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REVIEW OF 2012 DETAILED DECOMMISSIONING AND RECLAMATION PLAN

Sä Dena Hes Mine, Yukon Territory

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REPORT

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Study Limitations

This report was prepared for the exclusive use of the Liard First Nation and Teck Metals Ltd, its assignees and representatives, and is intended to serve as a review of Teck's Detailed Decommissioning and Reclamation Plan for the Sa Dena Hes mine. The plan was made available by Teck Metals Ltd.

The findings and conclusions documented in this report have been prepared for specific application to closure planning at Sa Dena Hes, and have been developed in a manner consistent with the level of care normally exercised by environmental professionals currently practicing under similar conditions in the jurisdiction. Golder and Keyeh Nejeh Golder make no other warranty, expressed or implied.

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APPENDICES

1.0 INTRODUCTION

The Sä Dena Hes Mine is a dormant property owned by Teck Metals Limited (Teck). The Liard First Nation (LFN) advises that the mine sits in the traditional territory of the LFN and that the LFN, as part of the Kaska Nation, holds unextinguished Aboriginal rights and title in the entirety of the project area. LFN retained Keyeh Nejeh Golder (KNG) to undertake a review of Teck's *Detailed Decommissioning and Reclamation Plan (January 2012 Update)*. Golder Associates Ltd. (Golder) undertook this review on behalf of KNG.

1.1 Scope of the Review

The technical review of the Detailed Decommissioning and Reclamation Plan 2012 Update (2012 DDRP) was aimed at identifying significant information gaps or potential issues in the closure plan that need to be addressed as a priority to facilitate the closure planning, assessment, and permitting process. Teck also aims to use the review as initial input from LFN, related to areas of concern that LFN might have regarding the planned closure.

The scope of work involved the following:

- Management and coordination of review activities amongst the technical specialists, as well as for the coordination of deliverables between Keyeh Nejeh Golder and LFN (and on to Teck).
- A review of regulatory information provided in the 2012 DDRP, as well as the main licences currently held by Teck.
- A review of the DDRP to confirm that major mine components, including disturbed areas, are accounted for in the plan, that proposed closure measures are adequate, and that consideration is given to:
  - Environmental baseline and technical basis for closure assumptions (with a focus on Section 3 and Appendices B and E of the DDRP).
  - Mine components (as described in Section 3 of the DDRP).
  - Implementation and post-closure monitoring schedule.
- Confirmation that major components are accounted for in the closure cost estimate and that costs are reasonable (costs are being reviewed in detail by Teck as a separate exercise).
- Gap analysis and reporting, including draft report and discussions with LFN and Teck.

The original scope of this review did not include a site visit or meetings with LFN representatives. Golder and LFN did, however, discuss possible approaches to obtain input from the community. It was agreed that a high-level of LFN input would be sought via a technical discussion with an LFN citizen or representative who has an applicable background and knowledge. Obtaining LFN input through that approach was delayed. Golder did, however, participate in a community meeting in Watson Lake on October 17, 2012 at which the mine closure plan was presented. A brief visit to the site was also conducted with Teck and an LFN representative. There were a number of themes of interest and concern voiced by community members at the evening meeting. Golder has tried to capture these issues as part of the closure review.

1.2 Project Background

1.2.1 Site History

The Sä Dena Hes mine is located near the southern Yukon border with British Columbia, about 70 km by road north of Watson Lake. The mine was constructed in 1991 and operated for a 16-month period by the Mount Hundere Joint Venture before shutting down in December 1992 due to a steep decline in metal prices. The property has been in temporary closure and "care and maintenance" mode since that time (with the exception of 1998 when re-opening of the mine was considered).

The property was bought in 1994 by the Sä Dena Hes Operating Company, a joint venture between Teck Metals Limited (25%), Teck Resources Limited (25%), and Pan Pacific Metal Mining Corp (50%). Teck Metals Limited (Teck) is the operator under the joint venture agreement, and is responsible for activities and commitments related to the site licences as well as those related to closure.

A summary of mine history from the 1960's to present, including ownership parties and site activities, is provided in Appendix A.

1.2.2 Detailed Decommissioning and Reclamation Plan

Information related to mine closure has been developed at various stages of the project development and during the temporary closure phase. Requirements for submitting a closure plan, referred to as a Detailed Decommissioning and Reclamation Plan (DDRP), are included as conditions to both the site water licence and mining licence.

The original DDRP for the Sä Dena Hes mine was developed by Teck and submitted to the Yukon Water Board in 2000. Subsequent updates to the DDRP in 2006, 2010, and 2012 built on the original plan and were submitted in compliance with relevant licence conditions.

Just prior to submission of the 2012 DDRP, the site owners decided that the mine would enter Permanent Closure in 2013. The 2012 DDRP still includes references to Scenario 2 (a future mining scenario if operations restarted); however, those references are no longer valid as closure will be implemented on existing mine working and conditions (*i.e.*, Scenario 1).

Teck is in the process of updating the closure plan and submitting a Final DDRP for regulatory approval. Expected submission is by end of March 2013, with the intent to start decommissioning activities at Site at the beginning of the 2013 field season.

1.3 Report Organization

This review of the Sä Dena Hes closure plan (2012 DDRP) is organized as follows:

- Section 1 Introduction;
- Section 2 Closure Context;
- Section 3 Regulatory Requirements;
- Section 4 Technical Review; and
- Section 5 Completeness of the Plan.

2.0 CLOSURE CONTEXT

2.1 Approach to Closure

In the DDRP, Teck commits to implementing an environmentally sound and technically feasible decommissioning and reclamation plan for the Sä Dena Hes mine. As stated in the plan, Teck aims to create closure conditions that minimize risk to the public and the environment, and that require minimal long term monitoring and maintenance. Mitigation measures will be implemented to manage risk, and the effectiveness of such measures will be monitored and evaluated. Where possible, the success of the decommissioning and reclamation plan will be measured against performance-based criteria to determine if closure objectives have been and continue to be met.

Teck has prepared the DDRP based on a series of closure objectives related to public health and safety, environmental protection, and passive post-closure monitoring. These are relevant and standard "holistic" objectives that are suitable for a mine closure plan; however, discussion with First Nations and stakeholders related to more specific objectives, and agreement to those objectives, has not occurred to date.

2.2 End Land Use

One of the main objectives associated with mine closure planning relates to the target end land use of the area. The DDRP states an objective that land use after closure be "commensurate with the surrounding lands". This statement is likely acceptable in a broad context, but should be expanded to elaborate on the types of activities that the lands would be suitable for as the project moves to final closure. It is expected that an end land use will be agreed to in consultation and discussion with affected individuals and communities. Consideration will also be given to any limitations to land use that are identified through the closure studies.

2.3 Closure Concerns for the Liard First Nation

The Liard First Nation (LFN) is interested in the Sä Dena Hes mine closure from a few perspectives. Based on comments made and questions posed during the community meeting (October 17, 2012), the main issues relate to: i) environmental degradation and potential effects on health; and ii) potential employment opportunities and economic growth.

The concerns can be expressed as questions such as those presented below:

- What activities will be safe to do in the area?
- Will the water be safe to drink?
- Will the animals get sick? Will the fish be affected?
- What foods (*e.g.*, plants, berries, animals) are safe to eat, and in what quantities?
- Which foods should be avoided, and for how long?
- What types of jobs will be created? Will the jobs be filled locally?
- What experience, training, and certifications will be required?
- When will the jobs be available? Will advanced notice be given?

LFN members expressed an interest in the above topics from both a temporal and spatial perspective, *i.e.*, when and where resources will be safe/unsafe to use, and when and where jobs will be available.

The concerns and areas of interest noted above are based on very limited direct input from LFN. A community and First Nation consultation plan is being prepared by Teck and LFN, as part of the overall closure planning and implementation process, and LFN members will be provided additional opportunities to participate in discussions, provide input, and clarify and expand on these and other concerns. Teck has indicated that if new concerns are raised or issues identified as a result of ongoing or planned studies, that the closure plan can and will be adapted to address those actual and/or perceived risks.

Discussion of the DDRP, and completeness in addressing community questions, is provided in Section 5.

3.0 REGULATORY REQUIREMENTS

3.1 Information Reviewed

The following information was reviewed in the context of regulatory requirements for closure planning:

- 2012 DDRP – Section 1
- Quartz Mining Licence QML-0004 November 29, 2001
- Quartz Mining Licence QML-0004 Amendment (letter) October 26, 2005
- Quartz Mining Licence QML-0004 Amendment January 15, 2010
- Quartz Mining Licence QML-0004 (letter) November 30, 2012
- Water Use Licence QZ99-045 November 19, 2001
- Water Use Licence QZ99-045 Amendment September 30 2005
- Water Use Licence QZ99-045 Amendment January 29 2010

3.2 Water Licence and Mining Licence

In 2000, a water licence renewal application and a subsequent request for a production licence were submitted by Teck for the Sä Dena Hes mine. An environmental screening was required and conducted in support of these applications. The screening was completed and following review of the applications, a water licence and mining licence were issued in November 2001, as follows:

- A Type A Water Use Licence, QZ99-045 (renewal of QZ97-025), pursuant to the *Yukon Waters Act*; and
- A Yukon Quartz Mining Production Licence, QML-0004, pursuant to the *Yukon Quartz Mining Act*.

3.2.1 General Licence Terms and Conditions

The Sä Dena Hes water licence and mining licence, including amendments, were reviewed. The terms and conditions of both licences are considered standard, and address such issues as design and construction, effluent quality, monitoring, and decommissioning, *etc.* There do not appear to be any terms or conditions that are particularly onerous (note: the required water quality Surveillance Network Program was not reviewed in detail).

Appendix B provides a summary of licence sections that are relevant to: i) temporary or permanent closure; ii) general environmental and closure considerations, and iii) potential interests and concerns of the Liard First Nation.

Requirements for the Detailed Decommissioning and Reclamation Plan (DDRP), as outlined in mining licence QML-0004, are as follows:

- Evaluation of the long-term physical stability of waste rock dumps and details of the reclamation plans.
- Plans for characterization and disposal of any split ore, concentrate, or unprocessed ore stockpiles.
- Evaluation of the risk for possible underground subsidence attributable to mine workings, and mitigation plan, if necessary.
- Conduct revegetation studies, including tailings revegetation testing in order to determine successful means of reclaiming terrestrial disturbances. Report on the success of revegetation testing.
- Establishing criteria and mitigation for access road stabilization, where erosion is a concern.

3.2.2 Licence Amendments Related to Closure

The water licence QZ99-045 was issued November 19, 2001 and expires on December 31, 2015. One of the definitions within QZ99-045 (Section 81; now Section 78) is that Permanent Closure will be (*i.e.*, commence after) "*the cessation of mining and/or discharge of waste from milling operations for a period of more than four year, except that if any of the requirements described in this licence in the section entitled Maintenance Activities During Temporary Closure are not carried out, then the undertaking shall be deemed to be in Permanent Closure.*"

Since the mine site was already in Temporary Closure and no milling was occurring when the license was issued in 2001, and since operations did not start up again, Permanent Closure was expected to start in November 30, 2005 (that is, 4 years after issuance of the water licence). Changes to this schedule were addressed through a series of licence amendments. The amendments to water licence QZ99-045 and mining license QML-0004 are complementary, and are shown in the timeline below:

- 2001 (November) original licenses issued.
- 2005 (October) Amendments issued:
  - Requirement for updated DDRP by January 28, 2006 and every 4 years thereafter.
  - Extension of Temporary Closure from November 30, 2005 to January 28, 2010.
- 2010 (January) Amendments issued:
  - Requirement for updated DDRP by January 28, 2010 and every 2 years thereafter.
  - Revised financial security conditions.
  - Change of corporate name.
  - Extension of Temporary Closure from January 28, 2010 to January 28, 2013.
- 2012 (November) Extension:
  - Extension of time limit (to February 15, 2013) for submission of the Updated Detailed Decommissioning and Reclamation Plan.

3.2.3 Closure Planning Requirements

A Detailed Decommissioning and Reclamation Plan (DDRP) was first submitted in 2000, as a requirement of a previous water licence and in support of the water licence and mining licence renewal process. In compliance with subsequent permit requirements, Teck submitted updates to the DDRP in 2006, 2010, and 2012.

Teck is currently completing the 2013 Updated DDRP, which will be submitted for approval and authorization to proceed with Permanent Closure activities.

3.3 Other Licences and Approvals

The DDRP acknowledges that as part of closure implementation, various other licences and/or permits may be required. These are outlined in Table 1-2 of the DDRP and relate to quarrying, solid waste management, hazardous materials and waste, contaminated soils, and petroleum products and storage tanks, *etc.*

The general topics of concern and relevant regulatory acts appear to be identified. Names of regulatory bodies and appropriate contact individuals were not reviewed; however, duplication of rows toward the bottom of the table was noted.

4.0 TECHNICAL REVIEW

4.1 Environmental Baseline and Technical Basis for Closure

This section provides the main review comments related to the Environmental Baseline and Technical Basis for Closure and related to supplemental information (presented in Appendix B and Appendix E of the 2012 DDRP).

Refer to Appendix C of this report for additional notes and commentary.

4.1.1 Climate and Water Resources

The regional precipitation and temperature analyses are based mainly on data available to 1997. It was concluded, by comparison of newer data from 2000 to 2005 to the old data set, that inclusion of the additional data (to 2005) would not substantively change the assessment.

- There is potentially an additional seven years of data now available since 2005, equating to a total of approximately 15 years of additional data since the original assessment was completed in 1999. An updated characterization of precipitation would be warranted to support closure planning (*e.g.*, establishing design flows, inputs to the site water balance and water quality model).

Hydrology (streamflow) data used in the regional assessment was also very limited, and it appears some site measurements have been conducted in more recent years (early 2000's). If that monitoring program has continued, the complete dataset should be reviewed to determine if it could support an update to the regional and site hydrology analyses. The appropriateness of methods selected to estimate flows should also be reviewed (*e.g.*, estimates based on recorded flows or estimates based on rainfall-runoff methods.

A discussion related to uncertainty would also be appropriate given the limited available data, particularly in the context of input to water balances and water quality modelling, and characterization of extreme and/or long-term conditions.

Additional comments and notes related to review of the available Climate and Water Resources baseline are provided in Appendix C of this report.

4.1.2 Geochemistry

General

Conclusions in Appendix B of the 2012 DDRP relating to the long-term acid generation and metal leaching potential of mine rock and tailings are based on the results of geochemical characterization discussed in the Initial Environmental Evaluation (IEE; not presented in the DDRP), and a limited number of samples collected during a site visit in 1999.

- Without a review of the IEE report, it is not possible to comment whether the dataset sufficiently represents the range of characteristics of mine materials present at the Project site.
- The dataset does not account for any changes to the site conditions, including runoff and seepage from the piles and physical and chemical weathering of waste rock in the pits and piles, since the 1999 site visit.

The summary of geochemical testing presented in Section 4 of Appendix B of the DDRP discusses information out of sequence, and not necessarily under the appropriate headings. For example:

- 1380 Zone Portal drainage is discussed under the heading of 1200 Zone portal drainage.
- Portal Zone drainage and mine pool compositions are discussed in several sections.
- Results of analysis are provided in Tables 4-2 through 4-5, and are not necessarily discussed in the relevant sections.

In general, the conclusions of Appendix B of the DDRP suggest that the waste rock dumps and tailings have an unlikely long-term potential for acid generation. Mineralization is dominated by lead and zinc sulphides, which do not produce acidity when oxidized. Metals, mainly zinc and cadmium, are released by sulphide oxidation in neutral conditions. Metal leaching is anticipated to continue in the long term, but not accelerate without some sort of activity to lower pH. Abundant carbonate mineralization is present in the waste rock and ore at the Site to counteract any acidity generated by oxidation of iron sulphides.

Closure Considerations by Mine Component

Waste rock dumps – Closure considerations for the waste rock dumps include long-term physical stability. The closure plan calls for re-contouring / regrading of the dumps, where necessary and natural revegetation.

- No toe seeps were noted from the Burnick Zone dump in 1999. Seepage collected from the Jewelbox and Main Zone dumps had elevated zinc concentrations. The potential for seepage / runoff from the dumps should be confirmed based on the current site conditions. The stability of the dumps has been assessed but should be checked or re-assessed after closure to confirm long-term stability.

Open pits – No water or rock samples were collected from the Jewelbox or Main Zone pits.

- Pit walls will be stabilized by drilling and blasting, and measures will be taken to ensure that no water is left standing in the pits.
- The DDRP states that “Water Quality from this discharge is expected to meet acceptable levels”, however rock samples were not collected from the pit walls, and seepage / runoff samples were not collected from either pit. The basis of this statement is not clear. Additional clarification is warranted and it may be practical to confirm conclusions with confirmatory testing in the initial closure or post closure period.

Mine Portals – Discharge of water (volume and quality) from mine portals will vary by portal location.

- Water collected from the Main Zone 1380 portal contains elevated concentrations of zinc. Water from the Main Zone portal is known to discharge and infiltrate soil in the dry headwaters of Camp Creek. The portal will be sealed to prevent access by wildlife and humans, but water will be allowed to discharge. Attenuation testing was performed to prove the attenuation capacity of soils in the infiltration zone. Soil effectively removes metals from solution.
- The description of attenuation modelling sufficiently addresses the fate of metals in water discharging from the 1380 Portal (Appendix E of the DDRP). The soils attenuating metals from portal water have a finite attenuation capacity; however, it is concluded that zinc concentrations in Camp Creek could almost meet the CCME criteria for receiving waters even in the loss of attenuation capacity of the soils. This should be reviewed as part of the updated water quality model results. (Teck has indicated this work will be done in 2013).
- The 1408 portal at the Jewelbox zone will be sealed to prevent access by wildlife and humans. It is considered unlikely that water will discharge from this portal. The potential for discharge from this portal should be confirmed, and if discharge can happen, the potential long-term water quality should be presented.
- Water discharges from the 1200 Portal at the Burnick Zone. The portal will be sealed in a manner to allow maximum flow of 800 L/min. Water from the portal will be redirected around the waste dumps. The results of attenuation testing indicate that the downgradient materials are capable of attenuating metals prior to reaching Camp Creek. These should be confirmed as part of the post-closure monitoring program.

Tailings – The mass loading model, which is based on the results of ongoing seepage and flow monitoring from the tailings, indicates that tailings seepage is not anticipated to have a significant impact on receiving water at MH-11 or MH-16. Therefore, no engineered measures to control metal leaching are recommended. This should be confirmed in design and again in the initial years of post-closure, *i.e.*, as part of the post-closure monitoring program.

4.1.3 Water Quality

The water quality model described in Appendix B of the 2012 DDRP was not reviewed in depth. The approach used to calculate the effect of site waters on receiving waters is reasonable, and relies on the results of monitored flow and water quality data to predict the effect of mine site sources on the whole basin. No specific engineered measures have been proposed to control the ARD / ML potential of the mine rock or tailings. The mined materials have been weathering on surface for almost 20 years; thus, using the existing data as input to the long-term water quality predictions provides a solid basis of understanding of the loadings contributed by mine rock and tailings.

An extensive water quality monitoring dataset is available for the project through 2011. The results of the water quality model were updated with data available through 2004 for some monitoring points (Appendices C and D of the 2012 DDRP). Updating the model with the most recent monitoring data should be completed to confirm the results of the 2005 water quality evaluation. Golder understands that the site water balance and water quality model is currently being updated and will be completed in 2013.

The results of ongoing seepage monitoring presented in Appendix C are not discussed in the context of the results of geochemical characterization of each mine component. This data provides a valuable, long-term record of the reactivity of exposed material at each monitoring point, and should be given consideration in the context of closure considerations.

As mentioned previously, the description of attenuation modelling in Appendix E of the DDRP sufficiently addresses the fate of metals in water discharging from the 1380 Portal. The soils attenuating metals from portal water have a finite attenuation capacity; however, it is concluded that zinc concentrations in Camp Creek could almost meet the CCME criteria for receiving waters even in the loss of attenuation capacity of the soils.

4.1.4 Terrestrial and Aquatic Resources

Descriptions of biophysical features of the mine site and surroundings are general but adequate for a decommissioning and reclamation plan; however, there is little information on site specific wildlife occurrence for the mine site area, there are no details related to vegetation and potential metals update, and the plan does not provide details related to reclamation from a revegetation standpoint. These aspects limit the ability to plan for end land use.

Background information on fish species distribution is adequate for reclamation purposes; however, the fish tissue analytical data are from 1992, and there is no indication that more recent sampling of fish tissues and laboratory analysis for metals in fish tissues have been carried out. These data are now 20 years old, and more recent data would be helpful to assess if fish populations have been affected by metals release from the mine site.

The DDRP indicates that a study of metals uptake in vegetation will be completed once the tailings facility is reclaimed, and that if metals uptake in forage for wildlife is detected, an ecological risk assessment will be carried out. Golder understands that baseline data collection for a risk assessment was initiated in 2012, and that the program/study will be developed with input from the community. It is unclear at this time, to what extent fish and other aquatic resources will be included in the assessment.

These are topics of key interest to LFN, and should be addressed in the closure plan. Refer to additional discussion in Section 5.2.

4.1.5 Geotechnical Stability and Dam Safety

The 2012 DDRP (Appendix B, Section 10) presents a discussion on Stability Analysis and indicates acceptable long-term factors of safety under both static loading and pseudo-static conditions corresponding to a design seismic event. The methods and assumptions used in the Stability Analyses were not evaluated as part of this technical review; however, Golder considered recent information from the 2009 dam safety review.

In the 2009 Dam Safety Review (Golder 2010), the tailings dams and associated water management infrastructure were assessed, as well as infrastructure that supported mill activities. The conclusions and recommendations of the review are captured in the Executive Summary of the report (refer to Appendix C, Annex 1), and a synopsis of the conclusions is provided below. The recommendations were related to inspection, repair, conveyance capacity, flood routing analysis, monitoring, and surveillance and reporting.

- In general, the dams and associated water management infrastructure were considered to be maintained in good condition.
- It was estimated that the water management infrastructure has the capacity to manage extreme flow events corresponding to the dam class of each dam, while providing adequate freeboard to prevent overtopping of any dam.
- All dams (North, South and Reclaim Dams, Cofferdam and North Creek Dyke) would satisfy the seismic requirement corresponding to their respective dam class.

The 2012 DDRP, Section 2.2, states that "Geotechnical inspections of the tailings management facility, as required by Water Licence QZ99-045, are conducted on an annual basis. This ensures that any potential geotechnical problems are identified early to enable remedial measures to be undertaken if required. The Company has implemented all recommendations that have results from these inspections."

The statement suggests that all recommendations from the 2009 Dam Safety review, besides those of the annual review, have also been implemented. This deserves clarification and confirmation, or warrants commentary or justification if some of the recommendations from the 2009 review, or subsequent annual reviews, have not been implemented. A Dam Safety Review should be considered after the closure effort is complete to confirm all recommendations have been addressed for closure.

4.2 Mine Components and Closure Measures

The 2012 DDRP covers the major mine components of the Sä Dena Hes mine, as understood by Golder based on the following:

- Site description and figures provided in the DDRP;
- Google Earth satellite imagery of the site (accessed in October 2012);
- General knowledge about the site and typical mine components; and
- Observations during the brief site visit in October 2012.

Tables 1 to 6 provide a summary of the various mine components and associated closure measures as described in the DDRP. In general, and from a high-level (*i.e.*, non-engineering) standpoint, the closure measures are considered appropriate and adequate for addressing concerns related to aesthetics and long-term physical and geochemical stability. Additional information and/or details are warranted in a few areas, and review comments to that effect are included in the tables for consideration.

Table 1: Closure Measures - Jewelbox Zone

Area	Description	Closure Issues	Closure Measures	Review Comments
1408 Portal (Main entrance to the Jewelbox mine)	4.5 m by 4.5 m opening set into the hillside. Water level was at 1350 m in 1998 prior to dewatering, and approximately 1344 m in 2005. No water has been observed flowing down the decline, and no major volumes are expected to flow out the portal after closure.	Access to the mine by public or wildlife. If mine water does discharge from this location in the future, water could flow toward and through the waste dumps.	Seal off the portal in a manner agreed on by Yukon Regulators and Company. Place a permeable cap of waste rock. Efforts will be made to ensure water drains away from the portal (grading away from the portal base, and construct a lined channel to direct flow around the dumps).	The potential for discharge from this portal should be confirmed.
1250 Portal	North side of Jewelbox Hill in the Camp Creek Catchment. The tunnel only reaches 3 m into the hillside and has not encountered ore. There is no water flowing from it.	Loose rock at the opening to the tunnel could pose a safety hazard to the public.	Locally borrowed waste rock will be used to cap the opening at a stable angle. The waste rock at the portal entrance will be regraded and revegetated.	No comment.
Ventilation Raises	Two ventilation raises on the hillside above the 1408 Portal.	Access to the mine by public or wildlife.	Permanent seals that prevent water from entering the mine workings.	No comment.
Pit	30 m deep pit located above the Main Zone pit that contains a small pond of seepage water.	Loose rock and steep slope of pit walls. Pooling of water that is draining through fractures in the ground and waste rock during spring freshet, and unconfirmed routing of this water.	Stabilization of pit walls by resloping with drilling and blasting. Partial infilling of the pit with blasted rock. Construction of a coarse rock drain to direct water safely out of the pit area, to ensure no free standing pool of water in the pit, and to reduce the potential for water to flow through fractures into the 1380 Portal.	The approach for design of the drainage channel should be provided. The basis for the following statement in the DDRP is unclear: "water quality from this discharge is expected to meet acceptable levels"; has the quality of the pooled water during freshet been characterized?
Waste Rock Dumps	Rock mined from Jewelbox underground was placed in 2.6 ha dump located below the 1408 Portal. Rock mined from the Jewelbox Pit was placed on a ridge immediately east of the pit, over an area of 1.9 Ha (placed in lifts; slopes are generally 2H:1V). Smaller pile of pit rock (0.4 Ha) located on steep ground below pit waste rock dump (end dumped; slopes 1.3H:1V). Rock also found above and below access road to Main Zone Pit over an area of 0.9 Ha (end dumped; slopes 1.3H:1V).	Long term physical stability.	Reslope of upper dump areas and recontour disturbed areas to conform to surrounding slopes and avoid ponding of water. Resloping of dump areas in lower slopes and/or on steep grades will not be feasible. Natural revegetation to be encouraged (the area is above the treeline and is slowly being naturally revegetated). Removal of culverts and safety berms.	The potential for seepage/runoff from the dumps should be confirmed based on current site conditions.

Table 2: Closure Measures - Main Zone

Area	Description	Closure Issues	Closure Measures	Review Comments
Open Pits	Steep sloped sidehill excavation, 1370 to 1400 m elevation.	Access to the mine by public or wildlife.	Stabilization of pit walls by resloping with drilling and blasting. Blasted rock will infill the pit and will be used to cover the 1380 Portal. Coarse rock will be directed to the base of the fill to encourage free drainage from the pit.	No comment.
1380 Portal	4.5 m by 4.5 m opening collared in limestone and skarn that does not connect to any other openings. Water discharges from a fault within the adit and contacts weathered, mineral rich skarns which generates zinc-rich drainage water. The drainage flows from the portal during the snow free period, through the waste rock, and infiltrates to ground approximately 500 m upgradient of Camp Creek. Zinc concentrations are amended by contact with the waste rock and by mixing with surface water.	Stability of the opening, and access to the mine by public or wildlife. Discharge of water from the Portal with elevated zinc.	The Portal will be sealed using the large quantities of blasted rock from resloping of the pit walls. It will prevent access by the public and wildlife, and will allow free drainage and discharge from the Portal.	Confirmation of acceptable post-closure (*i.e.*, into long-term future) zinc levels in receiving waterbodies warranted based on attenuation capacity and/or updated water quality model.
Waste Dump	Rock from the pit was end-dumped on hillside slopes below the pit flow, and above the headwaters of Camp Creek. The dump covers an area of 0.3 ha. Waste rock is composed of limestone and some ore-rich skarn; sphalerite and galena-rich sand have been released by the weathering of the skarn. Water from the Main Zone / Jewelbox pits flows through the dump.	Long-term stability of the waste dump.	Crest to be pulled back to remove over steepened sections; safety berms to be removed.	The potential for seepage/runoff from the dumps should be confirmed based on current site conditions.

Table 3: Closure Measures - Burnick Zone

Area	Description	Closure Issues	Closure Measures	Comments
1200 Portals	Two portals: i) main access, and ii) propane heating for ventilation air. Water drains from the ventilation portal. Water draining from fractures and drill holes at the entrance of the 1300 Portal flows downslope and exits from the 1200 level. Temporary shotcrete dam constructed in the ventilation portal to create a sediment settling sump. Water flows (15 L/min to 800 L/min) into a culvert below the portal, and over the existing waste dump.	Access to the mine by public or wildlife. Must be sealed in a manner to allow max flow of 800 L/min. Water should not flow through the waste dump. Formation of ice plugs in the portals, as a result of unrestricted air flow and freezing of mine drainage.	Sediment in sump will be removed and placed in the tailings pond. Portals will be sealed and covered with coarse waste. Engineered rock drain to be placed at base of waste rock fill to provide free drainage from the portals. Water from portals will be redirected around the waste dumps. Permanent seals that restrict air flow, and minimize ice plug formation.	Description of recent reduction in ice plug formation, as a result of recent mitigation, is warranted. What level of risk remains for future ice plug formation given the planned seals?
1300 Portal	Portal sealed in 2009 to restrict air movement and ensure public safety. No drainage from the portal.	Access to the mine by public or wildlife. Prevention of water entering the mine.	Permanent seal and waste rock cover. Contour of platform in front of portal to direct drainage away from the mine.	As above.
Waste Dump	1.4 Ha sidehill dump constructed using waste rock from the Underground workings at the Burnick Zone. Pile was regraded in 2000 after tension cracks were found at the crest of the dump.	Physical stability.	Dump will be resloped to as low an angle as the surrounding terrain will accommodate, and revegetated. Drainage from the 1200 Portal will be directed to the south and around the dump to prevent saturation of the dump. (Golder understands that the 2013 Closure Plan will include the crest of the dump being pulled back to further reduce loading on the crest and improve stability. Drainage will also be provided so that there is no erosion of the face of the hillside.)	The potential for seepage/runoff from the dumps should be confirmed based on current site conditions.

Table 4: Closure Measures – Tailings Management Facility (TMF)

Area	Description	Closure Issues	Closure Measures	Review Comments
North Dam	Starter dam was ~13 m high. North impoundment for tailings	Physical stability.	The downstream slope will be revegetated, and the crest of the dam will be graded so that it is flush with the tailings surface.	No comment.
South Dam	Starter dam was ~13 m high. South impoundment for tailings.	Physical stability.	Breach the South Dam; conveyance capacity for design flood is discussed.	The current (2013) plan is to decommission the South Dam leaving a small berm in place.
Coffer Dam	2 m high dam built between the North and South dams to control water and tailings flow.	Physical stability.	Cut down flush with the tailings and remove the sluice gate and pipe beneath the dam.	No comment.
Reclaim Dam and buttress, and Pond	About 15 m high at max section. Built to retain supernatant water decanted from the tailings pond for reuse at the mill. Permitted discharge from the Reclaim Pond between April and October.	Physical stability.	Breach the Reclaim Dam; conveyance capacity for design flood is discussed. Sediment quality to be evaluated, and if elevated in metals then potentially removed or capped.	The current (2013) plan is to completely remove the Reclaim Dam.
Tailings	Deposited tailings in the TMF	Geochemical stability; particularly elevated zinc levels.	The 2012 DDRP indicates that zinc loads are not expected to have a significant impact on receiving water quality, and that effluent has been and currently is in compliance with the water licence. Therefore, no engineered closure measures are planned to address geochemical stability. The tailings surface will be recontoured to provide positive drainage to the south, and a nominal 300 mm cover of till material will be placed to control dust and to provide a growth medium for revegetation. The tailings pipelines will be salvaged, and all drop boxes will be removed.	Compliance with the water licence does not necessarily mean there isn't or won't be an impact on receiving water quality. The source of the cover material, and required reclamation characteristics and depths of this cover should be clearly described.
Decant Tower	Concrete decant tower adjacent to the South Dam; conveys tailings supernatant to the Reclaim Pond. [Not being used during Temporary Closure.]	Removal of infrastructure.	The tower will be dismantled to ground level, and debris buried on site. Decant pipe filled with concrete.	No comment.
Siphon	System being used during Temporary Closure to drawdown water levels in the tailings pond prior to freezup and to provide extra storage during spring freshet.	Removal of infrastructure.	The 2012 DDRP does not address the current siphon system.	The siphon is assumed to be completely removed during closure.
Spillway	Two 900 mm culverts, at the west abutment of the South Dam. 200-year flood capacity directed to the Reclaim Pond. Verified capacity to meet the 1000-year event.	Conveyance capacity / physical stability.	The spillway is sized to convey the design flood.	The current (2013) plan is to decommission the South Dam, which would include the spillway. A small berm will remain that will require an engineered drainage channel from the South Dam area, through the Reclaim Pond area, to the confluence with Camp Creek below the site.
Camp Creek Diversion Channel	Along the west side of the Reclaim Pond	Conveyance capacity / physical stability.	Breached and recontoured to re-establish natural drainage patterns. Original Camp Creek alignment to be re-established with a rip rapped channel.	No comment.
Interceptor Ditches	Ditches along the east and west sides of the tailings facility direct drainage away from the TMF	Conveyance capacity / physical stability.	Ditches will be removed and the original drainage patterns re-established.	No comment.

Table 5: Closure Measures – Infrastructure and Roads

Area	Description	Closure Issues	Closure Measures	Review Comments
General	Across the Site.	Public health and safety Site aesthetics Restoration of disturbed lands	Salvage and remove from site, demolition, both onsite and offsite disposal. Concrete foundations will be broken up to ground level and covered with ~0.5 m of till.	No comment.
Concentrator Buildings (the Mill)	Mill building, crusher house, conveyors, and truck load-out facility.	As above.	Salvage and removal from site or demolition and burial.	Potential for sale of mill infrastructure has been noted.
Equipment	Ball and SAG mills; scaffolding; processing equipment.	As above.	Salvage and removal from site or demolition and burial.	Potential for sale of large equipment has been noted.
Power House and Power Lines	Three diesel generators. 6 km of overhead distribution lines and associated poles.	As above.	Salvage of the generators is expected. Removal and re-spooling of wire, and appropriate disposal or reuse of poles.	No comment.
Water Supply	Water pumps in small pumphouses, and 2 km of water line.	As above.	Salvage of the pumps and water line.	No comment.
North Creek Dyke	5 m max height, and about 50 m long. Was built for water supply at mill startup.	As above.	Dyke will be breached and the culverts removed. Size of breach based on the 1000-yr design event.	No comment.
Accommodation / Camp Buildings	Atco trailers for campsite accommodation and kitchen.	As above.	Demolished on site (trailers are in poor condition and no longer usable).	No comment.
Explosive Magazine	The 2012 DDRP does not indicate whether or not there are currently any explosive magazines on Site.	As above.	Return explosive magazines to the supplier or sell for salvage. Unused explosives to be returned to supplier or destroyed through appropriate procedures.	Teck indicated that this review should assume no explosives are currently on site.
Septic System	Sewage system designed for a 160 person camp. Three sewage tank and a pump out chamber which then drains to a septic field.	As above.	Tanks to be pumped out, sludge's disposed of in the tailings pond. Pump out chamber removed, and remaining components left buried.	No comment.
Site Roads	Haul roads, service roads, and exploration roads	As above	Roads will be decommissioned by recontouring and removing culverts; surfaces will be decompacted and revegetated	No comment.
Main Access Road	Approximately 25 km access road, constructed in 1990 by cut and fill methods. Road width is ~8 m plus ditch drainage.	As above	Reclaim the road when it is no longer needed for access to the site (*i.e.*, after the site is demonstrated to be stable and frequent monitoring is no longer required). Closure will include recontouring, berm removal, decompaction, and removal of culverts. Natural recolonization will be encouraged; revegetation by seeding is also planned.	The topic of the Main Access Road should be revisited and final end use confirmed through consultation.

Table 6: Closure Measures – Waste Management

Area	Description	Closure Issues	Closure Measures	Review Comments
Hazardous Waste	*e.g.*, solvents, paints, cleansers, battery acid.	Chemical stability; Requires special handling.	Give to a third party or remove and dispose of through a licenced hazardous waste disposal firm.	No comment.
Fuels and Lubricants	*e.g.*, diesel, gasoline, propane, hydraulic fluids, lubricants.	Chemical stability; Requires special handling.	Consume during closure activities; remove from Site by appropriate parties.	No comment.
Scrap Metal	Located in various storage areas.	Site aesthetics.	Material with no scrap value will be disposed of in an approved landfill.	No comment.
Landfill	Existing site landfill.	Chemical and physical stability.	Use of existing site landfill, and possibly requirement for new engineered landfill.	A new landfill will need to be engineered and permitted in accordance with the Yukon Solid Waste Regulations.
Contaminated Soils	*e.g.*, historic fuel spills, elevated metals concentrations in sediments	Chemical stability.	Characterization and quantification; removal and/or treatment.	A site assessment has been completed. Results of the assessment and planned activities to address contaminated areas should be communicated (*e.g.*, type of contamination, location/volumes, remediation approach, removal, or risk management, *etc.*)

Source: Adapted and summarized from the 2012 Sä Dena Hes Detailed Decommissioning and Reclamation Plan; Review comments by Golder.

4.3 Implementation and Post Closure Monitoring

Teck anticipates that it will take three years to substantially complete the significant aspects of site closure. Work is expected to occur seasonally between May and September each year. The schedule, including post-closure monitoring, is summarized as follows:

- Mine workings (pit resloping; sealing portals) — Year 1
- TMF (embankments, drainage, decant, pipelines) — Year 1 and Year 2
- Reclaim Pond (embankment) — Year 1 and Year 2
- Waste dumps (resloping) — Year 2
- Infrastructure (mill, power supply, camp) — Year 1
- Infrastructure (water supply) — Year 2
- Reagents and Waste — Year 1 and Year 2
- Reclamation and Revegetation — Year 1 and Year 2 (primarily)
- Environmental Monitoring (closure implementation) — Years 1, 2, and 3
- Environmental Monitoring (post-closure) — Years 4 to 6 (quarterly); Years 7 and 8 (annually)

The current Closure Implementation Schedule does not include consultation activities with the community and/or regulators, except through submission of the 2013 DDRP Update itself. Consultation and input from the community is required to confirm that community interests and concerns are addressed, to determine final land use objectives, and to obtain support for final closure measures. The timeline for these discussions, and clarification on how community input will be used to shape the closure plan, are warranted.

Regulatory authorities may need to provide approval of the entire DDRP 2013 Update (pending) prior to initiation of any closure activities at the Sä Dena Hes mine site. It is unclear which activities, if any, that Teck could initiate without this approval, and what level of detail may be required in terms of closure drawing submissions.

A number of studies are currently under way, which could alter closure requirements. For example, the water quality model is currently being updated, and results are not yet available to determine if downstream water quality is expected to be acceptable. An ecological risk assessment is also being initiated; however, will not be complete until 2014.

Other uncertainties and risks associated with the closure schedule relate to:

- Potential large-scale salvage activities, which may require extended periods of time and which may limit access to various parts of the site while salvage is occurring;
- Weather delays and number/type of equipment (contractor) to advance closure activities within a short construction season;

- Development of a detailed reclamation and revegetation plan, including soil and cover requirements, seed mixes and planting prescriptions, and long-term monitoring requirements;
- Development and execution of soils remediation and/or removal, or implementing risk management (including associated up-front studies); and
- Removal, storage, and movement of large volumes of materials through a relatively small work site near the entrance.

According to the schedule, the main access road will be decommissioned in 2016 (Year 4). The DDRP also states that the road will only be decommissioned once frequent monitoring is no longer required. Before that occurs, the road would likely be kept operational so that major equipment could be mobilized to site if any major physical or geochemical instabilities are noted. As such, decommissioning of the road may be more realistically scheduled for further into post-closure.

Post-closure monitoring is currently scheduled quarterly for a three-year period, followed by annually for a two-year period. This is based on the assumption that closure measures are effective and, presumably, that no long-term water quality issues are identified. Teck needs to define what the measures of "success" will be for various mine components and the receiving environment, as determined through consultation with the community and regulators. Depending on the success measures and level of risk assessed, regular monitoring may be required for a longer period than currently shown and the schedule and allowances should be revised accordingly.

4.4 Closure Cost Items

The 2012 DDRP includes a series of tables that provide a detailed cost estimate for the closure activities (Tables 6-3 to 6-6 of the DDRP). The tables were reviewed for completeness in terms of major cost items and activities; however, assumed quantities and unit costs were not evaluated.

No major deficiencies were identified; however, the following items were noted:

- 1408 Portal and 1200 Portal: The seals in the cost estimate are assumed to be constructed using large tires; the table notes that alternate methods may be used.
- 1380 Portal: The seal is described as a concrete plug covered by blast rock; however, in the closure measures description, only coarse rock from pit blasting is referred to, which will also provide free drainage of mine discharge water.
- Jewelbox Pit and Main Pit: The cost estimate does not include an activity for construction of a coarse rock drain to direct water safely out of the Jewelbox pit area. There is no specific activity related to directing coarse rock to the base of Main pit fill to encourage free drainage from the pit.
- South Dam and drainage: The cost estimate should be revised to reflect the current (2013) plan to fully remove the dam, instead of breaching it, and constructing an engineered channel to direct flows from the tailings area through the reclaim area and to the confluence with Camp Creek.

- Reclaim Dam: The cost estimate should be revised to reflect the current (2013) plan to fully decommission the dam, leaving a small berm in its place.
- TMF Siphon: Add costs of removing the siphon system.
- Contaminated Soils: Revise allocation for removal, treatment, and/or risk management of identified contaminated soils.
- Landfill: Update landfill design, permit, and build cost depending on revised landfill requirements.
- Exploration Trails: A small allowance is included for the revegetation of exploration trails; however, the DDRP text indicates that the trails will probably not require further treatments.
- Environment: Closure planning, implementation, and post-closure monitoring costs associated with anticipated ecological risk assessment are not included.
- Consultation: Costs associated with community consultation and regular communication and meetings with the community are not included (nor are they described in the DDRP).

5.0 COMPLETENESS OF 2012 PLAN

Comments provided in this section are related to the Sä Dena Hes mine closure and LFN involvement, in general, as well as to the specific content of the 2012 DDRP in terms of addressing LFN concerns.

5.1 Liard First Nation Engagement and Input

There has been very limited communication to date between Teck and LFN, at a community level, regarding closure of the Sä Dena Hes mine. The exception was the community meeting held in October 2012, and the follow-up newsletter sent to LFN for distribution.

While Teck has indicated plans to further engage with the community, the framework has not been developed and broader discussions have not yet started. To date, the only input, comments, feedback, or direction from LFN that has been considered in the closure planning stages are from the October 2012 meeting and this review of the 2012 DDRP. Even if the technical aspects of mine closure are straight-forward, and no long-term issues are anticipated, the community is expecting a better understanding of what closure will entail and what the land can be used for in the future.

It will be important to establish a regular forum through which the community can be meaningfully engaged. As part of these activities, suitable communication materials also need to be produced. These include:

- Non-technical summaries related to project history and site description;
- Simple schematics of the major mine components, including where ore, water, and waste materials are moved to through various activities;
- CLEAR and simple description of the closure activities associated with the major mine components;
- readable maps or other graphics that show the mine site in relation to the larger area (*e.g.*, major waterbodies and other familiar landmarks);
- Abbreviated closure schedule linked to a list of potential jobs, contractor opportunities, and training requirements; and
- Answers to specific questions posed by the community related to community and environmental health.

These materials will help the community understand the mine site, the closure issues that exist, and how those issues are being addressed by Teck. Commitments by Teck to address uncertainties, or a clear plan that allows for adaptive management, will also be required. At the moment the community is unclear of where there are risks or opportunities and, therefore, would not know where to focus interest, inquiries, or discussion.

5.2 Addressing Liard First Nation Views

As discussed in Sections 2.2 and 2.3, LFN is interested in the post-closure land use of the mine area, and has concerns related to food and water safety. The other main interest in the Sä Dena Hes mine closure relates to job creation and potential employment. These aspects relate to the near-term and long-term interests in the land that LFN collectively holds. From LFN's perspective, the long-term end land use is implicitly part of their legally recognized Aboriginal rights and title, which means not only the ability to resume traditional land uses but also to act as decision makers for any future use of the land. In the short-term, LFN would like to see that any benefits that do accrue from industrial activity (*e.g.,* jobs, revenues and capacity-building) are shared appropriately with the membership.

5.2.1 Water Management and Quality

Water management at the mine should be explained to the community to describe where water on site comes from, where it goes, where it is diverted and kept "clean", where it has high concentrations of metals due to contact (*e.g.*, zinc), where and when it is released, and how that will or will not change after closure. Connectivity with downstream waterbodies is also of interest. This information is either directly or indirectly provided in the 2012 DDRP; however, it is not presented in a suitable format for the community.

Teck also needs to, in as non-technical manner as possible, articulate what water quality information is available and what that information means in terms of aquatic health and suitability for consumption (*i.e.*, drinking water). The community is interested in specific locations downstream of the mine where membership continues to actively rely on the land (notwithstanding the desire to see the entire area returned to conditions that allow traditional land uses). Teck should continue to engage LFN citizens to identify particular locations of interest, and subsequently map these areas as a means of communication and to facilitate meaningful dialogue regarding potential effects or non-effects on fish or water quality (or other concerns that might be raised).

5.2.2 Vegetation and Wildlife

The LFN community wants to know which berries and plants are suitable for consumption or traditional uses, as well as which animals and/or parts of animals can safely be eaten. These details are not provided in the 2012 DDRP; however, Teck has indicated that an ecological risk assessment is currently being developed and will be initiated in Spring 2013. The study will evaluate vegetation health as well as the health of animals eating food sources in the local area. It will be important to provide opportunities for community members to participate in the study design, as well as in the sampling programs. They have in depth knowledge of the potential uses of different plants and animals, as well as secondary products derived these.

It is unknown at the moment whether a human health risk assessment will be warranted. The need for this type of assessment is not anticipated but will be evaluated based on results of the ecological work and potential pathways for human health effects.

All study objectives, methods, and results should be communicated to the community in as clear and easily-understandable manner as possible. Reference to numerical guidelines should be accompanied by what those guidelines mean and how numbers and results should be interpreted.

5.2.3 Employment

The LFN community is eager to become involved in the mine closure activities. To take advantage of these opportunities, LFN has requested advanced notification of potential contracts, identification of job types and required skills, and a commitment from Teck to source locally. Teck should proactively identify contracting opportunities and training requirements, so that LFN members can position themselves for jobs when they become available. This is not strictly required as part of an updated DDRP; however, it is an integral part of closure planning and implementation. Golder understands that Teck has initiated such an assessment.

5.2.4 Communication

LFN is seeking a commitment from Teck to develop a communication plan and framework that spans from now through the remaining closure planning phase, through implementation, and then through the post-closure period. As discussed in pervious sections, clear communication tools need to be developed and the information needs to be presented in a manner that is understandable to LFN citizens. The communication framework should be included in the DDRP, or could be acceptable as a standalone agreement. Appropriate allowances for ongoing communication need to be considered.

5.2.5 Other Concerns

As noted previously, there has been limited engagement to date between Teck and the LFN community related to the Sä Dena Hes mine closure. LFN members are likely to have concerns, in addition to those discussed above, that have not been raised to date but that should be considered as closure planning continues and implementation activities are initiated.

6.0 CLOSURE

We trust the information contained in this report is sufficient for your present needs. Should you have any additional questions regarding the project, please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

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7.0 REFERENCES

Teck Metals Limited (Teck). 2012. Sä Dena Hes Mine Detailed Decommissioning & Reclamation Plan January 2012 Update. January 28, 2012.

Golder Associates Ltd. (Golder). 2010. Report on Sä Dena Hes 2009 Dam Safety Review, prepared for Teck Metals Ltd. Reference 09-1427-0023. September 17, 2010.

APPENDIX A

Site History

APPENDIX A
Summary of Site History

Table 1: Summary of Site History

Date	Parties/Ownership	Activities
1962	Francis River Syndicate	Original surface showings were discovered. Geochemical and geophysical surveys conducted.
1979 to 1982	Cima Resources Ltd. and Canadian Natural Resources Ltd.	Diamond drilling of almost 3,000 m in 72 holes. Estimated 250,000 tonnes of zinc and lead mineralization.
1984 to 1988	Canamax	Over 23,000 m of drilling in 193 holes. Estimated zinc-lead-silver of >5 million tonnes in several zones.
1989	Mount Hundere Joint Venture[(a)]	Completed 29,000 m of drilling in 150 holes. Proven plus probable mineable reserves of 3.9 million tonnes[(b)].
1990		Prepared a development plan and secured financing.
August 1991 to December 1992		Production started in August 1991. Produced approximately 120,000 tonnes of zinc concentrates; trucked to Alaska for shipment to European and Asian markets. Downturn in metal prices resulted in shutdown in late 1992. Site was put on Care and Maintenance basis.
1993	Coopers & Lybrand Ltd.	Appointed by the court as Receiver and Manager of the property.
1994 to present	Sä Dena Hes Operating Company (SDHOC)[(c)] Operator: Teck Metals Ltd.	Purchased the property in 1994 through a court order. Kept on care and maintenance since that time, with the exception of 1998 when SDHOC intended to re-open the mine.

Source: Summarized from 2012 DDRP, Section 2.1

Notes:
(a) 80% Curragh Resources Ltd. and 20% Hillsborough Resources Ltd.
(b) at 11.5% zinc, 3.8% lead, and 53 g/tonne silver.
(c) 25% Teck Metals Limited (formerly known as Teck Cominco) and 25% Teck Resources Limited and 50% Pan Pacific Metal Mining Corp (a wholly owned subsidiary of Korea Zinc).

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APPENDIX B

Summary of Relevant Licence Sections

1.0 PURPOSE

There are two primary licences associated with the Sä Dena Hes mine:

- Type A Water Licence, QZ99-045; and
- Yukon Quartz Mining Production Licence, QML-0004.

This appendix summarizes relevant sections of each licence, as related to: i) temporary or permanent closure; ii) general environmental and closure considerations, and iii) potential interests and concerns of the Liard First Nation.

2.0 WATER LICENCE (QZ99-045)

2.1 Reference

There are a number of licence sections that relate to closure and the environment. An effort was made to identify those that may be of interest to the Liard First Nation; however, the list may not be comprehensive.

The Part and Section numbering referred to below relate to the January 2010 Amendment to Water Licence QZ99-045. General topics and scope of the sections are indicated. The summaries do not reflect actual text from the licence, therefore the reader is referred to the full licence for details and complete wording.

2.2 Summary of Sections

- Part A – **General Conditions**
  - Section 12 – Annual Reports. Annual reporting requirements related to water quantities, summaries of monitoring data, major maintenance or other works potentially impacting water, closure status, identification of any recommendations from inspections, and reviews that have not been implemented.
  - Section 16 – Hazardous Materials. Maintain a complete inventory of chemicals, fuels, oils, lubricant and other hazardous materials (*e.g.*, reagents, explosives, concentrates).
- Part B – **Design and Construction**
  - Sections 17 to 22 – Submissions. Requirements related to detailed design, modifications, and as-constructed drawings.
  - Section 23 – All instream earthworks and water-related structures to accommodate the peak instantaneous 200-year return period flow.

- Part D – **Effluent Quality Standards**
  - Section 36 – All waste discharge is required to meet effluent quality standards for suspended solids (50 mg/L), pH (not less than 6.0), colour (20 PT-CO units), turbidity (15 Jackson Turbidity Units), floating solids (none), and floating oils or grease (none visible).
  - Section 37 – Results of grab sample analysis of any waste discharge are required to meet a series of concentrations (refer to table in Licence QZ99-045, pages 9 and 10).
- Part E – **Monitoring and Surveillance**
  - Sections 41 to 45 – Surveillance Network Program. Data, analysis, and reporting requirements.
  - Sections 46 to 49 – Physical Monitoring Program. Annual inspections for all earthworks and water retaining structures by a (Yukon) licenced Professional Engineer. Establishment of an internal monitoring program. Dam safety reviews at least once every five years.
  - Sections 51 to 53 – Instrumentation and Monitoring of Dams. Monitoring requirements, including monthly observations and annual reporting.
  - Sections 54 to 56 – Fisheries, Benthic Invertebrate, and Sediment Monitoring. Fisheries program to be conducted at four sites, surveyed every two years in September. Benthic invertebrate and sediment sampling at five sites, every two years in August.
  - Sections 65 to 68 – Geochemical Assessment Program. Requirements to evaluate and identify potential long-term impacts and potential mitigation, including monitoring and mitigation planning.
  - Sections 69 to 70 – Surface Water Hydrology; Seepage Monitoring; Study plans and implementation related to hydrology and flood estimates, as well as seepage monitoring for the North Tailings Dam.
  - Section 71 – Operation, Maintenance and Surveillance Manual. Manual for safe operation and maintenance of all dams and appurtenances, in accordance with Dam Safety Guidelines.
- Part F – **Decommissioning and Reclamation**
  - Sections 76 and 77 – Temporary Closure. Requirements including having a full-time on-site caretaker, maintaining access and major equipment, undertaking all monitoring requirements. Reporting requirements.
  - Sections 78 – Permanent Closure.
    - Permanent Closure shall be the cessation of mining and/or discharge of waste from milling operations for a period of more than four years; or if any requirements of “Maintenance Activities During Temporary Closure” are not met.
    - <u>2005 Amendment</u>:
      - If all requirements of “Maintenance Activities During Temporary Closure” are carried out, then Permanent Closure shall be deemed to commence January 29, 2010 (or, if mining resumes, four years after cessation of mining and/or discharge of waste from milling operations).
      - If any of the requirements “Maintenance Activities During Temporary Closure” are not carried out, then the undertaking shall be deemed to be in Permanent Closure.

- 2010 Amendment:
  - If all requirements of "Maintenance Activities During Temporary Closure" are carried out, then Permanent Closure shall be deemed to commence January 29, 2013 (or, if mining resumes, four years after cessation of mining and/or discharge of waste from milling operations).

- Sections 79 to 82 – Permanent Closure. Submission of twice-yearly status reports for the first three years after commencement of Permanent Closure. Requirements for details design drawings and approvals to proceed.
- Section 83 – Permanent Closure. Requirement for updated Decommissioning Plan:
  - Within four years of licence date (or within two years following resumption of operations, whichever comes first), including updated costs.
  - 2005 Amendment: Update the Decommissioning Plan by January 28, 2006 and every four years thereafter, unless mine operations resume.
  - 2010 Amendment: Update the Decommissioning Plan by January 28, 2010 and every two years thereafter. Submission of reports by third-party consultants and any other correspondence with the Yukon government related to the Decommissioning Plan.

3.0 MINING LICENCE (QML-0004)

3.1 Reference

There are a number of licence sections that relate to closure and the environment. An effort was made to identify those that may be of interest to the Liard First Nation; however, the list may not be comprehensive.

The Part and Section numbering referred to below relate to the November 2001 Quartz Mining Licence QML-0004. No changes to numbering were made in subsequent licence amendments in 2005 and 2010. General topics and scope of the sections are indicated. The summaries do not reflect actual text from the licence, therefore the reader is referred to the full licence for details and complete wording.

3.2 Summary of Sections

- Activities
  - Sections 8 to 11. Description of authorized area of activities, restrictions to open pit and underground mining, and milling process and rates.
  - Section 12 – Waste Rock Dumps. Prior to waste rock deposition, a requirement to stockpile organic and fine grained material from the dump footprint for later reclamation purposes.
- Reporting (Section 13)
  - Annual reporting requirements related to mining volumes, updated mine plans, environmental studies, materials inventories, *etc.*

- Detailed Decommissioning and Reclamation Plan (DDRP) (Section 15)
  - Submit an updated DDRP prior to the fourth year of any temporary closure period (or within two years of the resumption of production activities).
  - 2010 Amendment:
    - Update the Decommissioning Plan by January 28, 2010 and every two years thereafter.
- Plan Requirements (Section 16)
  - Evaluation of the long-term physical stability of waste rock dumps and details of the reclamation plans.
  - Plans for characterization and disposal of any split ore, concentrate, or unprocessed ore stockpiles.
  - Evaluation of the risk for possible underground subsidence attributable to mine workings, and mitigation plan, if necessary.
  - Report on the success of revegetation testing.
  - Criteria and mitigation for access road stabilization, where erosion is a concern.
- Revegetation Studies (Section 17)
  - Conduct revegetation studies, including tailings revegetation testing in order to determine successful means of reclaiming terrestrial disturbances.
- Financial Security (Section 19)
  - 2010 Amendment: Updated financial security conditions.
- Temporary Closure (Section 24)
  - Requirements including having a full-time on-site caretaker, maintaining access and major equipment, undertaking all monitoring requirements.
  - If an extension of Temporary Closure status is required, notification must be provided at least ninety days prior to the end of the period. Include documentation that Temporary Closure measures have been implemented and have been effective in maintaining environmental integrity.
- Waste Disposal (Schedule A)
  - Requirements related to burning, salvage, off-site disposal, recycling, and landfilling.
- Temporary Closure (Letter from Yukon Minister of Energy, Mines, and Resources to Teck Cominco Ltd, October 26, 2005 and to Teck Metals Ltd. January 15, 2010)
  - 2005 Amendment: Temporary Closure period extended from November 30, 2005 to January 28, 2010.
  - 2010 Amendment: Temporary Closure period extended from January 28, 2010 to January 28, 2013, 2015.

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APPENDIX C

Review Comments and Notes related to the Environmental Baseline Update and Technical Basis for Closure Assumptions (Appendix B of the 2012 DDRP)

This appendix provides additional comments that were noted through the review of the 2012 Detailed Decommissioning and Reclamation Plan (DDRP) Appendix B – Environmental Baseline Update and Technical Basis for Closure Assumptions. The document was prepared by Access Consulting Group and Laberge Environmental Services in 2010 (dated January 2010), and was included unchanged in the 2012 DDRP update.

1.0 SECTION 1 GEOLOGY AND ORE RESERVES

- The discussion is based on the Sä Dena Hes Reopening Study from November 1995. The content remains applicable to current conditions of the project.

2.0 SECTION 2 CLIMATE

- The regional precipitation and temperature analyzes are based mainly on data available to 1997. It was concluded, by comparison of newer data from 2000 to 2005 to the old data set, that inclusion of the additional data would not substantively change the assessment.
  - There is potentially an additional seven years of data now available since 2005, equating to a total of approximately 15 years of additional data since the original assessment was completed in 1999. An updated characterization of precipitation may be warranted to support closure planning (*e.g.*, establishing design flows, inputs to the site water balance and water quality model).
- Format of, and references to, table and figure numbers should be uniform throughout the document.
- Section 2.4, Page 2-9: A discussion on uncertainty in the estimation of precipitation at the mine site is warranted, based on the scarce amount of data at site and the distant location of regional climate stations, and to support the selection of the adjustment factor.
- Section 2.4, Table 2-5: The 100-year low event is higher than the 20-year low event. The event is not fully defined, and the table or column heading should refer to Total Annual Precipitation.
- Section 2.4: There is no discussion or estimates related to shorter duration extreme events, *e.g.*, the 24-hour extreme rainfall or rainfall on snow events, or the probable maximum precipitation.
- Section 2.5: The effect of sublimation is not discussed, *e.g.*, comparison between snowfall and snowpack.
- Section 2.6: It is not clear how air temperature at the mine is estimated.
- Section 2: What are the predicted long-term changes in temperature and precipitation as a result of climate change? Are these changes taken into account in the water balance and water quality modelling? Environment Canada has done a study on climate change, specifically for the Yukon region.

3.0 SECTION 3 WATER RESOURCES

- Format of, and references to, table and figure numbers should be uniform throughout the document.
- Section 3.1, Page 3-19: Reference to Table 3-3 is incorrect, or Table 3-3 is missing (there is a Table 3-3 on page 3-30; however, it presents and does not relate to low flow events).
- Page 3-20, first bullet: Values for a 1000-year 24-hour rainfall events and a snowmelt rate are presented; however, there is no description as to how these values were obtained (and they should likely have been presented in Section 2 instead of Section 3).
- Section 3.1.5, Figures 5 to 9: Numbering and order within the document are not consistent.
- Section 3.1.5: Are the water management structures considered in the modelling, both at the TMF and Reclaim Pond, the same as those presented in the main body of the 2012 DDRP?
- Section 3.1.5: Figure 9 indicates that modelled scenarios provide peak predictions that are much higher than any observed peak. It should, however, be considered that none of the observed peaks may have been associated with a return period of similar magnitude compared to those used in the modelled scenarios.
- Section 3.1.5 Page 3-22: The third paragraph refers to a section (3.5) that does not exist. This may have been intended as Section 3.1.2.
- Section 3.1.5: Assumptions provided in the text do not mention how infiltration was accounted for (*e.g.*, a CN number, with justification as to the selection of that number).
- Section 3.2.2.1: Table 3-3 indicates an average evaporation of 450 mm, while a value of 430 mm is given in Table 2-4. A reduction in evaporation would mean an increase in seepage. However, I think that precipitation in Table 3-3 should also be reduced to account for snow sublimation. In all likelihood, changes in evaporation and precipitation would not change seepages by much.
- Section 3.2.2.2: Figure 3-8 is not related to seepages from the North Dam.
- Section 3.2.2: Reference to Figure 3-8 should actually be a reference to Figure 3-9.
- Section 3.6: First paragraph should refer to Appendix F, instead of Appendix E.

4.0 SECTION 4 GEOCHEMISTRY

4.1 Summary of Geochemical Characteristics of Mine Rock and Tailings

The notes below summarize the geochemical characteristics of mine rock and tailings, as described in Appendix B of the 2012 DDRP.

As described in Section 1 of Appendix B of the DDRP, the Project is underlain by metasedimentary rocks (calcareous and non-calcareous phyllite and limestone), which were intruded by igneous rocks (mafic to intermediate, intermediate and quartz porphyry). Skarns host mineralization, including medium to coarse grained sphalerite [ZnS] and galena [PbS]. Occasional occurrences of magnetite [Fe_3O_4], pyrite [FeS_2] and pyrrhotite [$Fe_{1-x}S$] are also noted. In situ oxidation of mineralized skarn horizons resulted in accumulations of quartz [SiO_2], smithsonite [$ZnCO_3$], angelsite [$PbSO_4$] and cerrusite [$PbCO_3$].

Section 4.2 of Appendix B of the DDRP states that rock sampling and testing was undertaken as a component of the Initial Environmental Evaluation (IEE). The dataset described in Section 4.2 includes static testing to determine the acid generation and metal leaching potential of mine materials, and kinetic testing to confirm the long term reactivity of materials. Oxidation of the main ore minerals, including sphalerite and galena, tended to be a source of zinc and lead, respectively, but not acidity. Leachable sulphate and zinc were measured in short-term leachates. Section 4.2 states that long-term kinetic tests identified a potential for ongoing leaching of zinc from ore-type materials.

The geochemical dataset discussed in Section 4.3 of the DDRP includes the following components: results of a site inspection conducted on June 17 and 18, 1999; water quality samples collected from seeps and discharges; water quality samples included in the water quality monitoring program; and tailings and rock samples collected from waste rock facilities and tailings areas. The water quality monitoring dataset and observations from site visits are an important component of the overall geochemical dataset, as data from existing facilities provides key input to the site specific geochemical reactivity of mine materials.

Results are discussed by mine area.

Underground Mine Workings

- **Burnick Zone**
  - Water from the 1200 portal discharges onto the Burnick Waste Rock Dump. Discharging mine water had an alkaline pH and elevated zinc, cadmium and lead concentrations.
  - Flow from the 1200 portal discharges from at least freshet, throughout summer and through winter. Water flowing from faults in the Portal comes into contact with weathered skarn in the adit.
  - Burnick portal discharge (MH-22) was monitored for total zinc and total suspended solids for a period of time. No apparent trend was noted.
  - Laboratory testing was performed using mine drainage water samples and samples of glacial till and alluvium from near the portal. It was concluded that zinc is being attenuated by soil prior to seepage reaching Camp Creek.
- **Jewelbox Hill Zone**
  - The declined ramp at the 1408 portal has been gradually flooding since the mine closed in 1992. The groundwater elevation in the portal was approximately 1350 m through 2004. Water quality samples were collected in 1999, 2002 and 2004, but the mine is not considered safe to enter for the purpose of inspection of water level and water quality.
  - Water sampled in 1999, 2002 and 2004 had a weakly alkaline pH (7.58 to 7.9), with sulphate concentrations of 84 to 104 mg/L. Cadmium and zinc concentrations increased between the 1999 and 2004 sample events. The geochemistry section of the DDRP states that a change in the chemistry of the mine pool is expected over time, and the dissolution of salts from the mine walls into the mine pool could influence mine pool chemistry. It is speculated that the zinc concentrations may eventually stabilize and decrease as the workings become a component of the groundwater flow-through system.

- Dissolved zinc concentrations were greater than 1 mg/L after the 2002 sample event. The current zinc concentrations in water in the 1408 Portal are not provided. It is stated that "the flooding rate indicates that it is unlikely that a discharge would be observed at the 1408 Portal".

- **Main Zone – 1380 Portal Discharge:**
  - Water discharges from the 1380 Portal and infiltrates into soils in the dry headwaters of Camp Creek.
  - Long-term water quality monitoring trends at MH-4, which receives drainage from the Main Zone, indicate stable concentration trends of zinc and sulphate.
  - The source water of the discharge is likely shallow groundwater that came into contact with oxidizing exposures and mineralized talus containing sphalerite. Elevated metal concentrations are expected to persist, owing to the exposure sphalerite-rich skarn portal wall rock.
  - Additional testing was performed to confirm the attenuation capacity of Camp Creek headwater soils. The results from the laboratory proved that the soils have a strong metal attenuation capacity.

Pit Walls

- **Main Zone Pit**
  - Pit wall exposures include limestone, phyllite and skarn. No rock samples or runoff samples were collected during the site inspection.
- **Jewelbox Pit**
  - Pit wall exposures described as limestone and phyllite. No rock samples or runoff samples were collected during the site inspection.

Waste Rock

- **Burnick Zone**
  - Waste rock dumped along the slope outside the 1200 portals consists of mixed weakly mineralized calcareous and non-calcareous phyllite which was concluded to be non-acid generating in the IEE (not confirmed).
  - A small sample of ore-type skarn containing sphalerite, calcite and actinolite (with minor pyrite) was found at the top of the dump. This material was concluded to be non-acid generating. No analysis was performed on this material.
  - No toe seeps were identified in 1999.
  - Waste rock was concluded to be "chemically stable" but "oxidizing" and "unlikely to generate acidity".

- **Jewelbox and Main Zone**
  - One sample was collected from the Jewelbox Zone waste rock dump, and one sample from the Main Zone 1250 waste rock dump, but these dumps/samples are not described explicitly in Section 4.3 of Appendix B. Results of geochemical testing presented in Table 4 indicate a low potential for acid generation. Samples collected from seeps in the Main Pit Dump and Jewelbox Dump seeps had a neutral pH. Sulphate concentrations were 137 mg/L in the Main Pit Dump seep, and 50 to 161 mg/L in seeps from the Jewelbox Pit. Zinc concentrations were as high as 11 mg/L in seepage from the Main dump. Zinc ranged from 0.22 to 0.842 mg/L in the seep from the Jewelbox dump.
- **Tailings**
  - Tailings are exposed in the north and south tailings beaches. The tailings were concluded to have a low potential for acid generation.
  - Results of seepage monitoring at the tailings impoundment indicate that sulphate, cadmium and zinc are capable of leaching from the tailings.
  - Water quality samples have been collected from MH-2 (tailings dam seepage) since 1991. Seepage has a weakly alkaline pH, and zinc concentrations are generally less than 0.25 mg/L. Sulphate concentration trends are unclear.
  - The mass loading model, which is based on the results of ongoing seepage and flow monitoring from the tailings, indicate that tailings seepage is not anticipated to have a significant impact on receiving water at MH-11 or MH-16, so no engineered measures to control metal leaching are recommended.

4.2 Summary of Water Quality Modelling

The loading calculations rely on the data in the site water quality monitoring network. Loadings were calculated based on flow and chemistry data, where available, through 2003/2004. Loading estimates have not been updated for the most recent site conditions using recent site monitoring data. [Golder understands that an update to the model is currently in progress, and that more recent data will be incorporated in the revision.] The objective of the loading calculation was to evaluate reclamation priorities, and determine if significant changes in water chemistry occurred over time and how this may affect overall site loadings.

Zinc was the main constituent of concern. Sulphate was used as an indicator of mine-related impacts that would not be affected by metal attenuation. The conclusions of the loading calculation indicate that zinc will decrease at most monitoring stations over time. It was concluded that the main source of sulphate and zinc in the catchment area is natural weathering of soil and rocks, unrelated to mining activity.

5.0 SECTION 5 TERRESTRIAL RESOURCES

- Descriptions of biophysical features of the mine site and surroundings are general but adequate for a decommissioning and reclamation plan; however, there is little information on site specific wildlife occurrence for the mine site area, which limits the ability to plan for end land use. The information on wildlife referred to in the document is dated and no specific details of survey results are provided (original studies were not obtained or reviewed).
- There is mention of background data on metals content of vegetation but data are not provided, neither is a sampling plan or map showing past and proposed future sampling locations. These data are important in establishing a baseline to which post-reclamation monitoring data can be compared, particularly with respect to the potential for metals uptake by wildlife (*e.g.*, moose). The report makes a commitment to complete a study of metals uptake in vegetation from the tailings management facility once it is reclaimed, and that if metals uptake in forage for wildlife is detected, an Ecological Risk Assessment will be carried out, and that alternate plant species will be selected to reduce the risk to wildlife (through ingestion or plant materials).
  - It is understood through discussions with Teck that initial field sampling was conducted in 2012 to support an ERA. The ERA study plan is currently in development.
- There is little information on weedy or invasive plant species in the mine site area, other than mention of several grass species that have invaded disturbed land. Spatial data on weedy or invasive plant species is important for establishing a baseline prior to closure and reclamation work, so that an assessment can be made of what type of seed mix could be used on site. The DDRP states that native plant species will be used where feasible.

6.0 SECTION 6 AQUATIC RESOURCES

- Background information on fish species distribution is adequate for reclamation purposes; however, the fish tissue analytical data are from 1992, and there is no indication that more recent sampling of fish tissues and laboratory analysis for metals in fish tissues have been carried out. These data are now 20 years old, and more recent data would be helpful to assess if fish populations have been affected by metals release from the mine site.

7.0 SECTION 7 CURRENT LAND USE AND TENURE

- Trapping and hunting are noted as the primary activities in the project area. There are several registered and active trapping concessions.
- No major changes in the reported “current land use” are expected; however, this could influence discussion on target end land use following closure and, therefore, should be verified.

8.0 SECTION 8 CULTURAL RESOURCES

- The DDRP refers to previous evaluations were the archaeological potential of the area was considered low.
- The area does (or can) provide resources to First Nations and other subsistence users, and existing levels of trapping, hunting, recreational, and subsistence use is expected to remain the same.

9.0 SECTION 9 AIR QUALITY

- No comment on contents of the 2012 DDRP; however, air quality may be a consideration and may require management during closure implementation (*e.g.*, mitigation to reduce fugitive dust from decommissioning activities; selection of heavy equipment from an emissions standpoint).

10.0 SECTION 10 STABILITY ANALYSIS

- The 2012 DDRP presents a discussion on Stability Analysis and indicates acceptable long-term factors of safety under both static loading and pseudo-static conditions corresponding to a design seismic event.
- The methods and assumptions used in the Stability Analyses were not evaluated as part of this technical review. [However, results of related dam safety reviews are discussed in the main review document.]

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APPENDIX C - ANNEX 1

EXECUTIVE SUMMARY OF THE SA DENA HES 2009 DAM SAFETY REVIEW

September 17, 2010

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REPORT ON

Sä Dena Hes Mine
2009 Dam Safety Review

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Teck Metals Ltd.
Sä Dena Hes Mine
c/o Bag 2000
Kimberley, BC V1A 2E1

Attention: Bruce Donald, Reclamation Manager

Project Number: 09-1427-0023

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REPORT

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Executive Summary

This report summarizes a dam safety review for the Sä Dena Hes Mine. The work was supported by a review of all project documents listed in this report and a site visit conducted by John Hull, senior geotechnical engineer, on June 23 and 24, 2009. This report provides the results of the dam safety review, which was conducted in accordance with the current Dam Safety Guidelines published by the Canadian Dam Association (CDA 2007).

Description of the Mine Development

This mine development is a zinc mine located in the Yukon approximately 70 km by road from the Town of Watson Lake. The mine was put into production in August 1991, and operations ceased in December 1992 due to a sharp downturn in metal prices. The mine is now owned by the Sä Dena Hes Joint Venture, which is comprised of Teck Metals Ltd. (50% ownership), and Pan Pacific Metal Mining Corp., a wholly owned subsidiary of Korea Zinc, (50% ownership). Teck Metal Ltd. is the operator under the Joint Venture Agreement.

The mine site is currently under active care and maintenance by Teck. A caretaker is present at the mine site to perform routine surveillance and maintenance work. Steffen Robertson & Kirsten Consulting Engineers (SRK) have been identified as the consultant for the dam infrastructure of the mine. Since 1992, SRK has carried out annual review site visits and other design and construction monitoring activities related to the maintenance of the key dams and dykes.

The Sä Dena Hes Mine received a water licence for the mine (licence number QZ99-045, YTWB 2002), which requires that a dam safety review be conducted at regular intervals. A first review was conducted in 2003 (KC 2003).

The dam safety review is intended to assess the tailings dams and associated water management infrastructure built for the tailings management facility and for supporting mill activities. The structures included in the dam safety are

- The North Dam;
- The South Dam;
- The Cofferdam;
- The Reclaim Dam;
- The Camp Creek Diversion;
- The North Creek Dyke; and
- The East and West Interceptor Ditches.

The Camp Creek Diversion, Cofferdam, and North, South and Reclaim Dams are parts of the Tailings Management Facility (TMF) at the Sä Dena Hes Mine, while the North Creek Dyke is a part of the mill water

supply system. The mine also has water pumping facilities at the Reclaim Dam and the North Creek Dyke that have not been used since the shut-down of mining operation and are not included in this review.

The North and South Dams retain the Tailings Impoundment. Between these two dams is the Cofferdam, which has a gated culvert to control the flow of water and tailings from the northern half of the impoundment to the southern half. All three dams are earthfill structures. The South Dam has a concrete decant tower structure to decant supernatant water from the Tailings Pond to the Reclaim Pond through a decant pipe. The decant tower has been temporarily sealed off to prevent discharge while the mine is not in operation. An emergency culvert spillway is located on the west abutment of the South Dam.

The Reclaim Dam is an earthfill structure that retains the supernatant water decanted from the Tailings Pond. This structure also collects seepage water from the Tailings Pond as well as the surface runoff between the South and Reclaim Dams. The Reclaim pond has an open channel emergency spillway which discharges into the Camp Creek Diversion Channel, upstream of the culverts across the west abutment of the Reclaim Dam.

The Camp Creek Diversion Channel diverts Camp Creek flows along the west side of the Reclaim pond. The diversion channel directs run off downstream of the Reclaim Dam, into the original Camp Creek channel.

The North Creek Dyke is located on North Creek approximately 1 km north of the Tailings Pond. The dyke forms a head pond for the mill water supply pipeline pump station. Several culverts carry the overflow through the dyke and discharge into North Creek downstream. Immediately below the dyke is a second culvert road crossing of the creek.

Conclusions and Recommendations of the Dam Safety Review

Key conclusions from the dam safety review are as follow:

- In general, the dams and associated water management infrastructure are considered to be maintained in good condition.
- Based on the CDA (2007) dam classification, the North, South and Reclaim Dams are in the Significant class. Consequently, these dams and their associated water management infrastructure *(i.e.,* the South Dam Emergency Spillway, the Reclaim Dam emergency spillway channel and Camp Creek Diversion) must be able to sustain flood events of 200 years (Reclaim Dam) or 1000 years (South and North Dams).
- The North Creek Dyke and the Cofferdam are in the low dam class, and their associated water management infrastructure (*i.e.,* the North Creek Dyke Culvert and the Cofferdam gated culvert) must be able to sustain a flood event of 100 years.
- It was estimated that the water management infrastructure has the capacity to manage extreme flow events corresponding to the dam class (*i.e.,* Significant or Low) of each dam, while providing adequate freeboard to prevent overtopping of any dam.
- All dams (North, South and Reclaim Dams, Cofferdam and North Creek Dyke) would satisfy the seismic requirement corresponding to their respective dam class.

- Since the previous dam safety review (KC 2003), an operating, maintenance and surveillance manual (SRK 2004) was developed to describe the operation and maintenance of these dams and related water management infrastructure as well as to provide guidelines for the monitoring of these structures. The manual also include an emergency and preparedness response plan that address actions to be taken for several possible incidents.

Recommendations provided as a result of this dam safety review are as follow:

- An inspection of the seal of the pipe inlet at the decant structure (South Dam) would be recommended to determine if repairs or a replacement are required. Detail design of a permanent seal will be needed if the decant tower is expected to remain in place following permanent closure of the mine.
- Repair to the weir at water quality monitoring station MH-07 should be made when possible to ensure that all water pass through the V-notch and the seepage flow from the Reclaim Dam are not underestimated.
- The conditions of the steel plate armour in the Camp Creek Diversion should be monitored on a regular basis and repairs undertaken as soon as possible when needed. Alternate and more stable armouring options must be considered in plans for permanent closure of the mine site.
- The siphon systems at both the Reclaim Dam and the South Dam should be maintained in a working condition so that the water levels in the Reclaim and Tailings Ponds can be positively controlled.
- Sand bags are used as erosion control measure on the upstream face of the North Creek Dyke. Any damage sand bags should be replaced as early as practical.
- It is important that the capacity of the conveyance structures be maintained to their full potential. Any material accumulating in culvert entrance should be removed (e.g. gated culvert). Shrubs and trees should also be removed from channels (*e.g.,* Reclaim Dam emergency spillway channel and Camp Creek Diversion).
- Flood routing analysis should be undertaken to verify the capacity of the Cofferdam gated culvert to pass the 200 flood event. The result of this analysis will determine if the capacity of that conveyance structure needs to be increased (*i.e.,* add culverts or develop low point on cofferdam to allow overflow or controlled breach of the Cofferdam).
- Flood routing analysis should be undertaken to verify water levels in the Reclaim Dam emergency spillway channel during 200 year flood event. This analysis is intended to verify if the banks of this channel can be overtopped and eroded during this event. The channel bank height should be increased if overtopping is predicted to occur.
- Flow velocities in the Camp Creek Diversion channel should be estimated for average and extreme flow conditions to assess the ability of unlined bank and bed material to resist erosion. The result of this estimation will determine the need and size of any riprap lining.
- Confirm that surveillance activities in the log sheets match activities listed in the OMS manual. For example, the daily log sheets list 16 and 5 surveillance items, respectively during mine operations and shutdown, while the text in the OMS manual refer to 15 and 9 items. Other similar discrepancies exist in

the daily activities. Checking for seepages on a weekly basis is not identified on the weekly log sheets, although this activity is mentioned in the surveillance summary table in the manual.

- The log sheets should details the extent of the monitoring for the Camp Creek Diversion channel. Monitoring near the Camp Creek Diversion culverts and spillway chute on a daily and monthly basis is considered sufficient. Monitoring the entire length of the diversion channel is recommended on a monthly or at least on an annual basis.
- The monthly and annual log sheet should include inspection of the east and west interceptor ditches.
- The surveillance section of the OMS manual provides specific details on: 1) rates of rise of tailings; 2) water balance; 3) freeboard; 4) seepage flows; 5) piezometers and pond water levels; 6) precipitation; 7) diversion structures; and 8) settlement gauges. It is recommended that a clear distinction be made in the text as to which of these components are addressed in the log sheets (likely components 3, 4, 5, 7, and 8) and which are not (likely components 1, 2 and 6). Additional details should be given in the text on the components not addressed in log sheets, notably about who is responsible for collecting the information, and how the information must be processed and filed.
- Details on surveillance activities following storm or seismic events should also include assessment of incident level as part of the emergency preparedness and response plan.
- The emergency preparedness and response plan describe the typical characteristics of several possible incidents as well as detailing response plans based on the incident level. The treatment of each incident is consistent and sufficient, except for the following:
  - The description of the characteristics of Channel Slope instability is not provided; and
  - The response plan for Puncture/Burst Tailings Distribution Pipeline is not provided.
- Internal and external notifications based on incident level are part of the response plan and presumably summarized in a figure in the OMS manual. This figure was absent in the copy of the manual provided for the DSR. Care should be given to ensure all available copies of the OMS manual are complete.

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