	Diptera	8
	1998	13033	30	46764	Diptera	2
	2000	1704	50	6114	Plecoptera & Diptera	4
	2002	1020	46	3660	Diptera	3
	2004	7289	72	26153	Diptera	9
	2006	5168	46	18543	Diptera	4
	2008	6319	50	22673	Diptera & Plecoptera	8
	2010	4003	33	14363	Ostracoda & Diptera	0
	2012	3465	53	12433	Diptera & Other	3
MH-16	1998	3754	60	13470	Diptera & Ephemeroptera	10
	2000	3578	65	12838	Diptera & Ephemeroptera	9
	2002	5588	67	20050	Diptera & Ephemeroptera	8
	2004	5995	63	21510	Diptera & Ephemeroptera	10
	2006	7445	76	27713	Diptera	10
	2008	4769	58	17112	Diptera & Ephemeroptera	8
	2010	12266	52	44011	Diptera	6
	2012	5893	61	21145	Diptera	8
MH-20	1992	394	22	1414	Ephemeroptera	6
	1994	720	31	2583	Ephemeroptera & Diptera	8
	1996	936	54	3358	Ephemeroptera & Diptera	12
	1998	2564	59	9200	Ephemeroptera & Diptera	10
	2000	412	28	1478	Diptera & Ephemeroptera	6
	2002	1591	43	5709	Diptera	6
	2004	1853	56	6648	Diptera & Ephemeroptera	11
	2006	1196	64	4291	Ephemeroptera & Diptera	11
	2008	826	49	2964	Ephemeroptera & Diptera	7
	2010	3474	54	12465	Diptera & Ephemeroptera	8
	2012	682	52	2447	Ephemeroptera	10

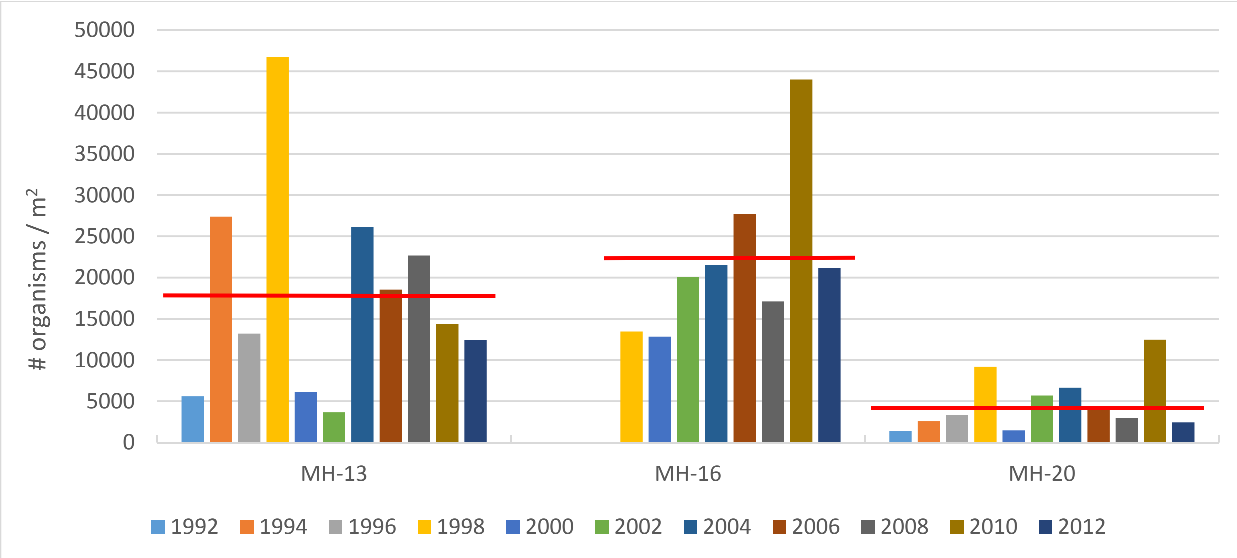

Figure 4-6 Community Density by Site Over Time

Taxonomic richness has continued to fluctuate over time at MH-13 and MH-20, but has been relatively stable at MH-16. The community at MH-13 was at its most diverse in 2004. The most diverse communities at MH-16 and MH-20 occurred in 2006, with an overall record number of 76 different organisms identified at MH-16. The number of sensitive taxa has varied significantly at MH-13, but has been very low during recent surveys. This was likely due to natural degradation in habitat quality. The communities at MH-16 and MH-20 continue to have high numbers of sensitive taxa.

The dominance of the respective communities has remained virtually unchanged over the study period. Diptera has been the dominant or co-dominant order at MH-13 during every sampling period. Ephemeroptera and/or Diptera have been the dominant orders at MH-16 and MH-20 over time.

The temporal data generally indicates that the community at MH-13 fluctuates depending on the changing habitat characteristics during the particular sampling period. Although abundance varies somewhat over time, the communities at MH-16 and MH-20 are relatively stable.

Overall, the benthic invertebrate communities within the False Canyon Creek drainage have remained relatively diverse and have had good representation from the major groups of organisms that are usually present in lotic waters.

During a late June 2014 survey of the aquatic environment of Camp Creek and North/Burnick creeks by Azimuth, these watercourses were examined for physical habitat features, sediment chemistry, aquatic macrophytes, amphibians, benthic invertebrates and fish. A single location was examined on North/Burnick Creek at MH-12 and five locations on Camp Creek at MH-04, CC-3 (upstream of Reclaim Pond adjacent to culvert protection), MH-28a (upstream of Portal Creek) MH-27 upstream of Access Creek and MH-29 within Access Creek. Although complete results from this investigation are not available yet, preliminary results indicate a diverse aquatic invertebrate community typical of cold water environment at MH-12. In Camp

Creek and Access Creek, the benthic community appeared reasonably abundant and diverse at MH-04 and CC-03 and depauperate relative to upstream at MH-28, MH-27 and MH-29.

4.1.5.3 Stream Sediments

Baseline stream sediment samples were collected by EPS in 1988 and 1990 (EPS, 1994). Stream sediment samples have subsequently been collected concurrently during the biological monitoring program as described in the water licence, every two years since 1992, at the same locations as the fisheries and benthic invertebrate investigations. In 1998 assessments were also conducted on North Creek upstream and downstream of the North Creek dike. Sediment data have been summarized and are presented in Table 4-7, while detailed results are available in the respective annual reports. Stream sediment sampling locations are shown in Figure 4-5.

High levels of lead and zinc were found in the 1988 samples collected by EPS from a site identified as "headwaters of False Canyon Creek" at 60°32'N by 128°57'W. This site may lie within the vicinity of the ore body. No corresponding licence station exists at this location and samples were only collected in 1988.

Sediment results were compared to data collected in previous studies in the previously mentioned annual reports. Arsenic concentrations have consistently surpassed the Interim Sediment Quality Guideline (ISQG) and have approached or exceeded the Probable Effects Level (PEL) at MH-13, ranging between 18.2 mg/L to 8.1 mg/L since 1990. The concentrations do not appear to have impacted the aquatic communities.

Copper levels remain well below the ISQG, which has been changed since 2000. As the copper ISQG was raised from 22.7 to 35.9, this is not a significant issue with respect to sediment copper concentrations. Concentrations were very similar at MH-13 and downstream at MH-20. Levels at MH-16, located between these two sites, were lower.

Cadmium, lead and zinc concentrations were significantly higher in the sediments at MH-13 than downstream at MH-16 and MH-20. The ISQG cadmium was exceeded on all occasions at MH-13, and frequently at MH-16. There has been one exceedance at MH-20 in 1996, which is considered an anomalous reading. Concentrations of lead in the stream sediments at MH-16 and MH-20 continue to be much lower than at MH-13, and are well below the ISQG. Lead levels in the sediments at MH-13 have frequently exceeded the ISQG over the study period. Zinc concentrations in the stream sediments are greater at MH-13 than at the other two sites, and have exceeded the ISQG on each sampling event.

In general, the concentrations of the various metals have remained relatively consistent in the sediments at MH-20. Concentrations tended to fluctuate more widely in the sediments at MH-13 and moderately in the sediments at MH-16.

Table 4-7 Comparison of metals (µg/g) in Sediments over the Study Period

Site	Year	Arsenic	Copper	Cadmium	Lead	Zinc
MH-13	1992	17.0	21.7	1.2	65	256
	1994	11.5	22.8	1.5	47	216
	1996	12.0	19.2	1.7	27	160
	1998	14.0	20.7	1.2	37	174
	2000	17.3	24.1	2.1	71	266
	2002	8.1	17.8	1.2	24	148
	2004	9.6	23.5	1.3	30	185
	2006	18.2	23.9	2.4	38	224
	2008	12.8	22.0	1.9	48	226
	2010	16.1	24.5	1.9	38	233
	2012	16.2	22.9	2.0	28	199
MH-16	1998	<8	9.2	0.4	8	72
	2000	11.3	9.8	0.4	8	80
	2002	6.0	13.0	0.8	11	90
	2004	7.8	17.5	1.0	12	118
	2006	8.4	14.6	0.8	11	96
	2008	5.9	13.8	0.8	11	95
	2010	9.3	20.0	1.4	15	138
	2012	4.3	10.4	0.6	8	82
MH-20	1992	13.0	22.1	<0.1	15	78
	1994	<10	20.6	0.5	9	70
	1996	9.0	16.6	1.5	9	69
	1998	10.0	18.7	0.3	11	74
	2000	7.3	23.0	0.3	13	88
	2002	4.6	16.9	0.3	8	57
	2004	6.1	22.9	0.4	10	78
	2006	6.0	18.0	0.3	8	66
	2008	5.8	21.1	0.4	10	75
	2010	9.3	16.8	0.5	8	75
	2012	6.0	21.2	0.6	9	69

Note: *ISQG = Interim Freshwater Sediment Quality Guidelines, in red where exceeded*
PEL = Probable Effects Level (>50% of adverse effects occur above this level), shaded and in red where exceeded

4.2 AQUATIC RESOURCES POTENTIAL EFFECTS CHARACTERIZATION

There are no anticipated effects on hydrology and hydrogeology from the mine's transition into the post-reclamation phase. As discussed in SRK's Post-Closure Water Quality Predictions Report (Appendix J), it is not expected that water quality parameters under post-reclamation conditions will be significantly different from what they currently are under temporary closure. However, SRK also produced a conservative scenario (considered highly unlikely in the 25 years term of the requested Water Licence), which assumes that the natural attenuation from the Jewelbox zone is consumed, which would result in increased concentrations of some parameters downstream. Under this scenario, there are potential adverse effects to aquatic resources if contaminant concentrations reach levels of chronic or acute toxicity. Two flow conditions were evaluated for the conservative case: average monthly flow and the seven-day average flow low that occurs once every 20 years during the summer (7Q20s).

The spatial scope of the aquatics resources effects assessment is limited to the False Canyon Creek watershed, and the temporal scope is considered to be the duration of the Project – 25 years.

As demonstrated by the recent fisheries investigations and historic monitoring (see Section 4.1.5), there is no fish use of upper Camp Creek or Access Creek, consequently the effects assessment focuses on contaminant concentrations at station MH-13 in False Canyon Creek, where slimy sculpin are known to be present. Despite significant effort, no other fish species were captured at this location since 1992, however, arctic grayling, burbot, round whitefish and one lake chub were captured at downstream locations on False Canyon Creek (MH-16 and MH-20).

The following sections will examine potential adverse effects of the contaminant concentrations that may exceed the CCME *Guidelines for the Protection of Aquatic Life* (PAL) (see Table 4-3) at station MH-13. The contaminants of concern for which water quality predictions were carried out by SRK include zinc, lead and cadmium, as results of ongoing water quality monitoring at site have shown that these parameters regularly exceed the CCME guidelines. Other parameters for which occasional exceedances were observed during monitoring, but for which no water quality predictions were made, will also be discussed where appropriate, as the expected case is that concentrations will remain unchanged from current conditions under post-reclamation.

For the Burnick Portal discharge, studies indicate that the attenuation mechanism will last much more than 200 years, which is sufficiently longer than the 25 year duration of the post-reclamation water licence, and the "expected case" and "conservative case" are therefore the same. Predicted zinc, lead and cadmium concentrations did not exceed CCME WQG PAL at monitoring locations MH-12 and MH-18 in Tributary E, and as such, drainages to the north of the mine site will therefore not be considered further in this effects assessment.

4.2.1 Aluminum

Elevated aluminum levels, particularly in acidic water, may be toxic to fish. "Gills, skeleton, kidney, liver and muscles are the main target organs for Al toxicity; former three being more susceptible. The effects of pH and Al on fish vary not only from species to species but also among different life stages." (Sharma 2003)

Exceedances of the CCME guideline at MH-13 for aluminum are rare (only one exceedance in 40 samples) and the mean concentration (0.036 mg/L) is well below the guideline value of 0.1 mg/L. In an evaluation of Water Quality Data to Support Permitting, Azimuth has noted that (Azimuth, 2014):

> The WQG is based on the original CCREM (1987) document for total aluminum concentrations in an unfiltered sample. The guideline is pH-dependent: 0.005 mg/L if pH < 6.5 and 0.1 mg/L if pH is ≥ 6.5. Calcium ions (Ca^{2+}) and DOC were also factored into the original guideline, but have since been removed due to the lack of supporting rationale. The pH dependent guideline is based partly on Neville's (1985) observation that the physiological response of juvenile rainbow trout to 0.075 mg/L aluminum is severe at pH 6.1, but minimal at pH 6.5. The numerical limit of 0.1 mg/L first proposed by the U.S. EPA was tentatively recommended for waters with a pH equal to or greater than 6.5 (US EPA 1973), where aluminum exists primarily as $Al(OH)^{-4}$. For acidic waters with a pH equal to or below 6.5, a guideline of 0.005 mg/L is recommended based on the no-effect concentration for egg hatching success in the toad *Bufo americanus* (Clark and LaZerte 1985).
>
> A review of other available guidelines in other jurisdictions was undertaken to determine if there are more up-to-date criteria available for aluminum in aquatic environments. British Columbia Ministry of Environment and Parks[6] established its own water quality criteria for aluminum in 1988, which was most recently updated in August 2001 (Butcher 1988). As opposed to the CCREM (1987) WQG, the BC criteria are expressed in terms of dissolved aluminum for 30-d average[7] (i.e., chronic) and maximum (i.e., acute) concentrations. Criteria were derived specifically for the dissolved fraction as it is likely to contain the most bio-reactive forms of aluminum in absence of detailed site-specific information (Butcher 1988). BC adopted the CCREM (1987) 0.1 mg/L guideline as the maximum guideline for waters with a pH > 6.5. The 30-d mean guideline when pH is > 6.5 was set arbitrarily to 50% of the maximum guideline value (Butcher 1988). The BC pH-dependent criteria for aluminum for water with pH < 6.5 are less restrictive than the CCREM guidelines and more representative of conditions found over the low pH range in BC. The table below outlines the applicable criteria for BC freshwater:

Criteria	Maximum Aluminum (dissolved fraction and instantaneous pH)	30-day Mean Aluminum (dissolved fraction and median pH)
pH ≥ 6.5	0.1 mg/L	0.05 mg/L
pH < 6.5	Criteria = $e^{[1.209 - 2.426(pH) + 0.286(K)]}$ where K = $(pH)^2$	Criteria = $e^{[1.6 - 3.327\ (median\ pH) + 0.402(K)]}$ where K = $(median\ pH)^2$

The mean pH value at MH-13 is 8.1 and ranges from 7.0 to 8.8, and the only exceedance of the guideline occurred at a pH of 8.05 (June 8, 2006). The dissolved aluminum value is not available for this date to allow for a direct comparison with the BC guideline, however it can be assumed to be less than the total concentration of 0.17 mg/L. In recent samples (September 2013), dissolved aluminum represented 36% of

[6] Now called Ministry of Water, Land and Air Protection.

[7] Based on a minimum of 5 approximately weekly samples.

total aluminum at MH-13. Applying this ratio to the 0.17 mg/L value for total aluminum would yield a concentration of dissolved aluminum of 0.06 mg/L, which would fall below the guideline. This value should however be taken only as a rough approximation, as there is very little dissolved aluminum data available to validate this estimation.

"Dissolved organic matter reduces the toxicity of Al to fish, by complexing Al and reducing the amount of Al in solution that can bind to fish gills. Dissolved organic carbon apparently has an additional protective effect against Al toxicity to fish, which could be related to a DOM-caused reduction of Al precipitation and polymerization in the gill microenvironment. Dissolved organic matter is likely more important in protecting against Al toxicity than is F– or Si. Finally, fish can acclimate to Al, but at a metabolic cost." (Gensemer et al. 2010) Although there is only a limited number of DOC values available, DOC levels at MH-13 seem to be relatively high (average of 3.76 mg/L) compared to levels at other WQ stations in the Project area (ranging from an average of 1.29 mg/L to 4.24 mg/L) and aluminum levels have been reasonably constant in the past 15 years which could have allowed fish to acclimate.

For these reasons and because aluminum exceedances are rare (low frequency and probability) and of small magnitude, aluminum expected and observed concentrations at MH-13 are not considered to result in adverse effects to aquatic resources.

4.2.2 Cadmium

Cadmium toxicity has been found to be variable in fish, with salmonids being particularly susceptible (CCME 1999a). Adverse impacts include reduced growth (due to increased metabolic burden and/or impaired olfactory system), decreased recruitment (due to young fish being more sensitive and spawning adults avoiding contaminated areas), and mortality (Morris 2010). Sub-lethal exposure can cause accumulations in the olfactory systems or affect the central nervous system, and cause changes in behavior (social, foraging, predator avoidance) (Morris 2010).

Aquatic organisms take up cadmium from both their diet and respiratory surfaces (Chapman 2012, McGeer et al. 2012). Cadmium toxicity depends on a number of physical and chemical parameters, including pH, salinity, and hardness (Environment Canada 1994, McGeer et al. 2012). Currently, the primary quantitative correlation used to modify metal toxicity estimates is water hardness. Hardness has a direct effect on cadmium toxicity, since calcium and magnesium ions compete with the metal for binding sites on the gill, but it also serves as a surrogate for pH, alkalinity and ionic strength as these parameters are usually positively correlated with hardness (USEPA, 2001).

Approximately 9% of samples are in exceedance of the long-term CCME cadmium guideline at MH-13 (or five out of 57 samples). In SRK's Post-Closure Surface Water Quality Predictions Report (see Appendix J), no exceedances of the CCME short-term or long-term guidelines are predicted under the expected case, and only the February monthly average predicted concentration exceed the long-term guideline under the conservative scenario.

In an evaluation of Water Quality Data to Support Permitting, Azimuth has noted that (Azimuth, 2014):

> Species sensitivity distributions (SSD) were used to derive the updated 2014 CCME WQG (CCME 2014). The updated WQG is site-specific, and is expressed as an equation that reflects the importance of water hardness when applying the

> site-specific guideline. Derivation of the WQG equations was done by first determining the empirical relationships between hardness and cadmium toxicity for both short and long-term exposures using datasets for fish and invertebrate species where toxicity data were available over a wide range of hardness. Relationships (i.e., slopes) of hardness-toxicity were then calculated for the applicable short-term and long-term exposures separately using the pooled invertebrate and fish data. Pooled slope factors for the short-term and long-term exposures were then used to derive hardness-dependent water quality equations. These equations were then used to adjust the toxicity endpoints to a common hardness value (50 mg/L as $CaCO_3$) for comparison of the SSD for the short-term and long-term exposures. Using the 5th percentile of all species in the short-term SSD dataset, the hardness-adjusted short-term cadmium WQG is 1.0 µg/L. The hardness-adjusted cadmium WQG for long-term exposure calculated from the 5th percentile of the long-term SSD dataset is 0.09 µg/L. […]
>
> Rainbow trout were the most sensitive species for determining the short-term (96 hr LC50 = 0.47 µg/L) and long-term (62-d EC10 for weight in early lifestage = 0.23 µg/L) freshwater benchmark cadmium concentration. For invertebrates, the most sensitive were the cladocerans (water fleas, daphnids), amphipods (e.g., Hyalella sp.), and hydras in both short-term and long-term exposure. The most sensitive short-term invertebrate endpoint was the 96 hr LC50 for Hyalella azteca of 0.84 µg/L (Schubauer-Berigan et al. 1993). The most sensitive long-term endpoint was a hardness-adjusted 7-d EC10 value (for both reproduction and feeding inhibition) for Daphnia magna of 0.045 µg/L (Barata and Baird 2000).

Because the most sensitive fish species (rainbow trout) on which the derivation of the guideline was based is not present in False Creek Canyon, the guideline is overprotective for slimy sculpin that are present at MH-13. Since cadmium exceedances are relatively rare and only predicted to occur during the month of February under the conservative scenario (low likelihood, frequency and magnitude), predicted and observed cadmium concentrations are not expected to result in adverse effects to aquatic resources.

4.2.3 Chromium

Hexavalent chromium is a toxic metal that can induce alterations at biochemical, histologic, genetic, and immunologic levels in fish as a function of time (Venkatramreddy et al. 2009). "The aquatic toxicology of Cr depends on both biotic and abiotic factors. The biotic factors include the type of species, age and developmental stage. The temperature, concentration of Cr, oxidation state of Cr, pH, alkalinity, salinity, and hardness of water constitute the abiotic factors. Moreover, lethal and sub-lethal concentrations of the metal and its speciation also determine the sensitivity of the individual organism." (Venkatramreddy et al. 2009)

In an evaluation of Water Quality Data to Support Permitting, Azimuth notes that (Azimuth, 2014):

> The chromium guidelines for the protection of aquatic life were updated in 1999 (CCME 1999b). Two guidelines are available depending on the valance state: 1.0 µg/L for hexavalent chromium [Cr(VI)] and 8.9 µg/L for trivalent chromium [Cr(III)]. Both guidelines are for unfiltered samples. According to the CCME Factsheet (1999), approximately 10 to 60% of the total chromium in unfiltered samples occurs as dissolved Cr(VI). In filtered samples, the percentage of dissolved Cr(VI) is between 70 and 90%.
>
> The numerical WQGs were derived according to protocols outlined in CCME (1991) by applying a safety factor of 0.1 to the lowest observed effect level (LOEL) from a chronic study using a non-lethal endpoint from the most sensitive lifestage of the most sensitive species from the available set of data. In the case of Cr(VI), invertebrates are the most sensitive group of organisms, and the most sensitive chronic endpoint available was the 14-d LOEC of 0.01 mg/L for *Ceriodaphnia dubia*. Applying the 0.1 safety factor to the LOEC of 0.01 mg/L for *C. dubia* produced the 1.0 µg/L guideline for Cr(VI) for the protection of freshwater life. The WQG for Cr(III) is based on the 102-d LOEC of 0.089

> mg/L for rainbow trout mortality, which after the application of the 0.1 safety factor, results in the interim water quality guideline of 8.9 µg/L.

Very few samples are available for chromium at MH-13. Sampling results show that three out of five samples were in exceedance when comparing total chromium data to the hexavalent chromium guideline of 0.001 mg/L, with a mean concentration of 0.002 mg/L. When considering all the stations in the Camp Creek to Canyon Creek drainage, 23 out of 30 total chromium samples exceed the hexavalent guideline and the mean concentration is also 0.002 mg/L. However, when applying the ratio of 10-60% of total chromium occurring as dissolved Cr(VI), the exceedance rate is much lower.

Chromium toxicity is greater at lower pH values as exemplified by a study that found that Cr toxicity was 50-200 times higher at pH 6.4 to 7.4 than at pH 7.8 to 8.0 (Venkatramreddy et al. 2009). The mean pH value at station MH-13 is 8.1 which would be conducive to a reduced chromium toxicity. Moreover, among the 30 fish species studied for the development of the CCME guideline, salmonids were found to be the most sensitive group (CCME 1999b). As no salmonids are present at MH-13, the guideline is likely overprotective.

Additional monitoring for chromium will be carried out as part of the long term monitoring program at station MH-13 and other stations to better characterize concentrations and distribution patterns and to allow for quick identification of any arising issues.

Based on the considerations outlined above and considering also that the guideline incorporates a safety factor of 0.1, chromium levels observed and expected at MH-13 are not expected to result in adverse effects to aquatic life.

4.2.4 Copper

In addition to acute toxicity caused by exposure to high copper concentrations, chronic exposure to lower concentrations can have sublethal effects on fish reproduction, behavior, growth, osmoregulation, olfaction, respiration and metabolism, enzyme activity, teratogenesis and resistance to disease (USEPA 2007). Copper toxicity has been well studied and includes effects at low concentrations (low parts per billion range) under certain water quality conditions. However, it is widely recognized that the aquatic fate, bioavailability, and toxicity of copper are strongly influenced by a complex combination of physical, chemical, and biological conditions (e.g., Paquin et al. 2002, USEPA 2007, and Grosell 2012). In natural waters, the bioavailability and toxicity of waterborne copper are particularly influenced by dissolved organic carbon, pH, and hardness (USEPA 2007, Kennedy et al. 2012, and Grosell 2012).

Exceedances of the CCME guideline at MH-13 for copper are relatively rare (only two out of 30 samples) and concentrations are only slightly above the corresponding guideline value. In an evaluation of Water Quality Data to Support Permitting, Azimuth has noted that (Azimuth, 2014):

> Canadian WQG for copper were derived based on the US EPA 1985 revision of the copper criteria (US EPA 1985). Copper toxicity is dependent on the hardness of the water, and in soft water (0-82 mg/L $CaCO_3$) the CCME guideline is set to a minimum value of 2.0 µg/L. At hardness ≥ 82 mg/L and ≤ 180 mg/L the WQG is calculated using this equation:

$$WQG = e^{[0.8545 * \ln(\text{hardness}) - 1.465] \times 0.2}$$

The US EPA derived this equation by dividing the final acute value (18.46 µg/L at 50 mg/L hardness) by the acute-to-chronic ratio (ACR) ACR (2.823) to obtain the hardness-normalized final chronic value of 6.539 µg/L. The application factor 0.2 was added to the CCREM guideline due to the uncertainty at the time regarding the effect of hardness on the chronic toxicity of copper (CCREM 1987). Chronic toxicity data were available for 5 invertebrate species and 10 fish species when the US EPA derived the 1985 guideline. Early life stage testing of brook trout indicated they were the most sensitive species, with chronic effects observed at a concentration of 3.87 µg/L (US EPA 1985). Above 180 mg/L hardness, the CCREM guideline is set to a maximum value of 4 µg/L.

Acute and chronic guidelines were derived by BC MOE in 1987:

Criteria (hardness as $CaCO_3$)	**30-d Average WQG** (total copper µg/L)	**Maximum WQG** (total copper µg/L)
hardness > 50 mg/L	0.04 x (average hardness)	(0.094 x (hardness) + 2)
hardness ≤ 50 mg/L	2.0	(0.094 x (hardness) + 2)

The BC guidelines were developed to be more flexible and suitable to provincial background conditions. Data used to derive these equations came from embryo-larval bioassays on fish and amphibians presented in Birge and Black (1979). LC50 values were the lowest for rainbow trout (0.11 mg/L at 100 mg/L CaCO3). The corresponding LC1 value, defined as the exposure concentration that produced a 1% impairment, was 4.1 µg/L at 100 mg/L CaCO3. Using these results, BC Ministry of Environment set the guideline to 2 µg/L for soft water to allow for a 1 µg/L increase in copper for every 25 mg/L step in hardness above 50 mg/L. The slope (0.04) in the 30-d average WQG hardness-dependent formula was calculated by dividing range of acceptable copper concentrations by the range of hardnesses reported by Birge and Black (1979): upper limit = 8 µg/L at 187 mg/L hardness; lower limit = 2 µg/L at 37 mg/L hardness.

A more recent update to the US EPA's WQG was issued in 2007. The updated chronic copper guideline was derived from chronic and comparable acute toxicity data for six invertebrate species and 10 fish species. Chronic endpoints include no adverse-effect concentrations (NOAECs) and lowest observed adverse effect concentrations (LOAECs) for survival, growth and reproduction endpoints. These data were used to calculate a final chronic value, which was used to derive the hardness-dependent criteria formula by first dividing the final acute value by the updated ACR[8]. The resulting final chronic value and pooled slope of the chronic data were then solved for the chronic y-intercept to produce the updated hardness-dependent WQC:

$$\text{Update US EPA chronic WQC (in µg/L)} = e^{[0.8545 * \ln(\text{hardness}) - 1.702]}$$

When comparing the results to the BC chronic guideline which is calculated to be 0.00784 mg/L using an average hardness of 196 mg/L (average over all the samples collected at MH-13), no exceedances are observed. Similarly, no exceedances of the US EPA guideline are observed at MH-13. For these reasons, copper observed and expected concentrations at MH-13 are not expected to result in adverse effects to aquatic resources.

[8] *Calculated as the geometric mean of the ACR of the sensitive species* C. dubia*,* D. magna*,* D. pulex*, chinook salmon (*O. tshawytscha*), rainbow trout.*

4.2.5 Iron

The mechanisms of iron toxicity in fish are not well understood but one possible mechanism is the precipitation of ferric hydroxide directly onto the gills of fish (Philippen et al. 2008). Organic material in the water was found to have an ameliorating effect on ion regulation and facilitated oxygen uptake by preventing most of the accumulation of iron on the gills. (Philippen et al. 2008) Studies have shown that fish can acclimatize to iron and regulate toxic concentrations. (Philippen et al. 2008).

In an evaluation of Water Quality Data to Support Permitting, Azimuth notes that (Azimuth, 2014):

> The CCME freshwater guideline for iron has not been updated since the CCREM (1987) document was published. CCREM referred to the 0.3 mg/L guideline in use by the Ontario Ministry of Environment (1984) and the IJC (1978) as the most relevant and protective guideline available. Manitoba and the US EPA were using a 1.0 mg/L criteria at this time, but the 1.0 mg/L value was considered too close to the EC50 for fathead minnow hatchability to be considered adequately protective by the CCREM.
>
> British Columbia issued a revised guideline for iron in 2008 of 1.0 mg/L for total iron and 0.35 mg/L for dissolved iron (Phippen et al. 2008). The dissolved iron guideline is based primarily on the lowest 96-hr LC50 value that was reported by the BC MOE in toxicity tests they conducted in 1997. Freshwater tests were conducted on the following species in three different waters with varying hardness concentrations: rainbow trout, *Hyalella azteca*, *Chironomus tentans*, *Daphnia magna*, and *Selanastrum capricornutum*. *Hyalella* was the most sensitive organism tested, with an LC50 = 3.5 mg/L in soft water (50 mg/L). A safety factor of 10 was applied to this LC50 value to arrive at the guideline value of 0.35 mg/L for dissolved iron. The 1.0 mg/L guideline for total iron is based on field research conducted by Linton et al. (2007) using changes in community structure to define ecological effects-based criteria for total iron. The establishment of a total iron guideline accounts for the direct and indirect mechanisms whereby iron can have detrimental effects on aquatic systems. Direct toxicity of iron is related mostly to ferrous (Fe^{2+}) iron which is more soluble and bioavailable than ferric (Fe^{3+}) iron while indirect effects of iron are related to the precipitation of iron colloids causing negative effects on respiration and food consumption (Linton et al. 2007). Quantile regression was used to model the decline in maximum abundance of benthic taxa along a gradient of increasing iron concentrations[9]. Two field-based effects concentrations (i.e., 20% reduction in the 90th quantile of organisms) were calculated using this method. The most conservative benchmark is 0.21 mg/L total iron, which corresponded to no/minimal changes in the aquatic community structure and function. The second benchmark of 1.74 mg/L corresponds to moderate changes in the aquatic community as a result of the loss of some rare species and/or increases in the population of more tolerant species (Linton et al. 2007). Based on this information, and applying the precautionary principle, the 1.0 mg/L guideline was deemed appropriate for continued use in BC (Phippen et al. 2008).

Sampling results at MH-13 show an exceedance rate of 24% when comparing total iron data to the CCME guideline of 0.3 mg/L, however when comparing to the guideline of 1.0 mg/L used in Manitoba, BC and by the US EPA, the exceedance rate is only 3.4% (or two samples out of 58), and results are only marginally over the guideline.

Also, although there is only a limited number of DOC values available, DOC levels at MH-13 seem to be relatively high (average of 3.76 mg/L) compared to levels at other WQ stations in the Project area (ranging

[9] *The benthic invertebrate dataset used in the model came from the West Virginia (USA) Department of Environmental Protection (WVDEP) Water Assessment Program for years 1996-2001.*

from an average of 1.29 mg/L to 4.24 mg/L) which could have an ameliorating effect, and iron levels have been reasonably constant in the past 15 years allowing fish to acclimate.

For these reasons, iron observed and expected concentrations at MH-13 are not expected to result in adverse effects to aquatic resources.

4.2.6 Lead

Approximately 7% of samples are in exceedance of the CCME lead guideline at MH-13 (or four of 58 samples). In SRK's Post-Closure Surface Water Quality Predictions Report (see Appendix J), no exceedances of the CCME guidelines are predicted under the expected case or under the conservative scenario.

The acute and chronic toxicity of lead is greater in soft water than in hard water (CCREM, 1987). In an evaluation of Water Quality Data to Support Permitting, Azimuth notes that (Azimuth, 2014):

> The CCME aquatic life water quality guideline for lead is based on the original information presented in CCREM (1987). […] the guideline is hardness dependent and takes into account the site specific hardness values for deriving the guideline value. For soft water (< 60 mg/L as $CaCO_3$), the lead guideline is 1 μg/L, and in very hard water (> 180 mg/L as $CaCO_3$) the guideline is 7 μg/L. At hardness concentrations between 60 and 180 mg/L, the chronic 4-d average criterion derived by the US EPA (1985) was adopted as the maximum concentration guideline. According to Nagpal (1987), the formula was "designed to protect 95% of a group of diverse genera from the harmful effects of lead." The chronic guideline was developed using acute toxicity data for fourteen species, and chronic toxicity for four species to obtain the pooled slope (1.273). Species and genus mean acute values were calculated, normalized to 50 mg/L, and a final acute value was calculated from the species with the four lowest genus mean acute values: amphipod (*Gammarus pseudolimnaeus;* 142.6 μg/L), the *Daphnia magna* (447.8 μg/L), rainbow trout (2448 μg/L), and brook trout (*Salvelinus fontinalis;* 4820 μg/L). The final acute value (67.54 μg/L) was divided by a safety factor of 2 to obtain an acute water quality criteria of 33.77 μg/L at 50 mg/L hardness (as $CaCO_3$), which in turn was used to solve the acute y-intercept (-1.460). Below is the formula for the acute US EPA water quality criteria:
>
> $$\text{US EPA acute guideline } (\mu g/L) = e^{[1.273 * \ln(\text{hardness}) - 1.460]}$$
>
> The chronic guideline was developed using ACRs with the studies performed within similar hardness ranges. The final ACR was 51.29, corresponding to a chronic lead concentration equal to 1.317 μg/L at 50 mg/L hardness. The chronic y-intercept was solved (-4.705) at 50 mg/L hardness to yield a final chronic lead guideline:
>
> $$\text{US EPA chronic guideline } (\mu g/L) = e^{[1.273 * \ln(\text{hardness}) - 4.705]}$$
>
> British Columbia has adapted the US EPA chronic guideline value to account for results presented by Davies et al. (1976) that indicated maximum acceptable lead concentrations between 4.1 ug/L and 7.6 ug/L at hardness 28 mg/L for rainbow trout. By comparison, the chronic US EPA guideline at 28 mg/L hardness equals 0.6 ug/L. Based on these data, the 30-day average lead criteria was set to 4.0 ug/L, and the hardness-dependent WQG was established by solving for the adjustment factor "*A*" in the modified US EPA chronic formula:
>
> $$4.0\ \mu g/L = A + e^{[1.273 * \ln(30\ mg/L\ \text{hardness}) - 4.705]}$$
>
> $$A = 3.31$$
>
> By solving for the adjustment factor, the BC chronic WQG accounted for the "no effect" data observed for rainbow trout to yield a hardness dependent guideline (when hardness > 8 mg/L) of:
>
> $$\text{BC 30-day WQG} = 3.31 + e^{[1.273 * \ln(\text{hardness}) - 4.705]}$$

As was the case for cadmium, the most sensitive fish species (rainbow trout and brook trout) on which the derivation of the guideline was based are not present in False Creek Canyon, and the guideline is therefore overprotective for slimy sculpin that are present at MH-13. Because observed lead exceedences are relatively rare and not predicted to occur under the expected case or conservative scenario (low likelihood, frequency and magnitude), predicted and observed lead concentrations are not expected to result in adverse effects to aquatic resources.

4.2.7 Selenium

Selenium (Se) is an essential element that can bioaccumulate to toxic levels under certain biogeochemical conditions. Exceedences of the CCME guideline at MH-13 for selenium are relatively rare (only three out of 25 samples) and concentrations are only slightly above the guideline value. In an evaluation of Water Quality Data to Support Permitting, Azimuth has noted that (Azimuth, 2014):

> The CCME WQG was carried forward from the original CCREM (1987), which adopted the International Joint Commission recommendation of 1 µg/L selenium in an unfiltered sample. The recommended guideline was based on field studies in the Great Lakes that observed water borne selenium concentrations between 5 and 10 µg/L have the potential to cause acute lethality to predatory fish due to bioaccumulation in the food web.
>
> Since the CCREM guideline was first published, a considerable volume of research has been conducted, resulting in implementation of revised/updated WQG in many jurisdictions. In British Columbia, the approved freshwater aquatic guideline of 2 µg/L[10] for surface water came into effect in 2001. The guideline was established by applying a safety factor of 5 to the LOEL of 10 µg/L that was observed for a number of fish species and an EC50 of 10 µg/L for *D. magna* (Beatty and Russo 2012). In 2012, BC published an updated draft of the WQG for selenium that incorporated more recent data in the derivation process. The application of the 2 µg/L WQG was supported by bioaccumulation modeling of the concentration of selenium in the surface water corresponding to EC10 egg selenium toxicity for larval survival and deformity in cutthroat trout (Beatty and Russo 2012). As an added level of protection, an alert concentration of 1 µg/L was recommended to identify potential areas at risk of elevated selenium, and to trigger more frequent monitoring of water and other components of the aquatic environment.
>
> The US EPA is also in the process of updating its freshwater aquatic criteria from the 1987 guideline value of 5.0 µg/L. Below are a list of other WQG values in place various jurisdictions throughout North America.

Jurisdiction	Guideline/Criteria/Objective	Reference
International Joint Commission	≤ 1 µg/L	IJC (1981)
CCME	1 µg/L	CCREM (1987)
BC MOE (approved)	2 µg/L	Nagpal and Howell (2001)
Ontario Environment and Energy	100 µg/L	OMEE (1994)
US EPA	5 µg/L (chronic)	US EPA (1987a, 2004)

> In addition to the WQGs, some agencies have developed guidelines for other components of the aquatic environment. Selenium is known to bioaccumulate in aquatic food webs, and predicting effects to aquatic organisms based solely on measuring the selenium concentration in surface water is challenging. The US EPA published a draft tissue guideline

[10] *Total selenium in an unfiltered sample.*

> of 7.91 µg/g in whole body fish tissue in 2004 that recognized the difficulty in establishing protective selenium criteria based solely on water monitoring. The derivation of the draft criteria relied mainly on a study by Lemly (1993) that found increased sensitivity to selenium toxicity for bluegill sunfish when they were exposed to low temperatures[11]. In BC, a fish tissue criteria of 4.0 µg/g dw was proposed based on a whole-body toxicity threshold (EC10) for chinook salmon (see discussion in Nagpal and Howell 2001).

Selenium bioavailability and bioaccumulation is also known to be highly site-specific. In general, the mobilization of selenium into the aquatic food chain appears to be much higher in lentic (standing water) habitats than in lotic (flowing water) habitats (Lillebo et al. 1988, Canton and Van Derveer 1997, Lemly 1999, Orr et al. 2006, Presser and Luoma 2010, and Orr et al. 2012). Overall, the more productive an aquatic environment and the longer the food chain, the greater the risk of selenium-related effects (e.g., Presser and Luoma 2010, Orr et al. 2012).

Even though the site at MH-13 frequently exhibits unconfined channels, deep pools, and altered watercourses resulting from beaver activity, False Canyon Creek as a whole is generally a lotic environment (flowing) and is predominantly erosional with limited opportunity for selenium accumulation in deposited sediment. It is a low productivity system and does not support the type of (detrital) food chain considered to be conducive to the conversion of selenium to bioavailable forms and mobilization into the food chain. In light of these facts, and that measured and predicted selenium concentrations at MH-13 are all well below the BC MOE guideline of 2 µg/L (the maximum observed concentration was 1.68 µg/L), no adverse effects to aquatic resources are anticipated from selenium concentrations.

4.2.8 Zinc

Toxic concentrations of zinc compounds cause adverse changes to the morphology and physiology of fish. “Once absorbed internally, the zinc may be concentrated especially in the gills, gut, and liver. If the exposed fish are returned to zinc-free water, most of the absorbed zinc is subsequently lost.” (Reed et al., 1980) Generally, the acute toxicity of zinc is lower in waters with a higher water hardness and a lower pH (CCREM, 1987).

Approximately 2% of samples are in exceedance of the CCME zinc guideline at MH-13 (or one of 58 samples). In SRK’s Post-Closure Surface Water Quality Predictions Report (see Appendix J), no exceedences of the CCME guidelines are predicted under the expected case or under the reasonable worst-case scenario.

In an evaluation of Water Quality Data to Support Permitting, Azimuth notes that (Azimuth, 2014):

> The CCME guideline for zinc is held-over from the CCREM (1987) guidance that tentatively set the value at 30 ug/L according to the Great Lakes IJC (1976) and the Province of Ontario Ministry of the Environment (1984). No hardness adjustment was applied to this guideline, which is based on the two no-effects concentrations: 36 ug/L for egg hatching success of rainbow trout in soft water (Goettl et al. 1976), and 30 ug/L for egg hatching success of fathead minnows in hard water (200 mg/L as $CaCO_3$) (Brungs et al. 1969). At the time this guideline was published, there was insufficient data showing a link between chronic zinc toxicity and water hardness; however, in 1987, the USEPA

[11] *LOEC < 5.9 µg/g dw for bluegill sunfish survival based on exposure to water at winter temperatures.*

revised their chronic zinc guidelines to account for the influence of water hardness (US EPA 1996). The CCME guideline has not been updated to incorporate the importance of water hardness.

In British Columbia, the freshwater WQG established in 1997 is hardness-dependent according to the following equations presented in Nagpal (1997):

Criteria (hardness as $CaCO_3$)	**Chronic Zinc WQG** (µg/L)	**Acute Zinc WQG** (µg/L)
hardness > 90 mg/L	7.5 + 0.75 x (hardness - 90)	33 + 0.75 x (hardness - 90)
hardness ≤ 90 mg/L	7.5	33

The chronic WQG is based on the most conservative LOEL of 15 µg/L for decreased zooplankton taxa abundance from a study by Marshall et al. (1983). Water hardness was not reported in the study, but was inferred to be between 0 and 90 mg/L based on average water hardness values for the location of the study (Lake Michigan). Fathead minnow reproductive endpoints were selected as the most conservative LOEL for the 150 to 250 mg/L hardness range, which was calculated to be 180 µg/L (Brungs 1969). A safety factor of 0.5 was applied to each of these LOELs, which was derived from the average ratio of LOELs to NOELs from eight different species studies (Nagpal 1997). The adjusted LOELs from these two studies were then plotted against the hardness concentrations, and the slope of the linear regression line was calculated for the two data points.

The US EPA issued acute and chronic freshwater criteria for zinc in 1987, and updated the guidance in US EPA 1996 (US EPA 1987b, US EPA 1996). The criteria were calculated by first determining the slope of the relationship between hardness and toxicity for 8 species which were tested over a range of hardness (US EPA 1987). The individual slopes for each species were calculated, and no statistical difference was found. As such, the data were pooled and common slope was calculated (0.8473) to express the relationship between hardness and toxicity. The chronic zinc guideline was derived as the geometric mean of the ACR for three studies. The ACR based on these three studies equaled 1.994, but according to US EPA methods, if the final ACR is less than 2, the value is set to 2. The final acute value for zinc calculated from the four most sensitive species (at an adjusted hardness of 50 mg/L) was 133.2 µg/L. The final chronic value at 50 mg/L was determined by dividing the final acute value 133.2 µg/L by the ACR of 2, which equals 66.6 µg/L. Using this final chronic value, the chronic y-intercept (0.884) was solved for the 50 mg/L hardness-specific guideline value of 66.6 µg/L, to yield the final chronic zinc WQG:

$$\text{Chronic AWQC } (\mu g/L) = e^{0.8473 (\ln \text{hardness}) + 0.844}$$

When taking hardness into consideration as is the case in the BC and US EPA guidelines, it is found that the only observed exceedance of the zinc CCME guideline (and of the BC and US EPA guidelines) occurred at a very low hardness value (14.6 mg/L) compared to the mean hardness value of the site (196 mg/L) and is therefore not typical of the site conditions. Because observed zinc exceedences are very rare and not predicted to occur under the expected case or conservative scenario (low likelihood, frequency and magnitude), predicted and observed zinc concentrations are not expected to result in adverse effects to aquatic resources.

4.2.9 Monitoring and Mitigations

Environmental monitoring for surface water quality, fisheries, benthic invertebrates, and stream sediments will continue as per the schedule presented in Section 7. A Water Quality Monitoring Plan and Adaptive

Management Plan have been developed to ensure that the results of the monitoring programs are evaluated and responded to appropriately.

The combination of monitoring of environmental parameters and the responsive nature of the proposed Adaptive Management Plan will ensure that any changes to expected conditions in the post-reclamation period are identified and acted upon early. This will reduce the likelihood that emergent or changing conditions lead to effects in the terrestrial or aquatic receiving environments.

No mitigations are planned or expected to be necessary for the post-reclamation period beyond the closure and reclamation activities currently permitted and underway. Any additional mitigations to changing conditions identified through monitoring efforts will be commensurate with their nature and location, and the AMP will guide their development and implementation.

5 TERRESTRIAL RESOURCES EFFECTS ASSESSMENT

This section addresses the implications for terrestrial resource associated with the post-reclamation phase of the SDH mine. Existing conditions are detailed for wildlife, vegetation and terrain in the DDRP (Appendix B of the DDRP); potential positive and negative effects are characterized in the subsequent sections.

5.1 EXISTING WILDLIFE CONDITIONS

The SDH mine site is located within the False Canyon Creek watershed and the Mine Access Road traverses the headwaters of various tributaries of the Tom Creek watershed. The area encompasses several mature mountains with a predominance of boreal forest and limited alpine and sub-alpine terrain. This general area is capable of supporting various ungulates, large carnivores, other fur-bearers and many bird species. However, species that generally exploit alpine zones are rare due to the limited availability of habitat in the area.

In 2013, Gebauer & Associates (Gebauer) conducted field visits in the Project area to document plants, wildlife and habitats, to collect small mammals for tissue analyses, and to identify and describe Wildlife Receptors of Concern (ROCs) as part of Azimuth's ERA baseline work. Prior to this, wildlife use and habitat potential investigation within the SDH mine Project area was undertaken in 1989 to complement similar studies conducted in the area by other agencies.

The following subsections summarize some of the results from Gebauer's work and the complete report is provided in Appendix M (specifically, Appendix B of Attachment 5).

5.1.1 Mammals

During three field visits (August 2012, June and August 2013) conducted by Gebauer, 16 mammal species were recorded (Table 5-1). The most common larger mammals were Moose and Black Bear with abundant sign (i.e., tracks, scats, pellet groups, browsing sign etc.) evident throughout the site. Wolverine tracks and a Marten scat were observed once. Marten are expected to be relatively common given the availability of habitats and prey (e.g., Red Squirrel and other small mammals) and the presence of an active trap line. Porcupine and Snowshoe Hare were commonly encountered and many small mammals were captured during the pitfall and snap-trapping program (Appendix M). Hoary Marmots appear to be relatively common in higher elevation areas of the Site.

Table 5-1 Mammals Observed at the SDH Mine Site

Common Name[Status]	Scientific Name
American Beaver	Castor canadensis
American Marten	Martes americana
Black Bear	Ursus americanus
Deer Mouse	Peromyscus maniculatus
Gray Wolf	Canis lupus

Common Name[Status]	Scientific Name
Hoary Marmot	Marmota caligata
Long-tailed Vole	Microtus longicaudus
Meadow Jumping Mouse	Zapus hudsonicus
Meadow Vole	Microtus pennsylvanicus
Moose	Alces alces
Northern Red-backed Vole	Myodes rutilus
Porcupine	Erethizon dorsatum
Red Squirrel	Tamiasciurus hudsonicus
Shrew sp.	Sorex sp.
Snowshoe Hare	Lepus americanus
Wolverine Special Concern, Yukon Watch List	Gulo gulo

Other mammal species that are known or expected to occur based on distribution maps, include Muskrat (*Ondatra zibethicus*), Red Fox (*Vulpes vulpes*; photo has been taken at Site), North American River Otter (Lontra canadensis), and Ermine (Mustela erminea)(Banfield 1974; Steffen Robertson and Kirsten Inc. 1990). According to historical records, Dall (Stone) Sheep (Ovis dalli) once occurred in the alpine areas proximal to the Site, despite a lack of suitable escape cover; however, overhunting is thought to have led to local extirpation (Steffen Robertson and Kirsten Inc. 1990). The Site appears to be outside the range of Collared Pika (Ochotona collaris), but it has been identified as a species of traditional value by the LFN and has some potential to occur on or in the vicinity of the Site.

No Wildlife Key Areas for wildlife species, or habitat overlap with the SDH mine Site.

5.1.2 Birds

During the 2012 and 2013 field surveys of the SDH mine site, 56 bird species were identified (see Table 5-2). Overall, the five most common species recorded were American Pipit (82 cumulative), Barn Swallow (77), Tennessee Warbler (68), Pine Siskin (56) and Yellow-rumped Warbler (54). Thirty-eight species were recorded during the June 2013 breeding bird surveys (Appendix M). The five most common breeding birds observed during the surveys were Chipping Sparrow (25 cumulative), Yellow-rumped Warbler (25), Tennessee Warbler (24), Wilson's Warbler (24), and Swainson's Thrush (15).

Waterbirds known or expected to have breed on the site included Barrow's Goldeneye, Semipalmated Plover, Spotted Sandpiper, and Osprey (Table 5-2). Although the Osprey nested on the edge of the Reclaim Pond, food was likely captured off-Site; assuming that the Reclaim Pond does not contain fish. Other wetland-associated bird species that were observed, including Canada Goose, American Wigeon, Green-winged Teal, Pacific Loon and Solitary Sandpiper, likely did not breed but were either migrants or non-breeding individuals.

The only other raptor species observed on the Site during the field visits were Golden Eagle and Sharp-shinned Hawk (Table 5-2). Other raptor species that may occur include American Kestrel (Falco sparverius), Red-tailed Hawk (Buteo jamaicensis), Great Gray Owl (Strix nebulosa), and Boreal Owl (Aegolius funereus).

Table 5-2 Birds Observed at the SDH Mine Site

Common Name Status	Scientific Name
Pine Grosbeak	*Pinicola enucleator*
Pine Siskin	*Carduelis pinus*
Red-breasted Nuthatch	*Sitta canadensis*
Ruby-crowned Kinglet	*Regulus calendula*
Savannah Sparrow	*Passerculus sandwichensis*
Say's Phoebe	*Sayornis saya*
Semipalmated Plover	*Charadrius semipalmatus*
Sharp-shinned Hawk	*Accipiter striatus*
Solitary Sandpiper	*Tringa solitaria*
Spotted Sandpiper	*Actitis macularius*
Spruce Grouse	*Falcipennis canadensis*
Swainson's Thrush	*Catharus ustulatus*
Tennessee Warbler	*Oreothlypis peregrine*
Townsend's Solitaire	*Myadestes townsendi*
Townsend's Warbler Yukon Watch List	*Dendroica townsendi*
Tree Swallow	*Tachycineta bicolor*
Varied Thrush	*Ixoreus naevius*
Violet-green Swallow	*Tachycineta thalassina*
Warbling Vireo	*Vireo gilvus*
White-throated Sparrow Yukon Watch List	*Zonotrichia albicollis*
White-winged Crossbill	*Loxia leucoptera*
Willow Ptarmigan	*Lagopus lagopus*
Wilson's Snipe	*Gallinago delicata*
Wilson's Warbler	*Wilsonia pusilla*
Yellow Warbler	*Dendroica petechial*
Yellow-bellied Flycatcher Yukon Track List	*Empidonax flaviventris*
Yellow-rumped Warbler	*Dendroica coronata*

5.1.3 Other Wildlife

Other wildlife observed during Gebauer's site visits included: wood frog (*Rana sylvatica*), Darner sp., Dragonfly sp. and a periwinkle type snail (*Gastropoda*).

5.2 EXISTING VEGETATION AND TERRAIN CONDITIONS

The SDH mine site is located in the Liard Basin Ecoregion (ESWG, 1995). The site includes boreal forest, subalpine and alpine vegetation zones with treeline at an approximate elevation of 1400 masl.

Climax vegetation in the boreal forest zone is: white spruce (*Picea glauca*), black spruce (*Picea mariana*), subalpine fir (*Abies lasiocarpa*) or a combination of these species. Black spruce and alpine fir are the most common boreal vegetation communities in the area. Black spruce forest is prevalent on poorly drained bogs and fens such as those in the tailings impoundment area. Open stands of black and white spruce are found on upland slopes. The area around the mill and camp upwards to the treeline is primarily subalpine fir.

Paper birch (Betula papyrifera) occurs on moist sites throughout the area. Trembling aspen (*Populus tremuloides*) is found on well-drained south-facing slopes, and balsam poplar (*Populus balsamifera*) colonizes alluvial gravel bars and other moderately well-drained disturbed sites. Lodgepole pine (*Pinus contorta*) forms pure even-age stands in some upland areas on the mine site, presumably following fire. Larch (*Larix laricina*) is found in lowland bogs along the Main Access Road.

Willow (*Salix spp*.), alder (*Alnus crispa*), rose (*Rosa acicularis*) and Labrador tea (*Ledum groenlandicum*) are the common understorey shrubs. Mountain ash (*Sorbus scopulina*) is found in the tailings impoundment area. Ground cover is dominated primarily by kinnikinnick (*Arctostaphylos uva-ursi*), bearberry (*Arctostaphylos rubra*), crowberry (*Empetrum nigrum*), ligonberry (*Vaccinium vitis-idaea*), bunchberry (*Cornus canadensis*) and toadflax (*Geocaulon lividum*).

Shrub birch (*Betula glandulosa*), along with alpine fir and willows dominate the subalpine zone. Low ericaceous shrubs are common in alpine areas, along with a groundcover of mosses and lichens.

Bluejoint reedgrass (*Calamagrostis canadensis*) is a prominent graminoid in the area, particularly in moist semi-shaded areas. Altai fescue (*Festuca altaica*) is dominant on drier slopes. Fowl bluegrass (*Poa palustris*) prevails in moist open areas. Slender wheatgrass (*Agropyron pauciflorum*), violet wheatgrass (*Agropyron violaceum*) and bearded wheatgrass (*Agropyron subsecundum*) are the primary invaders of disturbed areas.

Legumes are not prominent in the native flora. Elegant milk vetch (*Astragalus eucosmus*) and arctic lupine (*Lupinus arcticus*) are the most common indigenous legumes in the SDH mine area.

Further details on habitat types, plant species, and animal species occurrence within the study area can be found in the Appendix M (specifically, Appendix B of Attachment 5) (Wildlife and Habitat Assessment of the SDH mine by Gebauer and Associates).

5.2.1 Soils

Soil classification within the SDH mine site area are primarily morainal, fluvial or glaciofluvial. Organics overlying morainal or fluvial material occur in wetlands such as the tailings impoundment areas. Upper alpine zones are bedrock while zones of colluvium occur on the steeper upland slopes.

A layer of silty loam or gravely sandy loam supports white spruce and mixed deciduous forests. These moderately well drained soils are slightly acidic to neutral (pH 6.1 to 7.3) with low to moderate organic matter and with a low level of available nutrients. Wetlands supporting black spruce vegetation have soils of mesic, fibric peat or silty loam. These poorly drained soils are slightly to strongly acidic, have high organic matter and have very little nutrients available. Alpine and subalpine vegetation is found on moderately well drained silty loam or loamy sand. These soils are slightly acid to neutral with low organic matter and with a low level of available nutrients.

5.3 TERRESTRIAL RESOURCES RISK ASSESSMENT APPROACH

One of Teck's primary closure objectives is to implement protection measures that minimize adverse environmental impacts. A critical tool in meeting this objective is the Terrestrial ERA being conducted by Azimuth. Currently the Terrestrial ERA is in draft form and will be finalized in early 2015.

The draft Terrestrial ERA (Appendix N) is also an import tool for this Terrestrial Effects Assessment as it contains the most current baseline work and analysis of results, as well as characterizes risk and uncertainty related to the closure (present phase of closure implementation) and future (post-reclamation phase) scenarios. This assessment focuses on the future scenario as the Project will commence during the post-reclamation phase.

The final Terrestrial ERA will be completed in early 2015; however, the draft Terrestrial ERA (Appendix N) is currently being used to guide closure and can be applied to this Effects Assessment. At this time, further field investigations are taking place to refine the draft Terrestrial ERA and will be incorporated in the Final Aquatic and Terrestrial ERA.

The goals of the Terrestrial ERA are to support risk management decision making for mine closure and confirm whether the activities outlined in the DDRP will be sufficiently protective of ecological receptors in the SDH mine site area. The approach relies on a formal risk assessment framework consistent with guidance from EY (2011), Environment Canada (EC 2012), and the Canadian Council of Ministers of the Environment (CCME 1996, 1997).

The Risk Assessment approach used in the ERA is outlined in detail in Section 2 the Draft Terrestrial ERA (Appendix N). Azimuth's Terrestrial ERA is a process that evaluates potential adverse effects to ecological receptors (e.g., plants, insects, birds, mammals, and fish), resulting from exposure to metal-contaminated soils, water and other media (i.e. food sources such as plants, invertebrates, and small animal prey that may have accumulated higher levels of metals from areas with contaminated soil). Ecological receptors included in the Terrestrial ERA are: microbial communities, terrestrial invertebrates, plants, birds and mammals.

Consideration of ecological receptors within each area of environmental concern (AEC) (identified by Golder's during a recent site assessment) has been given. The AECs used in the Terrestrial ERA include:

- AEC 1: Jewelbox*
- AEC 2: Burnick Zone and 1300 Portal
- AEC 3: Mill Site
- AEC 8: Tailings Management Facility
- AEC 9: Main Zone Pit, 1380 Gully and 1250 Portal*

**AECs were combined because they are spatially connected*

Risks to each ecological receptor were considered by establishing lines of evidence (LOE) which included:

- Soil chemistry for plants and invertebrates.

- Tissue chemistry (plants, invertebrates and small mammals) and hare and moose fecal pellet chemistry as measures of exposure to the ROC groups themselves (relative to background).
- Field surveys for plants and catch rates for invertebrates and small mammals.
- A plant colonization study and revegetation test plots.
- Food chain modeling

The final outcome of the Terrestrial ERA is a risk characterisation and uncertainty assessment determining whether planned closure implementation (activities outlined in the DDRP) is likely to result in negligible, low, moderate or high risk to the ecological receptors. For reference, Azimuth's risk rating are defined as:

- Negligible (e.g. concentrations are below standards or no effects observed/predicted)
- Low (e.g. concentrations are 1-3 times above standards or low-level (e.g. 10-20%) sub lethal effects are observed/predicted)
- Moderate (e.g. concentrations are 3-10 times above standards or moderate level (e.g. 20-50%) sub lethal effects are observed/predicted
- High (e.g. concentrations are more than 10 times above standards or high-level sub lethal (>50%) effects or lethal (>20%) are observed or predicted

5.4 EFFECTS ASSESSMENT APPROACH

The Terrestrial Resources Effects Assessment addresses implications of the post-reclamation state of the SDH mine site, as well as potential effects associated with monitoring and inspection events undertaken during post-reclamation.

Two Valued Components were selected for consideration in the Effects Assessment: wildlife and vegetation. Wildlife was selected as a Valued Component due to its role in local ecological integrity, and its importance to LFN in terms of subsistence harvesting, as well as maintaining a connection with the local land and resources. The geographic scope considered is the SDH mine Claim Block while the temporal scope is the duration of post-reclamation; 2016-2040.

Vegetation and Soils was selected as a Valued Component within this assessment because of its linkage to LFN activities, such as berry picking and medicinal plant harvesting. The geographic scope is limited to the Project area and the temporal scope includes the duration of post-reclamation; 2016-2040.

Potential impacts on Land and Resource Use and other Socio-Economic Valued Components are considered in Section 8.

A significance determination was made for each Valued Component based on an understanding of the outcomes of the Terrestrial ERA (summarized above in Section 5.3); as well as using a conventional Effects Assessment approach considering criteria such as magnitude, duration, extent, etc.

5.5 WILDLIFE EFFECTS CHARACTERIZATION AND SIGNIFICANCE DETERMINATION

Wildlife resources known to the area have been described above in Section 5.1. This section considers potential effects on wildlife resulting from the post-reclamation environmental conditions. Potential effects associated with monitoring and inspection events are also considered.

Post-reclamation site monitoring and inspections may result in occasional disturbance to wildlife; however, significant adverse effects are not anticipated. Post-reclamation monitoring will be periodic (low frequency and short duration), human presence at the SDH mine site will generally be reduced considerably in comparison to an operations phase, or during closure implementation, which will result in less opportunity for disturbance and human-wildlife encounters. Likewise, traffic during the post-reclamation phase will significantly reduce from past levels and once the Main Access Road is decommissioned traffic will be absent. As a result there will be little to no potential for animal-vehicle collisions.

Post-reclamation conditions may affect wildlife in a positive way in terms of potentially adding some suitable habitat through site reclamation and revegetation. Potential adverse effects may result from the post-reclamation environmental conditions due to contamination of vegetation or habitat that may adversely affect survival, reproduction and growth of wildlife species. The landfill and tailings ponds will be capped to prevent exposure; further sampling has been conducted on the waste rock areas and sufficiently protective measures to manage any associated risks will be developed upon completion of the data analysis and in collaboration with YG and LFN.

Table 5-3 outlined the post-reclamation risk characterization and uncertainty assessment outcomes completed as part of Azimuth's Terrestrial ERA (full details can be found in Section 3 Appendix N). With the exception of two ecological receptors in AEC 1 and 9 (Jewelbox Hill/Maine Zone Pit/1380 Gully and 1250 Portal), the risk characterization for terrestrial receptors were negligible or low risk. The risk characterization outcome for AEC 1 and 9 included elevated risks to birds and mammals (classified as moderate or high with moderate or high uncertainty depending on the species) from exposure to lead and zinc are predicted to remain during the post-reclamation phase. As noted by Azimuth, these residual risks are primarily due to high metal concentrations in soils and tissues (ground insects and estimated small mammal prey) found with the 1380 Gully that is located within the Jewelbox AEC. Signage will be installed warning of the potential risks and additional measures may be considered upon completion of the Terrestrial ERA and review by regulators and LFN.

The proposed Project is not likely to result in significant adverse effects to wildlife with the implementation of the currently proposed DDRP. This determination was made in consideration of the outcomes of the risk characterization and uncertainty assessment detailed in the Terrestrial ERA, as well as considering criteria of a conventional Effects Assessment approach. For example, although the magnitude of effects has the potential to be moderate to high and the duration of contamination at the site may be long, the frequency of key harvest species being present is very low as their ranges extend far beyond the footprint of the mine. For the most part, effects are reversible or in the event of mortality, wildlife populations are unlikely to be affected.

Based on the outcome of the final Terrestrial ERA and in conjunction with YG, additional closure and reclamation measures may be applied that would directly or indirectly further mitigate potential risks for wildlife.

Table 5-3 Wildlife Related Outcomes of the Risk and Uncertainty Assessment Conducted by Azimuth

		Burnick/ 1300 Portal	Jewelbox/Main Zone/1380 Gully/1250 Portal	Mill Site	Tailings Management Facility	Risk Evaluation- Overall Mine
	LOEs	**Risk Characterization**	**Risk Characterization**	**Risk Characterization**	**Risk Characterization**	**Risk Characterization**
Terrestrial invertebrates	Soil Chemistry Invertebrates tissue chemistry Invertebrate biomass, abundance and richness	Negligible Risk with Moderate Uncertainty	Negligible Risk with Moderate Uncertainty	Negligible Risk with Moderate Uncertainty	TPN, TPN-West berm - Negligible Risk with Moderate Uncertainty Tailings - Low Risk with Moderate Uncertainty	N/A
Birds	Incidental bird tissue chemistry Food chain model Plant and invertebrate LOEs	'Listed birds (L, L*) (c. sparrow, warbler, chickadee, y. flycatcher, w. sparrow) - Low Risk with Moderate Uncertainty Common birds (junco, chickadee, c. sparrow, warbler) - Low Risk with Low Uncertainty:	'Common birds (junco, c. sparrow, jay) - Low Risk with High Uncertainty 'Listed birds (L, L*) (c. sparrow, kestrel, jay, w. sparrow) - Moderate Risk with Moderate Uncertainty 'Listed birds (L, L*) (warbler, chickadee) - High Risk with Moderate Uncertainty	'All birds - Negligible-Low Risk with Low Uncertainty:	Common birds (warbler, chickadee, jay) - Low Risk with Low Uncertainty Listed (L*) birds (warbler, chickadee, jay) - Low Risk with Moderate Uncertainty Other birds - Negligible Risk with Low Uncertainty:	'Great gray owl (L), boreal owl (C) - Low Risk with Low Uncertainty 'Barn swallow (L) - Moderate Risk with Moderate Uncertainty
Mammals	Small mammal tissue chemistry Hare and moose fecal pellet chemistry Food chain model Field survey using trapping Plant and invertebrate LOEs	Common mammals (vole, marmot, porcupine, shrew, mouse, squirrel, hare) - Low Risk with Low Uncertainty:	Common mammals (vole, marmot, porcupine, squirrel) - Low Risk with Low Uncertainty. Common mammals (shew, mouse, hare) - Moderate/High Risk with High Uncertainty:	Common mammals (mouse, vole, porcupine, hare) - Negligible Risk with Low Uncertainty Common mammal (shrew) - Low Risk with High Uncertainty:	Common mammals (mouse, vole, porcupine, hare) - Negligible Risk with Low Uncertainty Common mammal (shrew) - Low Risk with Low Uncertainty:	All mammals (moose, caribou (L), b. bear, marten (L), lynx, wolverine (L), myotis (L)) - Negligible or Low Risk with Low Uncertainty:

Note: Species status is noted according to the labels used in the Interim ERA, i.e., C = common species, L = listed species, and L* = common species that is a surrogate for one or more listed species. For surrogate species, risk ratings are provided for these species as surrogates for listed ROCs, and for these species themselves as common ROCs.

5.6 VEGETATION AND SOILS EFFECTS CHARACTERIZATION AND SIGNIFICANCE DETERMINATION

Vegetation known to the Project area has been described above in Section 5.2. The environmental conditions during post-reclamation conditions have the potential to impact vegetation and soils both positively and negatively. Positive effects will result as the SDH mine area is revegetated and reclaimed in consideration of Teck's DDRP objectives to provide short and long term erosion control, to ensure a final land use compatible with the surrounding lands, and to leave the area as a self-sustaining ecosystem. As taken from Section 3.7 of the DDRP:

> *Thus the overall goal is to conduct Ecological Restoration of the complete site. Ecological restoration is the process of assisting the recovery of an ecosystem that has been altered. The intent is to initiate and accelerate the recovery of this boreal environment with respect to all the components of its general ecosystem: species composition (flora and fauna) and functionality (productivity, energy flow and nutrient cycling). The revegetation program will include establishing an early seral plant community that will meet short term objectives of controlling erosion and initiate the reestablishment of ecological function. The initial plant community will allow the establishment of additional native plant species over time and will result in the development of a plant community with similar ecological function as to what existed prior to disturbance*.

Assessments of the current revegetation program are ongoing and will be used to inform potential remediation and monitoring programs. During the current closure implementation phase, metals uptake by the new plant community is being assessed, as well as determining if there are any changes in the plant community within the SDH mine site area. Seedling survival and other general observations of revegetation efforts is also being examined in the area. During the post reclamation phase, Teck will conduct assessments of site reclamation activities to identify potential areas that require remedial work. Progress will be monitored and adaptively managed in the event anticipated reclamation successes are not appropriately met.

Potential adverse effects that may result include the long term contamination of vegetation and soils in the Project area. As noted in the Effects Assessment Approach, contamination of vegetation and soils can contribute to adverse effects to other Valued Components. For example, in the event wildlife ingests enough contaminated food sources or inhabits contaminated areas for long enough to b affected. Further, contaminated vegetation and soils can adversely impact human health through certain traditional use activities, such as berry picking and using plants as traditional medicines. This is further discussed in Section 8 below.

Table 5-4 notes the outcomes of Azimuth's risk and uncertainty assessment (post-closure/reclamation scenario) in relation to terrestrial plants (details are provided in Section 3 of Appendix N). Azimuth defined terrestrial plant communities in the Project area as trees (e.g., subalpine fir), shrubs, (e.g., willow, alder, blueberry and currant) and herbaceous species that may be exposed directly to contaminants in soil through root uptake. The risk characterization for all AECs is negligible to low risk, with a range of uncertainties.

The proposed Project is not likely to result in significant adverse effects to vegetation and soils with the implementation of the currently proposed DDRP. Based on the outcome of the final Terrestrial ERA and in conjunction with YG, additional closure measures may be applied that would further reduce potential risks to vegetation and soil.

Table 5-4 Vegetation and Soils Related Outcomes of the Risk and Uncertainty Assessment Conducted by Azimuth (Appendix M)

		Burnick 1300 Portal	Jewelbox/Main Zone/1380 Gully/1250 Portal	Mill Site	Tailings Management Facility	Risk Evaluation- Overall Mine
	LOEs	**Risk Characterization**	**Risk Characterization**	**Risk Characterization**	**Risk Characterization**	**Risk Characterization**
Terrestrial Plants	Soil Chemistry Plant tissue chemistry Field Survey	Low Risk with High Uncertainty:	Negligible Risk with High Uncertainty:	Low Risk with Moderate Uncertainty:	Negligible (TPN) to Low (TPN-West berm) Risk with Low Uncertainty Tailings - Low Risk with Moderate Uncertainty:	N/A

6 Climate Change Considerations

The Intergovernmental Panel on Climate Change (IPCC) has reported on increasing global average air and ocean temperatures, widespread melting of snow and ice, and sea level rise, with effects on natural systems around the planet; with each assessment report, the certainty for the evidence of climate change has increased (IPCC 2013). Northern latitudes have experienced twice the rate of the global mean increase in surface air temperatures (McBean et al. 2005).

From 1950 to 1998, the Canadian western Arctic experienced warming of 1.5°C to 2.0°C (Zhang et al. 2000). In Yukon, winter and summer temperatures have increased in all regions over the last several decades, with some regional variations. In Watson Lake, the mean annual, average maximum and average minimum temperatures have not shown a strong increasing trend over the period of record (1939-2011) with an average increase of 0.005 °C/year, while the extreme maximum temperature has shown an increase of 0.007 °C/year and the extreme minimum, 0.020 °C/year. When looking only at the more recent data (1981-2010) the increasing trend for the mean annual temperature is a bit stronger at 0.026 °C/year. Similar trends are also hypothesized for the SDH mine site, given the relatively close proximity.

Projections from global climate models (GCMs) predict continued warming: the global mean surface temperature change for the period 2016–2035 relative to 1986–2005 will likely be in the range of 0.3°C to 0.7°C (IPCC 2013). Climate change projections have been obtained from the Northern Climate ExChange of Yukon Research Centre for an analysis of the range of changes in temperature and precipitation projected for the Project area. The projections, produced by the Scenarios Network for Alaska and Arctic Planning cover two emission scenarios – B1, moderate to low climate change and A1B, medium to high climate change, over two time-scales – 2030 and 2050 - using the average of five GCMs that were found to perform best over Alaska and the Arctic, and are statistically downscaled to a 2 km resolution over Yukon using the Parameter-elevation on Independent Slopes Model (PRISM) (SNAP 2011). Averages have been calculated using a 50 km buffer around the Sä Dena Hes site, and suggest an increase in mean annual temperature of 2.0 to 2.2°C by 2030 and 2.8 to 4.2°C by 2050 from the 1961-1990 baseline (Figure 6-1).

Global precipitation has increased more than 10% at higher latitudes during the 20th century in the Northern Hemisphere (Hengeveld 1997); however, changes to annual precipitation have been variable across Canada and in Yukon over the 1950–1998 period (Zhang et al. 2000). In Watson Lake, a slight decreasing trend in total annual precipitation (-0.20 mm/year) has been observed for the period of record (1939-2011), however the proportion falling as rain has increased. When looking only at the most recent data (1981-2010), the trend is opposite, with total annual precipitation increasing at a rate of 1.81 mm/year.

Many GCMs predict increasing annual precipitation at high latitudes of North America (Nohara et al. 2006). The Scenarios Network for Alaska and Arctic Planning projections suggest an increase in annual precipitation ranging from 5.7 to 7.8% by 2030 and 4.8 to 11.1% by 2050 from the 1961-1990 baseline (Figure 6-2).).

Changing temperature and precipitation regimes have, and will continue to, alter physical and ecological processes. The following potential climate change effects may have implications for the Project:

- Permafrost warming in the western Arctic associated with increasing air temperatures is anticipated to be greatest in discontinuous and sporadic zones where permafrost is warm (Hinzeman et al. 2005);, thus, heightening concern related to permafrost degradation.

- Trends in precipitation intensity from 1950 to 1995 show that heavy precipitation events have become significantly more frequent in winter and spring in Northwestern Canada (Stone et al. 2000), while increased numbers of high wind events were observed in Barrow, Alaska between 1970–1980 and 1990–2000 (Hinzman et al. 2005). The IPCC predicts that the frequency of heavy precipitation events or the proportion of total rainfall from heavy falls will likely increase in the 21st century over many areas of the globe, particularly in the high latitudes (IPCC 2012). Increases in extreme weather event size and frequency could present a challenge and need to be taken into account in the post-reclamation planning.

Refer to Section 4.3 of Appendix I for further discussion of the implications of climate change for the Project.

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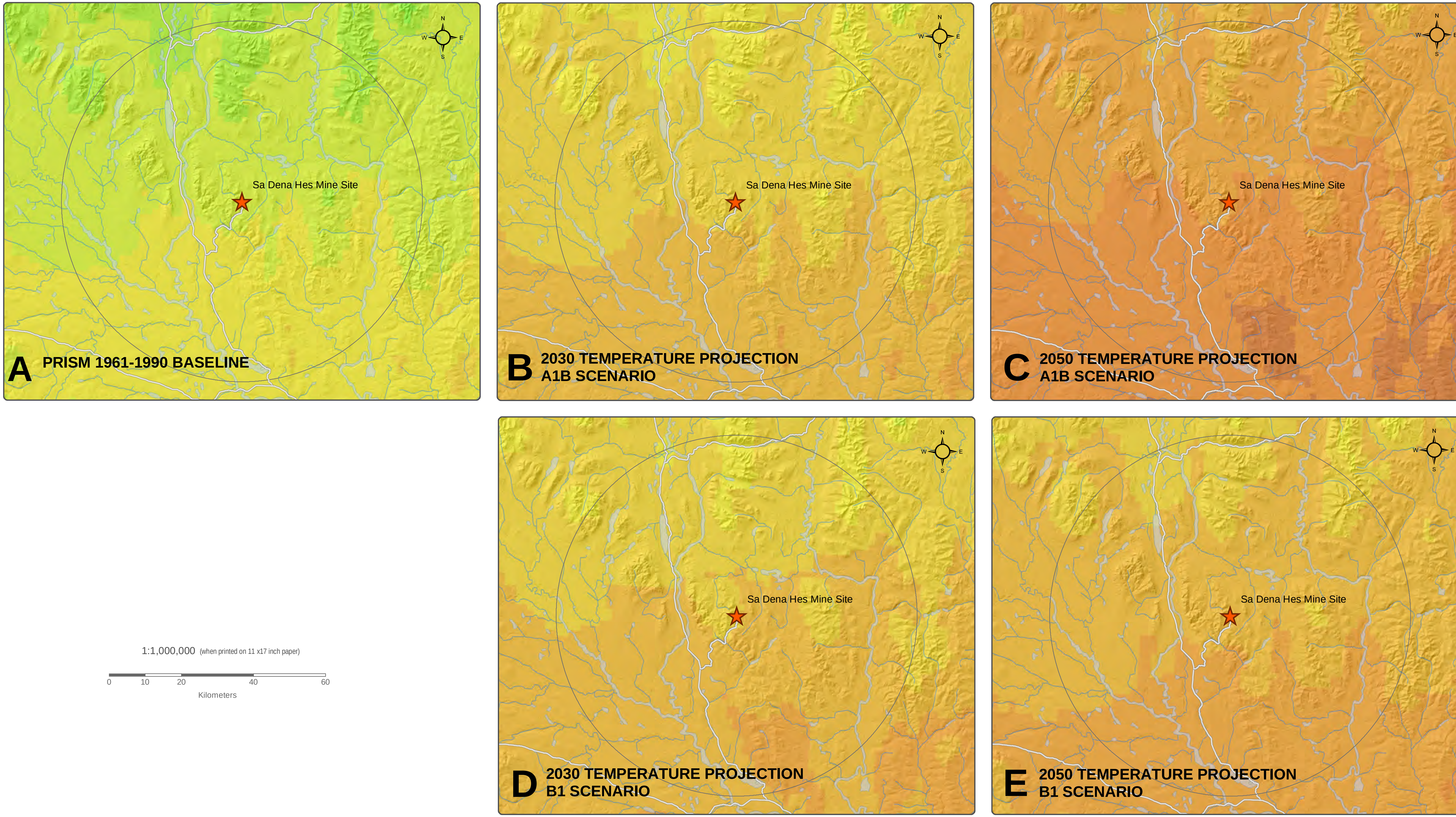

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Datum: NAD 83; Map Projection: UTM Zone 8N

Temperature (Degrees Celcius)

- -4.99 - -4
- -3.99 - -3
- -2.99 - -2
- -1.99 - -1
- -0.99 - 0
- 0 - 1
- 1.01 - 2
- 2.01 - 3
- 3.01 - 4

Other Map Features

- 50 km Buffer
- Roads

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SÄ DENA HES MINE POST-RECLAMATION PHASE

FIGURE 6-1

CLIMATE BASELINE AND PROJECTIONS: MEAN ANNUAL TEMPERATURE

SEPTEMBER 2014

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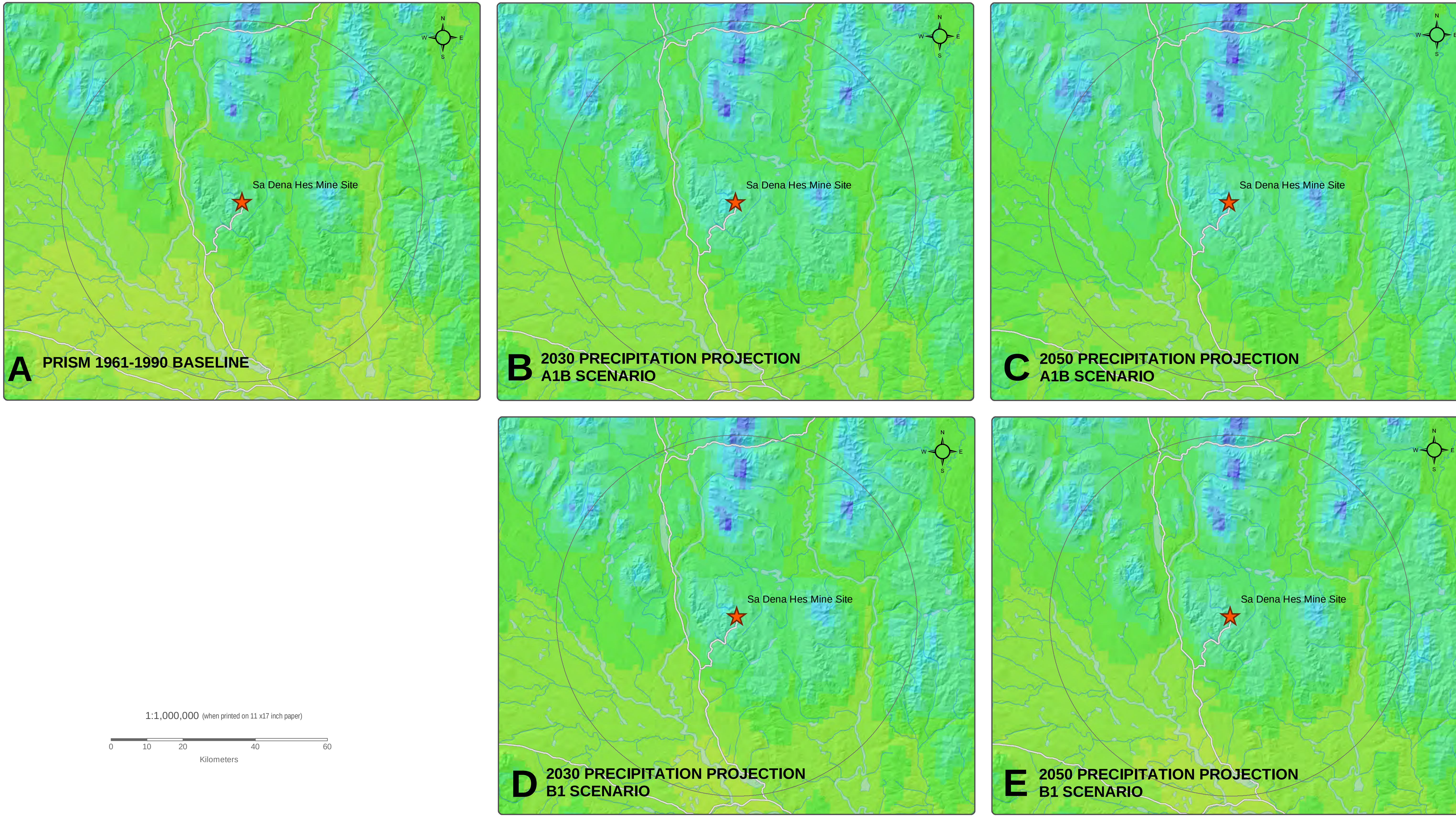

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Datum: NAD 83; Map Projection: UTM Zone 9N

Precipitation (millimeters)

- 400 - 450
- 450 - 500
- 500 - 550
- 550 - 600
- 600 - 650
- 650 - 700
- 700 - 750
- 750 - 800
- 800 - 850
- 850 - 900
- 900 - 950

Other Map Features

- 50 km Buffer
- Roads

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SÄ DENA HES MINE POST-RECLAMATION PHASE

FIGURE 6-2

CLIMATE BASELINE AND PROJECTIONS: MEAN PRECIPITATION

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7 ENVIRONMENTAL MONITORING AND ADAPTIVE MANAGEMENT PLANNING

Environmental Monitoring and Adaptive Management Planning are part of a comprehensive system of identifying and managing potential adverse effects through the post-reclamation phase of the SDH Mine. This section outlines the proposed post-reclamation monitoring and adaptive management framework for Surface Water Quality, Groundwater, Aquatic Resources, and Terrestrial Resources.

Table 7-1 presents the comprehensive monitoring schedule and summary of the various monitoring programs for the post-reclamation period.

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Table 7-1 Summary of Post Reclamation Monitoring Programs

Monitoring Program	Monitoring Locations	Timing	Summary	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
				Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	Y25
Surface Water	MH-02, MH-04, MH-11, MH-12, MH-13, MH-15, MH-22, MH-29, MH-30, SDH-S2	S – Freshet (spring) and low flow (fall) A - low flow (fall)	Field measurements and laboratory analysis	S	S	S	S	S	A	A	A	A	A	-	A*	-	A*	-	A*	-	A*	_	A*	-	A*	-	A*	-
Groundwater	MW13-01, MW13-06, MW13-13, MW13-05, MW13-10, MW13-07, MH14-04	Low flow (fall)	Field measurements and laboratory analysis	A	A	A	A	-	A	-	A	-	A	-	A**	-	A**	-	A**	-	-	A**	-	-	A**	-	-	A**
Aquatic Resources: Benthos/Sediment	MH-04, MH-11, MH-12, MH-13, MH-29, MH-30	Low flow (fall)	CABIN protocol field collection and laboratory taxonomy, laboratory analysis for sediments	A	-	A	-	A	-	-	-	-	A	-	-	-	-	-	A	-	-	-	-	-	A	-	-	-
Aquatic Resources: Fisheries	MH-30, MH-13	Low flow (fall)	Population and fish size	A	-	A	-	A	-	-	-	-	A	-	-	-	-	-	A	-	-	-	-	-	A	-	-	-
Terrestrial Resources: Revegetation Success	Specific locations where reclamation/re-vegetation occurred and other discrete locations.	Mid-summer	Seedling survival, height growth, germination success, composition, natural succession, metals uptake	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terrestrial Resources: Terrestrial Effects Monitoring	TBD through Terrestrial Risk Assessment - complete in 2015	TBD	Monitoring of metals in soil and biota	TBD																								
Geotechnical	Relevant mine components.	Spring/early Summer	Geotechnical engineering inspections	A	A	A	A	A	A	A	A	A	A	-	-	-	-	A	-	-	-	-	A	-	-	-	-	A

Notes:

Y – Year; S - Semi-annual; A - Annual
** The data collected to Y10 will be evaluated to determine whether a reduction in monitoring frequency is appropriate.*
*** MH13-01, MW13-06 and MW13-13 will continue to be monitored after Year 10 as part of the Adaptive Management Plan; an evaluation will be conducted after Year 10 to determine whether the other wells will continue to be monitored.*

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7.1 Surface Water Quality Monitoring Program

Appendix O presents the proposed Post-Closure Water Quality Monitoring Program, including the surface water monitoring regime. Figure 7-1 shows post-closure surface water sampling locations that will be routinely monitored. Table 7-2 lists coordinates and the purpose of the monitoring locations. Two of the ten stations are proposed compliance points (MH-11 and MH-12).

Table 7-2 Description of Water Quality Sampling Stations (from SRK, Water Quality Monitoring Plan, 2014)

Station Category	Station ID	Coordinates		Station Description
		Northing	Easting	
Compliance Point	MH-11	509460	6707788	Upper False Canyon Creek
	MH-12	509688	6712755	East Fork of Tributary E
AMP Loading Source	MH-02	508060	6711477	North Dam seepage
	MH-22	506767	6712946	Burnick 1200 Portal discharge
	SDH-S2	506325	6709558	Drainage from the 1380 Portal, present as a seep in the downslope waste rock dump
AMP Indicator	MH-04	507267	6710292	Camp Creek
	MH-13	512541	6709113	False Canyon Creek main channel
	MH-15	510041	6718408	West Fork of Tributary E
	MH-29*	509146	6708895	Access Creek Upstream of Camp Creek
	MH-30*	510985	6707568	Unnamed Tributary Upstream of False Canyon Creek

*Note: *Denotes biological AMP station (MH-29: benthos/sediment; MH-30 benthos/sediment and fisheries resources), but the associated water quality data will be interpreted as part of the AMP.*

The Surface Water Quality Monitoring Program is a key monitoring program for the post-reclamation condition of the Sa Dena Hes site. As with most metal and former metal mines, the mobilization of metal and metalloid contaminants by surface and ground waters is an expected condition. This can lead to exposure of aquatic receiving environments and resources to contaminant concentrations, which can be harmful if allowed to reach certain levels and/or persist for certain durations. Appropriately designed monitoring programs which are executed under control and assurance of quality are the cornerstone of effective site management. They allow for the generation of reliable data which can be compared to historical and expected concentrations and objectives to evaluate the potential for adverse effects to aquatic resources.

Figure 7-2 shows all the pre-closure surface water monitoring stations at the SDH site. Appendix P presents the complete list of stations monitored during active care & maintenance, and closure/reclamation and provides rationale for elimination of several stations for the post-reclamation period.

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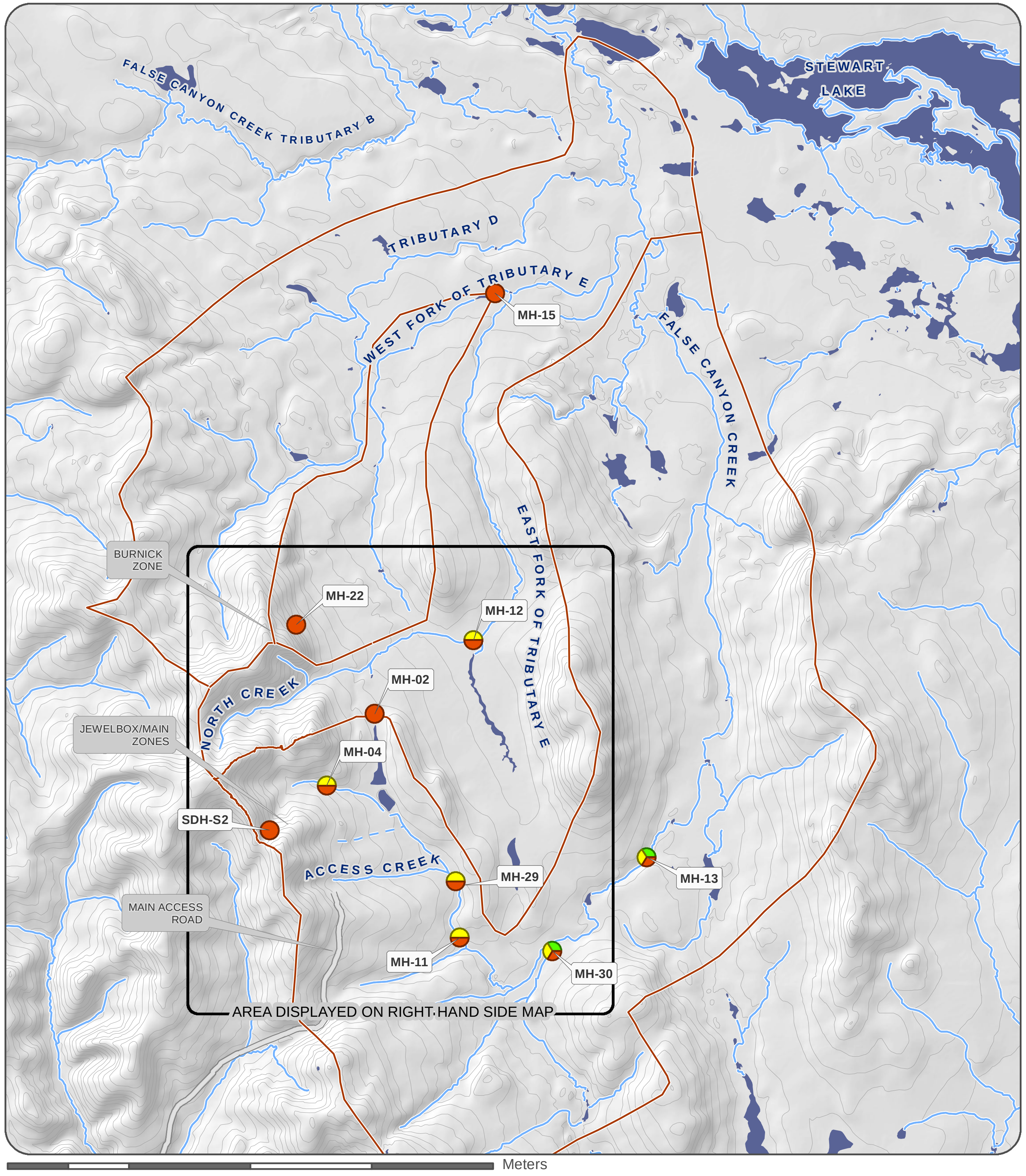

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Datum: NAD 83; Map Projection: UTM Zone 9N

Post-Reclamation Monitoring Stations

- Fisheries Monitoring
- Benthos/Sediment Monitoring
- Surface Water Quality Monitoring

Catchments Boundaries

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SÄ DENA HES MINE - POST-RECLAMATION PHASE

FIGURE 7-1

POST-RECLAMATION SURFACE WATER MONITORING STATIONS

OCTOBER 2014

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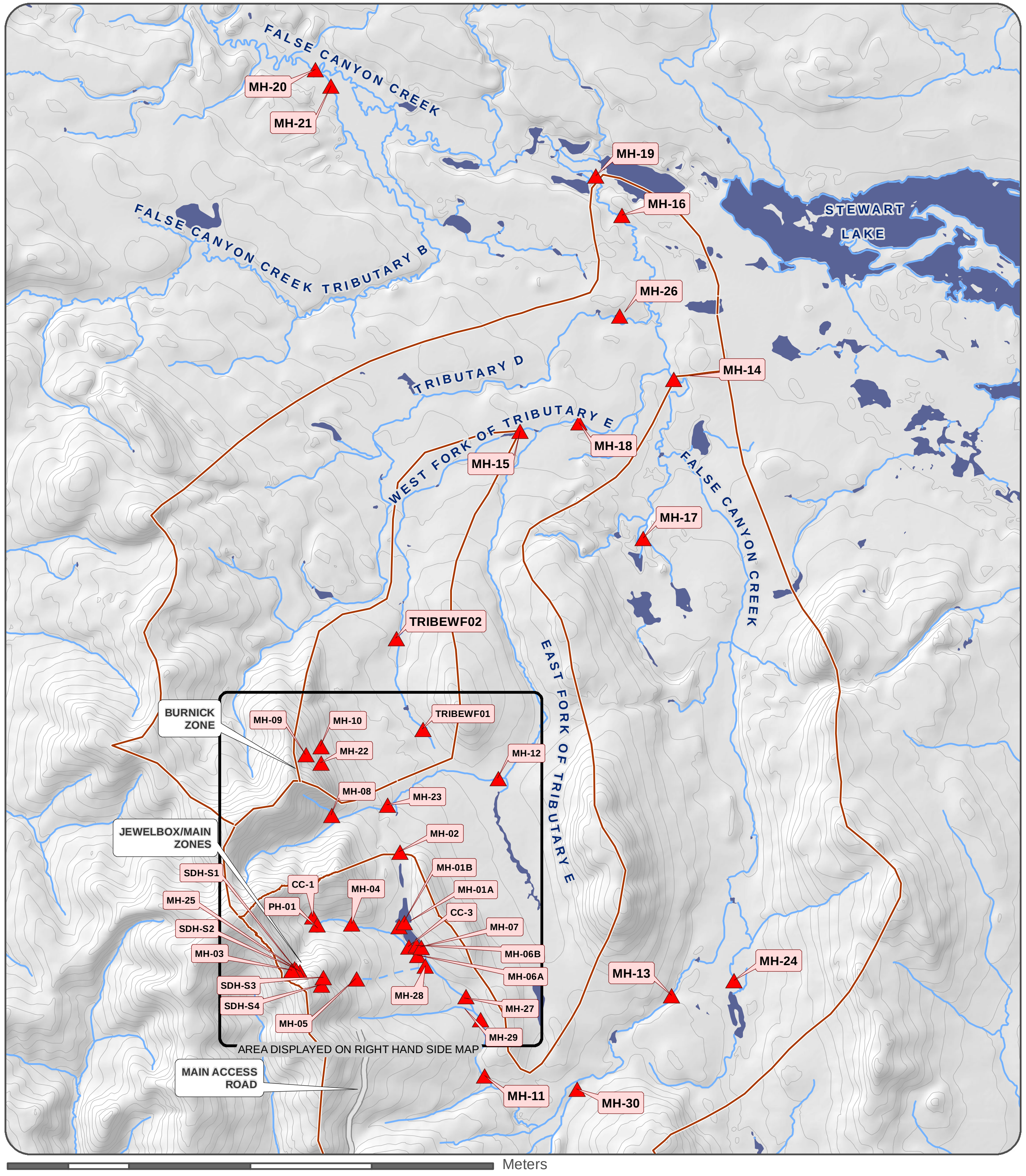

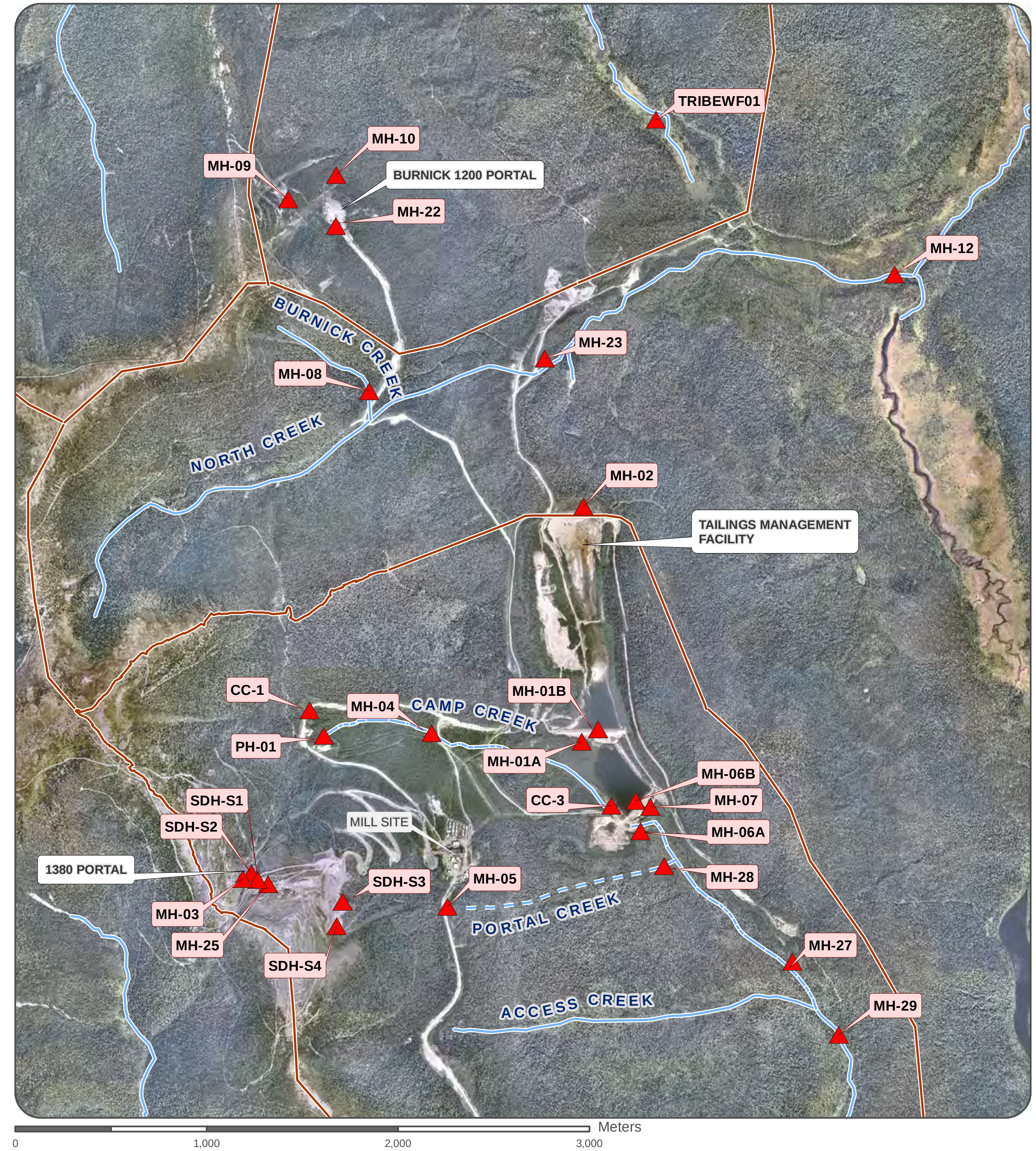

Datum: NAD 83; Map Projection: UTM Zone 9N

▲ Surface Water Monitoring Stations

— Catchements Boundaries

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SÄ DENA HES MINE - POST-RECLAMATION PHASE

FIGURE 7-2

CATCHMENTS AND ALL PRE-RECLAMATION SURFACE WATER MONITORING STATIONS

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7.2 Groundwater Monitoring Program

There are two post-reclamation groundwater monitoring programs for SDH: one is designed to monitor downgradient of mine-influenced loading sources and is linked to the AMP (Appendix O); the other is designed to monitoring areas where soil contamination has been identified as part of the Contaminated Site Assessment process (Appendix Q). The wells listed in Table 7-3 and shown in Figure 7-3 will be monitored during the post-reclamation phase for both programs.

Table 7-3 Groundwater Monitoring Wells

Station ID	Station Description	Purpose
MW13-01	Jewelbox/Main Zone – in 1380 Gully, north of 1380 Portal.	To monitor groundwater flow and quality from Jewelbox/Main Zone towards Camp Creek.
MW13-05	Main Access Road – south of the Mill Site on the Main Access Road.	To monitor groundwater flow and quality from Jewelbox/ Main Zone.
MW13-06	Burnick 1200 Portal	To monitor groundwater flow and quality from Burnick Zone.
MW13-07	North Dam – north of the North Dam and tailings pond area.	To monitor groundwater flow and quality from the tailings pond area.
MW13-10	Jewelbox/Main Zone – north of the 1380 Portal in 1380 Gully.	To monitor groundwater flow and quality from the Mill Site and Jewelbox/ Main Zone.
MW13-13	Downgradient of 1380 Portal	To monitor groundwater flow and quality from Jewelbox/Main Zone towards Camp Creek
MW14-04	In proximity to the landfill.	To monitor groundwater flow from Burnick area towards North Creek and the landfill.

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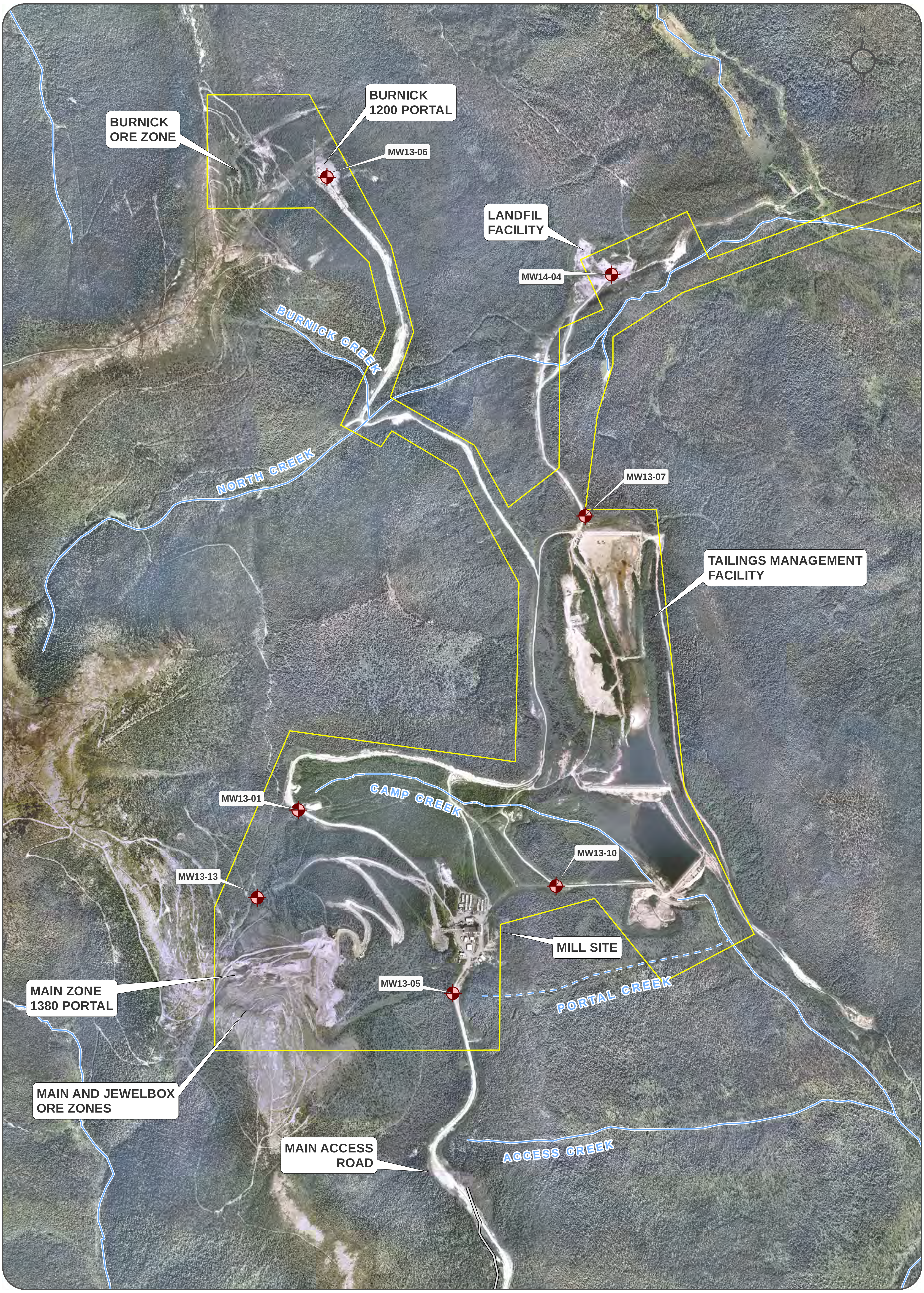

1:16,000 *When printed on 11 by 17 Inch paper*

0 250 500 750 1,000 Meters

Monitoring Wells
Mine Site Lease
Perrenial Stream
Ephemeral Stream

SÄ DENA HES MINE
POST- RECLAMATION RE-LICENCING

FIGURE 7-3

POST-RECLAMATION GROUNDWATER MONITORING WELLS

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7.3 AQUATIC RESOURCES MONITORING PROGRAM

Monitoring of aquatic biological resources and stream sediments has been ongoing in the Sa Dena Hes study area in various forms since the initial baseline biophysical resource characterization work prior to development of the mine. These historical programs and their results are outlined in Section 4.1.5. Teck proposes to continue the monitoring of these conditions in the post-reclamation period to provide context to the ongoing water quality results and to provide additional comparison points for the ongoing evaluation of the potential for effects to aquatic resources. The monitoring programs for these resources will be modified to focus on the potential for effects nearer to the mine – as opposed to the very far downstream stations that have been monitored historically. Should triggering of AMP thresholds warrant a re-evaluation of this network or the program frequencies, this can be conducted.

7.3.1 Stream Sediment Quality Monitoring

Monitoring of stream sediment quality will be conducted at the same time as the benthic community monitoring – in the fall in low flow conditions.

The sampling frequency for the monitoring of stream sediment quality will follow the same frequency as the benthic invertebrate monitoring. Harmonized monitoring of these programs will allow for more meaningful interpretation of results, and sediment quality is a key link between water column contaminant concentrations and benthic community health.

The proposed methodology for conducting stream sediment quality monitoring is presented in Appendix R.

7.3.2 Fisheries Monitoring

Monitoring of fisheries resources will be conducted in the late summer, which is when fish have historically been observed the highest up in the receiving environment watercourses, and individuals are developed to a size which allows for on the same frequency and timing as the benthic and sediment monitoring programs.

The proposed methodology for conducting fisheries monitoring is presented in Appendix R.

7.3.3 Benthic Invertebrate Monitoring

Monitoring of benthic invertebrate communities will be conducted at the standard collection time – in the fall in low flow conditions. This ensures that organisms are developed sufficiently to effectively identify to appropriate taxonomic levels.

The sampling frequency for the monitoring of benthic invertebrate communities will follow the same frequency as the current licence monitoring program (every two years, even years) until 2020, at which point it will reduce to once every 5/6 years for the duration of the licenced monitoring period. Monitoring of benthic invertebrate communities will always be conducted in a year during which water quality monitoring is conducted. Harmonized monitoring of these programs will allow for more meaningful interpretation of results.

The proposed methodology for conducting benthic invertebrate sampling is presented in Appendix R.

7.4 ADAPTIVE MANAGEMENT PLANNING

The most responsive of the comparison and evaluation methods is Adaptive Management, and a framework for responding to emerging or changing water quality conditions is proposed in the draft Adaptive Management Plan (AMP) presented in Appendix S.

The AMP for the post-reclamation monitoring period is based primarily on results obtained through the surface and groundwater monitoring programs. Thresholds triggering responses are linked to trend analysis of these results, and comparison with licenced water quality limits. Monitoring of aquatic resources will provide useful data with which investigations of the potential for effects can be initiated if water quality thresholds are exceeded. They can provide information to allow the development of appropriate responses which are based on a 'weight of evidence' and not solely a limited number of data points. Responses to such triggers could also include expansion of the aquatic resource monitoring network, adjustments to the frequency or intensity of monitoring efforts, or both. These requirements will be determined on a case basis and will be dependent on the nature of the trigger.

7.5 TERRESTRIAL MONITORING PROGRAM

7.5.1 Reclamation/Re-vegetation Success Monitoring

Assessments of the revegetation program will be conducted in midsummer for a minimum of five years. The main focus of the monitoring will be to ensure that the prescriptions applied to the disturbed sites on the mine are successful. During the assessments, assessments will be made on seedling survival and height growth, seeded germination success, composition and natural succession.

Analysis for metals uptake will be conducted as per the Terrestrial Effects Monitoring (below).

7.5.2 Terrestrial Effects Monitoring

Remediation of the mill site and tailings management facility will decrease contaminant exposure for wildlife using the property. To confirm that the contaminant pathway has been cut and exposure has been reduced or eliminated in these areas, concentrations of metals in soil and various biota tissues will be monitored periodically to confirm risk predictions. The monitoring requirements including sampling locations, parameters, and monitoring frequency are to be determined once the Terrestrial Risk Assessment is finalized in 2015.

7.5.3 AMP Linkages

An important component of the terrestrial monitoring plan is the concept of Adaptive Management Response planning. That is, the need and scope of the terrestrial monitoring program will be re-evaluated as required. For instance, if chemical exposure is shown to increase, monitoring frequency may be increased. Conversely, if chemical exposure is reduced, monitoring frequency may be decreased. A Terrestrial Adaptive Management planning would be based on the results of the Terrestrial ERA, and as reclamation and re-vegetation are refined further, in collaboration with regulators and LFN.

8 SOCIO-ECONOMIC EFFECTS ASSESSMENT

Socio-economic implications associated with the post-closure phase of the Sä Dena Hes (SDH) Mine are considered in this section. A general socio-economic overview is provided; potential positive and negative effects on the selected Valued Components are characterized in subsequent sections.

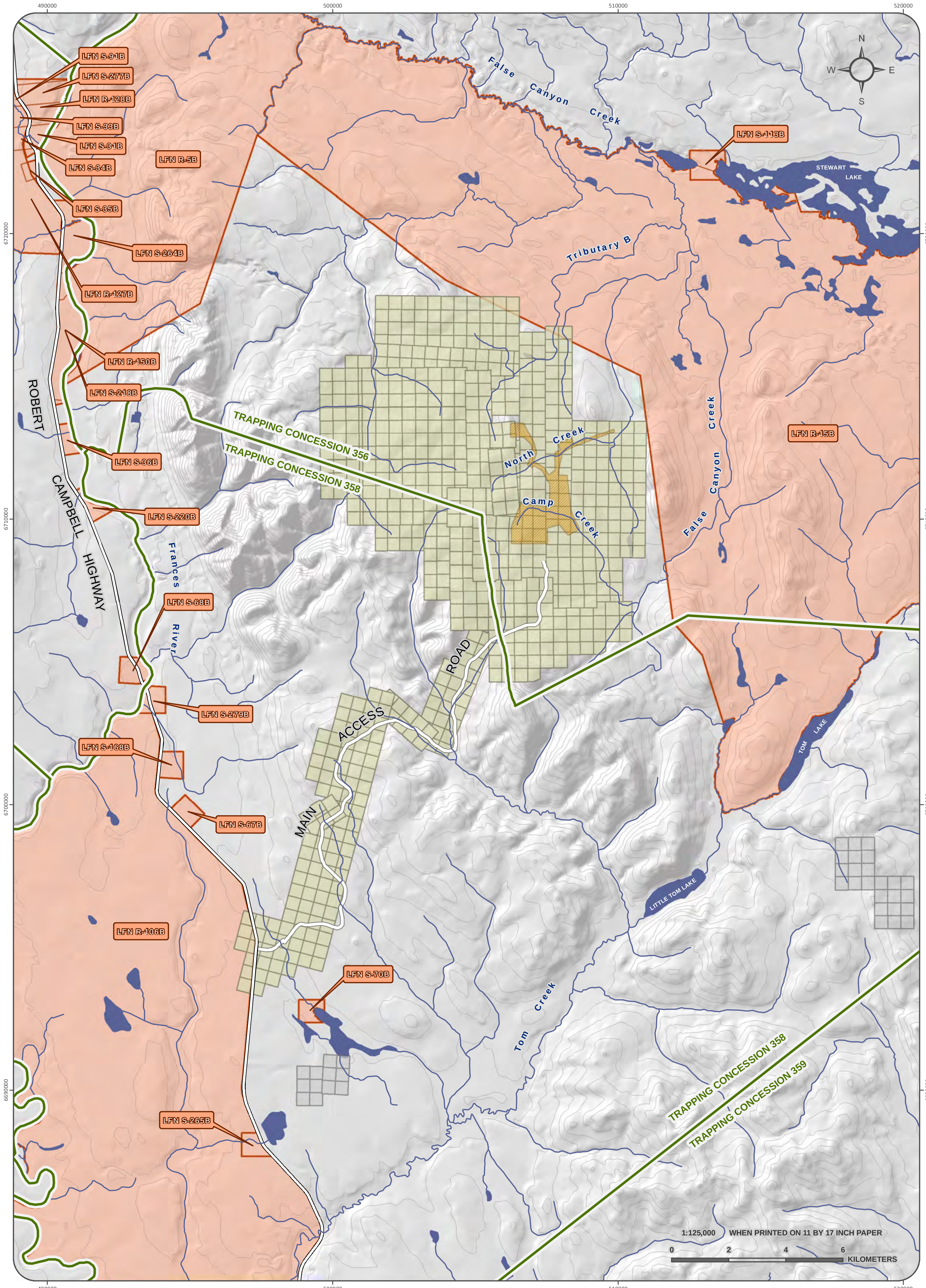
8.1 SOCIO-ECONOMIC OVERVIEW

8.1.1 Kaska First Nations

The Project is located within the Kaska Traditional Territory, which includes the LFN and Ross River Dena Council (RRDC). The area has been used actively by Kaska people for thousands of years. The following excerpt is taken from the *Initial Environmental Evaluation* for the project, compiled in 1990, referring to traditional use of the general area:

> The Kaska seasonal economic round was based on gathering, trapping, hunting and fishing. Women were' primarily collectors gathering a variety of berries, root crops and wild vegetables. Game was captured through snares, deadfalls, nets and pitfalls, though bows and arrows, spears, clubs and other implements were frequently used. Fish constituted the mainstay of the diet of the Upper Liard though game, particularly caribou and moose were preferred game. The seasonal round was highly mobile with small groups moving to seasonally variable resource bases. In late summer, small groups would disperse to the mountains to hunt goats, sheep, woodland caribou and marmots. Meat was dried and cached in the fall for winter consumption. During the winter, families would congregate at lakes for winter fishing, subsisting on fish and dried meat. This seasonal round changed dramatically with the advent of the fur trade and the consolidation of bands.

LFN has an Interim Protected Land (IPL) parcel (R-15B) situated immediately east and north of the SDH site; a few of Teck's claims overlap the land parcel (Figure 8-1). There is also an IPL parcel across the Robert Campbell Highway from the Main Access Road (R-106B). There are several Site Specific IPL parcels in the vicinity of the Project Area.



Sä Dena Hes Mine Site Lease

Sä Dena Hes Quartz Claims

Other Quartz Claims

Liard First Nation Interim Protected Land

Trapping Concession Boundary

SÄ DENA HES MINE POST- RECLAMATION PHASE

FIGURE 8-1

LAND AND RESOURCE USE

National topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada.
 Land disposition, quartz claims,trappng concession and first nation settlement lands obtained from Geomatics Yukon, July-August 2014
Datum: NAD 83; Projection: UTM Zone 9N

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8.1.1.1 Consultation and Engagement

While the Project is located in the Kaska Traditional Territory of LFN and RRDC, LFN is identified as the "lead" First Nation under the Kaska Collaboration Agreement. Teck and LFN have established a solid working relationship. LFN has been actively engaged through development of the DDRP and since 2013, LFN has been involved in the HHRA and ERA processes commissioned by Teck. Teck and LFN have formed the Sä Dena Hes Project Working Group, and have signed a Communication & Engagement Plan for the project.

The RRDC have been engaged and informed about the project status periodically since late 2012.

Section 1.2 and Appendix H of the DDRP provide further information on the consultation and engagement activities Teck has undertaken.

8.1.2 Community Profiles

The SDH Mine is situated roughly 45 km north of Watson Lake. Located in the southeast corner of the Yukon, Watson Lake has a population of roughly 1500 people. Watson Lake is often called "The Gateway to the Yukon." LFN is an important segment of the Watson Lake community and comprises roughly 50% of the population. Watson Lake is the regional service and business centre for the southeastern Yukon, and has a diversified economy. The government services sector is a major source of employment. The community has retail outlets that provide services to the community. There is a grocery store, hotels, two gas stations, and department/ hardware stores.

Yukon College has a campus in Watson Lake, providing a variety of training and educational opportunities. The local school services elementary to secondary students. Health care is provided through the Parhelion Medical Clinic and the Watson Lake Hospital. Local volunteers provide ambulance and fire emergency services; while policing services are provided by a local RCMP detachment.

Watson Lake has in place an Integrated Community Sustainability Plan, reviewed most recently in 2013.

Ross River has a population of 350 people, 80 % of which are Kaska Dene First Nation, represented by the RRDC. Health care is provided through the community health centre, which also provides 24-hour emergency service. There is a RCMP detachment, and volunteer fire service, ambulance crew, and search-and-rescue group in Ross River. Yukon Electrical supplies hydroelectric power backed up by three diesel-generating units. A local Yukon College campus offers some trades and business courses. Major economic activities include hunting, trapping, guiding and mineral exploration.

8.2 Effects Assessment Approach

The Socio-economic Effects Assessment addresses implications of the post-closure state of the SDH Mine site, as well as potential effects associated with monitoring and inspection events undertaken during post-closure. Table 8-1 presents the Valued Components have been selected for consideration in the Effects Assessment.

Table 8-1 Socio-economic Valued Components and Assessment Scope

Valued Component	Description	Geographic Scope	Temporal Scope
Human Health and Safety	Health and safety of site land and resource users, and monitoring and inspection crews.	Within the SDH Mine lease boundaries.	Post-closure; 2016-2040
Land and Resource Use	Cultural/traditional First Nation use; recreational use; commercial use and tourism.	Within the SDH Mine quartz claim block.	Post-closure; 2016-2040
Heritage Resources	“Moveable” and “non-moveable” heritage or historic resources.	Within the SDH Mine lease boundaries.	Post-closure; 2016-2040
Economic Resources	Employment and training opportunities.	Local communities and Yukon as a whole.	Post-closure; 2016-2040

8.3 Health and Safety

Protection of human health and safety is a primary closure objective for the SDH Mine site—for Teck, regulators and LFN. Section 3.1 describes the collaborative, iterative approach taken to develop, finalize and implement the DDRP to achieve the closure objectives. The various parties involved, including Teck and their technical consultants, regulators, LFN, and third-party reviewers, continue to use the findings of new and ongoing studies to inform decision-making about the most appropriate, sufficiently protective site closure and reclamation measures. With application of the closure and reclamation measures outlined in the final DDRP, significant risks to human health and safety associated with the post-closure conditions will be mitigated. In general, the SDH Mine site will be safer for humans (as well as wildlife) once closure and reclamation measures are implemented.

As outlined in the DDRP and summarized above in Section 3, closure measures are being implemented to minimize risks from physical safety hazards for several features at the SDH Mine site (e.g., sealing portals and ventilation raises; re-contouring and, where practicable, revegetating waste dumps).

There are also risks to human health and safety associated with metal concentrations in surface materials and surface water quality that need to be addressed at the site. The HHRA (Appendix U), as well as the ERA, commissioned by Teck has been used to refine closure and reclamation options for the site. The following excerpts from the report summarize some relevant background and methodology information:

> “There are naturally high levels of lead, zinc and other metals in the environment around the mine site, which is why a mine was built there. Because these metals occur naturally in the environment it is impossible to completely avoid some exposure to these metals. On the other hand, too much exposure over an extended period of time could lead to subtle health problems. Mining activities have resulted in higher than normal levels of metals in some areas of the site, such as in water, soil and some plants. The purpose of the HHRA is to ensure that once the site is cleaned-up, there are no areas of the site that will have residual levels of contamination that could result in human exposures greater than allowed under Yukon environmental regulations.” (p. ii)

> “Azimuth collected samples of soil, water, berries, and plants used as traditional medicines (caribou weed and Labrador tea) from the mine... Members of the Liard First Nation assisted Azimuth in the collection of these samples and elders from the Liard First Nation were consulted to identify plants and animals that might be used from the site as country foods or traditional medicines. Liard First

Nation elders also told Teck and Azimuth how they might use the site after the mine is closed. This is important because the amount of exposure people can have to environmental contamination at the site depends on how much time they will spend at the site and what kind of activities they are doing there.

Samples of soil, water, berries and traditional medicines collected from different areas around the mine site were tested in a laboratory to measure the amount of metals in them. Azimuth used this information to estimate how much people could be exposed to these metals if they spent time at the mine or consumed country foods or traditional medicines from the mine following closure. Azimuth compared these estimates to the maximum levels of human exposure allowed under Yukon environmental regulations." (p. iii)

The HHRA (Appendix U) identifies the relatively high concentrations of lead in soil at the Mill Site, Jewelbox Hill (including Main Zone and 1380 Gully), and in the tailings material in the Tailings Management Facility, as the "most significant environmental human health hazard" at the site. As described in Section 3.2 and Appendix H, YG has provided additional direction on required closure/reclamation measures to further reduce potential risks to human health and ecological resources.

Subsequent to the additional characterization work being conducted in 2014, additional risk remediation or risk management may be required if high concentrations of lead exist in soil and have the potential to be accessed by the public. The current plan for these areas will be to designate them as "no go" zones and to restrict the public from accessing these areas or collecting organisms that inhabit these areas for consumption or for use as traditional medicines. These areas would be mapped and signage at the site will include health and safety warnings.

While human health risks associated with groundwater and surface water were not directly assessed in the HHRA, it notes that water in Camp Creek is generally safe to drink and that "occasionally drinking water from the site, such as filling water from a water bottle from a creek, should not be a problem" (p. iii). It is recommended that if water on site is to be used as a long-term drinking water source, it should be tested to ensure it meets the Guidelines for Canadian Drinking Water. Signage at the site will include drinking water safety warnings and recommend testing and management measures in consultation with YG Environmental Health.

8.3.1 Worker Health and Safety

Negative impacts on the health and safety of monitoring and inspection personnel are not anticipated. Their health and safety falls under the jurisdiction of the *Occupational Health & Safety Act* and Regulations administered by the Yukon Workers' Compensation Health & Safety Board. Crew members will have the appropriate safety training, and will follow the health and safety protocols of their respective employers. Additionally, measures to protect the health and safety of land and resource users described above will also serve to protect workers.

8.4 LAND AND RESOURCE USE

The SDH Mine site and surrounding area has been used traditionally by First Nations, and continues to be used for cultural, as well as recreational, some commercial and other uses. This section reviews implications of the project for land and resource use of the area. Figure 8-1 shows the various uses of the lands and resources in the project area.

The SDH Mine is within the Kaska Dena Planning Region. A Land Use Plan for this region has not yet been developed.

In the context of post-closure land use, Teck has indicated in its DDRP that, "The primary objectives of the land reclamation and revegetation activities at the SDH Mine site are to provide short and long term erosion control, to ensure a final land use compatible with the surrounding lands, and to leave the area as a self-sustaining ecosystem." (p. 3-66, 2013).

8.4.1 First Nation Traditional/Cultural Use

In 2013, LFN undertook a *Historic Site Use Investigation and Assessment* funded by Teck. LFN Elders participated in focus group discussions and mapping sessions, and subsequent ground-truthing site visits, facilitated by the LFN Lands & Resources Department. The *Historic Site Use Investigation and Assessment* addressed historic use of the Sä Dena Hes (Ancient Peoples' Mountain) site and surrounding area, as well as LFN's intentions for future use. The following passages are excerpted from the report and have been selected to provide a summary for the purposes of this assessment. The full report will not be provided as part of Teck's Project Proposal, in respect of LFN's confidentiality concerns.

> "The general area - and more importantly the specific mine site – were concluded to have been used directly as, or as throughway to, regional gathering places for Kaska from surrounding regions... The region was a heavily used area as a travel and trade route and also as a gathering place for people coming from all over the Kaska Region."

> "Kaska people would come from Watson Lake, Ross River, Francis Lake, Pelly Banks, Lower Post, Dease River and Good Hope Lake. There was also travel and trade with Kaska people from communities in the Northwest Territories… The people would come to the Sä Dena Hes area for meetings, celebrations, hunting and gathering, trading and re supply for food. They would hunt for Moose / Caribou / Sheep / Groundhogs and Fish in (Stewart Lake, Tom Lake and Little Tom Lake). The area was known for the plentiful game and powerful medicines. The area was also known as a place with good springs for drinking water and water to prepare medicines."

> "The documentation, rehabilitation and long-term retention of Kaska trails have been identified as a cultural priority. Elders provided oral confirmation of trails in and around the mine area, which were subsequently ground-truthed (and mapped) during the site investigation and assessments."

> "During the time of the mine, the mine road was used to hunt / trap / gather medicines and food. There was no access to the mine site as there was a locked gate at the start to the property."

Through the *Historic Site Use Investigation and Assessment*, and subsequently through LFN's ongoing participation in the processes for the HHRA and ERA, LFN has developed several ideas for long-term use of the site. LFN and Teck are working together to ensure that LFN's intentions for long-term use of the site integrate human health and safety concerns, and are in conformance with Teck's closure objectives (Section 3) and liability considerations.

LFN has expressed a general desire to access the site during post-closure for plant and animal harvesting, as well as other traditional pursuits. As part of current site use planning, LFN is considering establishment of a *Kaska Knowledge/Cultural Camp* at or in the vicinity of the SDH Mine site following completion of decommissioning and reclamation activities. The Camp would be established to provide a means of facilitating knowledge transfer and practical experience on the land, involving any interested Kaska citizens, with a focus on Elders and youth. For the most part, use of the Camp would occur during the snow-free season. The Camp would likely include establishment of semi-permanent structures for temporarily housing participants.

8.4.1.1 Potential Effects Associated with Post-Closure Conditions

In general, closure and reclamation will transition the SDH Mine site to a state appropriate for several types of use, which is a positive impact. As presented and discussed in Sections 3.1, closure and reclamation measures undertaken at the site have been developed and continue to be refined to adequately protect human health and safety, and to rebuild and maintain environmental integrity.

As mentioned above, in areas where potential risks or uncertainty of risk remains, Teck will undertake measures to make LFN and other users aware of those risks. Teck will generate a map of the SDH Mine site that delineates areas of potential risks and will distribute the maps and accompanying information flyer in Watson Lake—for example, at the LFN Government Office and with the local Conservation Officer/ Environment Yukon office. Teck and LFN have discussed establishing signage, and if necessary, fencing, to manage access to and use of certain potential risk areas. The exact locations and content of the signs will be determined once final measures have been implemented and in collaboration with LFN[12]. Teck and LFN have also discussed erecting a general sign at the site entrance that includes site history, a map of the potential risk areas, and other important information.

8.4.1.1.1 Traditional/Subsistence Harvesting

The HHRA and ERA incorporate consideration of potential risk exposure associated with First Nation traditional pursuits at the site, including plant and animal harvesting, and medicinal plant use. The HHRA findings indicate that there may be risks with harvesting berries and medicinal plants from certain areas on site. While the refined closure and reclamation measures are likely to help alleviate those risks, the signage and risk mapping measures outlined above will further mitigate them and potential adverse effects on human health associated with consuming berries or using medicinal plants are unlikely.

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[12] *The trappers whose concessions overlap the SDH Mine site will also be engaged on signage development.*

If subsistence hunting occurs on or near the SDH Mine site, it is expected that for the most part, large mammals such as moose and possibly bear, would be harvested. As indicated in the ERA and HHRA, these species are probably safe for consumption because their ranges are large and consequently, they are likely to move through the area rather than spend considerable time at the site.

Some smaller mammals, such as rabbits and marmots, may also be harvested for food. The HHRA identifies that these species could possibly bioaccumulate contaminants from the site to levels that may be of concern for human consumption. This risk will be indicated on the signage and risk maps described above; therefore, consumption of small mammals inhabiting potentially affected areas is expected to be limited and significant adverse effects on human health are not likely.

There is very limited fisheries resource potential within the SDH Mine lease boundaries; however, there are some fisheries resources located within the rest of the SDH Mine quartz claim block. As described in Section 4.2, significant adverse effects on fisheries resources downstream of the SDH Mine site are not anticipated. Consequently, the post-closure state of the mine is not anticipated to impact fishing.

8.4.1.1.2 Site Access

LFN is aware that following completion of decommissioning and reclamation activities at the site, access along the Main Access Road will be limited. The road will be gated near the turnoff from the Robert Campbell Highway with authorized access only and will no longer be maintained in the winter during the first several years of post-closure, and it will eventually be decommissioned. In collaboration with Teck and the trappers in the area, LFN is investigating opportunities to establish alternative access to the site. LFN is aware that additional authorizations may be required to establish alternative access to the site.

8.4.1.1.3 Hunting Pressure

LFN expressed some concern about increased hunting pressure at the SDH Mine site during post-closure. It is possible that both non-First Nation and First Nation hunting on and around the site could increase following completion of closure and reclamation measures. Animal harvest data specific to the site are unavailable and it is not possible to accurately predict future hunting use of the site.

A significant increase in hunting pressure during post-closure is not anticipated though, for several reasons. Prior to implementation of the DDRP, there was generally limited activity onsite and access was maintained year-round. In general, access to the site via the Main Access Road will be limited until it is eventually decommissioned, as described above, which will limit hunting in the area. Teck and LFN discussed including information about current site use by LFN on the main site entrance sign, which also may help to deter hunting. LFN also indicated they would contact the local Conservation Officer to see what measures may be instituted to discourage or restrict hunting, if it appears to be an issue.

8.4.1.2 Potential Effects Associated with Monitoring and Inspection Events

During the post-closure phase, there will be periodic monitoring and inspection events undertaken at the site, as described in Sections 2.1.1 and 7. These events will be in general one-day events undertaken a few times each year and are not anticipated to result in significant adverse effects on First Nation traditional/cultural use of the site. LFN will have a copy of the monitoring and inspection plans for the sites, as well as the Water Licence, which will outline the type and frequency of monitoring and inspection events.

8.4.2 Recreational Use

During post-closure there may be some recreational use of the SDH Mine site, including: recreational hunting and possibly fishing, use of snowmobiles/All-Terrain Vehicles, hiking, etc. Potential effects on recreational users associated with post-closure site conditions are comparable to those outlined above for First Nation Traditional/Cultural Users. The mitigation measures described to protect human health and safety apply broadly to all users of the SDH Mine site; as such, significant adverse effects on recreational users are not anticipated.

Potential impacts on recreational use associated with monitoring and inspection events are not anticipated, because they will be short-term, infrequent and will generate minimal disturbance in limited areas.

8.4.3 Commercial Use

This section focuses on implications of the Project for trapping activities within the SDH Mine quartz claim block, because the Project is not anticipated to affect any other commercial activity. In terms of mineral exploration and development, Teck is currently the owner of all quartz claims within the SDH Mine claim block. There is a small block of quartz claims approximately 3 km south of the Main Access Road, and a few claim blocks approximately 11 km from the site (Figure 8-1) that are registered to other users. None of the quartz claim blocks within a 40 km radius have Mining Land Use Approvals in place. There are no placer claims within or near the site.

The SDH Mine site is not located within a Hunting Outfitting Concession.

There are no active oil & gas dispositions or activities on or near the SDH Mine site.

There are no other known licenced water users with water use rights in the Project area.

8.4.3.1 Trapping

The Project Area overlaps two trapping concessions, # 356 and 358, shown in Figure 8-1. This section considers potential implications for trapping in each concession separately.

The effects assessment focuses primarily on the implications of post-closure site conditions. Significant adverse effects associated with monitoring and inspection events are not anticipated. In general, there is limited temporal overlap between the monitoring and inspection events and the trapping season. Field crews would only be accessing the site for very short periods of time, resulting in minimal disturbance. Field personnel are aware and will continue to be made aware of the active trapping status of the site and will avoid any trapping equipment that may be encountered. Once finalized, the trappers will be made aware of the monitoring and inspection schedules.

8.4.3.1.1 Trapping Concession # 356

The SDH Mine site is located within trapping concession # 356, operated by Chad Hamer and Dick Behr of Watson Lake. A portion of the main access road is located in trapping concession #358 (Figure 8-1), addressed in the next subsection. Approximately four years ago, Messrs. Hamer and Behr took over operation of concession #356 and have operated it actively since. They trap the Project Area during the winter (November to March) via the main access road and utilize cabins along the road and at other locations on and near the property. They use snowmobiles to access their traplines in the rest of the area. They have traps established along certain minor roads throughout the site.

The trappers' ability to access the site will change during post-closure. There will be some form of blockade on the Main Access Road and it will no longer be maintained in the winter during the first several years of post-closure, and eventually the Road will be decommissioned. The trappers will have to travel the access road via snowmobile from the Robert Campbell Highway, instead of using their trucks. While Messrs. Hamer and Behr noted this would result in additional fuel costs and time for them, they have indicated that they are aware and accepting of the circumstances. The trappers purchased the concession while the site was in temporary closure under active licences, and that permanent decommissioning of the Main Access Road has always been a part of the DDRP approved under those licences. Teck is amenable to the trappers continuing to use the Main Access Road with their snowmobiles. In conclusion, the Project is not anticipated to have significant adverse effects on the trappers' ability to access to the site.

The trappers are considering the possibility of opening "the back road" (an old, largely overgrown trail/road) as a trapline trail, but recognize this would be an initiative they and not Teck would undertake. The trappers are aware that LFN is also considering alternative access routes because of the Main Access Road being decommissioned. The two parties should coordinate their planning efforts; Teck has explained that the company wishes to be apprised of such plans as owners of the site.

As described in Section 5.5, significant adverse effects on wildlife during post-closure, including those species desirable for trapping, are not anticipated.

The mitigation measures described in Section 8.3 to protect human health and safety apply broadly to all users of the SDH Mine site; as such, significant adverse effects on the trappers' health and safety during post-closure are not anticipated.

Messrs. Hamer and Behr explained that they have had some issues with vandalism of their cabins and equipment over the past years. This unfortunate issue is outside Teck's control. It is possible that vandalism may decrease once the Main Access Road is decommissioned.

8.4.3.1.2 Trapping Concession # 358

Trapping Concession # 358 overlaps with a section of the Main Access Road only (Figure 8-1). Several unsuccessful attempts have been made to contact the holder of this Concession. The trappers of Concession # 356 have used the Main Access Road to access their traplines for the past four years and indicated that they have not seen the trapper of Concession # 358 or any trapping equipment along the road during that time. Teck is open to discussing the project with the trapper and potential changes to his use of the Main Access

Road. If Teck receives a response from the trapper, a summary of the conversation will be filed with the YESAB Online Registry.

8.4.4 Tourism

There is minimal tourism use of the SDH Mine site area. With the exception of the Robert Campbell Highway, the surrounding area is also not known to be significant for tourism use. Local trappers noted that they have encountered a few deep wilderness tourists traveling near the site over the past several years. The few and short-term visits to the site by monitoring and inspections crews will not impact tourism. The Project is consequently not anticipated to have negative effects on tourism. It is possible that activities at the site contemplated by LFN for the future (e.g., cultural camps) may attract some tourists.

8.5 HERITAGE RESOURCES

The following excerpt is taken from the CEAA Screening Report on the SDH Mine Project (June 21, 2001; Sec. 8.2.3):

> The cultural resources of the study area have been previously examined as part of the IEE (SRK, 1990). The results of the Heritage Resource Overview found that the archaeological potential of the study area is low and no zones of high or even moderate potential are encroached upon by the development. No spiritual or special places were identified. However it is noted in the study recommendations that the area is relatively unknown in terms of heritage resource site distribution and recommends an awareness of the potential for discovery.
>
> The 1990 EARPGO screening determined that no further archaeological studies were considered necessary except for any new sites proposed for development as part of the project. No new archaeological issues or sites have been identified to DIAND since the initial screening report.

While no "moveable" heritage or historic resources have been discovered prior to or during operations, temporary closure or decommissioning and reclamation, Liard First Nation Elders and citizens identified numerous important sites and trails of heritage value through its *Historic Site Use Investigation and Assessment* undertaken in 2013. As identified above, the report states that, "The documentation, rehabilitation and long-term retention of Kaska trails have been identified as a cultural priority…" Establishment of the *Kaska Knowledge/Cultural Camp* described in Section 8.4.1 may provide an opportunity to realize this goal.

Activities associated with monitoring and inspection events are not anticipated to have significant adverse effects on heritage resources. Vehicles will only be driven on established roads and trails. In the unlikely event that a heritage resource is discovered while crews are walking onsite, the resource will not be disturbed; it will be photographed taken and LFN as well as the YG Heritage Branch will be informed.

8.6 ECONOMIC RESOURCES

There are minimal economic benefit opportunities directly associated with the Project because of its limited scope (i.e., monitoring and inspections). Teck supported the training of three LFN citizens as Environmental Monitors and currently retains them to undertake monitoring and related activities for the site decommissioning and reclamation. Teck intends to employ local Environmental Monitors to support the post-closure monitoring and inspections, to the extent possible. Local consultants will be retained to the extent possible to conduct the post-closure monitoring and inspections.

Teck will also petition Yukon-based graphic design and signage companies to bid on the information and warning signs for the site.

9 Project Alternatives

Numerous alternative approaches to closure and reclamation measures for the SDH mine have been considered through the 15 year long iterative, collaborative process of developing the DDRP, described in Section 3.1. During initial development of the DDRP in 1999, Teck engaged mine closure technical consultants and collaborated with territorial and federal regulators and First Nations. Subsequently, Teck has revised and updated its DDRP in collaboration with regulators and LFN, based on the results of ongoing environmental monitoring data and technical studies, new regulatory requirements, and First Nation and stakeholder expectations. The 2013 DDRP is approved under the WUL QZ99-045 and QML-0004 and is currently being refined and finalized based on the results of the most recent closure studies and HHRA and ERA to be sufficiently protective, to mitigate unacceptable risks and to meet Teck's Closure Objectives presented in Section 3.

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