CANADIAN ZINC CORPORATION

a wholly-owned subsidiary of NorZinc Ltd

POST-EA INFORMATION PACKAGE INCLUDING AN UPDATED PROJECT DESCRIPTION

ALL SEASON ROAD TO PRAIRIE CREEK MINE

MAIN REPORT

SUBMITTED IN SUPPORT OF:
Water Licences MV/PC2014L8-0006, and
Land Use Permits MV/PC2014F0013

SUBMITTED TO:

Mackenzie Valley Land and Water Board
Yellowknife, NT X1A 2N7

Parks Canada,
Nahanni National Park Reserve
Fort Simpson, NT X0E 0N0

SUBMITTED BY:
Canadian Zinc Corporation Vancouver, BC, V6B 4N9
February 2019

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ACKNOWLEDGEMENTS

This package was compiled by Canadian Zinc Corporation with the assistance of a number of consultants.

The majority of sections 1.2 and 1.4, the road and stream crossing designs, some of the management plans and the base reclamation cost estimate were prepared by Allnorth.

The majority of the management plans, geotechnical, geochemical and hydrology information, as well as the Reclaim estimate, were prepared by Tetra Tech.

Hatfield and Tetra Tech collaborated on the Sundog Diversion plan.

Lifeways provided archaeological information.

Alpine Solutions provided avalanche input.

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INTRODUCTION

The Prairie Creek Mine (the Mine) site is located in the southern Mackenzie Mountains in the south-west corner of the Northwest Territories (Figure 1-1). The Mine is 100% owned by Canadian Zinc Corporation (CZN), a wholly-owned subsidiary of NorZinc Ltd. CZN seeks to permit an all season road (ASR) connecting the Mine to the Liard Highway via a 10 km section of the already established Nahanni Butte access road. The road will allow the transport of mineral concentrates from the Mine to market, and the delivery of operating supplies to the Mine, year-round.

A summary of the proposed development is as follows:

- Total ASR length of 170 km.
- A general 5 m wide running surface, wider at curves and turns, and with a 40 km/hr design speed.
- Pull-out lanes for passing averaging 2 to 3 per km (minimum 1 per km).
- A variable 15 to 30 m wide cleared right-of-way, wider in places where design requires.
- 17 major stream crossings and 120 minor stream crossings.
- 81 borrow pits identified (49 required, plus 12 primary and 20 secondary pits as back-up) to supply subgrade borrow, aggregate, and rock from quarrying for the road.
- A total disturbed area for all activities of approximately 440 hectares.

Permit conditions for the planned development will need to address the recommendations of the Mackenzie Valley Review Board (MVRB) in its Report of Environmental Assessment (REA) for EA1415-01, and specifically the measures contained therein. Chief among these from a schedule and process perspective are continuing engagement with, and involvement of, Indigenous groups in all aspects of the project, and the formation of an independent technical review panel (the Panel) to provide recommendations regarding road design principles.

Development of the ASR will take place over 3 calendar years, but in the first year (Phase 1), winter access is required in order to complete geotechnical investigation of the proposed alignment and borrow pits, followed by completion of road and stream crossing designs and the approval of many management and monitoring plans before ASR construction work can start in Year 2 (Y2) (Phase 2).

The Mackenzie Valley Land and Water Board (MVLWB) and Parks Canada requested that CZN provide a post-EA information package concerning the proposed ASR development, including an Updated Project Description (UPD), in their letter to CZN dated October 9, 2018. This submission provides the requested information, as well as proposed permit conditions reflecting the ASR development schedule, specifically the initial Phase 1 winter road development. Given that this Phase 1 access will be in winter only, and will carry only limited traffic operating at very low speeds (~30 km/hour), proposed permit conditions have been written such that some do not apply to the initial Phase 1 road. This will enable construction of the initial road in the winter subsequent to the issue of ASR permits and maintain the desired overall ASR construction schedule.

SCHEDULE 1 – WATER BOARD AND PARKS CANADA

1.0 UPDATED PROJECT DESCRIPTION

1.1 Regulatory History

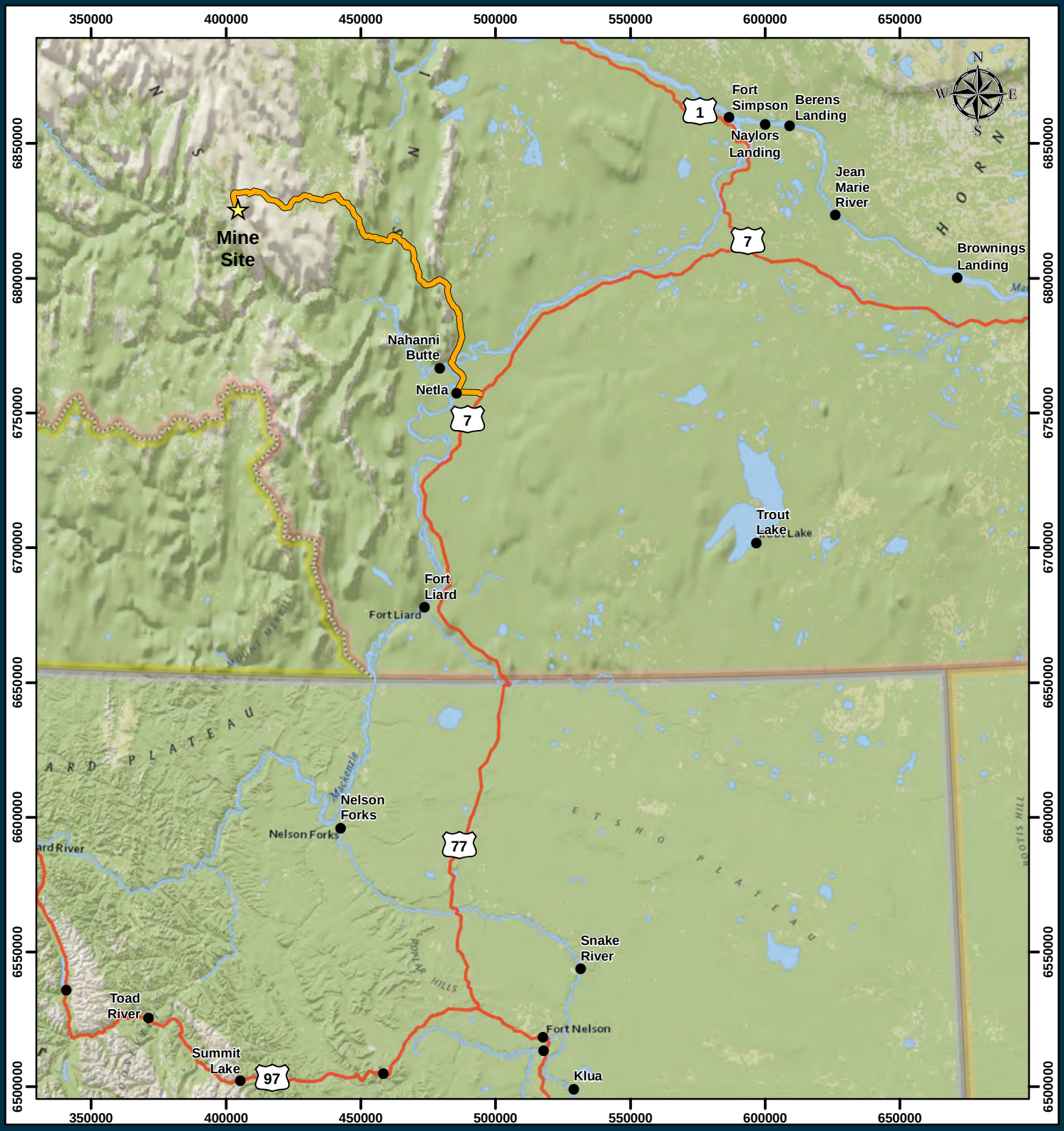
1.1.1 Regulatory History 1970 to 2007

Between 1970 and 1980, extensive underground development of the Prairie Creek Mine took place (then known as the Cadillac Mine). A winter tote road from Camsell Bend into the Mine was established in 1974/75 in order to bring supplies and heavy equipment in. An engineering feasibility study was completed by Kilborn Engineering (B.C.) Ltd. in 1980 for Cadillac Exploration, culminating in the May 1980 Preliminary Environmental Evaluation reports on the Mine, Mill and Camp, and on the Winter Access Road.

The Prairie Creek Mine first received an operating Water Licence in 1982 and Land Use Permits (LUP) in 1980 to allow production of concentrates of lead and zinc and a silver-bearing copper concentrate, and use of a winter access road from the Mine to the Liard Highway at Lindberg Landing (N80F249). The Mine was three months from production when it was placed into receivership due to market conditions. CZN, formerly named San Andreas Resources Corporation acquired the property in 1991, and has since expanded the mineral resource and determined a mineral reserve.

A winter access road was constructed from the then recently built Liard Highway (Northwest Territories Highway #7) into Prairie Creek, beginning in the summer of 1980. The winter road joined the Highway 3 km north of Lindberg Landing, approximately 7 km north of the Blackstone River. At that time, the Highway south to Fort Liard was not completed. The access road was used extensively over the period from January to March in both 1981 and 1982. In excess of 800 loads were hauled into the Mine over these two winters.

CZN applied for an LUP to use the existing access road alignment to re-supply the Mine in May, 2003. The MVLWB referred the application to environmental assessment (EA), however CZN requested a judicial review of the referral decision, and the Supreme Court of the Northwest Territories ruled that the road was ‘grandfathered’ according to Section 157.1 of the Mackenzie Valley Resource Management Act, because the undertaking was previously assessed in the 1980’s and LUP N80F249 was issued. LUP MV2003F0028 for use of the road was subsequently issued by the MVLWB on April 7, 2007. Subsequent to receiving the road permit, an evaluation of the road determined that washed-out sections of the road required repair, and further permits and authorizations were needed. A quarry permit and Water Licence were issued in relation to the repairs, as well as an authorization from Fisheries and Oceans Canada following several fisheries studies.



CANADIAN ZINC CORPORATION

Prairie Creek Mine Access Road

Date: 12/23/2014
Projection: NAD 1983 UTM Zone 10N
Scale:1:2,000,000
Author: ainglis
Last Modified By: ainglis
Checked By:
Revision #:

0 7.5 15 30 45 60 75
Kilometres

Legend

- Mine Site
- City / Towm / Community
- Proposed All Weather Access Road Route
- Highway

Allnorth

Path: C:\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\2400-GIS\2420-MXD\Prairie_Creek_Location_A.mxd

1.1.2 Regulatory History 2008 to 2013

After completing numerous engineering, environmental and economic studies, in 2008 CZN applied to the MVLWB for a Type A Water Licence and a Type A LUP to support reactivation of the Mine for production, and two Type A LUP's for transfer facilities approximately half-way along the access road and at the junction of the road with the Liard Highway. CZN already held LUP MV2003F0028 for operation of a winter road. As part of the regulatory process, the applications were referred to EA. In the terms of reference (TOR) for EA0809-002 (the Mine EA), issued by the MVRB, construction and operation of a winter access road in support of mine operations was included in the scope of development.

The MVRB issued their REA for EA0809-002 on December 8, 2011. The MVRB concluded that the proposed development, as described in the REA and including CZN's commitments, was not likely to have any significant adverse impacts on the environment or to be a cause for significant public concern. The file was returned to the MVLWB for the permitting phase, and mine operations permits were subsequently issued, including Water Licence MV2008L2-0002 issued on September 24, 2013.

In the TOR for EA0809-002, the MVRB indicated that it would not be assessing structures already in existence in connection with the access road. The MVRB also indicated that it would consider proposed changes to the access road. Changes were made to the access road alignment during the EA to address concerns from the Naha Dehe Dene Band (NDDB) about wetland/wildlife issues, and from Parks Canada regarding re-routing around the unique Polje-karst features. The eastern terminus of the road was also changed to connect to the Nahanni Butte access road.

After the EA, CZN applied for and received new winter road LUP's and Water Licences from both the MVLWB and Parks Canada. The MVLWB issued LUP MV2012F0007 and Water Licence MV2012L1-0005 on January 10, 2013 and Parks Canada issued LUP Parks2012-L001 and Water Licence Parks2012_W001 on August 26, 2013.

1.1.3 Regulatory History 2014 to 2018

In April 2014, CZN applied to the MVLWB and Parks Canada for LUP's and Water Licences to construct and operate an all season road (ASR) on generally the same alignment as the then permitted winter road. EA 1415-01 was initiated soon thereafter. The MVRB issued their REA for the ASR in September 2017, containing a positive decision with a number of required Measures and Suggestions.

Simultaneous to the issue of the REA, on September 12, 2017 the Northern Projects Management Office sent a letter to potentially impacted Indigenous groups inviting their comments on the adequacy of Aboriginal consultation following EA 1415-01 and the recommendation of the MVRB to approve the project. Following concerns raised by the Liidlii Kue First Nation (LKFN) and Dehcho First Nations (DFN), Indian Affairs and Northern Development Canada (INAC) wrote to CZN on January 19, 2018 stating that the responsible ministers are unclear as to how CZN will implement the measures in the REA, specifically regarding an inclusive approach for Indigenous group participation. INAC provided five specific "information requests" (IR's) in connection with the implementation plans for the various measures and proponent commitments contained in the REA.

On June 8, 2018 CZN provided responses to the IR's and informed that the Company had signed a Process Agreement, along with the NDDB and LKFN, which provides for CZN to negotiate an

Environmental Management Agreement (EMA) with the NDDB and LKFN to provide for Indigenous review, participation and oversight of the ASR during permitting, design, construction, operation and closure phases, and the implementation of the mitigation measures contained in the Review Board REA.

The MVRB REA was formally accepted by the federal Minister of Crown-Indigenous Relations on behalf of the responsible ministers on October 9, 2018. Subsequently, dated the same day, MVLWB and Parks Canada issued a joint letter titled 'Submission Requirements for All-Season Road Applications – Water Licence MV/PC2014L8-0006 and Land Use Permit MV/PC2014F0013 – Prairie Creek Mine, Prairie Creek, NT' that outlined the requirements for this Post-EA Information Package and a generic work plan and timeline.

1.2 Development Approach, Schedule and Permits

1.2.1 Approach and Schedule

CZN is proposing to construct the ASR in a 2 step process; Phase 1 being construction of a winter access road, and Phase 2 being construction of a fully operational all season access road.

The initial Phase 1 winter road (Y1 and Y2) would primarily utilize the same alignment footprint as the final ASR, with the exception of some defined, short sections. The function of this road is to provide the necessary project access along the route to support:

- A detailed, geotechnical investigation, critical to acquire required geotechnical data to complete detailed designs;
- Support winter delivery and staging of material and equipment to complete Phase 2 ASR construction; and
- Support winter delivery of materials and supplies to the Mine site for required upgrades during the following summer season.

Phase 2 is the construction of the ASR (Y2 and Y3). This construction will require the support of a winter road to access sections to receive ASR base material.

Overview road maps (1:150,000) are provided in Appendix 1-1. More detailed maps of the alignment can be viewed in Appendix 1-2 (1:10,000).

Table 1-1 below provides an overall schedule of ASR construction, including the timing of key, deliverables and construction activities. The key initial project milestones are as follows:

- Establish the Panel in Q2 2019;
- ASR permits issued within Q3 2019;
- Panel review of non-typical winter road sections within Q2, 2019;
- Approvals to proceed with Phase 1 construction within Q3 2019;
- Phase 1 mobilization and construction to commence Q4 2019 (Year 0);
- Limited Liard River ice bridge established by January 1 and full service January 15 each year;
- Complete required field investigations and surveys as required in winter Y1;
- Operational Phase 1 winter road in Q1 Y1;
- Geotechnical and geophysical investigations completed in winter, Y1. Final report completed by end of Q1 Y1;

- Panel to complete review of Phase 2 ASR road and stream crossing detailed designs for initial ASR sections in Q2 Y1;
- MVLWB and Parks issue approvals for initial Phase 2 ASR sections in Q3 Y1.

1.2.1.1 Phase 1 Winter Road

A summary of the approach regarding the construction, operation, and deactivation of the Phase 1 winter road is provided below. A description is also provided in the draft Road Construction Management Plan, contained in Appendix 1-3.

The intention of winter road construction is to minimise any mineral soil disturbance and confine the alignment to the ASR footprint as much as possible. Combining the winter road and ASR alignment footprints where possible will significantly reduce the total project footprint and in turn minimize ground/watercourse disturbances. The construction of the winter road is intended to largely occur along the lower side slope of the ASR alignment. It is a generally considered best practice to avoid disturbing the natural ground (defined in the proposed ASR alignment) until full construction can proceed.

The majority of Phase 1 construction will use typical winter road construction techniques comprised of a snow and ice road base. On terrain not suitable for a typical winter road approach, for example side slopes, a modified or non-typical winter road construction technique will be applied. A description of the typical and non-typical winter road construction approaches is provided below.

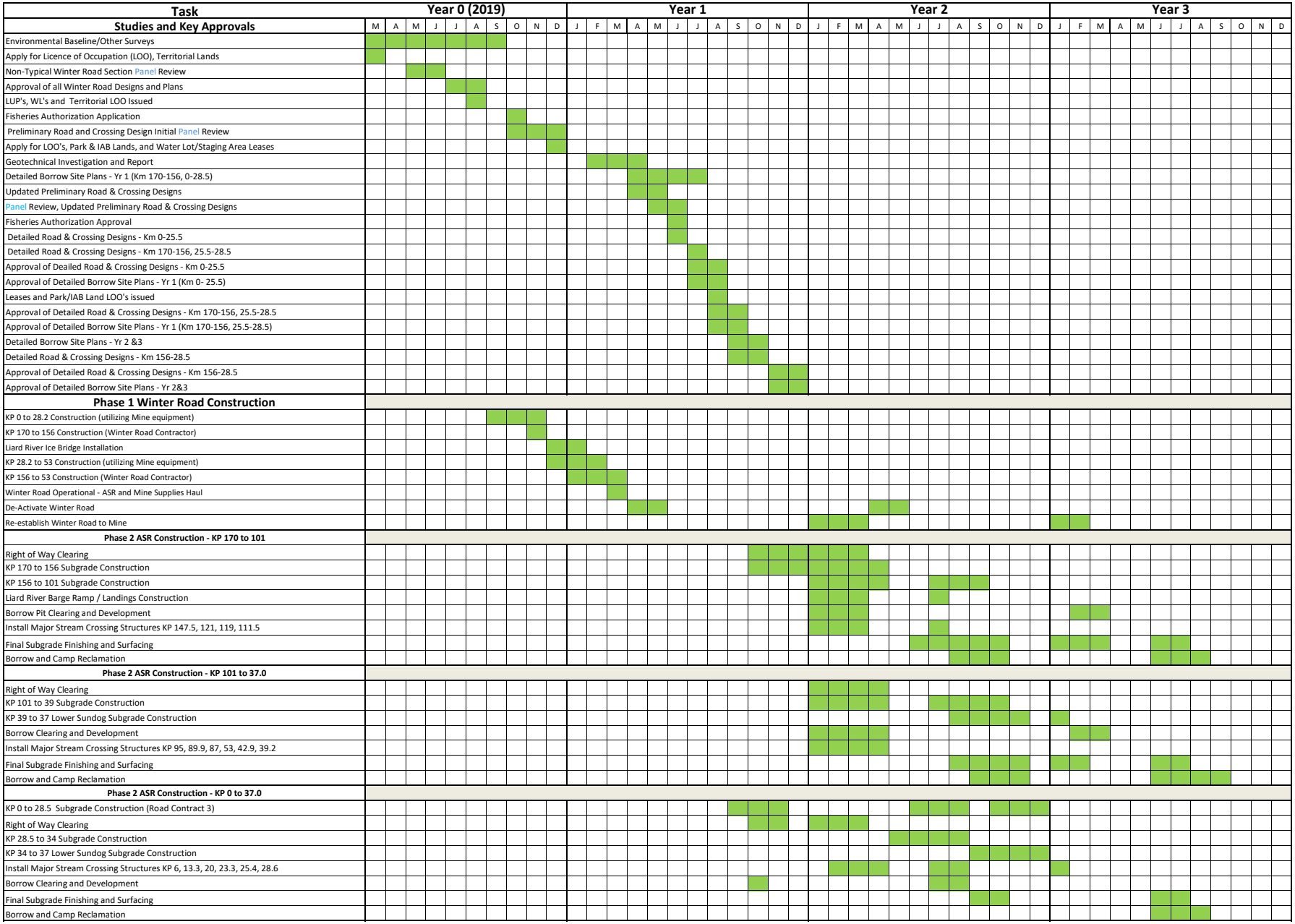
Typical Winter Road Construction

The *Northern Land Use Guidelines; Access: Roads and Trails*, Winter Access Road, Table 2.1A, defines a typical winter access road as:

- Being constructed by dragging and levelling the surface to allow for smoother travel; and
- Utilizing water to build up ice for the roadbed.

Snow and ice are shaped and compacted to form a solid road prism to support heavy commercial traffic without degrading the subsurface. This standard fits well with the majority of terrain within the Northwest Territories (NWT); however, portions of the Prairie Creek ASR are located in mountainous and/or rocky terrain, and some locations have greater than 20% side slopes where snow/ice fills alone are not practical or safe to support a road base.

Table 1-1: ASR Construction Schedule



Non-Typical Winter Road Construction

When the alignment traverses incised terrain or terrain with side slopes >20%, a non-typical winter road prism structure will be constructed. The fill material of the road prism will consist of a potential combination of, organic debris mixed with some side cut mineral soil. To reduce the volume of mineral soil disturbance, log corduroy may also be placed in the toe fill. Snow/ice would cap any exposed mineral soil to help preserve structure from direct sunlight and warmer temperatures. Figure 1-2 shows the makeup of the road prism cross section of a non-typical winter road and Table 1-2 provides the locations of the non-typical winter road sections. Depending on the terrain slope and available solid organic material, the road prism structure will require minimal amount of side slope mineral soil cutting and disturbance. Generally, the greater the side slope, the greater the potential for required side slope cutting/mineral soil disturbance. This is a common forestry road construction practice in the B.C. interior for short term winter access.

Mineral soil disturbance within areas considered to contain permafrost will be avoided. The majority of ground considered to contain permafrost exists on ground with side slopes less than 20%.

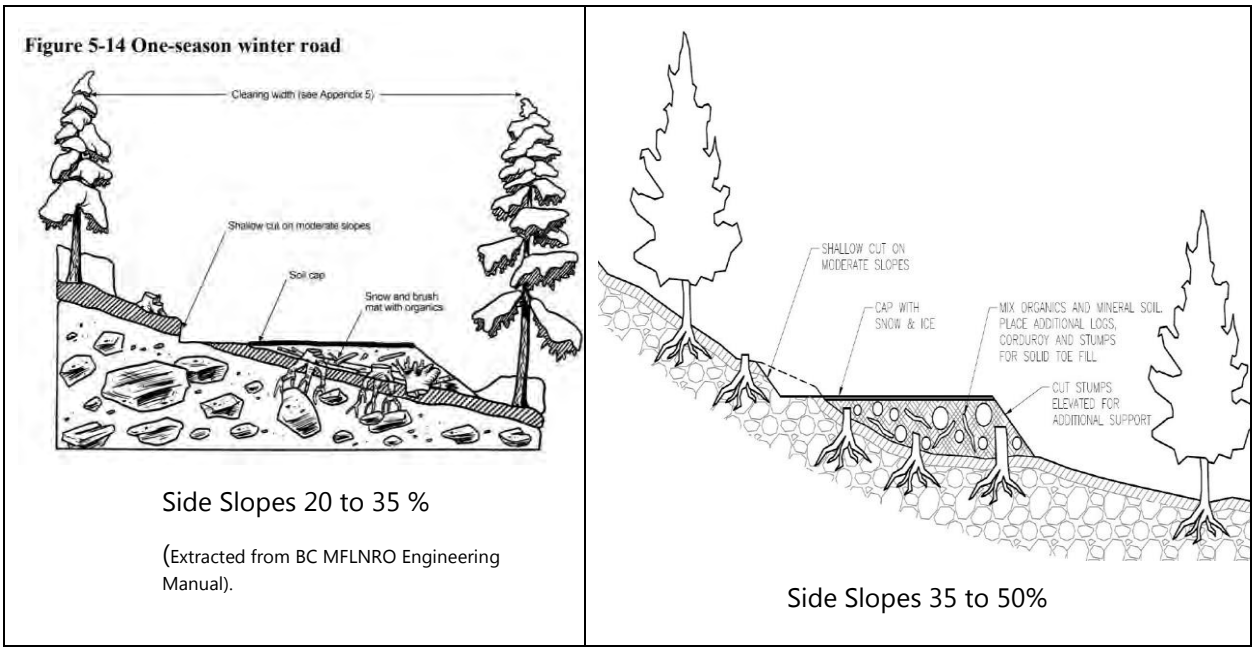


FIGURE 1-2: NON-TYPICAL WINTER ROAD TYPICAL SECTION

Specifications

The Phase 1 winter road will be of suitable quality to support the proposed relatively low volume and low speed delivery of road and mine construction supplies. The following design criteria will apply:

- On side slopes <20% - road base primarily constructed from snow and ice;
- On side slopes >20% - road base constructed with snow and ice mixed with a significant component of woody debris, organics and cut mineral soil;
- Typical winter road running surface width - minimum 5 m wide;
- Road surface will be wider on curves as required;

- Operating speed – Normal 30 km/hr; Terrain Challenged 20 km/hr
- Right of way width - minimum 10 m, maximum 20 m;
- Maximum road grades - typically 9% (sustained) with short pitches (<100 m) up to 12%. Road sections (e.g. KP 25.4 area) with steeper than 12% slopes may require a tow vehicle to support access; and,
- Pullouts – approximately 80 m long (40 m of which is full lane width) and established in natural vegetation openings to minimize clearing where possible, and approximately 1 per km.

Construction Schedule

The initial construction of a winter road would advance on two locations simultaneously; Nahanni Butte Access Road heading north (Spread 1) and from the mine site heading south (Spread 2). The main advance will be from the south and will be from the Nahanni Butte Access Road, KP 170, working in one continuous front up until it meets up with the southern advance from the mine site at around KP 40 to 50. Because of the limitation of crossing the Liard River via a suitable ice bridge in the early winter, it may be preferable to use a temporary barge to transfer equipment and supplies to the staging area on the north bank prior to freeze-up.

Spread 2 construction would utilize the existing road and could commence as early as Q4 2019 from KP 0 (mine) to KP 24.2. CZN has previously accessed this road section in summer and fall. At KP 24.2 the Phase 1 road will diverge from the existing road bed and will follow the ASR alignment along the south side of Sundog Creek. From KP 24.2 to 25.7, a 1.5 km access trail for tracked equipment will be constructed to gain access to the KP 25.4 incised crossing. Earthworks are required at this crossing site to establish winter access over the stream. The earthworks completed to gain access at and through this crossing are expected to be largely contained within the footprint of the ASR. The base soils are gravels and rock throughout this section.

Spread 1 winter road construction would commence once sufficient snow depth and frost will ensure minimal ground disturbance. Construction would advance to the Liard south landing, and beyond if equipment has been staged on the north bank prior to freeze-up. An adequate winter ice bridge would be established across the Liard River. It is expected that limited access across the ice bridge would be established by January 1. Construction would advance at a rate of 2 to 3 km per day, and is anticipated to meet up with Spread 2 by late February. Geotechnical works would follow in tandem with Spread 1 construction.

The length of the winter road would reduce progressively in Y2 and Y3 as the ASR is constructed and established.

Deactivation

The Phase 1 winter road access to the Mine is expected to be operational during March up to the end of the month. De-activation of the winter road will commence immediately following road closure and will typically include:

- Pullout/removal of all temporary structures and any log fills at watercourses, and the notching of snow fills;
- Stabilize fills and disturbed areas at crossings as necessary. This may include the application of silt fences, filter berms, etc.;
- Possible installation of water bars to ensure natural drainage courses are maintained and potential ponding of water is minimized;

- Stage equipment and basic supplies at key locations along the route to provide support should additional preventative action be required during the spring freshet period; and
- Monitor throughout the spring to preventively identify and stabilize any potential surface water drainage issues.

1.2.1.2 Phase 2 ASR

The construction of the ASR is expected to extend over a two-year period after the Phase 1 winter road and is scheduled to commence within Q3 of Y1, and be complete and operational by late summer of Y3. A summary of the approach to be applied and general assumptions is as follows:

- Construction schedule will reflect wildlife operating restrictions/limitations including migratory bird nesting periods and Pika presence and habitat;
- Clearing of right of way, required borrows, camps, and other required areas to be completed primarily during winter periods outside of the bird nesting period (April through end of August);
- Stripping to be completed followed closely by progression of subgrade construction to minimize erosion and sedimentation issues;
- Generally, the subgrade is to be constructed in two passes; initial preliminary subgrade followed by completion of subgrade with a scheduled time delay in between to permit subgrade stabilization, settlement, and thawing/drying;
- Commence preliminary construction of subgrade in fall (end of Y1) from the Mine site (KP 0) to KP 28 and KP 170 to 156;
- A winter ice bridge across the Liard is expected to provide limited access annually by January 1, and full access by January 15;
- A total of up to seven minor and major camps would be required;
- Multiple construction spreads will be in place throughout the two-year period and will have designated camps near-by to support these works;
- The bulk of the main earthworks construction will occur in Y2;
- All major supplies, materials and fuel to be delivered on the winter road to support proposed summer operations;
- 17 Major stream crossing structures to be installed based on environmental constraints and schedule demands;
- Liard River barge landings to be primarily constructed in winter, Y2;
- Limited barge access across the Liard River to be established to support summer, Y2 operations;
- Focus winter subgrade construction at significantly wet areas or defined permafrost sections;
- Lower Sundog construction and channel re-alignment to occur in late summer/fall Y2, during low or no flow periods;
- Establish limited ground access from Liard (KP 154) to Grainger Camp (KP 121) by late summer, Y2.
- Construction of stream crossings located in permafrost will be completed during frozen periods of the year to minimize degradation of the permafrost; and,
- All construction activities will conform to regulatory requirements and be

conducted applying best management techniques.

Phase 2 Construction Schedule

The list below summarizes the key considerations related to the construction schedule and key project milestones:

- Schedule incorporates Panel reviews;
- Additional environmental baseline studies to be completed prior to construction;
- Re-establish winter road in Y2 and Y3;
- Construction to be completed over two-year period (Y2 and Y3);
- Lower Sundog Creek re-alignment and ASR construction will be completed in Y2 during low or no flow periods (late summer to early winter);
- Majority of major stream crossing structures installed in first winter of Phase 2 construction (Y2) to support construction site access;
- Small temporary barge capable of transporting 5 tonne trucks will provide limited access during summer operations;
- Multiple construction spreads will be operating concurrently supported by up to 7 camps;
- A number of camps will be isolated during Y2 summer operations. Materials, fuel, and supplies will need to be transported via the winter road and stockpiled to support summer operations;
- During summer Y2, helicopters will be utilized to transport camp consumables and project personnel to isolated construction camps/spreads;
- Limited ASR road access will be established to Camp 87 by early fall, Y2; and
- Operational ASR constructed road by late summer, Y3.

1.2.2 Permits

CZN applied to the MVLWB and Parks Canada for ASR Land Use Permits (LUP's) and Water Licence's (WL's) for their respective jurisdictions in April 2014. We understand the MVLWB will also facilitate the issue of a LUP for the road section crossing Indian Affairs Branch (IAB) Lands. We propose that the terms of the LUP's be 5 years. The ASR will take 3 years to build, and is intended to operate for at least 15 years, followed by a 2-3 year reclamation period. Therefore, we propose that the WL's have 20 year terms. We further propose that the WL's include a condition requiring a review of all WL conditions approximately every 5 years.

The MVLWB provides a draft template for typical conditions in a LUP on their website. This has been used to generate a draft LUP for all jurisdictions, which is provided in Appendix 1-4. The regulator listed is the MVLWB. Parks Canada and Indigenous and Northern Affairs Canada (INAC) would be substituted for companion LUP's.

Some permit conditions have been structured to be specific to certain activities. This is to reflect the development plan consisting of construction of the Phase 1 winter road first to allow for geotechnical investigation, and ASR construction subsequently. Hence, conditions not considered to be specific to the Phase 1 winter road have been written to be triggered by activities relating to the all season road. Development of borrow pits was assumed as that trigger, since borrows will be needed for ASR construction but not winter road construction. Excavation or 'cut and fill' were not selected as a trigger since they will be required for the non-typical winter road sections.

Some management plans are assumed not to be relevant to the winter road (Condition 144). The Road Operations and Management Plan was included in these. Traffic management requirements are included in the Traffic Control Mitigation and Management Plan, which is required for the winter road. This is considered to suitably address traffic during ASR construction and the limited Y1 winter road operating periods in winter to transport supplies into the Mine for mine construction.

1.3 Geology, Geochemistry, Stability

1.3.1 Geology

Terrain

The Mine site is at an elevation of 850 m above mean sea level (AMSL), and is situated in topography characterized by low mountains and narrow valleys with an average relief of 300 m. The Mine site is located within the Alpine Forest-Tundra section of the Boreal Forest, characterized by stunted fir with limited undergrowth and open areas dominated by lichen.

The formerly permitted winter access road leaves the Mine site heading north along the Prairie Creek valley for about 7 km before turning east to cross the Mackenzie Mountains. As the road climbs out of the Prairie Creek valley it enters Sub-Alpine Shrub and Alpine Tundra from an elevation of approximately 1000 m AMSL at Km 10. The road continues to climb through the Alpine terrain to a summit of 1530 m near Km 17 (also the western boundary of the NNPR), then dropping down and leaving the Sub-Alpine terrain again at the 1000 m elevation around Km 25. As the road drops from the 1000 m elevation to the 900 m elevation, it passes through a spruce-lichen Alpine forest zone similar to that found at the Mine site and then into Riparian Alluvial habitat in the Sundog tributary valley bottom.

From Km 40 to Km 55, the road crosses forest developed on glacial depositional deposits, and crosses Polje Creek (otherwise known as Bubbling Springs Creek) which drains the Poljes before ascending the Ram Plateau. As the road crosses the Ram Plateau, it passes through an open forest Black Spruce/Pine Parkland setting between the 830 to 930 m elevations, before dropping down into the Tetcela River valley. The valley consists of a mixed coniferous/deciduous closed forest. The road then passes through a short distance of muskeg open shrub/sedge wetland at the headwaters of Fishtrap Creek, and climbs up and over the Silent Hills, again a closed mixed coniferous/deciduous forest. The road alignment then runs along the eastern slopes of the Silent Hills, an area of black spruce, before passing through mixed coniferous-deciduous-pine parkland prior to entering the Grainger River headwaters at Grainger Gap (Second Gap), staying north of, and never crossing into, the Bluefish Creek basin.

Once through the Grainger Gap, the road alignment turns south along the foothills of the Nahanni Front Range through mixed deciduous coniferous forest towards Nahanni Butte, avoiding the Grainger Tillplain. The road crosses the Liard River downstream near the community and continues through forest to the Nahanni Butte access road and on to the Liard Highway.

Geology

The access road is entirely underlain by sedimentary rock sequences generally consisting of various combinations of limestone, dolostone, siltstone, shale and mudstone.

There is a general reduction in geological structural complexity from the area of the Prairie Creek Mine site (steeply folded and faulted rock units) east to the Liard River (flat lying undisturbed sedimentary units). All rocks west of the Grainger Gap (Km 120) have been affected and displaced by the Laramide mountain-building events that affected much of western North America in Late Cretaceous time.

Structural complexity is also expressed in topographic relief which generally decreases from west to east. For ease of reference, based on geology and topographic expression, the access road has been divided into six regional physiographic zones (refer to Figure 1-3), namely:

- Prairie Creek Basin (Km 0-Km 14.5)
- Mackenzie Range (Km 14.5-Km 40)
- Ram Plateau (Km 40-Km 90)
- Silent Hills (Km 90-Km 119)
- Nahanni Range (Km 119-Km 122)
- Platformal Lowlands (Km 122 to Liard River)

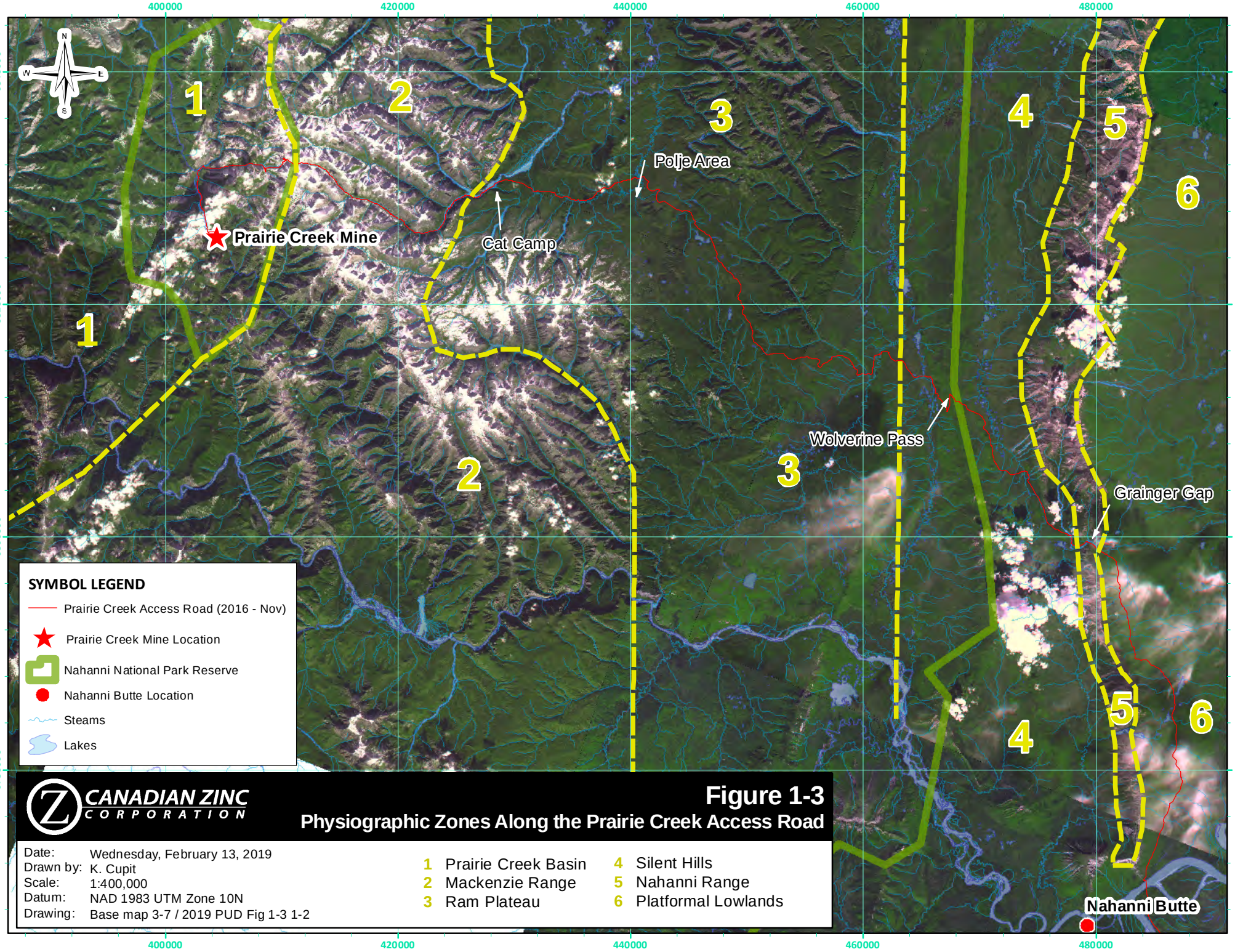
The region has been mapped on a broad reconnaissance scale by the Geological Survey of Canada. The Prairie Creek area has been mapped and documented in GSC Memoir 412 (Figure 81) entitled "The Prairie Creek Embayment and Lower Paleozoic Strata of the Southern Mackenzie Mountains" by Morrow and Cook in 1987. The most detailed maps for the remainder of the road are covered by the Geological Survey of Canada "Map 1378A, Geology of Virginia Falls" and "Map 1377A, Geology of Sibbeston Lake", both printed in 1976. These reports along with mapping completed by CZN, have been adapted to show the geology in simplified form in Figure 1-4.

Prairie Creek Basin (Km 0-Km 14.5)

The area adjacent to Prairie Creek (PC) lies within the Mackenzie Mountains and contains up to 1,000 m of topographic relief in the form of abrupt cliffs and mountains.

Between Km 0 and Km 14.5, the road is underlain by rocks of the Prairie Creek Embayment which is a paleo-basin developed during Ordovician times and received active sedimentation during Ordovician-Silurian times. The regional Laramide deformation severely foreshortened the Prairie Creek Embayment units and the entire sedimentary rock sequence underwent compression to form complex folds and steep regional reverse-type faulting.

A basal thrust is evident, as exposed on the north side of Funeral Creek, at approximately Km 14.5, and is referred to by Morrow et al. as the Tundra Thrust. The Thrust is a regional structure that dips moderately to the east and defines the eastern edge of the Prairie Creek Embayment rock sequence. The thrust displaces the eastern sedimentary sequence over the folded Prairie Creek units (Cadillac Formation).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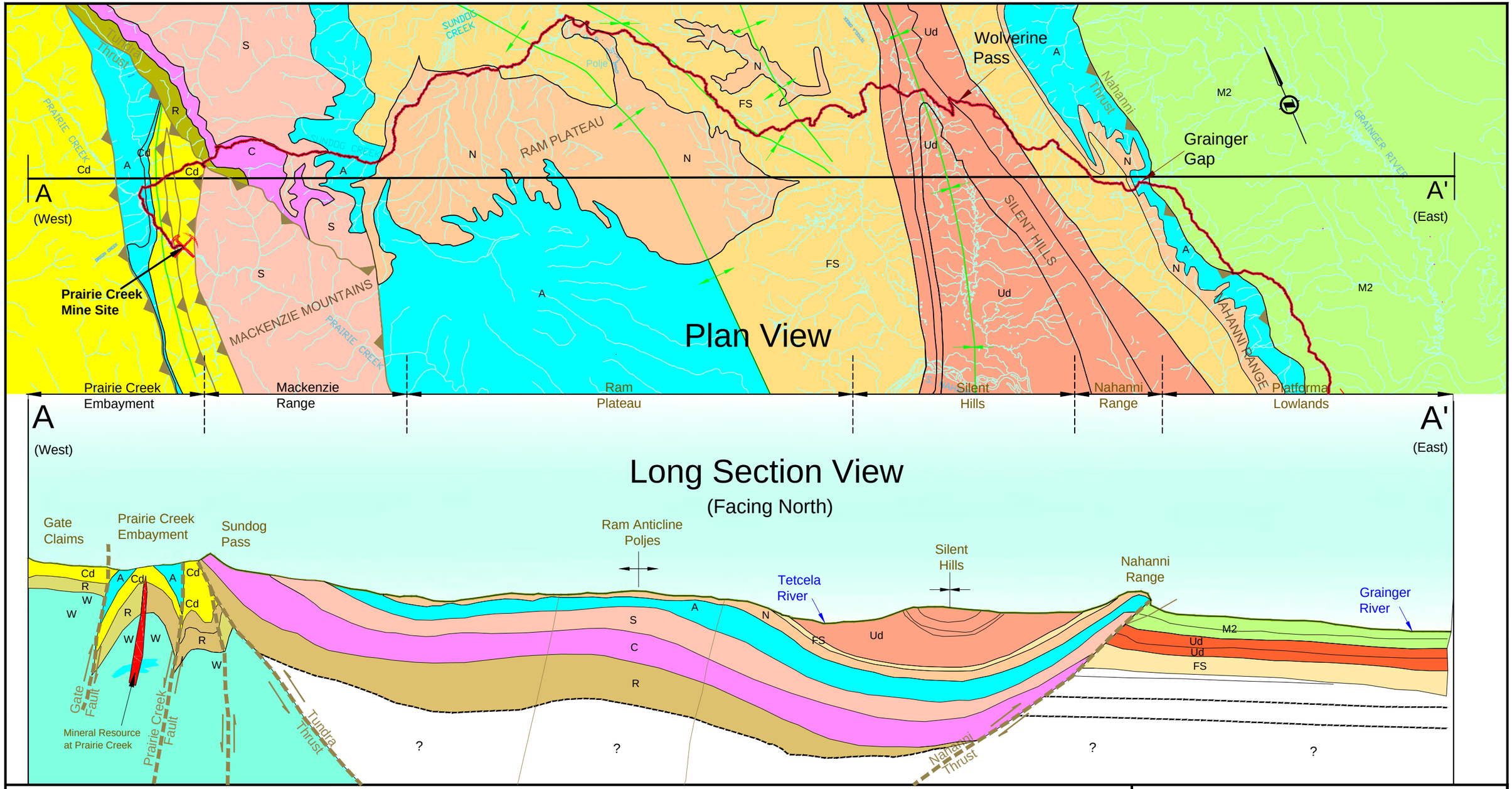
Polje Area
Prairie Creek Mine
Cat Camp
Wolverine Pass
Grainger Gap
Nahanni Butte
SYMBOL LEGEND
Prairie Creek Access Road (2016 - Nov)
Prairie Creek Mine Location
Nahanni National Park Reserve
Nahanni Butte Location
Steams
Lakes
CANADIAN ZINC CORPORATION
Figure 1-3
Physiographic Zones Along the Prairie Creek Access Road
Date: Wednesday, February 13, 2019
Drawn by: K. Cupit
Scale: 1:400,000
Datum: NAD 1983 UTM Zone 10N
Drawing: Base map 3-7 / 2019 PUD Fig 1-3 1-2
1 Prairie Creek Basin
2 Mackenzie Range
3 Ram Plateau
4 Silent Hills
5 Nahanni Range
6 Platformal Lowlands



Legend

Prairie Creek Formations

- Cd Cadillac
- A Arnica
- W Whittaker
- R Road River

Platform Formations

- M2 Mesozoic Units
- Ud Upper Devonian Unit
- FS Fort Simpson
- A Arnica
- N Nahanni
- S Sombre
- C Camsell
- R Road River

- Major Faults
- Access Road
- Access Road Re-Alignments
- Formation At Depth

Approximate Scale

0 1 2.5 5 10 20

Kilometres

Partly Adapted from Geological Society of Canada Maps 1378A and 1377A

Figure 1-4

Simplified Regional Geology
Along the Prairie Creek Access Road

File: 2019 PUD Fig 1-4 1-1.ai
Date: February 2019
Scale: As Shown

CANADIAN ZINC CORPORATION

Mackenzie Range (Km 14.5-Km 40)

The road attains a maximum elevation of 1,522 m at Km 17, referred to as Sundog Pass. From the Pass eastward, all drainage reports to Sundog Creek, a tributary of the Ram River which subsequently drains into the Mackenzie River. In this physiographic section, the road slopes downhill to the east towards Cat Camp. The area is characterized by tight valleys, a number of stream crossings, active talus fields, box canyons and steep slopes.

East of the Tundra Thrust (Km 14.5), thick mountain forming assemblages of sedimentary rocks forming the Cadillac mega-breccia are overlain by the Camsell Formation which is in turn overlain by the thick sequence of the Sombre Formation. The latter consists of dolostones and limestones, and is subsequently overlain by the cherty siltstones referred to as the Arnica Formation up to the eastern edge of the Mackenzie Mountain range at Km 40. These platformal rock units are thought to be related to the rock units found within the Prairie Creek Embayment.

As the road approaches Cat Camp (Km 37), younger Devonian age units of the Headless Formation and the thick, competent limestone units of the Nahanni Formation become exposed and form the prominent bluffs and walls of the large box canyons around Sundog creek. At around Km 40, the terrain opens up into the broad, undulating Ram Plateau.

Ram Plateau (Km 40-Km 90)

The Ram Plateau is a regional feature which, depending upon what is included, is an area up to 30 Km east-west and over 100 Km north-south. It is characterized by moderately rolling terrain with local steep walled canyons and incised drainages.

The Ram Plateau is underlain by the Nahanni Formation which, where eroded, forms prominent bluffs and box canyons. The Nahanni Formation is a limestone unit and is susceptible to erosion and/or dissolution by surface and ground waters. The dissolution of the Nahanni Formation has been intense enough in places to form karstlands. The Nahanni Formation is well exposed in the rugged area of the Ram River just to the north of the access road. The Nahanni Formation arches up in a broad antiform and has been eroded to form spectacular box canyons. Overlying the Nahanni Formation are the black shales of the Horn River and Fort Simpson Formations, which tend to form impermeable caps that protect the underlying limestones from erosion.

Silent Hills (Km 90-Km 117)

Rock exposure in this area is generally poor, however regional mapping has shown the area to be underlain by Mesozoic sedimentary formations which vary from carbon-rich shales to mudstones and siltstones. These units overlie and are younger than the Nahanni assemblage to the west. Formations mapped by the GSC above the Nahanni Formation include the Yohin Formation containing thinly bedded sandstones, the Clausen Formation, consisting of black shales, and the Flett Formation limestones in the core of the syncline at Wolverine Pass.

Nahanni Range (Km 117-Km 121)

At Km 117, the road approaches a mountain pass, referred to locally as the Grainger Gap or Second Gap, which cuts through the front range mountains of the Nahanni Range. The eastern basal slope of the Nahanni Range contains the Nahanni Thrust structure which defines the eastern limit of the Mackenzie Fold Belt. The Nahanni Thrust is a regional fault that dips at a shallow angle to the west and can be followed for many kilometres surficially and at depth through seismic profile. From the east, the Nahanni Range is the first set of mountains and forms the prominent regional

buttress of bluffs against the lowlands to the east. The rugged appearance of the Nahanni Range is formed by the competent rock units of the Arnica and Nahanni Formations which have been thrust upwards.

The elevation in Grainger Gap is 520 m and is bounded to the north and south by steep mountain peaks of the Nahanni Range up to 1,400 m in elevation.

Platformal Lowlands (Km 121 to Liard River)

East of the Nahanni Thrust lie the relatively undisturbed horizontal sedimentary layers of the Interior Plains.

Topography is very subdued and poor drainage produces extensive areas of swamp and muskeg; hence, exposure of bedrock in the area is very limited. All drainage in this area reports to the Grainger River which in turn flows into the Liard River. Some historic oil and gas wells show the subsurface being underlain by Mississipian age black shales, mudstones and siltstones of the Besa River Formation.

Extensive Quaternary river alluvium material occurs associated with the Liard and South Nahanni Rivers. In addition, glacial moraine-type deposits, including till deposits, are extensive throughout the area. Surficial geology has been mapped by the GSC in Map 1693A, entitled "Surficial Geology Southern Mackenzie River Valley", dated 1988.

1.3.2 Geochemistry

Initial geochemical characterization and confirmation was undertaken in 2018 as part of a Geochemical Verification Program, consisting of static geochemical characterization analyses on available overburden granular samples for evaluating the potential for acid rock drainage (ARD) and metal leaching (ML). Additional samples and bedrock materials will be analyzed in the next phase of the project work, planned for 2019. The proposed Geochemical Verification Program, including presentation of the results of the initial analysis program on granular material samples, and recommendations for further work planned for 2019, is presented in Section 13.0.

Samples were initially collected from a geotechnical site investigation program that was carried out by Tera Tech between in August 2018 and consisted of window sampling and testing of overburden. A total of 43 sample holes with depths ranging from 0.6 m to 5.0 m were completed and logged at 39 sites along the proposed ASR. For initial geochemical characterization, 18 samples were selected for testing. Samples were submitted for static geochemical characterization analyses.

The results indicate that the granular material samples are consistently classified as Not-Potentially Acid Generating (Non-PAG) and are not anticipated to be of concern for ARD generation. Sulphur content is generally low in the granular materials, representing low potential for acid generation. Neutralization potential in the materials is provided variably by silicate and carbonate minerals, and is considered to be present in sufficient quantities to neutralize against acid production and maintain near-neutral or alkaline drainage.

Potential for metal leaching is considered low overall based on the results of the shake flask extraction (SFE) tests, however potentially elevated levels of iron and aluminium may occur and will be considered further in the context of site specific drainage conditions.

Future work is planned to characterize the geochemical characteristics of bedrock to be disturbed.

It is anticipated that the bedrock materials will generally have low potential for acid generation given the presence of carbonate bearing rocks in the sedimentary sequence observed in the site geology, including limestone and dolostones. Shale units, that have been noted at the Mine site as containing variable amounts of sulphide, may present some potential for acid generation in isolated areas.

In addition to characterizing the ARD/ML potential of the bedrock materials, further work is needed to confirm the distribution and volumes of expected granular and bedrock excavation materials, and to develop plans for the management of materials and mitigation of potential ARD/ML during construction of the ASR.

1.3.3 Stability

The proposed ASR alignment traverses mountainous terrain with potential geohazards and instabilities. Potential geohazards identified by terrain mapping along the proposed ASR alignment include bedrock slumps; debris slides; debris flows; rockfalls; rockslides; earth slumps and flows; lateral spreads in surficial deposits; soil creep caused by permafrost presence; thaw flow slides and gully erosion. These geohazards were initially discussed as part of CZN's Developer's Assessment Report (DAR) submission in 2015 (Tetra Tech EBA 2015a).

Background

Tetra Tech EBA completed terrain mapping and air photo reviews in September 2015 (Tetra Tech EBA 2015b). Several sets of maps were prepared as part of that review, including slope gradient and slope aspect for the route as well as surficial geology and geomorphology mapping. Detailed terrain stability mapping (TSM) was subsequently carried out for the entire ASR alignment, including areas identified as "high-risk", in a mapping summary report from December 2015 (Tetra Tech EBA 2015c) which was updated in 2016 (Tetra Tech EBA 2016a). In discontinuous permafrost regions like the ASR, TSM is a synthesis of the slope gradient, slope aspect, surficial geology, geomorphology, drainage pattern and permafrost information that can be gleaned from air photo analysis. It provides additional insight into the terrain types and conditions that may be encountered along the ASR route, and the potential for terrain instabilities to occur in particular areas. Priority mapping areas included sections near the Poljes and the east side of Silent Hills where several types of slope instabilities were identified. Other geohazard sections were mapped from air photos and LiDAR images along the proposed ASR alignment. Air photos produced in 1949, 1963, 1982, 1983 and 1994 were analyzed, as well as 2012 LiDAR images, while other photo years cover some parts of the route.

Risk Analysis

Further to the assessments above, Tetra Tech EBA completed a desktop magnitude/frequency analysis for landslide hazards, provided in Technical Memo No. 1 from April 2016 (Tetra Tech EBA 2016b). The purpose of the magnitude/frequency analysis was to provide a preliminary assessment of the susceptibility of the proposed ASR alignment to geohazards. Findings from the magnitude/frequency analysis were then incorporated into an updated risk analysis for landslide-related hazards along the proposed ASR route in Technical Memo No. 5 (Tetra Tech EBA 2016c). This risk analysis estimated the likelihood of occurrence of particular landslides that would be considered hazardous to the proposed road and its users.

The magnitude (volume) of landslide hazards were estimated based on the runout length and width of an event (e.g., the length and width of a rockfall or rock slide scar and its deposits), or by the

mapped areal extent of larger slides. Runout lengths are shown by symbols and areal extents by mapped terrain stability polygons on the terrain stability map figures provided. The year of the air photo that a geohazard first appears on was used to estimate landslide frequencies and magnitudes. A minimum landslide debris thickness of 1 m was used to estimate magnitude, as this cannot be determined via air photo interpretation alone. Frequency was estimated based on professional judgement and the activity levels observed on air photos and the LiDAR imagery.

Higher-Risk Sections

The general features of higher-risk stability areas plus additional findings based on historical air photo reviews are described below for the respective ASR sections:

- KP 26.2 - 26.3 – Debris flow of moderate likelihood and high consequence. A sinuous ridge of debris above the road is of unknown origin. It appears to have directed water flow across the proposed road alignment in the past, scouring out the area below and forming a small depositional fan adjacent to the creek. Uncertain if debris flows have formed above road or not. Mapped as debris flow to be conservative;
- KP 27.2 - 27.4 – Debris slide or flow with high likelihood and consequence. This feature is to be spanned with a bridge. Regular monitoring is advisable in case additional mitigations are required in the future.
- KP 28.2 - 28.4 – Minor rockfall activity in limited areas in 1994 and 2012 with high likelihood but moderate consequence; shaded in 1949, so unable to determine activity level at that time. Rock fall activity should be monitored and mitigations considered, if necessary.
- KP 49.7 - 50.0 – Realignment was adjusted after Terrain Stability Mapping to shift the road back from potentially retrogressive slides; the road is already well back from slide areas that are being eroded by the creek. The likelihood of ongoing movements is considered moderate and the consequence is very high (the latter areas would have a high frequency). Further shifting of the road upslope is not practical in this section due to steeper side-slopes and road grades, and another proposed stream crossing further upstream was determined to be less amenable to development due to slope stability issues. The current road location is therefore likely to receive fewer impacts from potential future slope movements than the adjacent routes that were considered. Should movement resume along existing slide paths in this section, it may be necessary to consider additional mitigations, including possible erosion protection at the creek, retaining or buttressing parts of the slope, and/or implementing additional water drainage measures. Appropriate mitigations will be considered at the time of detailed design and would include monitoring and/or specific measures. The latter would be determined in accordance with the likely contributors to, and types of, movement considered to be likely;
- KP 53.7 - 54.2 – A thaw flow slide visible on 2012 LiDAR image nearby, offset 100 m from the road alignment at the closest point, and set back 125 m from road route upslope. Although the likelihood of continued climate change means that the thaw flow slide might continue to retrogress, the route is now located outside of the apparent near-surface permafrost area, and the increased setback compared to the originally proposed route has reduced the likelihood that potential future

movements will affect the road. However, monitoring is required, to keep track of slope movements that might require future mitigation;

- KP 59.7 - 60.4 – Route crosses a few older slides visible in 1949 photos. Debris slide of moderate likelihood and high consequence because part of feature is below road and potentially could cut into road. Monitoring is warranted, in case slope mitigations are needed in the future;
- KP 83.5 - 85.5 – Debris slides on slope above river and below alignment have moderate likelihood but high consequence. Road is well back from older and younger debris slides and tension cracks. Regular monitoring of the slope below this road section is advisable to keep track of slope movements that might require additional mitigation;
- KP 95.5 - 101.7 – Large rotational to translational slide or slump in bedrock that likely occurred quite some time ago. Although this location has a low hazard likelihood, due to its size and potentially low to high velocity, it has a very high consequence. Because of its very large size, mitigation requirements could be considerable if movement renews. In particular, the large amount of gullying indicates that there is abundant water movement on this slope. Drainage planning will be very important here to prevent lubrication of old slide planes during exceptional rain or rain-on-snow events. The goal is to have sufficient drainage measures such that surface water does not flow in channels in locations where water would naturally flow as sheet flow. The design of appropriate drainage measures is especially important at switchback locations. Also on this slope are some newer soil debris slides that have occurred in the colluvial soils overlying the bedrock slide, as well as some larger debris slides/flows to the south and north of the alignment in similar terrain. While such slides/flows are likely to continue, the soil debris slides tend to be small, and appropriate drainage measures will also help to reduce the possibility of the road contributing to local debris slides or flows. While no significant changes have occurred affecting the former winter road, this is not necessarily a reliable predictor of future performance;
- KP 136.4 - 137.3 – Large debris slides in this section have been assigned a low likelihood and very high consequence. Potentially, a moderate likelihood exists but these features are difficult to discern on both sets of photos. One feature at KP 136.4 may be a debris flow, but the feature is rather indistinct – may have a low frequency and/or may be intermixed with fluvial sediment. Monitoring is needed to track slope movements;
- KP 154.5 - 155.3 – Earth slump/flow assumed to be old, as it was inactive in 1949, but could have up to moderate likelihood; road alignment has been moved upslope to avoid this area. In the analysis, this hazard was given a low likelihood of affecting the road, but it has a very high consequence due to being about 800 m long. If the slide moves again, it could be a very large event, entailing a lot of work to repair. The adjacent section of slope (KP 155.9-159.3), with tension cracks above a similar slope failure in similar terrain, indicates that the possibility of renewed movement should not be disregarded in this section. Although the road has been moved upslope, it is not at low-risk: the risk is simply reduced from what it would be if the road was immediately above the scarp. Regular monitoring of the slope below this road section is advisable, to keep track of slope movements

that might require additional mitigation.

- KP 155.9 - 159.3 – Recently-developed debris flows, visible only on the 2012 LiDAR images, cross the route at KP 158.4-158.5. These flows are presently narrow (each about 25 m wide for the two that cross the road), but the source area for the debris is large. The debris flows have a high hazard likelihood rating and a high consequence rating. Culvert mitigation including larger culverts, strategic placement of back-up culverts, and channel armouring should be considered in the detailed design for this area. Culverts may still plug if debris flows occur, so culverts at staggered locations and elevations may be beneficial in case the lower culverts become plugged with debris. Additional mitigations may be needed if debris flow activity grows in magnitude due to increased water flow from thawing rock glaciers upslope.

Other ASR sections were identified to have moderate and low risk ratings, which are outlined in *Technical Memo No. 5.*

Mitigations

A range of potential instability conditions exist along the ASR alignment including rockfalls, rockslides, debris slides, slumps, and others. The primary mitigation for each of the instability conditions is avoidance; that is, if a hazard could be avoided by realigning the proposed ASR route, that was the preferred solution. This has been carried out for numerous locations but sometimes realigning the road route was not possible, due to a narrow corridor in the mountains, for example; or because a greater hazard would present itself by avoiding the first hazard (e.g. avoiding a thermokarst area, but resulting in a higher risk from a debris flow or rockfall due to moving the road too close to this new source of hazard). In that case, the route location was optimized to reduce the risk from each hazard, or the more serious hazard could be avoided in favour of the less serious hazard.

When a hazard could not entirely be avoided, and some residual risk remains, other mitigations have been considered, consisting of engineering controls and/or administrative controls. Sometimes the most appropriate controls will only become obvious after further analysis or identification of a problem that arises after construction or as a result of an unexpected environmental event (e.g. unusually large rainstorm).

Upcoming geotechnical investigations may identify or reduce geohazards as the ASR design is finalized. The remaining will likely be mitigated by implementing a program to monitor slope stabilities, settlement, and other geohazards as identified. A summary of typical instabilities that may be encountered along the ASR and some appropriate mitigations for each are tabled in Technical Memo No. 6 from July 2016 (Tetra Tech EBA 2016d).

1.4 Development Components

1.4.1 Road Alignment and Design

The initial step for selecting and defining the ASR alignment for the Prairie Creek mine started in 2014. CZN directed Allnorth to define an all season road alignment based on the then permitted winter road alignment following EA0809-002. A desktop analysis was completed to initially define a road corridor. Two field investigations followed which focused on confirming and defining terrain limitations and major stream crossings critical to defining the alignment. In

conclusion, a 174 km long ASR alignment connecting the Mine site to the Nahanni Butte Access Road was the basis for the 2015 Developers' Assessment Report (DAR). A terrain analysis was completed in 2015 and, with some re-alignments, an updated, shorter 170 km alignment was defined in 2016.

The flow chart in Figure 1-5 illustrates the process followed to date and future steps required to obtain completed detailed designs.

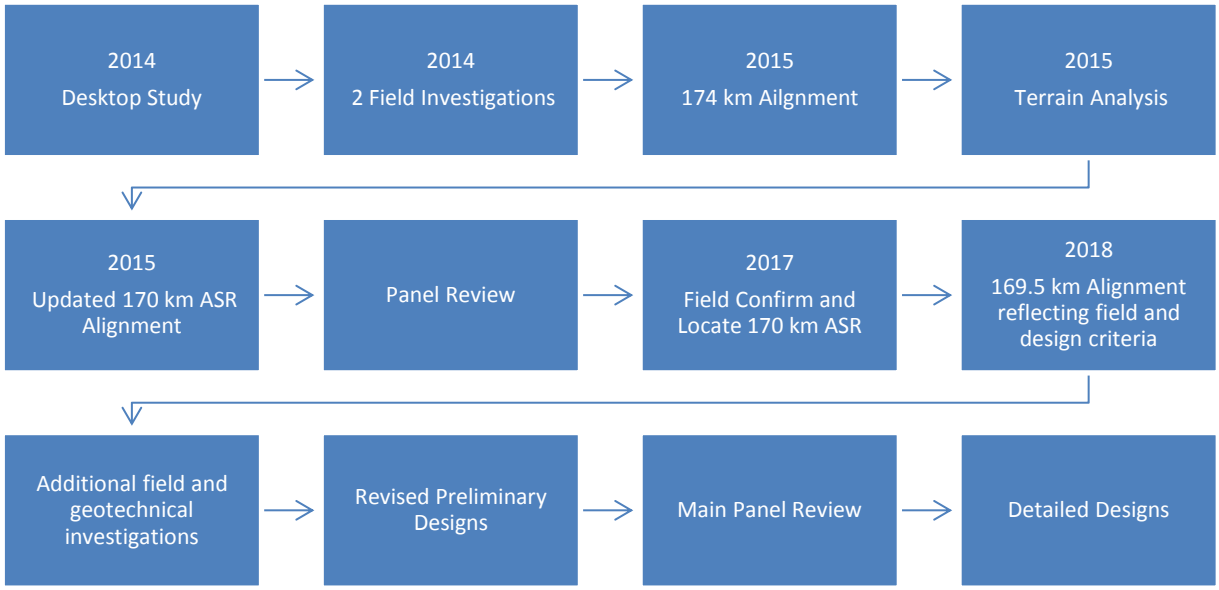


FIGURE 1-5: CHRONOLOGICAL APPROACH TO ASR DETAILED DESIGN

1.4.1.1 Phase 1 Winter Road Alignment

The Phase 1 winter road alignment will primarily utilize the ASR alignment. Relatively small deviations from the ASR alignment occur between KP 25 to 164. Many of these deviations will utilize portions of the original 1980's winter road alignment to avoid side slope (rock blasting) cutting in several places. The Phase 1 winter road alignment deviations from the ASR alignment can be viewed in the Access Road Maps located in Appendix 1-2.

Quantifying Phase 1 Winter Road Non-Typical Construction Sections

To quantify the level of mineral soil disturbance for non-typical winter road sections, an analysis was completed on the ASR alignment. Sections of the Phase 1 winter road alignment that utilize the original 1980's winter road alignment were not considered in this analysis (from KP 0 to 39.2). For example, from Km 29-39, the original alignment will be used to approximately traverse the centre of the valley. The Phase 1 winter road does not need to overlap the ASR alignment over this section since further investigation requirements of this portion of the alignment are limited, the ASR alignment would still be accessible for further investigation from the Phase 1 road, and ASR alignment disturbance can be deferred until Phase 2.

Using the preliminary road designs, all road sections containing side slopes greater than 20%, and/or broken terrain profiles not considered suitable for typical winter road construction, were identified. A non-typical winter road construction approach will be required for these. A non-typical winter road construction approach will occur in 53 individual sections ranging from 250 m

to 1,250 m in length, located between KP 24 to 170. Designs for these sections have been completed to determine the soil disturbance areas. Table 1-2 summarizes the 53 road sections and calculated soil disturbance. The designs are located in Appendix 1-5.

1.4.1.2 Phase 2 All Season Road Alignment

In 2017, using the November 2016 EA alignment (the last alignment submitted in the EA process), the full ASR was field confirmed, centreline ribboned and GPS surveyed reflective of local terrain and site characteristics; all stream crossings were quantified, and potential permafrost sections identified. Minor adjustments were made to the 2016 alignment to reduce grade, reduce corners and/or move the alignment onto firmer ground. This did not alter any of the major stream crossing locations. Based on the findings of the investigation, an internal 2017 road alignment was produced and adopted for future studies.

The proposed 2018 ASR alignment, submitted within this UPD, is based on the 2017 road alignment and the application of the following:

- Preliminary road designs for the full road length integrating all the engineering specifications defined in the DAR and EA process;
- Preliminary designs for stream crossing site plans and general arrangements for all major streams and selected minor stream crossings;
- Geotechnical detail and input;
- Integrating the approaches and commitments made during the EA process; and
- Increased level of review and scrutiny by professional engineers and peers.

The proposed 2018 ASR alignment can be viewed on the maps located in Appendix 1-2.

The final ASR alignment will incorporate the following:

- Further input and direction from the geotechnical engineer following a review of the results obtained from the geotechnical investigation;
- Input and direction from the Panel; and
- Any findings/factors that are identified during the detailed design and planning process.

2016 and 2018 ASR Alignment Comparison

Table 1-3 identifies the 2018 road alignment sections which deviate more than the 50 m from the 2016 alignment. In all cases, the justification is improved alignment, terrain considerations, and most commonly, reducing potential exposure within permafrost. Refer to the maps in Appendix 1-2 for visual confirmation of alignment variations.

TABLE 1-2: NON-TYPICAL WINTER ROAD SECTIONS

Design Section		Length (km)			Description	Disturbance Area (m2)			
Start	End	Typical Winter	Non-Typical	Total		Terr.	NNPR	IAB	Total
25.1	25.9	0.5	0.3	0.8	profile	0	6235	0	6235
26.8	27.45	0.4	1.6	2.0	profile, side slopes	0	26160	0	26160
27.45	28.25				profile, side slopes				
28.25	28.8				detour section				
40.1	41	0.75	0.15	0.9	profile, permafrost	0	4416	0	4416
44.9	45.25	0.1	0.25	0.35	profile	0	2512	0	2512
49.1	50.35	0.25	1	1.25	profile	0	11442	0	11442
50.65	51.2	0.25	0.3	0.55	profile	0	3813	0	3813
55.7	56.45	0.525	0.225	0.75	profile	0	3368	0	3368
56.8	57.4	0	0.6	0.6	side slopes	0	6000	0	6000
60.3	60.55	0.15	0.1	0.25	profile	0	1364	0	1364
64.75	65	0.1	0.15	0.25	profile	0	1283	0	1283
68.5	68.75	0.225	0.025	0.25	profile	0	451	0	451
81.5	82.2	0.15	0.55	0.7	profile, side slopes	0	5534	0	5534
90.1	90.5	0.3	0.1	0.4	profile	0	1545	0	1545
90.8	91	0.125	0.075	0.2	profile	0	872	0	872
91.45	91.7	0.15	0.1	0.25	profile	0	1103	0	1103
91.9	92.15	0.175	0.075	0.25	profile	0	894	0	894
92.5	92.8	0.25	0.05	0.3	profile	0	910	0	910
93.3	93.55	0.1	0.15	0.25	profile, side slopes	0	1725	0	1725
96.7	97.5	0.1	0.7	0.8	profile, side slopes	0	6856	0	6856
98.75	99	0.075	0.175	0.25	profile, side slopes	0	1765	0	1765
99.2	99.5	0	0.3	0.3	side slopes	0	3028	0	3028
99.65	100.55	0.325	0.575	0.9	side slopes	0	7705	0	7705
100.8	101.2	0.1	0.3	0.4	side slopes	0	4371	0	4371
103.1	103.35	0.25	0	0.25	profile, permafrost, no cutting	0	0	0	0
106.8	107.05	0	0.25	0.25	side slopes	2767	0	0	2767
110.7	110.95	0.175	0.075	0.25	profile	1030	0	0	1030
111.6	111.8	0.1	0.1	0.2	profile	1605	0	0	1605
113.9	114.25	0.675	0.725	1.4	side slopes @ 20 %	6336	0	0	6336
114.25	114.6				pp @ 30%				
114.8	115.5				side slopes @ 20 %				
117.4	117.65	0.175	0.075	0.25	profile	830	0	0	830
123.35	123.8	0.2	0.25	0.45	profile, side slopes	2290	0	0	2290
128.1	128.35	0.225	0.025	0.25	profile	375	0	0	375

Design Section		Length (km)			Description	Disturbance Area (m2)			
Start	End	Typical Winter	Non-Typical	Total		Terr.	NNPR	IAB	Total
129.9	130.15	0.15	0.1	0.25	profile	1054	0	0	1054
131.15	131.4	0.175	0.075	0.25	profile	970	0	0	970
131.9	132.15	0.15	0.1	0.25	side slopes	932	0	0	932
132.7	132.95	0.15	0.1	0.25	side slopes	1178	0	0	1178
133.95	134.2	0.1	0.15	0.25	side slopes	1336	0	0	1336
134.7	134.95	0	0.25	0.25	side slopes	1994	0	0	1994
140.65	140.85	0.175	0.025	0.2	stream crossing	886	0	0	886
143.25	143.45	0.2	0.00	0.2	profile	0	0	0	0
144.65	144.9	0.25	0	0.25	side slopes	1537	0	0	1537
145.5	145.85	0.175	0.175	0.35	profile	1427	0	0	1427
147.75	148	0	0.25	0.25	profile	2860	0	0	2860
148.65	148.9	0.175	0	0.65	profile	5636	0	0	5636
149.05	149.45				side slopes		0	0	
150.1	150.35	0.175	0.075	0.25	profile	1995	0	0	1995
154.05	154.38	0.25	0.08	0.33	profile	976	0	0	976
155.2	155.3	0	0.1	0.1	Liard north	500	0	0	500
155.9	156	0	0.1	0.1	Liard south	500	0	0	500
163.3	163.55	0.2	0.05	0.25	profile	632	0	0	632
Total Design Km		**9.25**	**10.955**	**20.68**		**39646**	**103352**	**0**	**143442**

1.4.1.3 Prairie Creek ASR Design Specifications

ASR design specifications are listed in Table 1-4 below. The 2018 specifications reflect improvements to the overall design of the ASR. For example, in the EA submission, a 4 m wide operating road width on very limited, defined locations which require rock blasting was defined. A standard minimum 5 m road operating width has now been applied for the full length of the access road. Designs for the whole road are provided in Appendix 1-6.

Road Width

The minimum road width (operating surface) is 5 m. A turn radius analysis was completed for the entire road based on a conventional Super B unit to determine adequate road width to be applied in horizontal curves. Road width will increase as curve radius decreases. Table 1-5 below summarizes the variable road operating width for various horizontal curves.

ASR Right of Way Clearing

All right of way clearing will be scheduled outside migratory bird nesting windows. Any clearing completed within bird nesting periods will conform to satisfactory bird nesting investigations and monitoring prior to clearing. Options for disposal of right of way vegetation include pile and burn (in acceptable season), trench and bury, and mulching and dispersal. Log fibre will be stockpiled within existing disturbed footprint, utilized where possible as corduroy, and where in closer

proximity to local Nahanni Butte community, made available for local use. All of these measures are consistent with the original DAR application.

To minimize the size of the right of way footprint, widths will be variable from a minimum of 15 m to a maximum of 30 m, except when road design dictates otherwise, such as for cross slopes and curves. The right of way width will be calculated based on the following criteria:

- Road prism width, from toe of cut to toe of fill plus minimum of 3 m clearance to vegetation either side. Within permafrost sections, minimum of 1 m clearance to vegetation either side of cut/fill toe;
- Vegetation height (increased height = increased width);
- Stripping depth/soils type; and,
- Sufficient line of site for safety.

ASR Right of Way Clearing

All right of way clearing will be scheduled outside migratory bird nesting windows. Any clearing completed within bird nesting periods will conform to satisfactory bird nesting investigations and monitoring prior to clearing. Options for disposal of right of way vegetation

Table 1-6 summaries the right of way clearing widths based on preliminary designs completed by Series section. Overall, the clearing area was reduced.

TABLE 1-3: ASR SECTION DEVIATIONS FROM 2016 ASR ALIGNMENT

Section	Deviation from 2016 Alignment		Justification
	<75m	<100m	
	Section Length (km)		
KP 39.5 to 40.8	1.3	n/a	To reduce exposure to potential permafrost
KP 51.7 to 53.2	1.5	n/a	To reduce exposure to potential permafrost and natural drainage considerations
KP 68.2 to 68.5	0.3	n/a	To improve alignment and road grade
KP 82.2 to 82.4	0.2	n/a	To improve alignment and road grade
KP 83.4 to 84.0	n/a	0.6	To reduce exposure to potential permafrost
KP 91.4 to 91.7	0.3	n/a	Terrain considerations and improved alignment
KP 92.3 to 92.4	0.1	n/a	To reduce exposure to potential permafrost, and improve alignment
KP 96.0 to 97.0	1.0	n/a	To reduce exposure to potential permafrost, and improve alignment. Avoids problematic minor stream crossing.
KP 104.5 to 105.1	0.6	n/a	To reduce exposure to potential permafrost, and improve alignment
KP 105.7 to 106.3	n/a	0.6	To reduce exposure to potential permafrost, and improve alignment
KP 108.0 to 109.3	1.3	n/a	To reduce exposure to potential permafrost, and improve alignment
KP 110.3 to 110.7	0.4	n/a	To Reduce heavy cut through off steep bank
KP 122.5 to 123.5	n/a	1.0	To reflect terrain conditions, reduce exposure to potential permafrost, and improve alignment
KP 128.4 to 128.8	n/a	0.4	To reflect terrain conditions, reduce exposure to potential permafrost, and improve alignment
KP 133.4 to 133.8	0.4	n/a	To reduce exposure to potential permafrost
KP 150.3 to 152.5	n/a	2.2	To reduce exposure to potential permafrost
Totals	**7.4**	**4.8**	
% Adjusted	**4.3**	**2.8**	Based on 170 km ASR

TABLE 1-4: ASR DESIGN SPECIFICATIONS

Design Parameters	2016 Specification	2018 Specification
Running Surface Width (primary)	5.0 m	Min. 5.0 m (All)
Running Surface Width (secondary)	4.0 m	Not considered
Design Speed (primary)	40 km/hour	40 km/hr
Design Speed (secondary)	20 km/hour	20 or 30 km/hr
Minimum Curve Radius (primary)	65 m	65 m
Minimum Curve Radius (secondary)	25 m	25 m
Optimum Maximum Sustained Grade	6 %	6 %
Acceptable Maximum Sustained Grade	8 to 10%	8 %
Maximum Short pitch Grade (< 250 m)	12 %	10 to 12 %
Turnouts optimum (minimum)	2-3 (1) per km	2-3 (1) per km
Road Life Expectancy	20 years	20 years

TABLE 1-5: VARIABLE ROAD WIDTHS AT CURVES

Horizontal Curve Radius (m)	Adjusted Road Width (m)
65	6.3
125	5.7
200	5.3
300	5.25
500	5.0

TABLE 1-6: RIGHT OF WAY CLEARING WIDTHS

Series	Road Length (km)	Right of Way Footprint (ha)	Average Width (m)
000	20.9	38.24	19.2
100	18.1	31.45	19.1
200	14.5	31.4	21.7
300	16.5	34.07	20.7
400	19.5	37.38	20.9
500	23.0	52.56	23.9
600	8.5	15.06	19.3
700	19.0	37.2	20.5
800	16.1	51.97	21.8
900	13.7	41.03	30.0
TOTALS	**169.8**	**367.56**	**21.6**

Design Segments

The road design was segmented into 10 equal sections (referred to as Series) each approximately 15 to 20 km long. Table 1-7 shows a breakdown summary of the Series. Series 000 commences

at the Mine site and Series 900 terminates at the junction with the Nahanni Butte Access Road. Series splits were governed by logical geographic divides and major stream crossing locations.

Truck Turn Around Locations

Truck turn around locations will be installed approximately every 10 km to allow trucks to park or turn around in the event of poor weather or unplanned road closures. Truck turn around locations will utilize existing disturbed/developed areas such as camps or borrows. If existing disturbed areas are not available, suitable flat, dry easy to construct locations will be utilized to minimize footprint. Table 1-8 identifies proposed turn around locations. Some of these locations are identified on preliminary road designs.

TABLE 1-7: ROAD DESIGN SERIES SUMMARY

Series	Design Station		Total Design Length (km)
	Start	End	
000	0+000	20+900	20.9
100	20+900	39+000	18.1
200	39+000	53+500	14.5
300	53+500	70+000	16.5
400	70+000	89+500	19.5
500	89+500	112+500	23.0
600	112+500	121+000	8.5
700	121+000	140+000	19.0
800	140+000	156+000	16.0
900	156+000	170+000	14.0
Total ASR Design			170.0

TABLE 1-8: PROPOSED TRUCK TURNAROUND LOCATIONS

Road Design Station	Description	Road Design Station	Description
6.3	Utilize existing road infrastructure, flat and gravels. Will also be utilized as chaining up/off location.	15.8	Utilize existing road infrastructure and BP 16.
23.3	Camp 23 footprint.	29.0	Open, flat gravel historic floodplain. Will also be utilized as chaining up/off location.
39.3	Laydown KP 40, original Cat camp. Open, flat gravel historic floodplain	42.1	Camp 42 footprint
52.7	BP 53 footprint	59.1	BP 59. Semi-open, flat, dry gravels
64.6	Camp 65 footprint	76.7	BP 77A footprint
87.0	Camp 87 footprint	95.5	BP 96 footprint. Will also be utilized as chaining up/off location
101.2	BP 102 footprint. Will also be utilized as chaining up/off location	112.0	BP 112.3 Alter. footprint
120.4	Camp 124 footprint	129.1	BP 132 footprint
136.5	Junction with BP 139 access road	147.8	BP 151 footprint
154.9	Camp 159 footprint	156.0	North/south Liard Barge Landing

Speed Reduction Zones

The majority of the road has been designed to a 40 km/hr operating speed, however at some locations the terrain restricts the ability to satisfy the design criteria, and therefore a reduction in design speed was necessary. The majority of speed reductions are 30 km/hr, with a few 20 km/hr sections, and are mainly associated with mountainous terrain from KP 7 to 29. Other notable speed reduced locations include the switchbacks in the Silent Hills section, KP 96 to 101. Speed reduction sections are identified within the preliminary designs.

Rock Fall Mitigation

Additional consideration will be given to areas susceptible to rock fall, and mitigation approaches will be integrated into detailed road designs. All of the rock fall susceptible areas are located in the mountainous areas from KP 0 to 40. Rock fall mitigation options include:

- diligent annual inspections/assessments of problematic areas,
- daily monitoring,
- deep and wide ditches to catch loose rock,
- gabion basket secured walls to catch and hold loose material,
- rock scaling on problematic slopes, and
- placement of chain link fence mat against slopes to catch and reduce rock fall energy.

Table 1-9 summarizes the known rock fall sections, or portions within, which may require mitigation.

Blasting

Blasting is required at a number of locations along the ASR alignment to construct road subgrade between KP 0 to 40. Blasting will also be required to produce quarry at specific borrows. All blasting will comply with permits and wildlife restrictions listed within the Wildlife Management and Monitoring Plan. Table 1-10 summarizes all of the known locations which blasting is potentially required. Preliminary designs incorporated rock layers associated with heavy blasting sections.

Construction Approach within Permafrost

The approach selected for construction in permafrost terrain is “overland” to reduce road footprint, avoid disturbance of natural ground, and minimize permafrost degradation. Initially, sections considered to be influenced by permafrost were based on vegetation, terrain, and slope orientation and aspect. As the design advances with specific investigation data, specific design criteria will be adopted based on type of permafrost, and soil types. Tetra Tech completed further investigation in 2018 and provided additional guidance regarding suitable road embankment design. This was incorporated into the preliminary designs in this UPD.

Table 1-11 summarizes the progression of design detail with respect to permafrost in the preliminary road designs following further geotechnical input.

All stream (culvert) crossings located in permafrost areas will be oversized as a conservative measure to ensure passage of water in the event of any possible blockage such as ice or debris.

TABLE 1-9: ROCK FALL SECTIONS POTENTIALLY REQUIRING MITIGATION

Road Section Design Station		Description
From Km	To Km	
3.4	4.2	Continuous
7.4	8.3	Sporadic
13.8	15.4	Continuous
16.1	16.9	Continuous
17.6	19.0	Sporadic
22.2	22.6	Sporadic

TABLE 1-10: KNOWN BLASTING LOCATIONS

Location	Description
ASR KP 5, 7, 14 to 16	Spot Blasting
ASR KP 23 to 23.6	Blasting
ASR KP 25 to 25.6	Blasting
ASR KP 26.5 to 28.3	Spot Blasting
ASR KP 28.3 to 28.8	Blasting
ASR KP 31	Spot Blasting
ASR KP 34.9 to 35.5	Spot Blasting
ASR KP 36.2 to 37.1	Blasting
BP 39B	Quarry Blasting
BP 47A (backup)	Quarry blasting
BP 47C	Quarry Blasting
BP 70	Quarry Blasting
BP 107 Alter.	Quarry Blasting
BP 109 Alter.	Quarry Blasting
BP 123B (backup)	Quarry Blasting
BP 125 A, B	Quarry Blasting
BP 126 (backup)	Quarry Blasting
BP 136 (backup)	Quarry Blasting
BP 138 (backup)	Quarry Blasting
BP 158	Quarry Blasting

Road Template Cross Sections

The proposed 170 km ASR alignment traverses a variety of terrain and site conditions. Road cross section templates were developed based on terrain and soil type to serve as bases for road designs adapted to variable terrain and site conditions. For example, the road is designed and constructed in mountainous, bedrock terrain differently from permafrost overland sections. Nine road templates were developed, which are shown with the road designs in Appendix 1-6. These road templates were assigned along the full road length, sometimes segmented as short as 150m long. This emphasizes the level of detail the preliminary ASR designs reflect.

TABLE 1-11: PERMAFROST DESIGN APPROACH

2016		Updated Approach	
Permafrost Type	**Design Criteria**	**Permafrost Type**	**Design Criteria**
No distinction between "ice rich" or "ice poor" or soil types	Overland minimum 1.2 m shoulder depth; 2(h):1(v) fill slopes	Ice Poor combined with poor draining soils	Overland minimum 1.0 m fill depth at shoulder; 2:1 fill slope. Foundation provision may use corduroy or geotextile.
		Ice Poor combined with granular, well drained soils (thaw stable)	Conventional construction.
		Ice Rich	Overland minimum 1.5 m fill depth at shoulder; 3:1 fill slope or on fill depths >2 m and/or side slopes > 10%, 2:1 fill slope. Foundation provision will use corduroy or geotextile.

1.4.2 Stream Crossing Structures

1.4.2.1 Phase 1 Winter Road

The winter road will cross all watercourses in accordance with the *Northern Land Use Guidelines – Access: Roads and Trails.* Crossing profile integrity would be protected. This would include:

- Use clean snow and ice fills within the riparian areas of streams;
- Use of solid pipes and/or timber for crossing streams which maintain water flow during the winter period; and,
- Use of temporary spans at deep incised stream crossings to minimize site disturbance.

All the streams along the route have been assessed to verify the crossing method prescribed. The majority of streams along the route are expected to be dry or frozen solid during winter operations. Only some of the larger major crossings are expected to retain water, such as the two Tetcela crossings, Fishtrap and Grainger main stem. Snow/ice fill will be the preferred crossing method.

Table 1-12 summarizes the crossing method for all the significant streams.

1.4.2.2 Phase 2 All Season Road

A total of 137 stream crossings were identified in the 2017 (route flagging) field investigation, 17 of which are considered as major and 120 as minor. A detailed field survey was completed for all major crossings and 18 minor crossings (those considered to be unique). General Arrangement drawings (GA's) for the 17 major and 18 minor crossings surveyed can be viewed in Appendix 1-7.

Major Stream Crossings

All major stream crossing structures have been designed to pass Q100 flow levels. Hydrotechnical data was supplied by Tetra Tech and is summarized in Appendix 1-8.

Table 1-13 summarizes all the major crossings prescribed structure type and size. It includes 12 bridges crossings, 3 large multi- culverts crossings, 1 open bottom arch crossing, and barge/ice bridge crossing over the Liard River. The majority of major stream crossing structures will be constructed in the winter of Y1 Phase 2 operations to support access for construction as the project progresses. All bridge structures are designed with additional freeboard of 1 m or greater based on professional judgement related to ice or debris loading potential. All major stream crossing approaches are either comparable or enhanced/improved from the models used in the 2016 EA submissions. A few structures are located in potential permafrost. Final designs will be completed following geotechnical report.

Minor Stream Crossings

Minor stream GA designs (18) were sized to adequately handle Q100 flow levels. For all remaining smaller streams, the standard B.C. MoF procedure was applied which sizes culverts based on stream field calculations, 3 times the channel area. The general approach for stream crossings is to be conservative and oversize.

The approach to be applied for culvert installations within permafrost includes:

- Install during freezing periods but avoid extreme cold periods to avoid challenges with placing fill and obtaining adequate compaction around structure; Installing in colder temperatures will help to preserve permafrost if exposed;
- Consider additional overflow culvert to be installed at a higher elevation than the primary culvert to allow water flow in the event of primary culvert blockage;
- Oversize culverts to ensure passage if partially frozen or blocked;
- Culverts should be sized and located to prevent significant back up and ponding; and
- Excavate and remove poor soils, replace with preferred thaw stable crushed backfill to reduce impacts related to thaw/freezing cycle. This is less of a concern in existing streambeds where there is already a thermally disturbed area under the existing channel.

All minor streams will be crossed with standard culverts from minimum size of 600 mm up to 2000 mm. For streams considered to be potentially fish-bearing, culverts have been oversized and will be embedded to recreate fish habitat and maintain passage. Culverts for streams considered to have permafrost influence have been oversized to allow sufficient flow during periods of icing. Appendix 1-9 contains a table summarizing the minor crossings by prescribed structure type and size.

Non Classified Drainages / Cross Drainages

During the 2017 field investigation, all Non Classified Drainages (NCDs) were identified and prescribed a culvert. This included wet draws and noticeable depressions in which natural water drainage is noticeable, but a scoured channel is not distinguishable (that would be considered a stream). Culvert sizing includes minimum of 500 mm to maximum of 800 mm based on field interpretation.

In addition to all NCDs, cross drainage culverts have been prescribed for all noticeable depressions detected in the profile, and at a minimum of 3 per km depending on road design specifications. This approach is to ensure all natural surface water drainage is maintained.

TABLE 1-12: SUMMARY OF WINTER ROAD STREAM CROSSINGS

Stream	Crossing Method	Site Description
STR 6.2	Existing Bridge with overflow culverts	Existing road structure in place. Stream expected to be frozen solid.
STR 13.3	Snow fill / ice crossing	Expect minimal, shallow, surface water, frozen solid.
STR 20.0	Snow fill / ice crossing	Expect minimal, shallow, surface water, frozen solid.
STR. 23.3 Sundog	Snow fill / ice crossing	Expect minimal, shallow, surface water, frozen solid.
STR. 25.4 Sundog	Temporary bridge	Steep, incised crossing. Expect minimal, shallow, surface water, frozen solid. Approaches require significant grading out.
STR. 28.4 Sundog	Snow fill / ice crossing	Expect minimal, shallow, surface water, frozen solid.
STR. 28.8 Sundog	Ice bridge crossing or potential temporary bridge	Expect minimal, shallow, surface water, frozen solid.
STR. 29.7	Snow fill / ice crossing	Expect minimal, shallow, surface water, frozen solid.
STR. 30.8 Sundog	Snow fill / ice crossing	Channel will be dry. Any surface water will be frozen.
STR. 31.3 Sundog	Snow/ice bridge crossing	Channel will be dry. Any surface water will be frozen.
STR. 32.9 Sundog	Snow fill / ice crossing	Channel will be dry. Any surface water will be frozen.
STR. 33.3 Sundog	Snow fill / ice crossing	Channel will be dry. Any surface water will be frozen.
STR. 34.5 Sundog	Snow fill / ice crossing	Channel will be dry. Any surface water will be frozen.
STR. 36.3 Sundog	Snow fill / ice crossing	Channel will be dry. Any surface water will be frozen.
STR. 36.7 Sundog	Snow fill / ice crossing	Channel will be dry. Any surface water will be frozen.
STR. 37.4 Sundog	Snow fill / ice crossing	Channel will be dry. Any surface water will be frozen.
STR. 37.7 Sundog	Snow fill / ice crossing	Channel will be dry. Any surface water will be frozen.
STR. 39.3	Snow fill / ice crossing	Channel expected to be dry. Expect minimal, shallow, surface water, frozen solid.
STR. 42.7	Snow fill / ice crossing	Channel expected to be dry. Expect minimal, shallow, surface water, frozen solid.
STR. 49.3	Snow fill / ice crossing	Possible winter water flow. Incised. May require timber/culvert for water and frozen supported rig mat.
STR. 53.2	Temporary bridge/rig mat	Incised, tributary of Poljie. Use temporary short span bridge or frozen supported rig mat.
STR. 53.3 Poljie	Temporary bridge	Incised, 20 m temporary span
STR. 56.1	Snow fill / ice crossing	Possible winter water flow. Incised.
STR. 87.0 Tetcela	Snow fill / ice crossing	Expect winter water flow. May require timber/culvert.
STR. 89.5 Tetcela	Snow fill / ice crossing	Expect winter water flow. May require timber/culvert.
STR 94.7 Fishtrap	Snow fill / ice crossing	Assume winter water flow. Wetland area.
STR 111.7	Snow fill / ice crossing	Assume winter water flow.
STR. 119	Snow fill / ice crossing	Channel expected to be dry.
STR. 121 Grainger	Snow fill / ice crossing or ice bridge crossing	Expect winter water flow. May require timber/culvert.
STR. 141	Snow fill / ice crossing	Incised crossing.
STR 147.7	Snow fill / ice crossing	Channel expected to be dry.

Stream	Crossing Method	Site Description
Liard 155.9, 156.4	Ice Bridge Crossing	Establish major ice bridge

TABLE 1-13: SUMMARY OF MAJOR STREAM CROSSINGS

Location KP	Design ST	Crossing Type	Size	Install Season Summer / Winter	Watershed	Probability of fish presence at crossing	Site Characteristics and Install Comments
Casket Creek KP 6.2	6.125	Bridge	18.326m	S or W	Prairie Creek	Present	Road traverses active floodplain. Additional cross drainage measures are applied.
Funeral Creek KP 13.4	13.260 & 13.420	Multi-Culverts	(1200mm)-33m (1800mm)-31m	S or W	Prairie Creek	Low	Install
Sundog Creek KP 20.3	20.47	Multi-Culverts	2000mm x 2 x 24m	S or W	Sundog Creek	Low	Install
Sundog Creek KP 23.3	23.45	Bridge	61.0 m	S or W	Sundog Creek	Low	Multi-span structure. Expect significant rock blasting.
Sundog Creek KP 25.4	25.32	Bridge	70.1 m	S or W	Sundog Creek	Low	Multi-span structure. Expect significant rock blasting.
Sundog Creek KP 28.5	28.49	Open Bottom Culvert	8300mm x 3300mm x 22m	S or W	Sundog Creek	Present	Install
Sundog Creek KP 39.2	39.17	Bridge	55.015m	S or W	Sundog Creek	Present	Install
Unnamed KP 42.9	42.77	Bridge	17.268m	S or W	Sundog Creek	Low	Install
Poljie KP 53.2	53.14	Bridge	45.89m	S or W	Poljie Creek	Present	Install
Tetcela KP 87.0	86.88	Bridge	30.516,2000	S or W	Tetcela River	Present	Install
Tetcela KP 89.5	89.33	Bridge	67.208m	S or W	Tetcela River	Present	Install
Fish Trap KP 95	94.585	Bridge	18.326m	W	Fish Trap	Moderate	Permafrost
Unnamed KP 111.5	111.41	Bridge	18.326m	W	Unnamed	Moderate	Potential Permafrost.
Grainger KP 118.9	119.00	Bridge	55.019	S or W	Grainger River	Low	Anticipate heavy seasonal water flows during spring period. Dry most of the year. Multi span bridge.
Grainger KP 121	121.30	Bridge	55.017	S or W	Grainger River	Present	Install
Unnamed KP 147.6	147.86	Multi Culvert	(1800mm)-30m (1800mm)-29m	S or W	Liard River	Low	Install
Liard KP 155.9 & 156.4	156.00	Barge	n/a	S or W	Liard River	Present	Barge landings on north and south side. Ice bridge crossing in winter.

1.4.3 Borrows, Quarries and Waste Areas

1.4.3.1 Borrows and Quarries

Borrow supply will include all borrow material types required to construct the ASR for all construction applications, including subgrade, surfacing aggregate supply, and rock quarry supply.

To reduce the overall project footprint, the preliminary designs reflect borrow volume from within the right of way by using cut material from the embankment footprint and ditches. However, significant volumes of borrow are still required outside the right of way to build subgrade, surfacing and rock armouring, and for long term road maintenance.

For the DAR in the EA process, borrow locations were verified in the 2014 and 2015 field investigations. The field investigations included a preliminary opportunity to ground assess all potential borrow sites. In a number of cases, field investigation consisted of a low level helicopter assessment and interpretation based on correlation with ground investigations conducted on similar sites. A total of 34 samples were taken in the field utilizing a hand shovel and/or hand auger to a maximum depth of 1.2 m. Numerous spot checks of soils types were also completed at random while traversing the terrain on foot.

The 2017 field investigations included additional ground assessments at borrow locations to confirm ground conditions and identify potential test pit locations. Additional shovel testing was completed within borrows and along the alignment to confirm surface soils types. In 2018, sampling was completed with a portable drill (window sampler) which recovered soil samples up to 5 m in depth. Sampling confirmed soil types, depths, and permafrost (preliminary) at a number of select locations. Information obtained from these investigations is reflected within the preliminary road designs and defined borrow areas.

Borrows were selected based on material type, location, volume of material, and potential to impact the environment. As in the DAR application and commitments made in EA submissions, a Borrow Pit Management and Reclamation Plan (BPMRP) will be completed for each borrow location selected for development. This site specific, detailed design would provide directions with regards to development, extraction, and reclamation on a site by site basis. This plan would reflect the following:

- Buffer strips or zones between the borrow and water bodies will be applied;
- Surface water runoff from the borrow site will not directly enter a natural water body. Water will be directed to naturally filter through forested areas or vegetated terrain to minimize sedimentation. If surface water cannot be directed away from the water body, then appropriate water setting ponds, capable of handling the water quantity, will be installed to allow natural settling and filtering of water;
- Re-direction of surface runoff away from the borrow location to prevent ingress to the borrow area;
- Slope stability considerations with final contouring and shaping;
- Presence, quantity, and extent of permafrost and/or ice rich soils;
- Required access roads; and
- Compliance with local laws, rules, and regulations and with the NWT “Northern Land Use Guidelines”.

A copy of the draft generic BPMRP submitted during the EA is provided in Appendix 1-10.

GNWT Lands have a generic pit development plan which will be used to complete the BPMRP's.

Borrows containing significant permafrost influence will be avoided.

Borrow details and volumes are summarized in Appendix 1-11, and the demands are based on the preliminary road designs submitted in this document. The preliminary road design identifies material requirements to construct the road, and therefore defines the quantity of borrow material required at specific locations. The borrow sites have been categorized by the type of material and the construction application. The borrow sites will be collectively utilized for three specific construction applications; subgrade, surfacing aggregate supply, and rock quarry supply. A site description for each proposed borrow pit can be viewed in Appendix 1-12.

A comparison of 2016 and 2018 borrow area requirements is summarized in Table 1-14.

TABLE 1-14: BORROW AREA REQUIREMENTS

Submission	Total Borrow Identified	Total Required	Backup	Backup Secondary	Gross Area (ha)	Net Area (ha)	Volume Required (m^3)
2016	82	52	30	n/a	257.14	40.59	789,464
2018	81	49	12	20	233.48	38.34	918,000

As a result of additional field confirmation and completion of preliminary road designs with earth volumes, the total number of borrows required, the gross area, and the net area (considered as footprint) were all reduced from the 2016 estimate. However, the borrow volume increased primarily because of a more conservative approach taken toward constructing over permafrost (assuming all is ice rich). It is expected that with geotechnical investigation completion, borrow volume requirements will decrease, with overland construction based on a greater understanding of soils and type of permafrost (ice poor vs. ice rich). Borrow pits 1, 6, 40A and 72 were dropped from the 2016 submission list. The 2018 list includes a revised location for BP 108 Alter. after field confirmation; BP 39 gross area was reduced and split into sub-units A and B; and, BP 110 and 156 were added.

Borrow Access Roads

The majority of borrow areas are identified adjacent to the road right of way, and access roads have not been identified as they will be contained within the defined disturbance area. A number of borrow locations are located off the right of way and access roads have been defined. The construction standard of a borrow access road will vary depending on season (summer, winter, or both), soil type, and operating duration (long or short term). Several of the borrow sites will be maintained through the life of the project to supply aggregate for maintenance and repairs to the road system. The selection of these sources will be subject to further consideration during and after road section construction. Borrow sources and access roads that will no longer be needed after construction will be reclaimed in accordance with the BPMRP's.

Access roads to borrow areas located outside of the road right of way have been identified and summarized in Table 1-15. The nominal width of these roads will be 3.5 m, within a cleared width of 10 m.

Borrow Pit Mitigation Measures

Borrow pit development will need to address potential issues and possible mitigation with respect

to dust, water quality and slope stability, amongst others. Specific information will be provided in the individual BPMRP's.

TABLE 1-15: BORROW ACCESS ROADS OUTSIDE RIGHT OF WAY

Borrow Label	Access Road Length (KM)	Area (ha)	Duration	Seasonal Limitations
BP 41	0.08	0.08	Short Term	Winter only. Access across permafrost.
BP 47A & 47B	0.38	0.38	Short Term	Winter, ice bridge over upper Poljie Creek required for access.
BP 64	0.32	n/a	Short Term	Will be contained with borrow and/or Camp 64 footprint. Summer or Winter
BP 97	0.16	0.16	Short Term	Summer or Winter
BP 102B	0.31	0.31	Short Term	Summer or Winter
BP 103	0.17	0.17	Short Term	Summer or Winter
BP 107 Alter,	0.6	0.6	Short Term	Summer or Winter
BP 109 Alter.	0.8	0.8	Short Term	Summer or Winter
BP 123B	0.24	0.24	Short Term	Summer or Winter
BP 125B	0.33	0.33	Long Term	Summer or Winter
BP 126	1.2	1.2	Short Term	Summer or Winter
BP 129	0.15	0.15	Long Term	Summer or Winter
BP 138	1.12	1.12	Short Term	Summer or Winter
BP 139	2.25	2.25	Long Term	Summer or Winter
BP 158	0.85	0.85	Long Term	Summer or Winter, Provide material for long term road maintenance
BP 159A	0.2	0.2	Short Term	Summer or Winter
TOTALS	**5.64** **3.52**	**5.64** **3.52**	**N/A**	**N/A**

Notes: Back-up Borrow sources are in *italics*, and have separate length and area totals.

Disturbance footprint area is based on a 10m wide road.

Borrow Pit Reclamation

All borrow pits utilized will be deactivated and reclaimed in compliance with their BPMRP's. All borrow pits no longer needed for road construction or for maintenance purposes will be de-activated as seasonal conditions permit. Disturbed slopes will be stabilized and drainage patterns will be re-established to minimize erosion potential within and around the developed pit area. Reclamation will encourage re-vegetation by natural species invasion of disturbed areas, although use of a northern seed mix may be warranted.

Borrow Pit Approval Process

All BPMRP's will require approval by MVLWB or Parks Canada prior to clearing. An estimated 50 borrow pits will require BPMRP's.

To facilitate the BPMRP approval process, we plan to complete draft generic BPMRP's for each

of the three different borrow material types required: subgrade, surfacing aggregate supply, and rock quarry supply. The contents of the draft plans would then be agreed. Subsequently, the estimated 50 BPMRP's would be completed as geotechnical data from investigation are available.

1.4.3.2 Waste Areas

The disposal of excess waste material, primarily from larger cuts, will generally be utilized within other portions of the road prism requiring material, such as overland sections. As a result, minimal waste areas are required outside the defined road right of way.

Two locations have been identified for waste, as summarized below:

ID	KP	Area (ha)	Volume (m3)	Comments:
WP 12	12.5	0.69	20,000	Waste from section KP 13 to 13.4
Camp 23	23.1	2.1	30,000	Utilized to develop camp and reclaim old winter road footprint.

1.4.4 Stockpiles

In most situations, material stockpiles will be maintained within existing borrow locations. However, the borrow sources at BP 47 A, B, and BP 158 or 159, will only be accessible in winter, and therefore stockpiling of surface aggregate or rock quarry materials will be required at alternative locations. These locations will still be contained within the disturbance footprint, such as at other borrows, within the road right of way, or at camps or laydowns which offer easy accessibility. All stockpiles will be established outside riparian areas and not in close proximity to streams, and adequate ditching will be installed to manage surface water drainage.

1.4.5 Disturbed Area Water Management

Managing surface water in relation to disturbed area is important to minimize the potential for impacts. Sediment control is addressed in the Sediment and Erosion Control Plan, however the following main approaches will be taken to manage water in and around disturbed areas:

- All natural streams and drainage flows will be maintained during construction. Approaches include leaving natural channels intact until permanent structures are installed, use of temporary bridges or pipes, or use of load bearing supported rig mats.
- Extensive use of temporary water bars and cross ditches to avoid road structures becoming flow paths or restricting water flow and creating ponding effects.
- Extensive use of temporary diverging ditches to catch and direct surface water away from critical areas.
- Directing flows to an "environmentally neutral" location, away from natural waterbodies and areas containing potential permafrost.
- Use of ditch blocks, sumps, silt fences/filter cloth to reduce surface water flow velocities and energy to reduce erosion and sediment potential within and outside of the footprint area.

1.4.6 Fuel Consumption and Storage

Fuel Consumption

Fuel Consumption is directly related to the number and type of equipment required for construction and support services. Y2, Phase 2 ASR construction will see the greatest construction activity with each camp serving up to 2 or more construction spreads. Each spread would operate several excavators, dozers, rock trucks, a packer, and service trucks. Other equipment may be operating borrows, drilling/blasting, and constructing bridges. Fuel consumption estimates were made based on the current Caterpillar Performance Handbook average hourly fuel consumption per equipment type.

Fuel Storage

The fuel storage capacity is based on peak operations during Phase 2 ASR summer construction. The fuel storage capacity considers the restricted ability to transport supplies, including fuel, through this active construction period when road segments may be isolated and road re-supply isn't possible. Operations in the winter and in Y3 will have connected road ground access to supply fuel as required, so fuel storage capacity can be reduced at these times. To determine the storage capacity requirements, an analysis was completed for each proposed camp location and the construction spread it will serve. The analysis estimated the total number and type of equipment utilized for construction, multiplied by the projected daily fuel consumption, multiplied by number of operating days for the Y2 ASR summer/fall construction period. Table 1-16 summarizes the estimated fuel storage requirements for each camp.

TABLE 1-16: DIESEL FUEL STORAGE REQUIREMENT PHASE 2 ASR, Y2

Camp	Fuel (litres)	Comments
Camp 23	247,848	Mine Access
Camp 42	169,916	Isolated
Camp 65	158,950	Isolated
Camp 87	134,879	Isolated
Camp 124	177,825	Isolated
Camp 159	145,747	Hwy 7 access?
Camp 178	30,000	Hwy 7 access
TOTAL	**1,065,165**	

In addition to fuel storage being in compliance with all permits and regulations, the following approaches will be adopted:

- Fuel caches will be located on flat, stable terrain, or in a natural depression, away from slopes leading to water bodies.
- Fuel will be located above the Q100 high water mark, outside the defined riparian area for bodies of water in the proximity of the fuel storage.
- Fuel and hazardous materials will not be stored on the surface of frozen lakes or streams.
- Secondary containment for stationary fuel containers with a capacity greater than 230 L. Secondary containment can consist of double-walled fuel tanks or engineered containment areas.
- Engineered secondary containment would be an impermeable storage structure that has the capacity to contain fuel in the event of a spill (110% of the largest tank).

1.4.7 Camps

A total of 7 camps are proposed for ASR construction (see Table 1-18). Three camp areas (Camp 42, 87, 121) will be retained at a reduced size for long term ASR maintenance and operations. Two backup camp locations are identified as Camp 102 (Wolverine) and Camp 151.

The selection of camp locations is dictated by the construction schedule while considering site characteristics favourable to support a camp. Favourable site characteristics include outside of a riparian area and distant from a water-body, reasonably flat and dry, and preferably with gravel based soils to minimize site development costs and environmental impacts.

Basic camp layout designs have been completed for all proposed camps (excluding backups) to reflect adequate sizing for the required facilities. Camp layouts can be viewed in Appendix 1-13.

The road contractor(s) will be responsible to provide and manage camp facilities in accordance with permit conditions. Camps have been defined as "major" and "minor" based on schedule and construction demands. Major may accommodate up to 48 people, minor up to 24 people.

The construction camps will be removed once construction activities have been completed in their proximity and their use is no longer required. Camp areas will be deactivated and reclaimed. Camps 42, 87, and 121 will retain sufficient area for long term operations and unused area will be deactivated and reclaimed.

1.4.7.1 Uses

All camps will provide accommodation for construction workers, supervision staff and monitors. Phase 1 winter road construction camps will utilize the same camp locations as Phase 2 but are expected to require a reduced footprint. These camps will likely support smaller work crews, up to 24 men and the majority of the facilities will be seasonal/temporary and removed at the end of the winter season. Phase 2 construction will demand the full camp area, will operate up to the maximum capacity, and the facilities will remain throughout Phase 2 ASR construction duration.

Long term camp facilities at KP 42, 87, and 121 will support road maintenance, crews and potentially refuge areas for transportation personnel in the event of adverse driving conditions. Facilities would include a single trailer, small generator with fuel tank, a laydown area for a limited volume of construction materials (e.g. culverts), and space for parking. These camps will also be used as "turn around" locations for concentrate trucks.

1.4.7.2 Footprints

Construction camps must have sufficient area to accommodate the following:

- Stockpiled organic stripping pile(s),
- Bunkhouses,
- Kitchen,
- Power generation,
- Fuel storage to support construction,
- Equipment parking, maintenance, and repair facility (larger camps),
- Construction services office,
- Waste water treatment, as required, and
- Solid waste collection.

A number of camps are located adjacent to proposed borrow locations, including KP 65, 87, 121, and 159. Effort will be made to share footprint with borrow and camp areas as construction operations progress to reduce project area footprint.

Camps will be used as laydown areas for construction materials. A small exclusive laydown area is also proposed at the original Cat Camp (KP 40) for additional staging of materials (except fuel) to support lower Sundog construction, however the camp for personnel will be at Km 42. Borrow areas, Liard River staging areas, existing ASR right of way areas will all be utilized as laydown areas for construction supplies.

Table 1-17 summarizes camp footprint and other site details.

TABLE 1-17: SUMMARY OF PROPOSED CAMP SITE DETAILS

Location	Design Location	Area (ha)	Class	Capacity	Description
Camp 23.2 Drum	23.2	2.4	minor	Up to 24	Utilize existing road bed adjacent to new alignment. Rolling with gravel base. Camp area will utilize stripping waste.
Laydown 40 Cat	39.4	1.0	n/a	n/a	Original camp and laydown area. Excellent location, lots of room, flat, dry gravel based soils.
Camp 42	42.0	2.25	major	Up to 48	Site is flat and dry. Will need to field confirm. Site improvements include gravelling.
Camp 65 Ram	64.5	3.0	minor	Up to 24	Close proximity to good gravel source, reasonably dry terrain with minor slopes. Could be integrated with BP 64 or share some footprint with BP 65.
Camp 87 Tetcela	87.2	1.75	major	Up to 48	Good location, reasonably flat with gravel based materials. Could be integrated with BP 87.
Camp 102 Wolverine	102	3.0	minor	Up to 24	**Backup**. East of the Wolverine Gap with gentle slopes. Integrated with BP 102B.
Camp 124 Grainger	120.2	2.0	major	Up to 48	Good location, lots of room. Flat, dry, gravel based location. Can be integrated with BP 123A.
Camp 151	147.5	0.0	minor	Up to 24	**Backup**. Could offer an alternative to KP 159 Liard Camp with gravel based material and gentle slopes. Integrated with BP 151.
Camp 159 Liard	154.5	3.0	minor	Up to 24	Would offer the best strategic camp location and can combine with the Liard crossing/landing. Could share some footprint with BP 159. May have limited space and will require significant gravelling.
Camp 178	176.5	2.0	minor	Up to 24	Portion of the camp area occupies existing borrow footprint.
Totals		**17.4**			**7 proposed camps, 2 Backups**. Backup areas not included in total area.

1.4.7.3 Surface Treatments

The majority of camps have been selected based on terrain and soil types (gravel base materials). The majority of camp areas will be stripped to mineral soils and stripped organics will be stockpiled along the perimeter for future use in reclamation. Access paths, trails, parking areas, and other areas exposed to foot and vehicle traffic will be surfaced with sufficient gravel. Surface drainage design will direct surface water away from critical areas to flow into neutral areas outside

the camp footprint. Drainage designs will direct water away from any riparian areas or streams.

The terrain varies for each of the proposed camps. The majority are relatively flat to minimize earthworks and camp development. Camp 42 will require gravel surfacing to be hauled in for access roads and parking areas. Camp 65 and 159 are located on gentle sloping terrain which will require some earthworks to develop the sites.

1.4.7.4 Sewage

The road construction and maintenance camps will generate sewage, consisting of greywater (kitchen, showers, laundry) and black water (toilets). The volume of sewage will vary by camp size, and the sewage management approach will vary according to camp location. Table 1-18 provides relevant details for the construction phase.

TABLE 1-18: CAMP SEWAGE MANAGEMENT

Camp		Size (max. persons)	Max.* Sewage Volume (L/day)	Grey Water Disposal	Black Water Treated On-Site
Km	Name				
Park Land					
23.2	Drum	24	6,480	No	No
42	Cat	48	12,960	Yes	Proposed
64.5	-	24	6,480	Yes	No
87.2	Tetcela	48	12,960	Yes	Proposed
Territorial Land					
102	Wolverine	24	6,480	Yes	No
120.2	Grainger	48	12,960	Yes	Proposed
147.5 or 154.5	Liard River	48	12,960	Yes	Proposed
176.5	Liard Hwy	24	6,480	Yes	No

* Based on 270 L/day/person

Grey water disposal via barrels, sumps or lagoons is proposed at all camp locations, except for Km 23.2, which does not have a suitable location for sewage disposal and is also accessible to the Mine. Black water treatment at camps will only be considered at the larger camps. Black water from the smaller camps will either be disposed of in pit privies or stored for later transfer to either the Mine, larger camps or an off-site facility. Black water treatment on-site at the larger construction camps is desirable because the camps will be isolated from the ends of the road for periods during the summer. The camp planned for Cat Camp was moved to Km 42 for this reason. This location is sufficiently distant from Sundog Creek and should be suitable for disposal of effluent.

The Km 23.2 camp will be small and the location is proximal to surface water.

The Km 64.5 camp would be developed in a borrow pit on a height of land between sub-basins. The camp would be >1 km south-east of Mosquito Lake, and a similar distance from watercourses.

The Km 87.2 camp would also be developed in a borrow pit, located in a relatively flat lowland area approximately 150 m east of a tributary to the Tetcela River.

The remaining camps will be combined with borrow pits, where possible, and located sufficiently distant from surface water.

Grey Water

Grey water will contain residual soap and grease. Maximizing the use of environmentally friendly and phosphate-free products will be targeted. The wastewater will be disposed of after filtering via either a barrel, sump or lagoon, depending on the expected flow rate and soil conditions (see Environmental Health Services Guidelines for Greywater Disposal at Remote Camps, Yukon Govt., 2012). Effluent seepage will contain organic matter and bacteria. These will naturally degrade completely before reaching a surface waterbody. There will be daily addition of bleach in the dishwater, and/or grease trap and lime or crystal lye in the sumps, to minimize the associated odours and wildlife attraction.

An alternative to the above for large camps that will have an on-site black water treatment plant is to treat black and grey water as a combined stream.

Grey water disposal locations will be sited distant from surface water in pervious material a sufficient distance above the water table. Before a disposal location is created, tests will be conducted to confirm suitable seepage capacity based on prevailing septic field standards. In addition to the Remote Camps document noted above, a variety of guidelines are available for siting and construction, for example, "Design Specifications for Sewage Disposal Systems, A Guide to their Design and Maintenance" issued by the Yukon Govt. (2016). The Remote Camps document specifies a minimum distance of 0.5 m between the disposal system bottom and the water table. A disposal system in use that lacks capacity or plugs will be filled, and either another one will be constructed or a storage tank used.

Black Water

On-site treatment of black water is proposed at the larger camps, which are likely to have a significant and steady flow of waste water. Once road construction contractors have been selected, more information will be provided on the type, design and expected effluent quality of the sewage treatment plants. We expect such plants will use some form of a properly designed biological digestion and solids filtration system, similar the existing plant at the Mine site. Plant effluents will be sent to grey water sumps.

Maintenance Camps

Small camps to support road operations and maintenance are proposed for Km's 42, 87.2, 120.2 and on either side of the Liard River where trailer transfer, barge and checkpoint (north side only) operations will occur. In accordance with the NWT Northern Land Use Guidelines (NLUG) for Camps and the Yukon Remote Camps guidelines, for small stationary camps, we propose to dispose of grey water via barrels or sumps, and provide pit privy toilets. The guidelines will be followed in terms of requirements (>31 m from surface water, occasional lime addition).

1.4.8 Water Withdrawal

Water withdrawal will occur using a water truck, pump and hose with a suitable screen. DFO's Measures to Avoid Causing Harm to Fish and Fish Habitat will be followed, specifically those for fish protection:

http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/measures-mesures-eng.html

1.4.9 Water Use Volumes and Withdrawal Locations

Winter

Water will be needed for winter road construction and possibly for potable supply to construction camps (with treatment prior to use). Volumes needed for road construction will depend on snow conditions. However, given that construction will occur mainly from the east, and the initiation of construction will be limited by the Liard River ice bridge (~January 15 for heavy traffic), sufficient snow is expected to be available and substantial quantities of water should not be required.

For potable use, the rule-of-thumb for water consumption is 270 L/person/day. With an estimated construction crew size of 80, this equates to 21.6 m3/day. For a 90 day winter construction period, the volume is 1,944 m^3.

Water will be drawn from the approved water sources defined during permitting for LUP's MV2012F0007 and Parks2012-L001. Quantity limits in m^3 for each location, based on the DFO 10% winter withdrawal limit, are as follows:

WATER WITHDRAWAL SOURCES

Location (2012)	**ASR Km**	**(m^3)**
Cat Camp	39.5	5,750
Mosquito Lake	63	33,528
Km 70 lake	74	52,475
Km 100-OR4 lake	103.5	2,448
Km 115 lake	117	5,773
Km 121, Gap Lake	120	4,090
Km 139 lake	138	5,382
Km 141 lake	140	16,803
Total		**126,249**

Information supporting these numbers and maps showing water source locations can be found here:

Water Sources

The lake/pond water sources are discussed from west to east below according to winter road Km marker:

- At Cat Camp (Km 40), a pit will be dug more than 100 m from the active channel of Sundog Creek, and not in proximity to the location of previously identified soil contamination associated with Cadillac-era fuel tanks. The pit will be located in a thinly vegetated area. Because the creek consists of outwash gravels at this location, and gravels are expected in adjacent, old floodplain areas, groundwater is expected to be shallow and plentiful. The actual size and depth of the pit will depend on the depth to water. The pit would be fenced off using snow fence to deter any wildlife. The proposed extraction volume of 5,750 m^3 is very small compared to the volume of groundwater in alluvial storage, and would have no

effects.

- Mosquito Lake at Km 63.5 is part of the Polje system which has no surface outlet for water. Consequently, the lake cannot host migrating fish. Also, it is a large lake, and water demand will be much less than the volume represented by 10% of lake volume.
- A lake at Km 70 also has a large volume, and water demand will be much less than the volume represented by 10% of lake volume.
- Ponds east of Wolverine Pass are part of an extensive system of wetlands and beaver dams extending north from the Grainger Gap area, unlikely hosts for fish. Extracted water would readily be replenished from upstream.
- A small lake east of Km 115 is also part of the same wetlands system draining north. However, this lake is some distance off the ASR alignment, and Gap Lake is nearby. Therefore, it is unlikely to be used.
- Gap Lake at Km 122 is part of the Grainger River headwater system. It is fed by wetlands to the south and west. The lake is fish-bearing. Extraction of 10% of lake volume is unlikely to cause effects given the upstream potential for replenishment.
- The small lakes at Km 142 and 144 are on tributaries of the Grainger River, and there is extensive beaver activity downstream with multiple dams. Therefore, the lakes are unlikely to host migrating fish.

Since initial winter road construction will occur primarily from the east, we also propose to extract water from the Liard River until the Km 142 and 144 lakes are reached.

Water extraction will not exceed 275 m^3/day for any jurisdiction along the road. Extraction volumes will be tracked by recording the number of fills of tanks with a known capacity, and the data collated by the road construction contractor.

Summer

In the non-winter period, potable water may be needed for summer construction camps (unless it is imported). Water will also be needed for culvert installation/dust control during construction, and for dust control during operations.

For a three-year construction period and 34 large diameter culverts (>/= 1000 mm) installed annually, it is estimated that 1,000 L at 50% of the crossings would be required, or 17 m^3 annually.

For construction dust control in summer, Allnorth estimated 4000 L per km per day for 60 days and 15 km. This generates a volume of 3,600 m^3.

During operations, for dust control in summer, Allnorth estimated 4,000 L per km per day over a twelve week period, watering 70 km three days per week. This generates a volume of 10,080 m^3. If all 70 km was watered in a day, the quantity would be 280 m^3.

The same water sources proposed in winter may be used. Also, the larger watercourses crossed by or adjacent to the road (Prairie, Fast, Casket, upper Funeral (Km 13.4-15.8), Sundog, Polje, Fishtrap, Tetcela, Grainger) may be used for water supply. For extraction from watercourses, no more than 10% of instantaneous flow would be drawn. Given the approximate nature of flow estimation in the absence of specialized flow estimation equipment, conservative assumptions will be made to ensure the rate or volume of extraction is less than the 10% limit. For all extractions, DFO's Measures to Avoid Causing Harm to Fish and Fish Habitat will be followed, specifically those for fish protection:

DFO Measures to Avoid Harm

Nearly all of the listed watercourses are large systems with considerable flow, and the extracted water will be much less than 10% of the flow. The exceptions are Funeral and Fishtrap Creeks. Water extraction from Funeral would be from upstream tributaries that are not fish-bearing due to downstream obstructions to migration. At the Fishtrap Creek wetland crossing, no fish were found in previous surveys, presumably due to the poor habitat and extensive beaver dam system downstream.

We estimate a summer water demand for dust control of 10,080 m^3. This is based on 70 km requiring watering 3 times/week over 12 weeks, at a rate of 4,000 L/km. Lakes we may use for water withdrawal are listed in Table 1-19 below (again, permitted winter road Km's are used). Smaller lakes, or lakes off of the alignment, were excluded from consideration. Lake data is derived from the 2012 report for which a link was provided above.

TABLE 1-19: LAKES FOR WATER WITHDRAWAL

Lake Name	Surface Area (m^2)	Total Lake Volume (m^3)	10% Withdrawal Volume	1% Withdrawal Volume	Water level change at 1% (mm)
Mosquito Lake	450,500	1,092,000	109,200	10,920	2.4
Km 70	217,700	1,248,000	124,800	12,480	5.7
Km 115	95,720	190,400	19,040	1,904	2.0
Km 121	252,400	291,600	29,160	2,916	1.2
Km 139	393,900	371,200	37,120	3,712	0.9
Km 141	186,200	486,000	48,600	4,860	2.6

Mosquito Lake

This lake has a stream inflow and outflow. In summer, inflows are assumed to keep the lake level static. The distance from Cat Camp (Km 40), where we identified a water source, and the Tetcela River main stem is about 50 km. For argument's sake, we can assume that dust control is required for this total section, without the use of any other water source (Polje Creek is at about Km 53, but was found to be dry in September 2015). Using the above noted watering schedule, a volume of 7,200 m^3 is generated. This amount is less than 1% of lake volume (10,920 and 1,092,000 m^3, respectively. See Table 1-21). Withdrawal of 1% is equivalent to a 2.4 mm level change (dividing the withdrawal volume by the lake surface area). In reality, no such level change is likely to occur since lake inflow will replace the water withdrawn. However, even if the calculated level change occurred, no significant effects are expected as the change is so small. Therefore, we propose to limit summer season withdrawal from this lake to 1% of lake volume.

Km 70

Using the same logic as for Mosquito Lake, we also propose to limit summer season withdrawal from this lake to 1% of lake volume. We may in fact not use this lake since it is somewhat off the alignment.

Km 115

This lake has a significant upstream catchment that would compensate for any withdrawal. For a

summer season withdrawal of 5% of lake volume, the maximum level change would only be 1 cm. Therefore, we propose this limit. We may also not use this lake as it is off the alignment.

Km 121

This lake west of Grainger Gap has a substantial upstream catchment to compensate for any withdrawal, being part of the upper Grainger River system. A 5% water withdrawal would mean a maximum level change of 6 mm. Therefore, we propose this summer season withdrawal limit.

Km 139 and 141

These lakes are in close proximity to one another. The Km 139 lake has a larger area, but smaller volume, and the upstream catchment is limited. Lake Km 141 has a significant upstream catchment. Limiting summer season extraction to 2% of lake volume means a maximum level change of 1.8 and 5.2 mm respectively, although the latter in particular is highly unlikely to occur.

Other Remarks

The water withdrawal rates noted above are based on each summer season (entire open water period). It is assumed that spring runoff will replenish all lakes to full capacity prior to the summer period. The rate of extraction for any given lake within the summer period will be limited by the fact that watering for dust control is not needed on successive days. Potentially dry road conditions are considered to be possible over the period July-September. This would be the likely period of dust control.

Monitoring

Water withdrawal volumes will be tracked either by using an in-line flow meter, or by recording the number of fills of tanks of known capacity. Records will be kept and provided at regular intervals along with other road monitoring data.

A staff gauge will be installed at any lake used for summer water extraction. The normal spring lake water level (this being controlled by the lake's outflow elevation) will be recorded and marked on the staff gauge. The gauge will also reflect the maximum lake drawdown allowed, consistent with the proposed maximum level changes noted above. If a lake is found to have a level at or lower than the allowable drawdown level, water will not be extracted from it. Seasonal lake water levels will be recorded and reported to demonstrate that lakes are continually recharged and are not prone to significant drawdown from water extraction.

As for winter, water extraction will not exceed 275 m^3/day for any jurisdiction along the road.

1.4.10 Maps

Overview maps of the road alignment at a scale of 1:150,000 are provided in Appendix 1-1. These maps show km markers every 5 km, proposed camp locations and major stream crossings. Appendix 1-2 provides environmental/engineering alignment sheets at a scale of 1:10,000 which show key environmental and engineering data, with approximately 3.5 km of road per sheet.

1.4.11 Studies to Date

A listing of studies to date can be found in Appendix 1-14.

1.4.12 Liard River Crossing

Crossing of the Liard River represents an important consideration for mine operations as it constrains the ability to transport mineral concentrates to market and the delivery of supplies, including fuel for power generation. It is important to the operation to minimize the closure periods associated with the crossing. A conventional barge and ice bridge approach would mean approximately 2 months of crossing closure. As a result, CZN has investigated enhanced crossing options and has determined that use of a hoverbarge instead of a conventional barge will suitably address the crossing closure issue. Use of the hoverbarge is reflected in the sub-sections below.

Crossing Mode

The Liard River crossing mode in winter, from approximately January 15 until break-up, will be via a conventional ice bridge. During this period, the hoverbarge will be parked on the river bank and, for part of the time, will be undergoing annual maintenance.

From immediately after break-up until the ice bridge is open, the river will be crossed via the hoverbarge. The hoverbarge can operate in low water and during periods of thin ice on the river. This will reduce the crossing closure period to 1-2 weeks.

A hoverbarge floats on a cushion of air with a skirt in contact with the water or ground surface. A hovercraft is different in that the skirt is above the water and results in a considerable amount of spray. The hoverbarge being proposed is propelled by a winch and cables, much like a cable-stay ferry. This is also different from a hovercraft which is propelled by large onboard fans and travels freely. The winch cables are raised when the hoverbarge is in operation, and dropped to the river bed when other river traffic needs to travel upstream or downstream. A traffic light system will operate at the crossing for other river traffic, green for 'go' and red for 'stop'. This approach is consistent with Navigation Canada regulations. More information and graphics for the hoverbarge are provided in Appendix 1-15. The selected hoverbarge will have capacity to carry 2 loaded B-trains per crossing.

A video of hoverbarge operation on the Yukon River, Alaska in 1975 can be viewed here:

Hoverbarge video

Hoverbarges are in use in unique situations in Asia, however they might also be considered for other locations in northern Canada.

Landing and Staging Facilities

Hoverbarge landings will need to be constructed on both sides of the river. The hoverbarge is able to travel up the river bank, so the required landing ramps will be shorter than for a conventional barge. The hoverbarge requires anchors for the winch cables which would be located at the top of the north and south banks.

The landing area above the ramp on the south side would include a shop area for maintenance, loading ramps, small office space, generator, fuel storage, an open water season wheel wash and sufficient parking area. There will be staging areas on both sides of the river where B-trains can stop and un-hitch their trailers and re-hitch return trailers.

The crossing and staging areas will be the subject of water lot and staging areas leases, water lot leases for areas used below the ordinary high water mark (OHM), and staging areas leases for areas above the OHM. The leases also afford CZN the legal right to deny access to unauthorized persons, which CZN will adopt. Preliminary designs for the Liard River crossing areas can be viewed in Appendix 1-16. Landing areas are summarized below.

Liard Landing	Land Lease Area (ha)	Water Lease Area (ha)	Total Area (ha)
North	1.6	1.25	2.85
South	3.2	2.14	5.34
Total	**4.8**	**3.39**	**8.19**

1.4.13 Total Project Footprint

Table 1-20 summarizes the projected disturbance of all areas proposed for ASR construction and operations, including values from 2016 for comparison.

TABLE 1-20: PROJECT FOOTPRINT

Item	Disturbance Type	Area (Ha)		Duration (years)
		2016	2018	
ASR	Road right of way and prism.	371.9	367.6	Long Term
Borrow Pits	Extraction of borrow material for ASR construction and long term operations.	40.59	38.34	60% Short Term, balance Long Term
Borrow pit roads	Access	7.20	5.64	
Waste Pit	Cleared for the deposit of excess cut material	0.69	0.69	Short Term
Camps and Laydowns	Cleared staging/ landing to support construction.	21.0	17.4	Short Term
TTF	Transfer facility and small camp for concentrate hauling.	3.4	n/a	n/a
Liard Staging Areas – North and South	To support barge operations and required infrastructure.	3.0	4.8	Long Term
Liard Water Lot Areas – North and South	To support barge operations.	n/a	3.39	
TOTALS		**447.78**	**437.86**	

1.5 References

Tetra Tech EBA, 2015a. Geotechnical Evaluation and Developer's Assessment Report Sections for Proposed Prairie Creek All-Season Road, Near Nahanni Butte, Northwest Territories. Prepared for Canadian Zinc Corporation. March 2015. Tetra Tech EBA File: Y14103320.01-001.

Tetra Tech EBA, 2015b. Addendum and Progress Report to Address Adequacy Review of Developer's Assessment Report for Environmental Assessment, EA1415091, Proposed Prairie Creek All-Season Road to Prairie Creek Mine, NT. Prepared for Canadian Zinc Corporation. September 2015. Tetra Tech EBA File: Y14103320.01-003.

Tetra Tech EBA, 2015c. Mapping Summary Report, Proposed Prairie Creek Mine All-Season Road, Northwest Territories. Prepared for Canadian Zinc Corporation. December 2015. Tetra Tech EBA File: Y14103320.01-003.

Tetra Tech EBA, 2016a. Terrain Mapping, KP159 – 184, Proposed Prairie Creek All Season Road. Prepared for Canadian Zinc Corporation. March 2016. Tetra Tech EBA File: Y14103320.01-003.

Tetra Tech EBA, 2016b. Technical Memo No. 1, Magnitude/Frequency Analysis – Landslide Hazards, Proposed Prairie Creek All Season Road, NT. Prepared for Canadian Zinc Corporation. April 2016. Tetra Tech EBA File: Y14103320.01-006.

Tetra Tech EBA, 2016c. Technical Memo No. 5, Risk Analysis – Landslide Hazards, Proposed Prairie Creek Mine All-Season Road. Prepared for Canadian Zinc Corporation. May 2016. Tetra Tech EBA File: Y14103320.01-006.

Tetra Tech EBA, 2016d. Technical Memo No. 6, Discussion for Undertakings #36, 37, 40, and 44. Prepared for Canadian Zinc Corporation. July 2016. Tetra Tech EBA File: Y14103320.01-008.

2.0 UPDATED COMMITMENTS TABLE

An updated commitments table is provided as Table 2-1 in Appendix 2-1, using the requested format. The jurisdiction columns were merged into one to conserve space. The numbering system from REA Appendix C was maintained.

3.0 TECHNICAL PANEL TERMS OF REFERENCE

During the Public Hearing for EA1415-01, CZN committed to establish and fund an independent technical review panel (the Panel) to evaluate and approve final road design principles, since there were some disagreements relating to the risks to traffic and thus, the environment, which was not adequately resolved during the course of the EA. CZN provides this terms of reference for the Panel based on the requirements of Measure 5-1 from the REA.

3.1 Panel Mandate

The mandate of the Panel will be to provide independent expert advice and recommendations on the design and construction of the road to minimize: traffic related accidents, road failure or malfunctions, and any resulting significant adverse impacts on human safety or the environment.

The Panel will ensure that the road is designed and constructed to an appropriate standard that is highly protective of people and the environment, including consideration of:

- the number and type of mine and potential non-mine related vehicles expected to use the road;
- how passing will be managed on the single-lane road;
- human safety and minimizing traffic related accidents;
- permafrost degradation and potential impacts on water quality; and,
- appropriate road design criteria, including:
  - watercourse crossings;
  - right of way clearing width;
  - road alignment, grades, subgrade width, and road widening at curves;
  - cut and fill slopes and angles, slope stability; and
  - number of, and distance between, pullouts.

In addition to the above, the Panel will also consider any relevant information on the record from EA1415-01, information gathered as a result of relevant CZN commitments, and the requirements and outcomes of relevant REA Measures. This will notably include:

- an updated risk assessment;
- terrain stability assessment reports and any additional mitigation subsequently proposed to address any instability;
- avalanche related information;
- individual detailed borrow site plans and designs, to the extent necessary;
- planned geotechnical, geophysical, permafrost, and hydrological investigations;

- the Traffic Control Mitigation and Management Plan;
- relevant management plans and proposed mitigations;
- extreme weather events;
- climate change; and,
- karst features.

3.2 Panel composition

Measure 5-1 specifies that the Panel is to be comprised of at least three members who are professional engineers or geoscientists. The Panel is to have expertise in northern road design, including permafrost and mountainous terrain experience. Members of the Panel are to have knowledge and experience to appropriately address the mandate in Measure 5-1 part 2 and considerations in Measure 5-1 part 5.

CZN identified nine candidates for the panel positions. Table 3-1 provides a list of candidates and a summary of their main attributes. CV's are provided in Appendix 3-1.

CZN proposes to engage with Parks Canada, MVLWB, GNWT, NDDB and LKFN on the Panel composition and member selection. However, our initial observations are provided here along with our preliminary recommendations. These are based on a review of CV's. CZN does not know these individuals (except for Nick Bevington who worked on CZN's winter road briefly while at Earth Tech).

The nine candidates collectively have extensive northern experience, including in the desired technical areas of road design and construction in mountainous terrain and considering permafrost, and are all very qualified professionals. Some candidates can perhaps be excluded quite easily, John Murray for example due to the Allnorth conflict. David Watt, while having extensive resource road experience, is not a professional engineer or geoscientist. Ryan Weymark has northern construction experience, but seemingly not related to roads. Nick Bevington is evidently strong on bridge design, and has strong NWT experience, however bridge design is seemingly not a core experience required for the Panel, and other candidates likely have some of this experience. This leaves Messrs Salanski, Hartley, Oswell, Johnson and Smith. Any of these individuals appear to be suitable panel members.

It would seem that the core strength of messrs Salanski, Hartley and Johnson is civils and construction, and that they have comparable experience. Salanski's and Johnson's experience seems to be primarily northern Canada, with Salanski's being more in road engineering. However, Hartley may have other tools, such as geotechnical engineering and stream engineering. Oswell is evidently strong on geotechnical engineering and permafrost. Smith brings different attributes, such as slope stability and risk assessment, but also has geotechnical engineering in his tool box. Smith's northern BC experience is considered to be appropriate to the ASR as the ASR would be in terrain more similar to northern BC than other parts of the NWT.

Our preliminary recommendations for the three Panel members are Salanski, Oswell and Smith. Salanski addresses road design and construction, as does Oswell to some extent but his strength is in geotechnics and permafrost engineering. Both individuals likely also have stream crossings and engineering experience. Smith brings different but relevant abilities for mountainous terrain, but also has geotechnical experience.

3.2 Panel Activities and Timing

The panel will be established prior to detailed design of the road.

At a minimum, the Panel will complete the activities listed below. Measure 5-1 specifies the following activities for the Panel:

i. Prior to detailed design of the road:
   - review and comment on the Panel's terms of reference.

ii. During detailed design of the road:
   - work with CZN to review updated information, design plans, and detailed design work, including the terrain stability assessments undertaken for the proposed cut and fill slopes, and the developer's detailed interpretation of the permafrost conditions at the site upon completion of geotechnical site investigation work; and,
   - provide advice and recommendations for improving road design, following the mandate above, and considering construction, operations and maintenance, closure and reclamation, and temporary closure.

iii. Following detailed design of the road:
   - review the detailed design documents for the road;
   - provide a preliminary report to CZN on the Panel's findings and conclusions, including any additional or outstanding recommendations;
   - review CZN's response and justification for any recommendations the developer does not wish to follow;
   - prepare and submit a final report to CZN that includes the Panel's findings and conclusions on the final design.

iv. During construction:
   - work with the developer and regulatory authorities to determine the frequency and nature of the Panel's activities during construction (at a minimum, the Panel will be consulted and have the opportunity to revise its final report if any material changes to design are made following the Panel's report).

CZN is in general agreement with these activities, however we believe there are more steps to item iii in terms of a logical design and review process. We see the Panel providing their main report on their findings after detailed investigations have been completed and preliminary designs have been updated. Thereafter, detailed designs would be completed incorporating the findings of the Panel. The Panel would then review the detailed designs to confirm that their findings have been adequately incorporated, with adjustments as necessary.

Preliminary designs have been submitted with this UPD. Detailed geotechnical and permafrost investigations are required to validate these designs. A winter road is needed (the Phase 1 road) in order to provide access for a drilling rig and backhoe to complete these investigations. The Phase 1 road needs to be built on the ASR alignment as much as possible in order to investigate the ASR alignment. For the most part, typical winter road construction (a frozen mix of packed snow and water) will be possible, however there will be sections where non-typical winter road construction (cut and fill) will be required. CZN had provided preliminary designs for these sections in this UPD also.

CZN proposes the following steps for road construction including the Panel's review:

1. Appoint the Panel;
2. Panel reviews the terms of reference;
3. CZN provides an initial information package for Panel review including this UPD and the existing risk assessments and responses to them from the EA process;
4. Panel provides review comments on the non-typical winter road sections and related management and monitoring plans and adjustments are made as necessary;
5. Panel provides further comments and conclusions based on the initial information package submitted in 4;
6. The Phase 1 road is built and the geotechnical and permafrost investigations are completed;
7. CZN provides the ASR geotechnical investigation reports to the Panel along with any updates to the preliminary designs;
8. Panel completes its main review of the information, determines whether it needs to have a technical meeting or meetings with CZN to complete its review, and subsequently provides its review comments via a formal report;
9. CZN challenges or does not challenge the Panel's findings and resolutions are adopted as necessary;
10. CZN completes detailed designs and updates management and monitoring plans, as necessary, and submits them to the Panel and regulators for final approval (to facilitate the construction schedule, road sections required to be constructed first will be submitted for final review first);
11. Panel verifies that the detailed designs and revised plans meet their requirements and sign off for construction; and,
12. CZN builds the ASR and the Panel is consulted and has the opportunity to revise its final report if any circumstances are encountered necessitating material changes to the design.

Given that CZN hopes to build the Phase 1 road in Q1 2020, CZN proposes to complete the first three steps during the course of the ASR permitting process. We would hope that step four is completed in Q3 2019, or at the latest Q4 2019. We would also hope that step 5 is completed in Q4 2019 since it may have a bearing on the scope and content of the detailed field investigations.

Step 6 is then completed in Q1 2020. Steps 7-11 would be completed in Q2 and Q3 2020, although steps 10 and 11 would be completed for only those road sections planned to be constructed in Q4 2020. Steps 10 and 11 would be completed for the remaining road sections ahead of the intended construction date for each section. This will allow for sign-off on the detailed designs for road sections based on their construction sequence over a two-year period.

During the course of the permitting process, and as the steps above are contemplated, CZN will engage with Parks Canada, the MVLWB, the GNWT, NDDB, LKFN and DFN on Panel activities. Specifically, engagement with and comments from these noted parties are expected prior to or during the completion of steps 1, 3, 5, and 7-12. Regarding step 8, the Panel's report, CZN will provide the report to the parties for review and comment.

Further to the above engagement, CZN has committed to develop the ASR collaboratively with the NDDB and LKFN, and therefore, consistent with the contents of the EMA expected to be signed by the three groups, the groups will work collaboratively in connection with steps 3, 4, 7,

9, 10 and 12.

TABLE 3-1: PANEL CANDIDATES

Person	Qualifications	Expertise	Northern	Other
Daryl Salanski	P. Eng.	Civils and construction, including highways and resource roads	Alaska, Arctic, NWT and northern BC	
John Murray	P. Eng.	Civils and construction, including highways and resource roads	NWT, Yukon and northern BC	Allnorth conflict
Mike Hartley	P. E.	Civils and construction, including highways and resource roads, geotechnical, stream engineering	Alaska, Nunavut	
Nick Bevington	P. Eng.	Civils, construction, bridge engineering	NWT	CZN conflict (Earth Tech)
Jim Oswell	P. Eng.	Geotech., permafrost, road engineering	Alaska, NWT, northern BC	
David Watt	BSc Forestry	Resource roads	Northern BC	
Robert Johnson	P. Eng.	Civils and construction, some resource roads, geotech.	Nunavut, NWT, Kyrgyzstan	
Ryan Weymark	P. Eng.	Civils and construction	Alaska, northern BC	
Tim Smith	P. Geo.	Landslides, slopes, risk, geotech., some resource roads	Northern BC, Yukon	

4.0 TRAFFIC CONTROL MITIGATION AND MANAGEMENT

A draft Traffic Control Mitigation and Management Plan is provided in Appendix 4-1. A summary follows.

The Traffic Control Mitigation and Management Plan (TCMMP) serves to set forth safe operating procedures for managing mine and non-mine traffic on the Prairie Creek All Season Road (ASR) and initial winter roads, and to ensure the safety of all road users and the general public while minimizing potential risk to the environment. The Construction Project Manager (CPM) will be responsible to implement and monitor the use of this plan during the construction of initial winter roads and ASR. The Road Operations Manager (ROM) will assume implementation and monitoring responsibilities associated with the ASR operation and Closure and Reclamation Plan. All managers will ensure that this plan is incorporated appropriately within the Site Orientation given to all employees, contractors and visitors that will use the ASR.

The TCMMP provides procedures for traffic control and monitoring over all phases of the Mine Project. This includes:

1. Construction Phase 1 - Winter Road Construction and Operation: Construct a winter road on the ASR alignment right-of-way (ROW) to support required

geotechnical investigation and future ASR construction;
2. Construction Phase 2 – ASR Construction: Re-construct the Phase 1 winter road and commence ASR construction, to be completed over two further years;
3. ASR Operation: Includes loaded concentrate transportation, the transportation of consumable materials and supplies to support mine operations, and road maintenance; and
4. Closure and Reclamation.

The main objective of the TCMMP is to ensure the transportation of goods, services, and materials along the Prairie Creek ASR is conducted in a safe, efficient, and courteous manner to ensure the protection of people, the environment, and wildlife. The TCMMP is intended to address 5 key areas that are related to traffic control on the ASR. These 5 areas are:

- Nature of Mine Traffic;
- Road Operating Conditions;
- Hazards;
- Daily Road Use; and
- Access Control, Tracking, Communications and Monitoring.

Nature of Mine Traffic

During ASR construction, there will be winter traffic to/from the Mine as well as construction deliveries for 3 winters before the ASR is operational. ASR Operations will extend from the completion of the ASR construction over the currently projected mine life of 15 years. The estimated number of round trips per day during normal operational periods is 26-32 vehicles.

Road Operating Conditions

These are the planned road operating conditions relating to safety of the mine trucks and drivers using the ASR. Speed limits will be posted along the ASR and enforced. Maximum speed limits will be posted for optimum driving conditions. Employees will be required to drive to road conditions and not endanger themselves or others in inclement weather or adverse driving conditions. Temporary emergency shelters will be maintained at the maintenance camps at KP 42, 87, and 121, in the event of unscheduled road closures. To ensure mine trucks remain in safe operating condition, a pre-trip inspection will be performed daily. Each vehicle will be equipped with a logbook to record inspections and regular maintenance. All vehicle operators will have a valid Driver's License appropriate for the vehicle under their operation, and have received the appropriate orientation and training prior to road use. A daily tailgate meeting will be held prior to hauls commencing. Drivers will be informed of present road conditions, potential hazards, and have an opportunity to express safety concerns.

Hazards

Potential hazards that may pose a risk to traffic on the ASR include avalanches and rock falls in mountainous terrain, forest fires and wildlife. The occurrences of hazards will be monitored and traffic advised and/or adjusted accordingly.

Daily Road Use

For ASR operations after ASR construction, CZN will adopt a journey management system (JMS) which will be overseen by a JMS Coordinator (JMSC). All users of the ASR will be required to check in with the JMS Coordinator prior to using the ASR. The JMSC will be responsible for ensuring procedures are followed, and managing the daily mine haul. Prior to the daily haul commencing, maintenance crews and environmental monitors (EM's) will leave first to check road conditions and advise the JMSC. The shorter haul periods for the initial winter roads will be coordinated by Liard River checkpoint and Mine site staff, liaising with the CPM.

Access Control, Tracking, Communications and Monitoring

Access control will be adopted on the winter and all season roads to promote safety and minimize hunting pressures.

All concentrate trucks will be equipped with a Global Positioning System (GPS) tracking device and a two-way radio to assist with communications and monitoring. Locations and speeds will be monitored by the JMSC. For all other authorized ASR mine traffic, GPS tracking devices and radios will be provided to these vehicles at the security checkpoint for their safety and to operate within the radio protocol procedures. Other potential industrial users will require a road use agreement with CZN which must comply with this TCMMP. The radios will be used to coordinate passing using the pullouts. Radios will also be employed on the initial winter roads.

Public travel will be discouraged by enforcing non-entrance to CZN's leases covering the ASR on both sides of the Liard River, only providing barge use to mine traffic in summer, and operating the security checkpoint on the road north of the Liard River crossing. If unauthorized vehicles persist in using the road, checkpoint staff will try to provide GPS tracking devices and radios. Failing that, and in any event, unauthorized vehicles will be tracked by cameras and/or EM's assigned to 'shadow' them. When the checkpoint is not in operation, motion-sensing cameras with detection relay will be used to relay the alarm.

Incident Response

Incident response actions are as follows:

Emergency Situation

- Secure the area if unsafe;
- Contact the JMSC or other representative;
- If trained, apply first aid measures if injuries are incurred;
- In the event of a spill, follow the approved Spill Contingency Plan; and
- Record incident details when site and situation is under control.

Non-Emergency / Unsafe Acts

- Report vehicle collisions or near misses involving single vehicles, multiple vehicles or wildlife;
- Report evidence of unauthorized access to the ASR by a vehicle; and
- Report evidence of unauthorized hunting, fishing, trapping or any other prohibited activity in the ASR.

Adaptive Management

This Plan will be adjusted as necessary based on operating experience to promote safety, access control and wildlife protection. All near misses and incidents will be investigated appropriately to determine root cause(s). The investigations will make recommendations in an effort to eliminate future similar incidents. The TCMMP is a living document and the ROM will ensure that the plan is reviewed and updated on an annual basis.

5.0 WILDLIFE

5.1 Baseline Data

Applicable wildlife and wildlife habitat baseline surveys have been completed for the Mine and winter road (EA08-09-002) and the all-season access road (EA1415-01) environmental assessments. Baseline surveys completed for the Mine and winter access road specifically targeted Northern Mountain and Boreal Caribou, and summarized the Mine's wildlife observation logs, which provided context for seasonal species distribution and abundance from 2001 to 2007. Baseline surveys completed for the All-season access road targeted birds, collared pika, black bear habitat suitability models, and beaver. Additional baseline surveys (EBA 2009; 2010) were also completed that report wildlife observations.

Below is a brief summary of the baseline data collected to date and proposed surveys from 2019 to 2021:

Northern Mountain and Boreal Caribou (Chillborne 2007; Golder 2014a; 2014b) baseline collected to date:

- A single aerial survey completed in April 2007 along the entire 1980s winter road and proposed winter alignment. Five caribou were observed near the Ram Plateau area and tracks were observed in the Tetcela River drainage and east of Nahanni Range along the 1980s winter road. Eight moose were observed between the Mine and Tetcela River drainage, and two sheep near approximately Km 16.
- A total of 8, multi-day, aerial caribou surveys completed between December 1 to March 31 (2010 and 2014) along the entire Access Road from the Mine to Nahanni Butte access road. Results from the aerial surveys were used to develop a Resource Selection Function and occupancy models for the winter period.
- One caribou pellet survey along 139 transects perpendicular to the proposed winter road and caribou occupancy model during the snow-free period. Study area was from the Mine to the Grainger Gap.
- During the aerial surveys, caribou were observed in 15-20% of the entire Access Road, primarily in the Tetcela River drainage, Prairie Creek, and Sundog Creek areas. A single visual observation of Boreal Caribou was recorded during the eight aerial surveys.
- Based on the model results:
    - Caribou winter occupancy was predicted in the Sundog Creek drainage and near the Mine site. Areas with the lowest predicted occupancy was throughout the Boreal Caribou range, with exception in the Tetcela River

and Silent Hills.
    - Caribou occupancy in the snow-free period was predicted in the western portion of the Access Road from Km 0-10, and a portion of the Sundog Creek drainage, portion of the Ram Plateau, and the Silent Hills (total of 26% of the entire study area).

Additional baseline mountain and boreal caribou surveys are proposed in 2019, continuing into 2020 and 2021. All baseline survey methods will be developed in consultation with Parks Canada and GWNT and will be designed to support future monitoring plans outlined in the WMMP. Prior to conducting baseline caribou surveys, CZN will correlate the existing caribou occupancy models with Parks Canada's collaring data. A collated map representing all baseline caribou empirical data collected to date along the access road will be developed. Anecdotally, the collaring data provided to CZN to date, appears to be consistent with the caribou occupancy models and indicates higher likelihood of caribou occurrence in the Sundog Creek drainage and in the Mackenzie Mountains near the Mine Site. However, access to the complete collaring dataset will be requested from Parks Canada.

In addition, systematic aerial baseline boreal and mountain caribou surveys are proposed in March 2019. Forest dwelling caribou are difficult to locate during the non-winter period. A March survey is recommended to improve caribou detection. March is also a period when caribou are less sensitive to disturbance, move around less, and is when ENR typically conducts their boreal caribou surveys. March baseline aerial surveys were completed in 2014 along the entire access road corridor. Caribou observations from these surveys will be integrated into the collated caribou occupancy map.

In 2020 and or 2021, a remote camera baseline mountain caribou program is proposed along and near the access road (during initial construction, i.e., cleared right-of-way). This camera survey would follow similar methods outlined by Parks Canada, form the baseline for CZN's caribou monitoring program (also using remote cameras; refer to WMMP), and would help finalize methods and data analyses prior to monitoring. Baseline survey methods will be developed in consultation with Parks Canada and GNWT. Stratified sampling along the access road is proposed based on the collated caribou occupancy map.

Baseline camera surveys are not currently proposed within boreal caribou range since previous baseline surveys have detected very few boreal caribou. During the eight, multi-day, aerial caribou surveys conducted from 2010 and 2014, a caribou track was observed in February 2011 and one visual observation in 2014 within boreal caribou range. A baseline camera survey may be considered following the results of the 2019 aerial survey.

Collared Pika (Tetra Tech 2016; 2018):

- In July 2016, presence/absence surveys were completed at proposed borrow sources from Km 32-38.5 and Borrow Sources 14 and 16. Survey methods followed the British Columbia Resource Inventory Committee's methods for pikas and sciurids. Pikas were currently occupying Borrow Sources 33 and 34, and evidence of past use at Borrow Source 38 and 16.
- In August 2017, pika occupancy and distribution surveys were completed in all suitable talus habitat within 300 m of the Access Road and borrow sources from Km 12-39. Survey methods were developed in consultation with Parks Canada and GNWT.

- 38 talus sites were assessed as potentially suitable for pika;
  - Collared pika were currently present in 26% of suitable pika habitat (or 10 talus sites) and evidence suggested past pika use in additional talus sites;
  - Active pika use was detected at Km 15, 18, 26, 32, and 34, and ranged from 7-244 m away from the proposed Access Road and 0-2,054 m from the nearest proposed borrow sources.
  - Pikas continued to occupy Borrow Sources 33 and 34 (also reported in 2016).

Baseline collared pika surveys may occur prior to or during road construction, as required based on the construction schedule. Baseline pika surveys would follow similar baseline methods employed in 2017, which were developed in consultation with Parks Canada and GNWT, and follow methods outlined in CZN's WMMP. The survey objective would be to identify pika presence at or near proposed construction sites, including borrow sources, prior to construction.

Breeding Birds (Tetra Tech 2018):

- 80 Autonomous Recording Units (ARUs) were deployed throughout the bird nesting period (late-May to mid-August) to and followed methods developed in consultation with ECCC and Parks Canada.
- Five bird species at risk were present along the Access Road: Trumpeter Swan, Common Nighthawk, Olive-sided Flycatcher, Bank Swallow, and Canada Warbler.
  - 57% of the ARUs detected Common Nighthawks. Detections were mostly between Km 39-63 and Km 112-143. A detection at Km 7 was also recorded.
  - 14% of the ARUs detected Olive-sided Flycatchers. Detections were mostly in open coniferous habitats.
  - 3.8% of the ARUs detected Bank Swallows. Detections were at Km 57, 95, and 112.
  - 12.8% of the ARUs detected Canada Warbler (or 10 ARU stations). Detections were within the Silent Hills and from Km 140-Liard River.
- Bird species at risk that are dependent upon wetland habitats (i.e., Yellow Rail, Horned Grebe, Red-necked Phalarope) were not detected.
- Most common species were Swainson's Thrush, Tennessee Warbler, White-throated Sparrow, and Chipping Sparrow; representative of coniferous and mixed-forest habitats.
- The least common species were those that favour wetland and lakeshore habitats, such as Sandhill Crane, American Bittern, and Common Loon.
- Additional analyses following ECCC draft guidelines remains to be completed.

Trumpeter Swan (Tetra Tech 2016; 2018):

- Aerial presence in Fishtrap Creek and Tetcela River drainages in July 2016. Survey methods followed the British Columbia Resource Inventory Committee's methods for waterfowl and allied species.
- A total of 14 Trumpeter Swans (including 8 adults and 6 cygnets) were observed during the survey and additional swans were recorded incidentally. Swans were present in the wetland complex of Fishtrap Creek and east of Silent Hills, as well as a pond at Km 143.
- A total of 5 Trumpeter Swans were also detected in the Autonomous Recording

Units deployed in 2017 near the Fishtrap Creek area.

Peregrine Falcon (Tetra Tech 2016):

- An aerial scrape survey in Sundog Creek area where cliff-nesting habitat is in proximity to proposed road construction (Km 34-38) was completed in July 2016.
- One large inactive stick nest (likely once occupied by a Golden Eagle) was observed.

Harlequin Duck (Tetra Tech 2016):

- An aerial survey along the Sundog, Fast/Funeral, and Prairie creeks in July 2016. Survey methods followed the British Columbia Resource Inventory Committee's protocol for riverine birds (Harlequin Duck, Belted Kingfisher, and American Dipper).
- No Harlequin Ducks were observed during the aerial survey; however, the pilot had reported observing an unknown duck species diving into Sundog Creek near Km 28.5 several days prior.

Black Bear (Tetra Tech 2016):

- Black Bear habitat suitability models for food, security, and denning habitat within 6 km of the proposed all-season road were completed in 2016 based on field evidence of black bear use of various habitat types and literature review. A total of 27 detailed 100 m transects and three 20 m radius visual plots were surveyed.
- Field evidence of black bear was most common in Mixedwood Open, Mixedwood Dense, Shrub-tall, and Shrub-low (including riparian floodplain) habitat types.
- Based on the model results:
  - High quality feeding habitat was predicted mostly from the Tetcela River area to the Liard Highway;
  - High quality security habitat was predicted east of the burn areas (east of Km 60) to the Liard Highway; and
  - High quality denning habitat was common along the length of the proposed Access Road, with exception at the large lowland complexes in Fishtrap Creek and east of the Silent Hills.

Beaver (Tetra Tech 2016):

- Aerial reconnaissance survey to determine presence in relation to the proposed Access Road. Beaver dams and lodges were recorded.
- A total of 37 beaver observations were recorded along the proposed Access Road, primarily within and near the wetland complexes of Fishtrap Creek and east of Silent Hills.

Western Toad Breeding Pond:

CZN committed to conducting a western toad breeding pond survey along the access road south of the Liard River to determine if the species is present, and if so, the species distribution before or in the early construction phase (before any non-winter traffic occurs). The breeding pond baseline survey is described in CZN's WMMP as part of the pre-construction mitigation monitoring program (refer to CZN's WMMP).

A western toad baseline survey is proposed following the GNWT's eDNA survey methods to determine western toad presence and distribution by simply collecting and analyzing water samples. The baseline survey, and survey methods, are to be completed in collaboration with the GNWT. Additional baseline, access road mitigation, and or monitoring will be considered depending on the results of the baseline survey.

Dall's Sheep and Lambing:

Dall's sheep and lambing baseline aerial and ground-based reconnaissance surveys are outlined in CZN's WMMP, and methods will be developed in consultation with Parks Canada and GNWT and may follow methods previously used by Larter and Allaire (2005). The objective of these surveys is to identify sheep distribution and habitat use during the lambing period within a 5 km radius of the Mine, airstrip, and airstrip approach, and determine the timing of lambing and location of specific lambing areas.

The baseline program is to begin by delineating potential lambing areas within the survey area based on contour mapping, literature review, and previous sheep observations. An aerial reconnaissance survey using a spaghetti-type survey technique within all potential delineated lambing areas is to be completed during the parturition period to document sheep distribution and habitat use. An additional ground-based reconnaissance survey (less disturbing to sheep than aerial survey) is proposed, after the aerial reconnaissance, to further document age and sex classification (i.e., lambs) and habitat use within the potential lambing areas. If lambing is identified near the Mine, airstrip, and airstrip approach, additional mitigation and behavioural monitoring surveys (during Mine operation, outlined in CZN's WMMP) will be considered.

Measure 6-1, Part 2 (Caribou, Collared Pikas and Bird Species Baseline)

The above description confirms that additional baseline data for collared pika and bird species at risk have been collected already. These surveys were completed following development of survey plans in consultation with Parks Canada, the GNWT and Environment and Climate Change Canada, and the surveys included NDDB representatives. Tetra Tech's data report can be found in Appendix 5-1.

5.2 Management and Monitoring Plan

A draft Wildlife Management and Monitoring Plan (WMMP) is provided in Appendix 5-2. The WMMP addresses Measure 6-1 part 3, 6-2 part 3, 6-3 and ENR's WMMP guidelines. Regarding annual reports and sharing results with Indigenous groups, this is part of the WMMP but will also be part of CZN's Environmental Management Agreement with NDDB and LKFN and commitments regarding Technical Advisory Committee meetings (see Section 7). A summary of the WMMP follows.

The WMMP describes the methods of mitigation, monitoring, and adaptive management responses that will be used to comply with all commitments and regulatory requirements. The Plan outlines the potential effects the Project (Mine and Access Road) could have on wildlife and wildlife habitat and the types of mitigation measures that will be implemented to avoid or minimize such effects. The main goal of the WMMP is to reduce the risk of any impacts occurring to wildlife and wildlife habitat, and where unavoidable, to reduce the severity of impacts.

The Prairie Creek Mine and Access Road are located in the southern Mackenzie Mountains; an area characterized by stunted spruce with limited undergrowth and open areas dominated by

lichen. The Access Road crosses 85 km of the Nahanni National Park Reserve. From the Mine, the Access Road climbs through the Alpine to a summit of 1,530 m and then decreases in elevation as it passes through a spruce-lichen Alpine forest zone like that found at the Mine site and then into Riparian Alluvial habitat in the Sundog tributary valley bottom. The Access Road then traverses mixed coniferous/deciduous closed forest, muskeg and open shrub/sedge wetland at the headwaters of Fishtrap Creek, and eventually climbs over the Silent Hills, a closed mixed coniferous/deciduous forest. The road then skirts and crosses wetlands adjacent to the Grainger River headwaters, continues through the Grainger Gap in the Nahanni Range, and turns south along the foothills of the Range to Nahanni Butte, avoiding the Grainger Till plain.

These habitats are occupied by important harvested species and Species at Risk. Across the Dehcho region, the Species at Risk Committee (2012) have reported habitat to be nearly unchanged since the 1970s. Traditional knowledge studies conducted by the Species at Risk Committee (2012) and the Dehcho Land Use Planning Committee (ND) have reported relatively intact wildlife habitat throughout the region.

CZN recognizes the importance of wildlife and wildlife habitat values at and near the Project. CZN's protective measures, used to avoid wildlife and wildlife habitat effects, are considered the primary means of mitigation. Mitigation is designed to avoid and/or minimize effects to wildlife and wildlife habitat from the Mine and Access Road, to the extent possible and to within an acceptable level. CZN will maintain Standard Operating Procedures (SOP's), Best Management Practices (BMP's), and Project-specific mitigation approaches to achieve these overall objectives, and update mitigation following the principles of adaptive management. The WMMP lists these protective measures and outlines Project effects on wildlife and wildlife habitat that could include:

- Habitat loss and alteration;
- Wildlife mortality and harm; and
- Wildlife disturbances (i.e., changes to local wildlife abundance, movement).

Project mitigation will include training and educating all employees, contractors, and visitors of their responsibilities concerning wildlife and wildlife habitat protection. To ensure that measures are in place to mitigate effects, the WMMP details the roles of the Site Superintendent and Environmental Monitors, who will be responsible for the management and implementation of project commitments, regulatory requirements and permit conditions, mitigation, and monitoring programs. The WMMP also details the roles that all employees, contractors, and visitors will play in ensuring that all commitments are followed. A Technical Advisory Committee will help to review and address concerns that may arise during the implementation of the WMMP for the life of the Project.

CZN has had the opportunity to hear from the territorial and federal regulators and the First Nations stakeholders of the region during environmental assessment and permitting and has compiled a list of commitments to address their concerns regarding the Project.

Some of the commitments included the collection of additional baseline data. CZN proposes baseline aerial Northern Mountain and Boreal Caribou surveys in 2019 (e.g., late February to March) and will be repeated over time during road operation as part of the monitoring programs. Over time, the aerial caribou surveys will be used to evaluate the effects predictions and better inform Access Road mitigation. Other baseline surveys for Collared Pika and breeding birds were conducted in 2017 to identify species distribution and relative abundance. Methods employed during the baseline surveys were developed in consultation with regulators and will continue for

future effects monitoring.

Despite adherence to mitigation, some effects on wildlife and wildlife habitat may still occur. CZN's monitoring programs will be used to test mitigation effectiveness and effect predictions made during the environmental assessment process, and better inform how adaptive management will best manage wildlife effects. The WMMP describes two types of monitoring programs:

1. Mitigation Monitoring:

The active collection of data necessary to carry out mitigation or to verify the effectiveness of mitigation, with a focus on areas where mitigation is needed and where failed mitigation has a higher risk to wildlife and wildlife habitat. Mitigation monitoring will focus on the following: − Bear den surveys prior to clearing

- Collared Pika surveys prior to construction
- Harlequin Duck surveys prior to construction
- Peregrine Falcon nest surveys prior to construction
- Western Toad breeding pond surveys prior to full construction
- Pre-blast surveys prior to blasting and crushing
- Mitigation audit for all Project phases
- Wildlife Observation and Incidents log reporting and analysis for all Project phases

2. Effects Monitoring:

The collection of data for analyses to detect change as a result of the Project. This monitoring goes beyond the Project activity or footprint and looks for potential effects that cannot be fully mitigated, or addresses concerns identified by regulators and or First Nations stakeholders. Effects monitoring will focus on the following:

- Effects due to traffic levels
- Effects from wildlife harvesting
- Effects on Dall's Sheep and lambing areas
- Effects on Northern Mountain Caribou abundance and distribution
- Effects on Boreal Caribou abundance and distribution
- Effects on Collared Pika presence
- Effects on Migratory Bird species densities

Monitoring begins during the pre-construction phase and continues from construction through operations to closure of the Mine and Access Road. Monitoring is completed on aspects of the Project with the greatest risk to wildlife and wildlife habitat mortality (e.g., traffic level effects, harvesting effects, Western Toad breeding pond mitigation, bear den mitigation), higher levels of disturbance (e.g., pre-blast monitoring, Collared Pika mitigation and effects monitoring, Dall's Sheep lambing effects), and of regulator and or First Nations concerns (e.g., migratory bird, Boreal Caribou, Northern Mountain Caribou effects).

The WMMP outlines a process of adaptive management by continually learning and improving mitigation and monitoring. The policies and management practices described in this draft Plan have been developed based on existing CZN and other northern project SOPs and BMPs. CZN will use the information gained through the implementation of the WMMP to evaluate the success of wildlife and wildlife habitat mitigation measures implemented during all phases of the Project,

and work to continuously improve management practices throughout the life of the Project.

The wildlife monitoring procedures and on-site mitigation measures will be evaluated regularly and reviewed with Parks Canada, Environment and Natural Resources, Environment and Climate Change Canada, and First Nations, as appropriate. Recommendations for improvement based on science, local and traditional knowledge, newly listed species at risk, and lessons learned from the Project and others will be incorporated into subsequent editions of the WMMP.

Regular reporting and analysis of the wildlife mitigations and monitoring programs are a component of the adaptive management process, whereby the data are analyzed for issues or potential problems, such as seasonal concentration areas or sections along the Access Road that have a higher risk of incidences or near miss occurrences. Results of these analyses will contribute to annual summary reports and comprehensive reports every five years. The annual summary reports will be provided to regulators and First Nations groups. CZN will also present the results during one of the proposed Technical Advisory Committee meetings, which will involve regulators and First Nations groups. The reports will be submitted to solicit review of the effectiveness of mitigation measures and, following discussion in Technical Advisory Committee meetings, to suggest modifications to mitigation and monitoring plans, as necessary.

This WMMP is a living management plan that will be updated throughout the life of the Mine and Access Road. It will be adapted to include any lessons learned (in terms of the Project, traditional knowledge, and recent technologies) that will be gained in the coming years.

6.0 SURFACE WATER

Section 6 of the Post-EA Information Package provides Surface Water information identified in Schedule 1, Part VI, of the MVLWB/Parks October 9, 2018 Submission Requirements letter to CZN. The information requested includes references to the REA.

Part VI includes four sub-items, a through d, which correspond to REA Measure 8-1 Parts 2 through 5 involving water baseline data, mitigation, monitoring, and adaptive management respectively.

6.1 Baseline Data

Information Request Part VI.a. states*: Measure 8-1, Part 2 – Provide plans for collecting baseline data in accordance with Measure 8-1, Part 2* (from the REA) which reads:

CanZinc will collect baseline data necessary to enable the design, construction, and maintenance of watercourse crossings that are protective of the environment and inform future monitoring. CanZinc will install hydrometric stations and use the resulting data in its road and crossing designs. These stations will measure continuous streamflow data during the open water season and instantaneous flow measurements during the ice-covered period for a minimum of one year prior to construction of watercourse crossings. The stations will be established to:

i. characterize spatial variability;
ii. characterize variability in watershed size;
iii. measure conditions at Sundog Creek and other key locations[1] (to be determined in consultation with regulators); and,
iv. *provide locations for ongoing monitoring during operations*.

The measure also specifies that a minimum of one year of data is to be collected prior to construction, will continue into construction, and that CZN work with Parks Canada, DFO and MVLWB to determine what, if any, additional baseline data is required. *The footnote to "other key locations" reads "Such as Casket Creek (km 6.2), Grainger River (km 124.8), and the tributary of Grainger River preferred alignment option (km 118.1)."*

Hydrology baseline monitoring will include ongoing operation of Water Survey of Canada (WSC) stream gauging station 10EC003 on Prairie Creek at the Mine[1], established in October 2013, plus three new stream gauging stations installed and operated by WSC on Sundog Creek, Tetcela River, and Grainger River. All four stations are being funded by CZN and the three new stations were selected considering REA Measure 8-1 Part 2 suggested station locations and specified objectives regarding spatial variability and variability in watershed size. **Error! Reference source not found.** shows the tributary basins draining to the four CZN-funded WSC gauges along the mine access road.

Additional challenges for Casket Creek and the Grainger River tributary are that the streams have split flows during flood events. Casket Creek occupies an alluvial fan, with distributed flows as shown in Figure 6-2 below. The Grainger Creek tributary shown in Figure 6-3 appears to flow very infrequently and have multiple channels over a wide unvegetated alluvial floodplain in which channel shifting is possible. It would be difficult at either site to accurately measure flood flow discharges which occupy multiple channels.

The stream gauges on Sundog Creek, Tetcela River and Grainger River were initially installed in 2018, including real-time telemetry for the Tetcela and Grainger River sites. The Sundog Creek station was initially installed at about KP 35 just upstream of the proposed diversion, but was subsequently moved upstream (at the suggestion of WSC) to be in a reach containing continuous flow. After further consideration with CZN, it was decided that the station should be returned to KP 35 since, even if the station reports zero flow, this is useful data, and the object is to obtain data indicative of the diversion reach. Locating the gauge at the upstream location may not satisfy the Review Board requirement for installation of a stream gauge at the Sundog Diversion. As of November 2018, the plan is to re-install the station in proximity to KP 35 in April 2019, with the understanding that there will periodically be intermittent flows. The following is an excerpt from a Nov 15, 2018 email message from Water Survey of Canada regarding this site:

"We did stop near km 35 in July but the flow varied from 0 to about 0.3 m^3/s within a few hundred metres. The flow was discontinuous/variable for several kilomteres extending down to at least Cat Camp. "Challenging" is the word I'm going to use in reference to gauging this station anywhere."

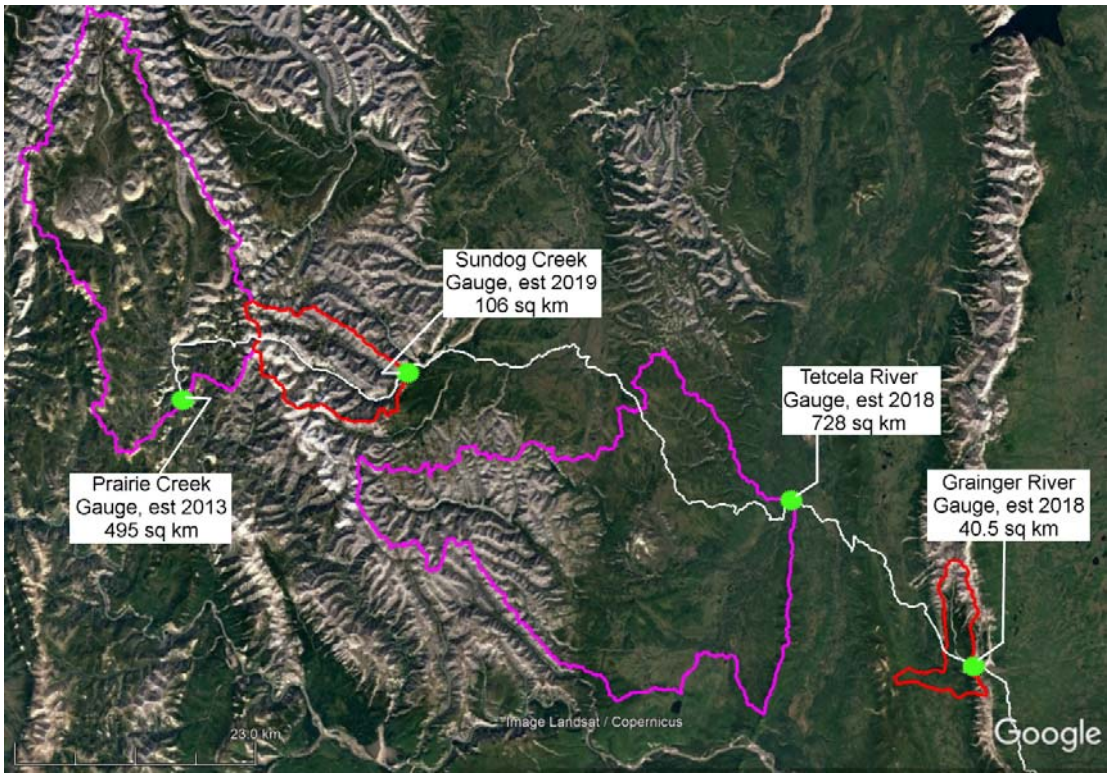


FIGURE 6-1: CZN STREAM GAUGE NETWORK

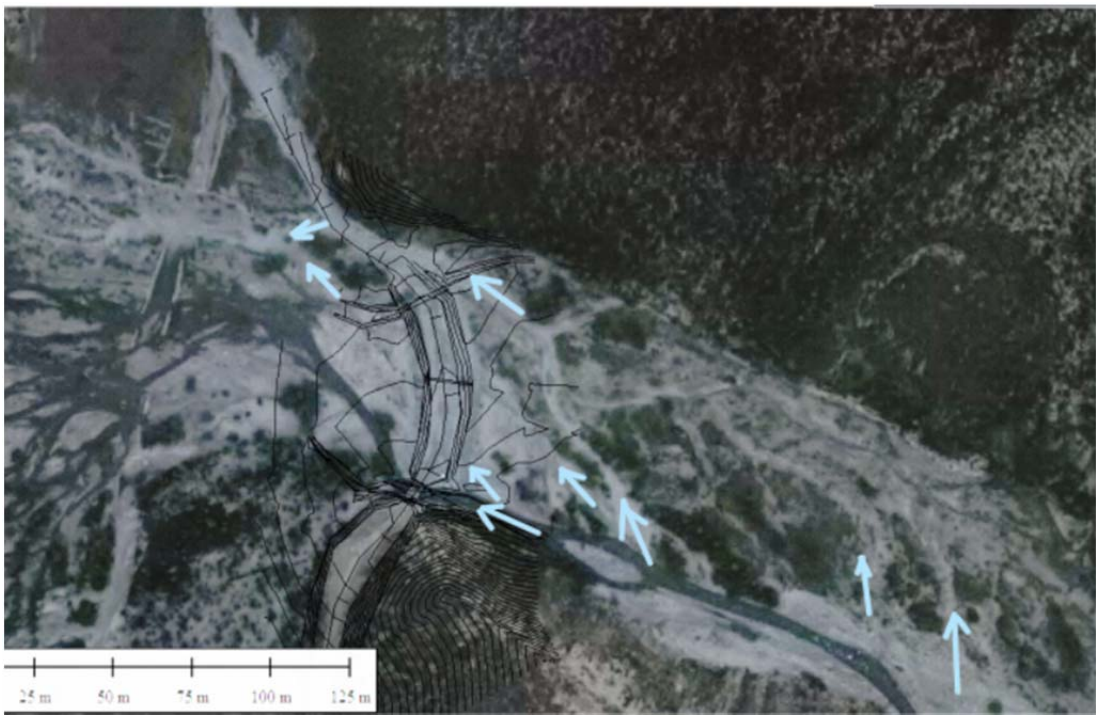


FIGURE 6-2: CASKET CREEK (KP 6.2) MULTIPLE POSSIBLE FLOW PATHS IN ALLUVIAL FLOODPLAIN

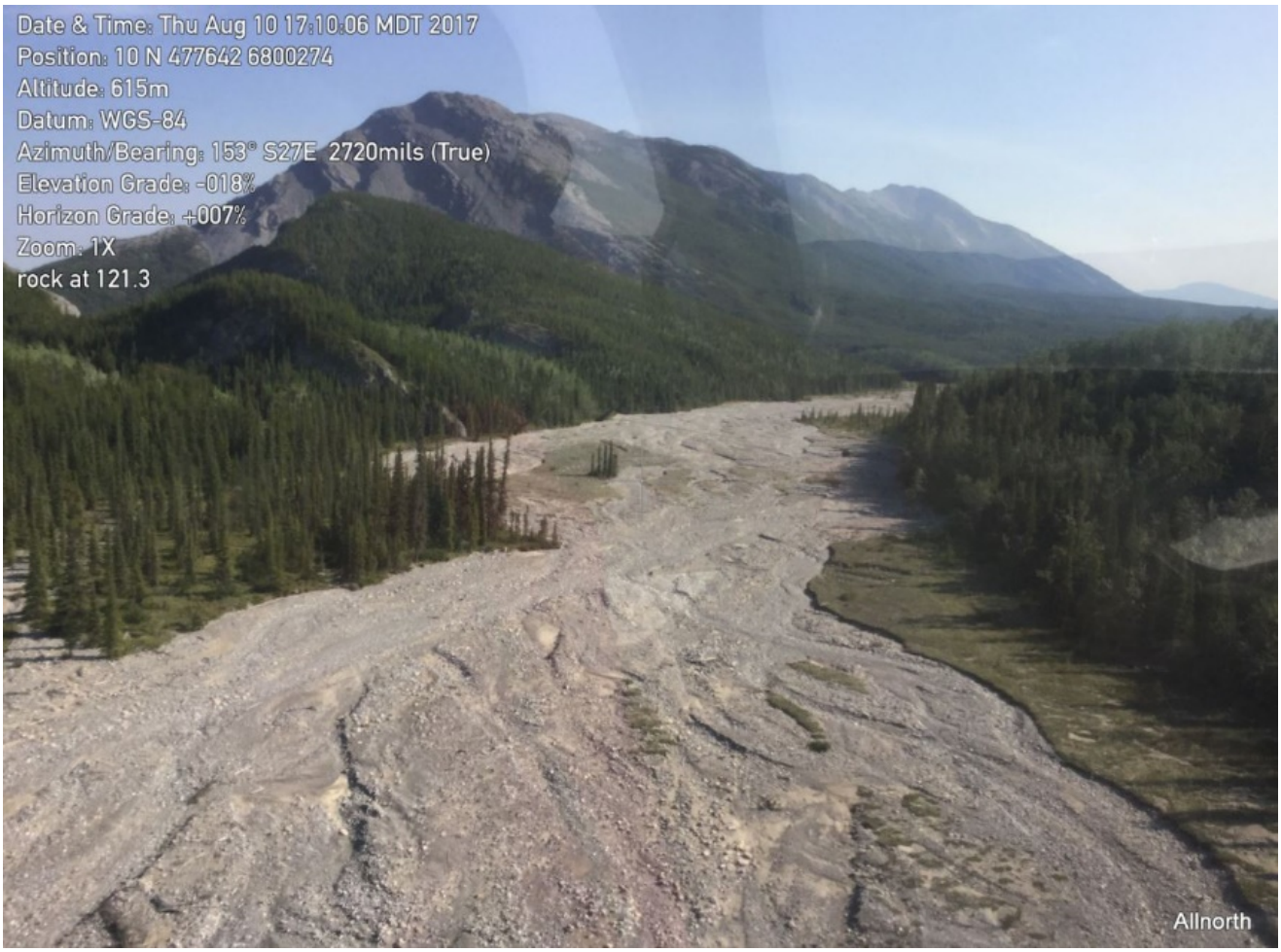


FIGURE 6-3: GRAINGER RIVER TRIBUTARY (KP 118) BRAIDED CHANNELS IN ALLUVIAL FLOODPLAIN

6.2 Mitigation of Impacts

Information Request Part VI.b. states*: Measure 8-1, Part 3 – Discuss how CZN intends to use baseline data collected in accordance with Measure 8-1, Part 2, to determine appropriate mitigation of potential impacts.* Measure 8-1, Part 3 (from the REA) is as follows: *CanZinc will use the baseline data collected, as well as any other relevant information and best management practices, to determine appropriate mitigation prior to construction and to revise detailed design plans for watercourse crossings. The developer will share the baseline data with all relevant regulatory authorities and the independent panel (Measure 5-1) to facilitate Project review, permitting, and licensing.*

Design phase mitigation of potential impacts from watercourse crossings has been accomplished by: (1) specifying bridges and culverts at locations that will minimize alteration of natural flow patterns and are sized to accommodate design flows; and (2) specifying best management practice erosion and sediment controls to be implemented during project construction and operation phases.

A 100-year return period is used for design flows along the CZN access road; this is consistent with the bridge design flows typically used in most Canadian provinces for "major" highways and bridges, and more conservative than the 50-year return period flow typically used for bridges on secondary highways. For resource roads, British Columbia Forest Planning and Practices Regulations require a 50-year return period peak flow for bridges that will remain on site from 3 to 15 years, and a 100-year peak flow for bridges to remain on site for over 15 years. The Canadian Highway Bridge Design Code (Canadian Standards Association Publication S6-14) specifies that the normal design flood shall have a return period of 50 years unless otherwise specified by the Regulatory Authority.

Erosion and sediment control is described separately in Section 14. The remainder of this section presents an overview of mitigation-by-design methods used to design watercourse crossings, followed by a discussion of the suitability of the regional analysis method used to establish reasonable and/or conservative estimates of 100-year design discharges for the major crossings.

Crossings of large streams with fish utilization requiring the greatest level of mitigation are designed as bridges sized to accommodate 100-year flows determined by a regional analysis of WSC stream gauge peak flow records. Hydraulic analyses of bridge crossings to determine design water levels and velocities were done with one dimensional HEC-RAS hydraulic models of existing and proposed (with bridge) conditions. The proposed Sundog Creek Diversion is being designed with two dimensional HEC-RAS hydraulic models to assess water levels and velocities for regional analysis 2-year and 100-year flows. Additional information on design, monitoring, and mitigation for the proposed Sundog Creek Diversion is provided in Section 26 and Appendix 26-1.

At large streams without fish utilization, culverts are sized to accommodate 100-year regional analysis flows, with a cross-check made using the Alberta Transportation's (AT) Hydrotechnical Design Guidelines for Stream Crossings[2] and companion Channel Capacity Calculator[3]. The AT calculator is intended for use with streams with considerable overbank storage, and yields design discharges based on high water levels up to 1.0 m above the bankfull level.

At smaller crossings with an identifiable channel, culverts are sized following methods presented in Section 3.6 of the British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRO) Engineering Manual[4]. This method assumes that the Q100 cross sectional area is equal to three times the measured mean annual flood (bankfull or 2-yr) cross-sectional flow area, and it is applicable for sizing circular culverts up to 1800 mm diameter.

Cross drainage culverts along road segments without an identifiable drainage are sized with a nominal size typically ranging from 500 to 800 mm diameter based on the apparent wetness of the area, and will be installed with a maximum spacing of about 250 m.

With respect to the design of construction and operation phase erosion and sediment controls, the mitigation approach is based primarily on use of best management practices and adaptive management which is described separately in Section 14.

The remainder of this section is focused on estimation of design flows for major watercourse

[2] http://www.transportation.alberta.ca/Content/docType30/Production/HyDgnGLStCr.pdf

[3] http://www.transportation.alberta.ca/PlanningTools/Tools/Hydraulics/

[4] https://www2.gov.bc.ca/gov/content/industry/natural-resource-use/resource-roads/engineering-publications-permits/engineering-manual/road-survey-design/culvert-design#high_water_estimation

crossings at fish-bearing streams where bridges are proposed, and for the fish-bearing segment of Sundog Creek where a diversion is proposed. The information provided includes more detailed information and analyses than has been submitted previously.

CZN's mitigation approach with respect to design flows for major crossings is based on analysis of baseline long-term historical regional streamflow data collected and published by Water Survey of Canada (WSC).

The sufficiency of published historical streamflow records to develop design flows was not raised as an issue during the project adequacy review which culminated in the Mackenzie Valley Review Board's (MVRB's) May 22, 2015 EA 1415- 01 Adequacy Review Report. No concerns over data sufficiency had been raised by any of the participating agencies or stakeholders as part of the public record prior to the EA Public Hearings in April 2017. The issue was first raised during a public hearing on April 27, 2017 when a consultant for the MVRB asked Environment and Climate Change Canada (ECCC) a question related to flow monitoring specifically limited to the context of erosion and sediment control planning.

The MVRB consultant's question, from Page 212 of the hearing transcript[5], is copied below, followed by excerpts from relevant ECCC and Tetra Tech correspondence which is also part of the public record. Emphasis is added.

Just one (1) quick question. So the hydrological info -- information that's currently available for the project for determining peak flows is three (3) regional stations, and for determining main and average conditions is one (1) station, the station at Prairie Creek. Do you believe this ***is sufficient information to support the erosion and sediment control planning*** *that's going to be required for the project, considering that the road covers over 180 kilometres of alignment?*

To which ECCC responded,

I would have to take that as an undertaking. I'm not sure.

And the MVRB consultant replied,

That's fine. So, yeah, we'd be looking for an undertaking to ***confirm the -- that the currently available information is sufficient to support erosion and sediment control planning****.*

ECCC's response to the subsequent undertaking was: *"ECCC notes that more data on flow conditions* ***would likely be helpful for the design and implementation of the sediment and erosion control plan*** *for the entire road. The details of the sediment and erosion control plan will be developed during the regulatory phase****. Adaptive management and contingency measures will also be important aspects of the plan*** *in order to ensure that sediment and erosion control measures are effective for varying flow conditions."*

A Tetra Tech (TT) response letter dated May 18, 2017, agreed with the substance of the ECCC position but gave the opinion that flow data from additional stations would be of no value whatsoever for the **design or implementation of sediment and erosion control measures**. Reasons for this were:

1. TT's previously stated belief that the regional relationships used to develop design flows for a range of return periods have given results that are conservative (high), especially for the smaller basin sizes;

[5] http://reviewboard.ca/upload/project_document/EA1415-01_Fort_Simpson_Public_Hearing_Transcript__April_27__2017.PDF

2. An understanding that sediment and erosion control measures will primarily address local site grading and drainage basins that are too small to warrant engineering analyses, and that adaptive management within the sediment and erosion control plan is an appropriate means to respond to additional information or events which may be encountered during the construction and operation of the proposed All-Season Road;
3. As per guidance documentation from Fisheries and Oceans Canada, ordinary high water mark (bankfull) hydraulic capacity could be used as a proxy for a 2-year flow, should that be useful for design of sediment and erosion control measures; and
4. Because of the significant variation in hourly, daily, seasonal and annual flows, a new station would need to be operated for many years to obtain sufficient data to reliably estimate a 2-year flood, and for decades to reliably estimate a 100-year flood.

The MVRB requirement that CZN will install and operate a network of hydrometric stations is burdensome. However, CZN has proceeded to have the stations installed. Quality control and data accessibility will be ensured by having WSC install and operate the stations, including publication of results.

The MVRB requirement that CZN will use the data from new hydrometric stations in its road and crossing designs is problematic. It exceeds the original context of erosion and sediment control planning. It is impractical, from a design and schedule perspective, to delay completion of engineering designs for watercourse crossing pending the future collection of this data. In short, 12 months of flow monitoring will not materially assist the mitigation or design process for watercourse crossings.

Based on proximity, basin size and record length, the long-term streamflow stations previously selected for use in a regional analysis to determine design flows for Prairie Creek and other basins along the access road are:

1. Prairie Creek above Cadillac [Prairie Creek] Mine, 495 km^2, 16 years of data 1975-1990, station re-established in 2013;
2. Flat River near the Mouth, 8,560 km^2, 51 years of data 1961-2014;
3. South Nahanni River above Virginia Falls, 14,500 km^2, 52 years of data 1962-2014.

Figure 6-4 shows the outlines of the watershed areas that drain to existing WSC stations, and for the basin draining to Sundog Creek at the proposed diversion location. Station locations (but not watersheds) are shown for two WSC gauges on small headwater basins that were used as a check on the regional analysis equations. Also shown are the locations of the two Environment Canada Climate Stations in the project vicinity for which rainfall Intensity Duration Frequency (IDF) characteristics have been computed by Environment Canada.

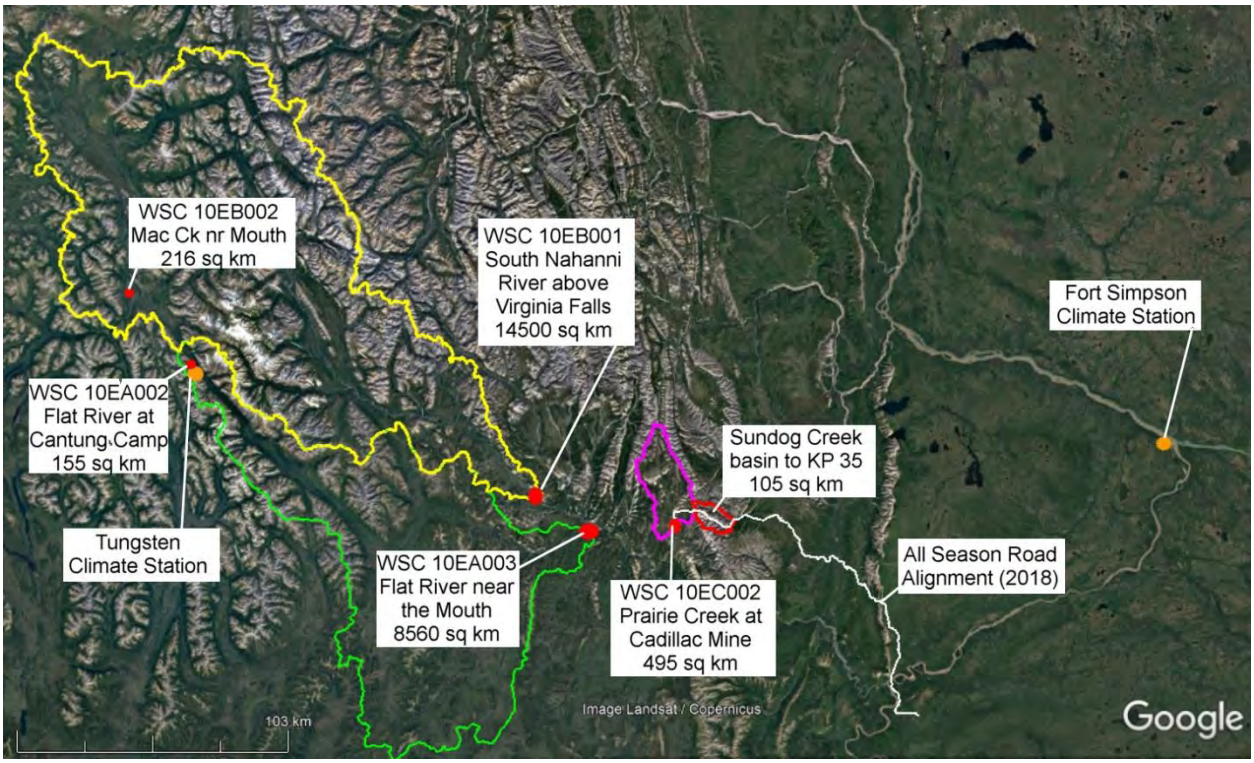


FIGURE 6-4: SUNDOG CREEK BASIN AND PROJECT ACCESS ROAD RELATIVE TO REGIONAL STREAMFLOW AND CLIMATE STATIONS

Flood quantiles for peak instantaneous flows at each of the WSC stations were computed using HYFRAN statistical software with a Log Pearson 3 distribution, selected based on the curves having a good fit to the underlying data. Figure 6-5 presents a compilation of the fitted frequency curve plots together with an Excel plot showing the regional analysis that relates basin area and flood flows for a range of the return periods.

The probability values marked on the horizontal axis of Figure 6-.5 frequency plots, 0.001 to 0.9999 represent the probabilities that the peak flow any year will be less than the associated discharge amount. The probability that values are equalled or exceeded is 1 minus the marked value. Probability grid lines plotted at 0.500, 0.800, 0.9500, 9950 and 0.9999 markers correspond to return periods of 2-, 5-, 20-, 200- and 1000-years, respectively.

The regional analysis equations for 2-year, 10-year, and 100-year returns periods are presented below, with discharge Q in m^3/s and basin area in km^2.

$Q2 = 0.2114 \times (Area)^{0.9112}$

$Q10 = 0.6033 \times (Area)^{0.8391}$

$Q100 = 1.7883 \times (Area)^{0.7523}$

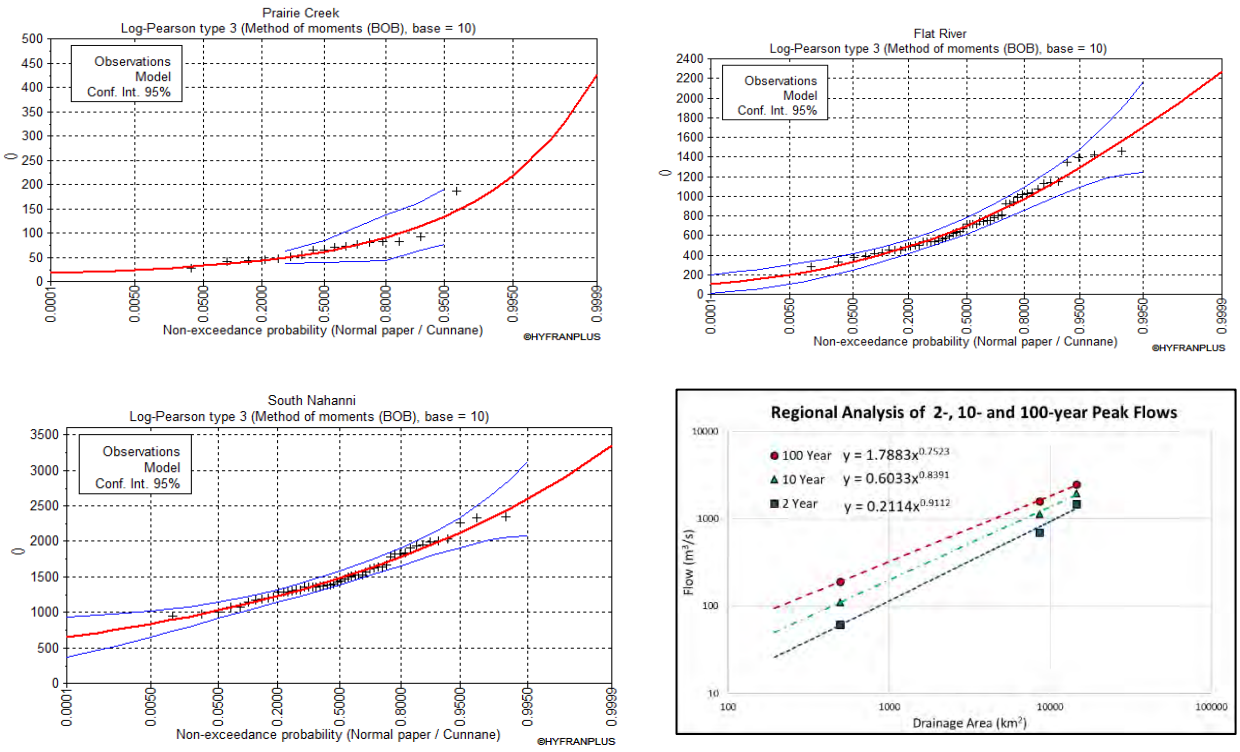


FIGURE 6-5: STREAMFLOW FREQUENCY CURVES AND REGIONAL ANALYSIS RESULTS

The fit of the computed frequency curves to the underlying data is visually good for the Flat River and South Nahanni stations with long periods of record. The frequency curve for the Prairie Curve station, with a relatively short (16 years) record is less good due to the record high peak flow of 187 m^3/s, recorded in 1977, that plots very high relative to the trend of the adjacent points. This outlier flow raises the Prairie Creek statistical 100-year flow to be at least 30% greater than an estimate without the high outlier.

Tetra Tech's interpretation of the available information is that estimates made using the regional analysis equations will result in design flows that are suitably accurate for steep well-drained basins and conservatively high for other basins. Reasons for this opinion include:

1. From Figure 6-4, the Prairie Creek and South Nahanni stations used in the regional analysis are both in well-drained mountainous basins without lakes or significant storage that would attenuate peak flows. Flood quantiles for the Flat River station, in a mountainous but less well-drained and more vegetated basin, plot slightly below the Figure 6-5 regional regression lines. The regression lines are believed to directly applicable to well-drained basins, including Prairie Creek and Sundog Creek. The relationships will overestimate peak flows for less well-drained basins that are encountered over about more than half of the length of access road, based on the amount of vegetation evident in Figure 6-1.
2. Prairie Creek has a high outlier discharge measurement which significantly increases the statistical estimates for high return periods such as a 100-year flood. How extreme this outlier value is was addressed by a normalization process,

dividing each station's record peak flow (with an unknown return period) by the station's median (2-year) peak flow that is known with a relatively high level of confidence. The ratios of record peak flow to median flow are 3.03 for Prairie Creek, 2.09 for Flat River, and 1.59 for the South Nahanni River gauges. These results suggest that the record flood on Prairie Creek was possibly more extreme than record floods at either the Flat River or South Nahanni River stations, each with more than 50 years of record. The computed frequency curve for the Prairie Creek station yields a 100-year discharge of 191 m^3/s, approximately equal to the record measured value, and seems reasonable and/or conservative.

3. For small basins, the regional analysis equations yield 100-year amounts that are conservatively high compared to direct frequency analysis results for gauged small headwater basins in the western portions of the Flat River and South Nahanni watersheds, with more than 12 years of record. WSC Station 10EA002, Flat River at Cantung Camp, drains a 155 km^2 basin in the upper Flat River watershed and has 14 years of record from 1974 to 1987. WSC Station 10EB002, Mac Creek near the Mouth, drains a 201 km^2 basin located in the upper South Nahanni River watershed and has 15 years of record from 1978 to1992. Computed 2- and 100-year frequency analysis results for these stations are given below, together with station record peaks and the regional analysis equation results for 100-year flows corresponding to the station basin size

Gauge & Basin Area	Q2 (m^3/s)	Peak (m^3/s)	Q100 (m^3/s)	Regional Eqn Q100 (m^3/s)	vs Station Q
Flat River at Cantung, 155 km^2	15.1	24.9	26.6	79.8	3x greater
Mac Creek nr Mouth, 201 km^2	45.9	66.4	73.0	97.1	1.3x greater

These stations were not included in the initial regional analysis because of the distance from the Project area and interest at the time in larger basin sizes. After determining that the regional equations yielded 100-year flows significantly higher than station-specific results for these small (and distant) basins, it was decided to continue with the original three-station regional analysis. Tetra Tech has consistently stated that this approach is believed to yield conservatively high values for smaller basins, but TT has not previously provided the above supporting data.

Parks Canada has expressed concern over reliance on a single method of flow estimation, and recommended that "*CZN shall provide at least one supplementary hydrotechnical calculation (based on existing information) for Sundog Creek as a check to support or correct the hydraulic model utilised for Sundog Creek*." CZN committed to provide this and has initiated a review of existing climate data to be used in a hydrologic model approach.

Existing information suitable for hydrologic modelling is available from Environment Canada climate stations at Tungsten and at Fort Simpson, both shown on Figure 6-4. Hourly rainfall data have also been collected by CZN since September 2009 at the Prairie Creek Mine. Rainfall Intensity Duration Frequency relationships have been computed by Environment Canada for the Tungsten and Fort Simpson stations, and are shown in Figure 6-6. Similar relationships have not been determined for the Prairie Creek Mine.

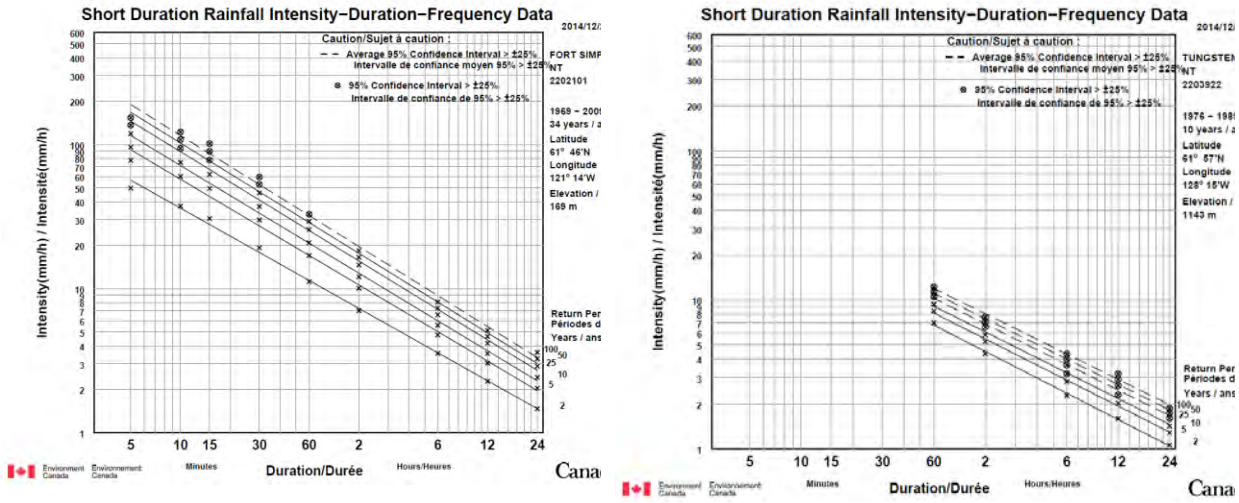


FIGURE 6-6: EC RAINFALL INTENSITY DURATION FREQUENCY DATA FOR TUNGSTEN AND FORT SIMPSON CLIMATE STATIONS

TABLE 6-1: EC RAINFALL EVENT DEPTHS FOR TUNGSTEN AND FORT SIMPSON CLIMATE STATIONS

Event	Tungsten (mm)	Ft Simpson (mm)	Ratio
	Elev 1143 m	Elev 169 m	
60 min, 2-yr	7.0	11.2	1.6
60 min, 10-yr	9.3	20.8	2.2
60 min, 100-yr	12.2	32.9	2.7
24 hr, 2-yr	25.6	35.2	1.4
24 hr, 10-yr	34.2	58.1	1.7
24 hr, 100-yr	45.0	86.7	1.9

Short duration rainfall amounts at Tungsten are significantly less than at Fort Simpson (Table 6-1). This is the opposite of the pattern shown in the Hydrological Atlas of Canada (1978) for annual rainfall amounts that are significantly greater at Tungsten (more than 600 mm) than at Fort Simpson (less than 400 mm). Lacking a defensible basis for interpolation of short-interval rainfall data between the two stations, the EC data are insufficient for accurate estimation of design storm events necessary for hydrologic modelling of the Sundog Creek basin or other watersheds along the project access road.

An alternative approach would be to use Prairie Creek data to develop a hydrologic model for the Sundog Creek basin, but the model inputs are so heavily dependent on Prairie Creek climate and streamflow data that the results are certain to support the regional analysis approach. Design storms to be applied directly to the Sundog Creek basin can be developed from statistical analysis of the CZN hourly rainfall data for the nearby Prairie Creek Mine. Basin runoff parameters for the Sundog Creek basin can be developed by calibration of a statistical 2-year design storm from the

Prairie Creek Mine to the statistical 2-year peak flow for Prairie Creek, with subsequent minor adjustments for more rapid runoff from Sundog's smaller watershed with shorter flow paths and slightly steeper terrain. The same model(s) would also be run for a statistical 100-year storm event, but the confidence in the results would be low. At the end of this exercise, we would still recommend using design flows for Sundog Creek that rely directly on the Prairie Creek recorded flows via the regional analysis equations rather than a hydrologic model that has been calibrated to Prairie Creek flows and relies on Prairie Creek rainfall statistics.

In closing, we believe that the hydrology regional analysis methods described above yield design flows that are reasonable and/or conservative, and are suitable for detailed design of watercourse crossings. Potential project impacts relating to erosion and sediment control can be mitigated by civil works that are designed to accommodate and withstand these flows.

Baseline streamflow data from new hydrometric stations can be used to support the interpretation of information collected under concurrent environmental monitoring activities, and adaptive management. The Sundog Creek Diversion Plan (Appendix 26-1) includes discussion of how the flow data to be collected at the new Sundog Creek gauging station can be used to better understand the baseline periodicity of flow in the diversion reach and assess whether the hydrologic similarities between Sundog Creek and the adjacent Prairie Creek basin are as expected.

6.3 Monitoring

Information Request Part VI.c. states: Measure 8-1, Part 4 – Provide a draft of CZN's water monitoring strategy.

Measure 8-1, Part 4 (from the REA) is as follows: *CanZinc has identified many different plans, programs, and commitments for monitoring Project effects on water during construction and operation. CanZinc will amalgamate these plans, programs, and commitments, to the extent feasible and practical, so that water monitoring is consolidated and coordinated. The Review Board understands that for operational purposes, CanZinc may wish to keep certain aspects of water monitoring separate. The Review Board encourages the developer to consolidate where it can, in order to simplify the number of plans to create and report on. The Review Board considers that this may be relevant to the following commitments (Appendix C): #55, #93, #94, #211, #212, #217, #218, and #239, among others.*

CZN's water monitoring strategy includes:

(1) abiding by the monitoring commitments made in the EA process;
(2) undertaking an ongoing program of monitoring inspections to identify preventative and/or adaptive management measures as may be required to maintain the operational integrity of the road and watercourse crossings;
(3) monitor and manage water withdrawals to comply with water license requirements; and,
(4) monitor and manage project-related erosion and sediment releases to be protective of the environment.

This strategy has been integrated with a number of management and monitoring plans, specifically the Road operations and Maintenance Plan, Sediment and Erosion Control Plan and Sundog Creek Diversion Plan. As explained in Section 7 below, this monitoring will largely be carried out by Dene monitors under the framework of an Environmental Management Agreement.

Stream hydrology results will be reported by WSC on the WSC website. Separate reports will be prepared for strategy items 2, 3, and 4 above. These reports will, in combination, satisfy the reporting expectations under strategy item 1 for specific commitments made in the review process.

Measure 8-1, Part 4 also listed eight developer's commitments in the REA in relation to water monitoring. The updated commitments table (Table 2-1) explains how these will be addressed.

6.4 Adaptive Management

MVLWB Schedule 1 Information Request Part VI(d) states: *Measure 8-1, Part 5 – Provide a draft of CZN's adaptive management framework for water, developed in accordance with Measure 8-1, Part 5 and Appendix B of the REA.*

Measure 8-1, Part 5 (from the REA) is as follows: *As part of the water monitoring program(s), CanZinc will establish and implement an adaptive management framework that satisfies the requirements of Appendix B. This will include thresholds and actions that will be developed and adapted using all available baseline information, effects monitoring results, and Traditional Knowledge and will consider ways to coordinate or compliment Aboriginal monitoring initiatives (see Measure 15-4).*

Please refer to the Sediment and Erosion Control Plan, sections 6 and 7. We considered it appropriate to address water quality monitoring and adaptive management in that document. Further, requirements will be integrated with independent Dene monitoring per the Environmental Management Agreement (EMA), and monitoring programs will be further developed under the EMA umbrella.

7.0 UPDATED ENGAGEMENT PLAN AND RECORD

This section presents an updated engagement plan and engagement record, in accordance with REA Measure 10-1. REA Measure 10-1 reads as follows:

> "In order to prevent significant adverse impacts on heritage resources, and to support Traditional Knowledge requirements in other measures in this Report of EA, the developer will:
>
> i. engage with potentially-affected Aboriginal groups, including Nahanni Butte Dene Band, Liidlii Kué First Nation, and Dehcho First Nations, about ways to avoid impacts from the Project, including impacts on heritage resources;
> ii. conduct this engagement prior to the Archaeological Impact Assessment (AIA), so that the resulting information can inform the AIA (see Measure 10-2);
> iii. thoroughly consider and, where applicable, incorporate Traditional Knowledge into Project design, mitigations, monitoring, and adaptive management; and
> iv. submit an updated engagement record and plan in accordance with Mackenzie Valley Land and Water Board (MVLWB) Engagement Guidelines for review and approval by Parks Canada and the MVLWB.
>
> The developer will do this in a culturally-appropriate way that respects applicable Traditional Knowledge policies and protocols."

The measure envisages a sequence of events whereby CZN is expected to engage with the listed

Indigenous groups prior to completing an AIA, and in order to incorporate Traditional Knowledge (TK) into Project design, mitigations, monitoring, and adaptive management, and **then** (bold added) to submit an updated engagement record and plan. We do not believe the Review Board contemplated, nor that the Water Board nor Parks Canada expect, that steps i. to iii. listed above need to have been completed before the issue of road permits and before the engagement record and plan can be updated. Further, it may be argued that, since it should not be expected that steps i. to iii. will have been completed, that it is premature to update the engagement record and plan. Rather than dwell on these possibilities, this section describes the engagement that has occurred since the issue of the REA that is relevant to Measure 10-1. We provide engagement records to support this, and an updated engagement plan to explain how we propose to continue engagement in connection with Measure 10-1.

7.1 Engagement since REA

CZN received a letter from Indigenous and Northern Affairs Canada (INAC), dated January 19, 2018, issuing five specific "information requests" (IR's) in connection with the implementation plans for various measures and proponent commitments contained in the REA. INAC, on behalf of the Responsible Ministers, in providing CZN with the five information requests, identified specific issues raised by Indigenous organisations that needed further clarity through proponent engagement, so the Responsible Ministers could be confident that the Crown had discharged its legal duty to meaningfully consult with potentially impacted Indigenous communities and organisations.

INAC requested that CZN engage with the Naha Dehe Dene Band (NDDB), Liidlii Kue First Nation (LKFN) and the Dehcho First Nations (DFN), as recommended by the Review Board, to gain an understanding of the concerns of the Indigenous organizations, discuss and determine how the Indigenous organisations will be included in monitoring, and discuss the Indigenous organisations' requests for support to participate in implementation of the measures recommended by the Review Board and the commitments made by CZN in the environmental assessment process.

As requested by INAC, CZN engaged with Indigenous organisations to discuss the implementation of various measures recommended by the Review Board, the sharing and incorporation of Dene traditional knowledge and values into project design, and the inclusion of Indigenous communities and organisations in environmental and wildlife monitoring of the ASR.

A number of engagements were held with Indigenous organisations, including NDDB, LKFN, DFN and Acho Dene Koe (ADK), and draft implementation plans and related documents were prepared and distributed on March 5, 2018 to those Indigenous organisations for review and discussion. Comments on CZN's draft IR replies were received from LKFN in a letter dated April 6, 2018 following which CZN revised the IR replies.

Arising from the discussions, CZN signed a Process Agreement, along with the NDDB and LKFN, which provides for CZN to negotiate an Environmental Management Agreement (EMA) with the NDDB and LKFN to provide for Indigenous review, participation and oversight of the ASR during permitting, design, construction, operation and closure phases, and the implementation of the mitigation measures contained in the Review Board REA.

The first EMA negotiation meeting was held in Nahanni Butte on June 5, 2018. The engagement records and logs provided in Appendix 7-1 show that multiple meetings have occurred since. CZN

has in fact been simultaneously negotiating three different agreements with the Indigenous groups: an EMA with the NDDB and LKFN; a Traditional Land Use Agreement (TLUA) with the NDDB; and, a Road Benefit Agreement (RBA) with LKFN. CZN and NDDB issued a joint news release dated January 16, 2018 advising of the signing of the TLUA, which can be found here:

Jan. 16 CZN-NDDB News Release

The news release also advises that EMA negotiations are at an advanced stage. CZN expects to conclude an agreement in the next few months. RBA negotiations are also advancing, and an agreement is possible on approximately the same schedule.

Subsequent to the signing of the Process Agreement, a joint letter from the NDDB and LKFN dated June 7, 2018 was sent to the Minister of Crown-Indigenous Relations and Northern Affairs (CIRNA) to inform her of the intention of the NDDB and LKFN to negotiate an EMA with CZN which will serve as a formal mechanism to ensure the mitigation measures and CZN's environmental protection commitments outlined in the REA are appropriately implemented and Indigenous group concerns are addressed. Further letters from each Indigenous group dated June 14, 2018 were subsequently sent to the Minister to confirm that they were satisfied with CZN's responses to all of the INAC IR's. DFN also wrote to LKFN on July 4, 2018 confirming their support for the negotiation of an EMA. Copies of these letters can be found in Appendix 7-2.

In the Process Agreement, the Parties also agreed to propose to the Federal Minister of CIRNA that the Minister include in her decision on the Review Board Report a condition, or a direction to the Mackenzie Valley Land and Water Board (Water Board) and Parks Canada, that permits for the ASR not be issued before an EMA is negotiated and concluded between the Parties.

CZN Commitment

In a June 8, 2018 letter to the Minister of CIRNA, CZN requested that the Minister consider including in her decision on the Review Board Report a condition or a direction as described above, if possible. Further, CZN requested that, if possible, the Minister of CIRNA also include in her decision a condition or a direction that permits for the ASR not be issued before a TLUA is negotiated and concluded between the NDDB and CZN. CZN agreed that in the event that the Minister is unable to include such conditions, or provide such directions to the Water Board and Parks Canada, CZN agreed to request and recommend to the Water Board and Parks Canada that the permits for the ASR contain a condition that an EMA is to be negotiated and concluded between the Parties, and a TLUA is to be negotiated and concluded between the NDDB and CZN, before any management or construction plans associated with other conditions in the permits can be approved. The Minister subsequently confirmed that she did not have the authority also include in her decision a condition a direction as described above, and therefore, CZN is now requesting and recommending to the Water Board and Parks Canada that the permits for the ASR contain a condition as described above.

Other Engagements

Regarding engagement with other Indigenous groups in the region, subsequent to the issue of the REA, CZN has engaged extensively in connection with extensions or changes to existing permits. During these engagements, it was normal course to inform the group of general project progress, including the status of the ASR application. Engagement submissions made to the MVLWB over this period include the following:

Nov 13 2017 Winter Road LUP extension request to MVLWB

Sep 21 2018 Engagement submission to MVLWB for Prairie Creek LUP extensions

While the ASR may not be directly referred to in these submissions, it was part of the engagement.

Further to Section 1.4.12, CZN engaged with NDDB and LKFN regarding the Liard River crossing optimization and use of a hoverbarge on October 25 and 26, respectively. The hoverbarge concept was explained and illustrated using the material in Appendix 1-10. Neither group raised concerns with the use of a hoverbarge. NDDB subsequently provided a letter of support for use of the hoverbarge, which can also be found in Appendix 7-2.

During CZN's engagements with NDDB, CZN explained that the Company is required to estimate and post security to remove and reclaim the ASR after mine closure. The Band indicated that they would like the road section from the Nahanni Butte access road to the Liard River, and the staging area on the south side of the river, to remain after closure to facilitate access to the IAB Lands and the river and support river-based activities. The Band subsequently issued a Band Council Resolution to this effect, a copy of which is also provided in Appendix 7-2. While the ASR may not be directly referred to in these submissions, it was part of the engagement.

7.2 Engagement Plan

CZN's Engagement Plan for the ASR development is provided in Appendix 7-3.

8.0 ARCHAEOLOGICAL IMPACT ASSESSMENT

Further to Section 7 above, and as noted, the proposed Environmental Management Agreement (EMA) between the NDDB, LKFN and CZN will provide for the participation of the Indigenous groups in all aspects of the ASR development, from initial planning and studies to construction, operation and closure. EMA negotiations have included the drafting of a formal agreement and the development of a cost estimate to cover Indigenous group participation. That estimate envisages a number of meetings or workshops with designated representatives of the groups to discuss the application of traditional and/or Dene knowledge, for the further development of environmental management and monitoring plans, and to determine the approach, scope and content of an Archaeological Impact Assessment (AIA), before the AIA is undertaken.

CZN's ASR development plans include the initial construction of a winter road on the ASR alignment in order to provide access for geotechnical and geophysical investigation. The geotechnical investigation will include the drilling of boreholes using a drill rig, and the digging of test pits using a backhoe. CZN was concerned that these investigations could be considered

sufficiently intrusive that impacts to cultural/heritage resources might occur as a result of them. Consequently, during the EMA negotiations, CZN brought this concern to the Indigenous groups and advised that the Company wished to complete a preliminary AIA focussing on the proposed geotechnical investigation locations. CZN also requested the participation of representatives from the groups in the fieldwork. Lifeways of Canada was contracted to do the work. Further details can be found in Appendix 8-1.

CZN still intends to follow the process laid out in REA Measure 10-2 for an AIA prior to ASR construction. CZN will conduct the AIA to the specifications detailed in Commitment 215 in Appendix C of the REA. The scope, content and approach of the AIA will also be developed with engagement with Parks Canada, the GNWT, NDDB, LKFN, and DFN. The AIA will account for evidence of place names, traditional land use, Traditional Knowledge, cultural and spiritual use, and harvesting in the vicinity of the Project, and be conducted for the road alignment and borrow sites. The scope of the AIA will also be informed by the results of the previously completed Archaeological Overview Assessment and preliminary AIA.

The AIA prior to ASR construction will require a field team and a professional archaeologist. CZN previously committed to include a NDDB member on the field team. A LKFN representative will also be invited to be part of the team.

9.0 INVASIVE SPECIES

A draft Invasive Species Management Plan (ISMP) is provided in Appendix 9-1. A survey of the right-of-way was completed, as described in Section 3.2 of the ISMP. A survey data report is provided in Appendix 9-2. Mitigation is discussed in Section 4 of the ISMP. A summary of the ISMP follows.

The ISMP focuses on vascular plants and presents invasive species management practices to be employed during the construction and operation of the ASR and associated infrastructure.

The purpose of the ISMP is to identify best management practices to identify, control, monitor, and prevent the spread and introduction of invasive species along the ASR and the surrounding environment during the construction and operation phases of the Project. The ISMP has also been developed in direct response to the following measure presented in the REA:

In order to prevent significant adverse impacts to vegetation communities (which also serve as wildlife habitat), CZN will revise the invasive species management framework and create an Invasive Species Management Plan prior to construction, considering off-site as well as on-site prevention and control. CZN will include the adaptive management principles within the invasive species management framework, the Invasive Species Management Plan, and any individual weed control plans, if or as they are developed.

Roadways provide a vector for the establishment of invasive species. Many invasive plants have the ability to aggressively establish and quickly spread in new environments, altering natural habitats, displacing native species, and reducing habitat effectiveness for wildlife. Oldham and Delisle-Oldham (2017) detected 118 invasive plant species along highways and rest stops in the NWT, including the Liard Highway. In past surveys for rare plants near the Mine and through the NNPR along the ASR, no invasive species were detected. However, in August 2018, twenty-two

(22) of the 118-invasive species listed, plus one species not documented by Oldham and Delisle-Oldham (2017) were found in high densities between KP 155 to KP 179.5 (south of the Liard River) of the ASR. No invasive species were detected between KP 155 (just north of the Liard River) to KP 0. However, four invasive species were observed around the Mine site in small numbers. Detailed identification and control measures are provided for each of the 23 species.

The main land management goals and objectives with respect to invasive plant species are as follows:

- As much as possible, prevent invasive species from spreading into the area north of the Liard River and into the NNPR. Vehicle inspections will occur at the Liard River crossing, which will include a wheel wash during the open water season;
- Collaborate with the community of Nahanni Butte to prevent further spread through education, engagement, and involvement with prevention, detection, control, and restoration measures;
- Collaborate with the Government of the Northwest Territories – Environment and Natural Resources' Invasive Alien Species Program to stay apprised of upcoming threats from adjacent districts and innovative treatment technologies; and
- Manage infestation levels so that the project does not result in an increase relative to local and regional background levels.

Four key principles (prevention, detection, control, and restoration) can be applied to any species detected throughout the lifetime of the Project to provide the most applicable mitigation for control. Several mitigation measures are suggested for each principle. Through monitoring, adaptive management can be applied to further refine prevention, detection, and control measures.

Monitoring provides the means to gather information to evaluate the success of prevention, detection, and control measures. Once control measures have been implemented, regular monitoring and follow-up reporting will occur to verify whether the eradication goal has been met and the site has been sufficiently restored to target conditions (e.g., pre-infestation conditions or some equivalent level of acceptability).

Adaptive management will be used to evaluate the effectiveness of the ISMP; the Plan is effective if the goals are being met. The ISMP is a living document. As part of the adaptive management approach, this document will require revisions if and when new species are detected/introduced, control methods are added or removed (based on effectiveness), new vectors for spread/propagation are introduced (e.g., natural disturbances such as fire or flood), and/or invasive species legislation changes.

Regular evaluation and self-assessment of all stages of the management process provide information on the outcome of previous interventions and allow for ongoing improvement (Timko & Innes 2009). Consistent, long-term management and control of invasive species is required. Should follow-up operations cease, any advances achieved may be lost in a very short time.

Prior to construction, invasive species should be controlled along the Nahanni Butte community access road, the old logging road and areas proximal to the road cleared by the community, and around the Mine. These areas pose significant risk for spreading invasive species along the ASR.

10.0 PERMAFROST

10.1 Baseline Data

An initial permafrost investigation was carried out in 2018 to collect preliminary data, inform the preliminary road designs contained in this UPD, and allow refinement of subsequent investigation plans. A data report for this investigation is provided in Appendix 10-1. The report also contains the defined permafrost investigation plans prior to, and subsequent to, the investigation. As explained in Section 3, results from the detailed permafrost investigations will be used to refine the preliminary road and crossing designs, following which we anticipate the Panel will complete their main review, leading to detailed and final designs.

10.2 Mitigate Degradation

Measure 12-1, part 3 states that *"CanZinc will design and construct the road, borrow pits, and other infrastructure in a way that anticipates and avoids permafrost degradation and associated impacts on the surrounding environment during all phases of the Project, including post-closure"*. The preliminary designs contained in this UPD were developed in many cases to specifically address permafrost (see sections 1.2.1 and 1.4.1.2). The overland construction approach is intended to provide insulation for potential permafrost. Also, embankment design (e.g. slope angle) in permafrost terrain was modified to provide better insulation. The approach to construction to minimize permafrost degradation is further explained in the Permafrost Management Plan (PMP). Borrow pits will similarly be investigated and developed accounting for permafrost potential. Measures to reclaim the road after mine closure to mitigate the potential for permafrost degradation are explained in the Road Closure and Reclamation Plan.

10.3 Management Plan

A draft PMP is provided in Appendix 10-2. The plan provides an initial outline of the proposed monitoring and adaptive management framework. This will be further developed after results from the main geotechnical investigation are available. A summary of the PMP follows.

The PMP describes the methods for managing permafrost during the construction and operation of the ASR leading to the Prairie Creek Mine. The primary goal of this PMP is to prevent and/or mitigate degradation of permafrost along the ASR alignment. It incorporates all commitments and recommendations outlined by applicable regulatory bodies including the Government of the Northwest Territories (GNWT), the Mackenzie Valley Land and Water Board (MVLWB), Natural Resources Canada (NRCan), and Parks Canada (PC). To achieve this, the PMP includes the following sections:

- Permafrost Description;
- Potential Impacts on Permafrost During Project;
- Permafrost Management Plan;
- Permafrost Monitoring Program; and
- Permafrost Adaptive Management.

The ASR alignment is located in a zone of extensive discontinuous permafrost, which means permafrost may be present under 50% to 90% of the terrain. It was previously estimated that

approximately 73 km of the ASR is underlain by thaw-sensitive permafrost with potential for another 24 km depending on slope aspects and elevation.

Numerous site reconnaissance, terrain mapping, and geotechnical investigations have been completed to date to better define the extent of permafrost. Currently, confirmed permafrost conditions have been observed in 17 boreholes at various locations along the ASR alignment. Additional geotechnical investigation work is planned as the project moves into detailed design. One of the primary goals will be to delineate and confirm areas of ice rich permafrost as these have direct implications on the road's alignment and embankment design.

Development of the ASR involves a number of different construction activities and external factors, all with potential impacts to permafrost. Four impacts were identified to potentially causing permafrost degradation:

- Road Construction and Borrow Pit Development;
- Road Operations;
- Climate Change; and
- Wildfires.

This PMP provides methods and strategies for preventing the above impacts to permafrost. Mitigations pertaining to road construction, route refinement, embankment design, watercourse crossings, borrow pits, snow accumulation, and thermokarsts are all discussed. This PMP also outlines a detailed monitoring program with an emphasis on early detection of changes in permafrost. The monitoring program is a vital component of adaptive management and will include visual inspections, ground temperature monitoring, instrumented road sections, and climatic data reviews. The program will be implemented at the start of the road's construction and will continue through to closure and reclamation.

The management plan was developed to be in line with recommendations from the applicable *Northern Land Use Guidelines (GNWT 2015) and the Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions (TAC 2010).*

11.0 CLOSURE AND RECLAMATION

A draft Road Closure and Reclamation Plan (RCRP) is provided in Appendix 11-1. The plan was developed in accordance with Suggestion 14-1, and closure activities were described separately for inside and outside of the Nahanni National Park Reserve (NNPR), to the extent necessary. A summary of the RCRP follows. Cost estimates for reclamation are discussed in Section 20.

The purpose and scope of the RCRP is to describe the plan for the closure and reclamation of the ASR and other parts of the Project such as the camps, bridges and culverts and any contaminated sites that may still be there at the end of life of the Project.

This RCRP outlines the approaches and concepts that will be used to meet the overall goal of returning the lands affected by the Project to healthy and self-sustaining environments for plants, trees, wildlife and fish and the continued use of the land for traditional harvesting, hunting and cultural activities by the people using the area. The Plan also recognizes the special importance of protecting and restoring the land crossed by the road in the Nahanni National Park Reserve area

(NNPR).

Progressive reclamation will take place throughout the access road construction and operations period to help to reduce soil erosion and the length of time a site is disturbed. Reclamation of the cleared right-of-way (ROW) beside the road can be helped by leaving tree and shrub roots in place during clearing. Monitoring the performance of progressive reclamation efforts will be carried out during the long-term operations period. Lessons learned will be applied during final closure and reclamation of the road.

As opportunities for progressive reclamation are identified, CZN is committed to engaging with the potentially-affected Indigenous groups, regulators and land managers to obtain advice on the kinds of progressive reclamation activities to be carried out. The results and lessons learned from the long-term progressive reclamation efforts, as well as reclamation trials and monitoring programs will be used by CZN and the interested Parties to help with the development of clear reclamation objectives, measurable targets and timelines for final closure and reclamation planning and adaptive management for the access road.

One of the greatest challenges related to the future closure and reclamation of the access road relates to the physical properties of the road, which will be built mainly with sand, aggregate, crushed rock. As a result, the road surface will be a “high and dry” environment which will be a challenge to revegetate.

To help restore the access road and affected areas around the Project to a more natural environment, CZN is proposing to mix mulched organic matter into the road surface during ripping and scarification activities that will happen during road closure and reclamation.

The main source of this organic matter will come from the grubbing and mulching of slash, vegetation and non-usable timber generated during the initial ROW clearing that will take place at the beginning of winter road construction followed by ASR construction. CZN’s plan is to place and store the mulched organic matter in separate mounds (piles) along the ROW for this future use. The organic material in these mounds is expected to break down (compost) over the life of the Project and produce good organic matter with natural nutrients needed for the eventual reclamation of the road.

Mixing this mulched local material into the loosened-up road bed will help to retain moisture and provide nutrients and possibly local root/seed stock needed to encourage natural and enhanced revegetation processes so that the lands affected by the Project can be returned to healthy and self-sustaining environments for plants, trees, wildlife, fish and water quality.

As part of final closure, all buildings, garbage, petroleum products and equipment will be removed from the road. Bridges and culverts will be removed carefully to avoid sedimentation, and the stream beds and banks will be re-established. Where culverts are removed, cross ditches will be constructed across the road to maintain natural drainage.

The RCRP is a living Plan that will be updated throughout the life of the Project to adapt to and build-in any useful lessons learned (in terms of both the Project, Traditional Knowledge, experience obtained from progressive reclamation and new technologies) that will be gained over the coming years.

CZN looks forward to sharing this Plan (currently a draft) for engaging with representatives of the NDDB, LKFN, and DFN to discuss and if necessary clarify and add to the current closure principles and objectives of this Plan as well as any other parts of the Plan that parties are interested

in contributing to.

12.0 WASTE MANAGEMENT PLAN

12.1 Management Plan

A draft Waste Management Plan (WMP) is provided in Appendix 12-1. A summary follows.

The purpose of CZN's WMP is to ensure that all wastes produced by activities associated with the construction and operation of the ASR are handled, transported, stored or disposed of in a safe and responsible manner and comply with all applicable legislation, regulations, authorizations, permits and licenses for the duration of the Project.

Road construction, operations and related infrastructure such as the camps and trucking operations are expected to produce small volumes of waste on a yearly basis. Road construction crews will likely use portable day trailers and accumulate modest volumes of domestic waste, sewage (black water) and grey water (wash water). The ASR maintenance camps will also generate domestic waste and sewage. The intent will be to temporarily store these wastes at the road camps. Domestic waste will be collected regularly and transported to the Prairie Creek Mine or a suitable off-site landfill. Sewage and grey water from the construction camps will either be treated on-site (larger camps) with disposal of effluent via septic fields or taken to the Mine for treatment. Sewage from maintenance camps will either be taken to the Mine or disposed of in pit latrines. Maintenance camp wash water will be handled as for construction camps.

The Plan identifies the types of wastes that will be produced by the project and the procedures to promote the reduction, reuse, and recycling of the waste materials. It also describes the practices and procedures for waste handling, collection, storage, transport, and disposal. Waste addressed are: domestic wastes (combustible and non-combustible - non-hazardous wastes); hazardous wastes; recyclable waste; domestic sewage and wash water; excavated material; and, waste explosives. Excavated material will consist of organic material and strippings that cannot be used in road construction. More detail is provided in the Road Construction Management Plan (RCMP). Waste explosives are covered in more detail in the Explosives Management Plan (EMP).

The WMP is a living document that will be updated throughout the life of the Project to adapt to and incorporate any changes (in terms of both the Project or available technologies) that may arise. This will also include the results of ongoing engagement with the potentially-affected Indigenous groups, including NDDB, LKFN, and DFN, and applicable regulators and land managers.

12.2 Wastewater

Regarding wastewater discharges to the environment, two sources are possible:

- runoff from construction sites, including borrow pits; and,
- sewage and grey water.

The management of runoff, and sediment control, is discussed in the Sediment and Erosion Control Plan. That plan refers to the use of CCME criteria for TSS and turbidity to manage discharges, and suggests appropriate adaptive management triggers.

Regarding sewage and grey water, we note that none of the INAC 'Northern Land Use Guidelines, Camp and Support Facilities', Yukon 'Design Specifications for Sewage Disposal Systems', June 2016 and Yukon 'Environmental Health Services Guidelines for Greywater Disposal at Remote Camps' have effluent quality criteria for discharges, presumably because the discharges are intended to be to soil, not surface water. This is the case for CZN's proposed sewage effluent and greywater disposal plans. We would agree that suitable treatment efficiency is required for a sewage treatment plant (STP) serving a large camp. The STP design parameters for treated sewage effluent at the Mine site are BOD <20 mg/l and TSS <20mg/l.

13.0 GEOCHEMICAL VERIFICATION

A draft Geochemical Verification Program is provided in Appendix 13-1. A summary follows.

Tetra Tech Canada Inc. (Tetra Tech) was retained by CZN to develop a Geochemical Verification Program (GVP) for bedrock and overburden granular materials along the proposed ASR leading to the Mine, NT.

Work was undertaken in 2018 as an initial part of the proposed Geochemical Verification Plan and consisted of static test geochemical characterization analyses on available overburden granular samples. Bedrock materials will be analyzed as a future phase of the project work. Additional sampling of granular materials will also be completed to supplement the initial analyses. This data report summarizes the results of the 2018 analysis program on granular material samples and provides a plan for further work that will be completed later.

Samples were initially collected from a geotechnical site investigation program that was carried out between August 10-30, 2018 and consisted of window sampling and testing of overburden. A total of 43 sample holes with depths ranging from 0.6 m to 5.0 m were window sampled and logged at 39 sites along the proposed ASR. For the Geochemical Verification Program, 18 samples were selected to undergo geochemical characterization testing. Samples were submitted for a suite of static geochemical characterization analyses.

The results on 2018 samples indicate that the granular material sampled is consistently classified as Not-Potentially Acid Generating (Non-PAG) and is not anticipated to be of concern for ARD generation. Sulphur content is generally low in the granular materials, representing low potential for acid generation. Neutralization potential in the materials is provided variably by silicate and carbonate minerals and is considered to be present in sufficient quantities to neutralize against acid production and maintain near-neutral or alkaline drainage.

Potential for metal leaching from granular materials is considered low overall based on the results of shake flask extraction (SFE) tests, however elevated levels of iron and aluminium may be observed and should be investigated further in the context of site specific drainage conditions and potential for environmental impacts to surface receptors.

Further work is needed to confirm the distribution and volumes of expected granular and bedrock excavation materials, complete additional analysis on granular materials, complete a geochemical characterization of the bedrock materials to characterize ARD/ML potential, and develop plans for the management of materials and mitigation of ARD/ML during construction of the ASR.

The sampling frequency for additional future characterization is based on industry best practise standards, and in consideration of estimated excavation volumes, risk potential and material variability. Samples will be collected form the road alignment and proposed borrow sources. An additional 84 granular material samples and 50 bedrock samples are proposed for sample collection. The actual number of samples collected and analyzed will be dependent on confirmation of borrow sources, refined excavation volumes and geotechnical suitability, and apparent material heterogeneity.

14.0 SEDIMENT AND EROSION CONTROL PLAN

A draft Sediment and Erosion Control Plan (SECP) is provided in Appendix 14-1. A summary follows. The plan includes proposals for short-term and long-term water quality monitoring. The plan also includes guidelines for the installation of watercourse crossing structures.

The SECP describes the methods to be used to mitigate and manage erosion and sedimentation during the relatively short-term construction and long-term operations phases of the ASR leading to the Mine. The plan outlines the approaches and concepts that will be used to ensure that potentially harmful environmental effects, due to the potential mobilization of sediments to surface waters during construction activities, do not occur. The primary goal of this SECP is to prevent erosion and proactively control it at the source before having to manage the mobilized sediment. To achieve this, the plan identifies the following:

- Potential erosion and sediment sources;
- Best management practices and procedures;
- Mitigation measures and methods for preventing erosion; and
- Monitoring and adaptive management.

CZN will identify areas that are susceptible to erosion and sedimentation and will implement industry-standard Best Management Practices (BMPs) to mitigate the potential hazards. Numerous sediment management and mitigation strategies are provided in documents from the Government of Northwest Territories (GNWT 2013), Alberta Transportation (AT 2011), and the Transportation Association of Canada (TAC 2005). Each strategy outlines measures to avoid erosion or minimize potential adverse effects of sedimentation on water quality and aquatic resources due to road construction activities. The BMPs presented in this SECP are adopted from the GNWT's Erosion and Sediment Manual.

Sediment and erosion control will be minimized by conducting ASR construction activities outside of more difficult or sensitive seasons, where possible, and by employing proactive control strategies for ground clearing, work in riparian areas, borrow pit development, and the installation of water crossings. Watercourse crossing structures will be inspected at least monthly to check on their performance and address any developing issues before impacts occur.

Water quality monitoring immediately prior to, during, and after ASR construction will focus on upstream and downstream differences, with TSS and turbidity being the prime parameters. A significant increase in either parameter downstream will trigger a response. A Canadian Council of Ministers of the Environment (CCME) guideline applies to both parameters and will be used for compliance. A sub-set of watercourse crossings will be monitored during road operations.

The SECP is a living management plan that will be updated throughout the life of the access road. It will be adapted to include any useful lessons learned (in terms of both the project, traditional knowledge, and recent technologies) that will be gained in the coming years. CZN looks forward to using this SECP for engaging with representatives of the NDDB, LKFN, and DFN to discuss, clarify, and add to the current principles and objectives of this management plan.

15.0 OPERATIONS AND MAINTENANCE PLAN

A draft Road Operations and Maintenance Plan (ROMP) is provided in Appendix 15-1. A summary follows. The plan discusses how CZN intends to mitigate impacts to vegetation from potential contamination along the road corridor, although this potential is now substantially less as concentrates will be shipped in sealed containers. The plan also describes the collection of baseline data on soil and vegetation metals concentrations prior to construction.

The ROMP serves to outline the maintenance, monitoring, and response actions to be employed during operation of the ASR leading to the Mine. It provides management guidelines and approaches with respect to operation and maintenance activities for the Prairie Creek ASR.

The ROMP will be in effect for all personnel using the ASR following the completion of road construction until mining operations have been shut down indefinitely. It is CZN's policy to ensure that proper procedures are implemented and followed at all times to promote the safety of ASR users and wildlife in the area. This ROMP provides operational guidance on the following:

- Traffic Intensity along the ASR including the estimated operational life and number of trips expected per vehicle type per day.
- Liard River Trailer Transfer where loaded concentrate trailers will be swapped on either side of the river for transport onward to Fort Nelson, BC.
- Winter Operations including management of road operations during winter months where cold weather, and potential avalanches are all factors to consider.
- Summer Operations including management of road operations during summer months such as barge operations, dust control, forest fires, increased wildlife, and rock falls are factors to consider.
- Barge Crossing at the Liard River during the summer months.
- Ice Bridge Crossings on the Liard River during the winter months.
- Security and Access Control to be implemented for public safety at the Liard River Crossing, including a manned checkpoint on the north side of the Liard River, motion cameras along the road alignment, and regular inspections to deter and monitor unauthorized activities.
- Road Rules and Regulations including commercial transportation use, off-highway use, speed limits, radio communication, traffic rights-of-way, vehicle inspections, and equipment requirements.
- Signage to identify speed limits, stop zones, kilometre markers, and special sections along the ASR including boundaries, confined watercourse crossings, wildlife crossings, down-grade sections, and hazard zones.
- Wildlife mitigations for avoiding interactions between vehicles and wildlife.

- Operation closures due to poor road conditions or unexpected hazards, poor road conditions.
- Emergency Shelters to be established at maintenance camps at KP 42, KP 87, and KP 120.
- Road Hazards including Avalanche Zones, Rock Fall Zones, and potential for Forest Fires.

Guidelines for maintenance of the ASR are also provided in this ROMP, including:

- Surface Conditioning and Updating such as road grading, snow removal, and right-of-way maintenance.
- Drainage and Watercourse Crossings maintenance for all bridges, ditches, and culverts.
- Barge Ramps including maintenance of running surfaces and repairs during low flow seasons.
- Borrow Pit maintenance per the individual Borrow Pit Management and Reclamation Plans.
- Dust Suppression, as required, during summer months when road conditions are dry.

Operational monitoring and adaptive management for the ASR also form part of this ROMP. Daily operational inspections and long-term monitoring are important for all infrastructure along the ASR, especially at watercourse crossings, rock fall zones, avalanche zones, and after hazardous events. Inspections may help to identify where additional rock fall and avalanche control mitigation is required. Operational closures of the ASR may be implemented following hazardous events, such as earthquakes or forest fires, that pose increased risk to road users.

This ROMP builds on the existing CZN Contaminant Loading Management Plan for managing contaminant loading along the ASR. A contaminant monitoring program will be established and will include permanent soil and vegetation sampling locations adjacent to the ASR. Sampling locations will be distributed along seven transects perpendicular to the ASR, spaced at approximate intervals of 25 km. Samples will be collected annually along each transect, at offset intervals of 0 to 30 m, 100 m to 500 m, 501 m to 1,000 m, and 1,001 m to 9,000 m. Two plant species will be targeted for collection at each interval along with 1 soil sample for a total of 28 soil samples and 56 vegetation samples.

At each sampling location, a brief plant survey will be conducted to identify target vegetation species for collection. Once identified, composite samples will be collected, within a 20 m radius, consisting only of the above-ground (stems and leaves) portion of plants. Lichens will be sampled by collecting the entire thallus, while berries will simply be picked. Surface soil samples will be collected from mineral horizons to a depth of approximately 100 mm below the organic mat. The analysis of total metal concentrations in vegetation and soil will focus on a subset of the metals, chosen based on baseline metal concentrations found in soils and vegetation as well as metals found to be present in Prairie Creek ore. A comparison of data to baseline concentrations will be used to identify trends over time.

Contaminant sampling will be conducted during the summer on an annual basis for the first three years of haul operations to assess potential effects and establish contaminant trends. In subsequent years, samples will be collected from the same locations to assess changes over time. If trends over

the first three years show no adverse effects from the ASR on soils and vegetation, the sampling interval may be reduced to every second year. After nine years, if adverse effects are still not recorded, the sampling interval may be reduced to every third year. Should the trend reverse, the sampling interval would revert to every year and response measures may be required to offset the adverse effects.

If an increasing trend in contaminants of concern is identified, response measures will be implemented based on three action levels. Action Level I occurs if annual concentrations are less than 20% greater than baseline concentrations and contaminant monitoring continues on an annual basis. Action Level II occurs if annual concentrations are more than 20% but less than 50% greater than baseline concentrations. The response is an internal review of concentrate handling and transport procedures resulting in corrective actions and additional mitigations to prevent further increases in concentrations. Action Level III occurs if annual concentrations are more than 50% greater than baseline concentrations and exceeds applicable guidelines. This will trigger additional sampling in the areas of concern to delineate the area of contamination both vertically and horizontally. After delineating the contamination, a response plan will be developed to review concentrate handling/transport procedures, implement new mitigation measures, increase contaminant sampling frequency, and remediate the affected area.

16.0 EXPLOSIVES MANAGEMENT PLAN

A draft Explosives Management Plan (EMP) is provided in Appendix 16-1. A summary follows.

The purpose of the EMP is to describe the safe, secure, and environmentally-sound practices for the handling, storage, and use of explosives needed for the construction of the ASR leading to the Mine.

The ASR construction project plans to use emulsion stick explosives to conduct blasting operations at certain specific road, quarry and borrow sites as necessary during the construction period.

The EMP is at a preliminary stage as suppliers have not been identified. For the ASR construction phase, explosives supply, management and use is expected to be contracted to a licensed contractor or contractors who will provide an operations manual for the safe transportation, storage, and handling of explosives.

Before carrying out a blasting program at a particular site, CZN's Environmental Monitor assigned to the program will undertake wildlife reconnaissance by scanning nearby slopes, ponds, and surrounding areas with binoculars to help determine whether blasting should be permitted to proceed at that time.

Consistent with CZN's commitments made during the Environmental Assessment Process the following mitigation measures will be undertaken to protect wildlife, birds and fish:

- Blasting within Boreal Caribou range is prohibited from May 1 to July 15 to avoid disturbance to potential Boreal Caribou calving and post-calving, unless a ground survey confirms the absence of animals within 1 km.
- Blasting is prohibited if Dall's sheep lambs are present within 1 km of the proposed Project from May 1 to June 15 or if Dall's sheep or wolverine are observed at any

other time within 1 km of the blast site until the animal(s) moves out of the area.

- Blasting is prohibited from April 1 to September 30 if Trumpeter Swans are located within 1 km of the blast site. Additional construction-related monitoring activities may be required during the Trumpeter Swan restricted activity period and will be conducted with the assistance of the CZN Environmental Monitor.
- Blasting activities located close to fish-bearing water bodies will be required to follow Department of Fisheries and Oceans (DFO) Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (DFO 1998) as modified by Cott & Hanna (2005) and DFO's NWT fish spawning timing window (http://www.dfo-mpo.gc.ca/pnwppe/timing-periodes/nwt-eng.html).

17.0 SPILL CONTINGENCY PLAN

A draft Spill Contingency Plan is provided in Appendix 17-1. A summary follows.

The purpose of the Spill Contingency Plan (SCP) is to provide a plan for quickly and effectively dealing with and cleaning up an accidental spill of fuel or other hazardous material associated with the construction and operation of the access road to the Prairie Creek Mine.

The SCP identifies key response people that will be available from the Mine, their responsibilities in the event of a spill, and the equipment and other resources that could be brought in to help in responding to a spill. The SCP also outlines the spill response strategies, tactics and procedures that will be used to minimize potential health and safety hazards and reduce potential environmental effects.

Incident Response Team

The initial CZN incident response team will come from the mine and will typically consist of six people including the Incident Commander, a Safety Officer and four responders, one of which will be a mechanic. The responders will work on the 'buddy system' in teams of two. Any required increase in the number of responders will also be in teams of two. The Incident Commander will be responsible for all communications off the spill site and will make sure that all activities undertaken are properly logged.

The Safety Officer will be an experienced employee with intimate knowledge of the operations and safe operating procedures. The Safety Officer's main responsibility will be to assess hazardous and unsafe situations and develop measures for assuring personnel safety. As mechanical equipment such as pumps and skimmers could be involved, a mechanic with appropriate tools has been included as part of the response team. The team would be supported by other units delivering additional equipment, as necessary.

In the event that the spill incident needs additional external resources, including specific technical expertise, additional equipment, etc. the Incident Commander will also be responsible for obtaining these resources in a timely manner from the off-site resources listed in Section 5.2 of this SCP.

Spill Control Points

When a spill occurs, there is a potential for spilled material to enter a water body and flow either

above or below any ice cover. A number of areas exist where a spill could enter a watercourse. Sensitive areas have been identified along Prairie and Funeral creeks, especially the upper section of Funeral Creek, Sundog Creek, and the Polje, Tetcela and Grainger stream crossings. “Control Points” will be established at pre-determined locations from which spill containment and recovery operations can be mounted to limit the migration of a spilled substance from an upstream location.

Spill Response Equipment

Necessary spill response equipment and supplies to be delivered to the appropriate Control Point for operations will include booms, absorbents, in addition to materials needed to create temporary dams, such as board weirs, sand bags and other inert materials that would be stored at the location. Shovels will also be left on site for use in in constructing berms, dams, etc. A supply of soda ash will also be kept at Control Points to neutralize any potential acid spill.

To help respond to a spill incident quickly, spill kits will be carried in all haul trucks. In addition, custom-built and stocked road trailers dedicated to spill response and containing more equipment, materials and tools will be maintained at the Cat Camp, the Km 87 Maintenance Camp and the Grainger Gap Camp during operations.

One or more of these trailers could be readily hooked up and towed to a spill site. There is no need to locate the trailers in high-risk locations because responders will still need to travel to the spill location and bring in the nearest trailer on the way. The tractor/trailer units would also provide emergency assistance if mechanical issues or adverse weather conditions occur. The trailers would also be used for preventative maintenance and spill response training. During ASR construction and operation of the associated winter roads, spill response equipment will be focused on diesel, and the location and type of equipment will be suitable for the season.

Spill Response Training

All members of the Spill Response Team will be trained and familiarized with the spill response resources, including their location and access, this SCP and appropriate spill response methodologies and reporting.

Operators stationed at the road maintenance camps will also receive appropriate spill response training. Response training will include classroom study, equipment deployment instruction and spill exercises. Training for individual employees/contractors would be commensurate with the duties each is to perform in their day to day functions plus basic spill response procedures.

The SCP is a living document that will be updated throughout the life of the Project to adapt to and incorporate any changes (in terms of both the Project or available technologies) that may arise. This will also include the results of ongoing engagement with the potentially-affected Indigenous groups, including NDDB, LKFN, and DFN, and applicable regulators and land managers.

Health, Safety and Emergency Response

A copy of the Health, Safety and Emergency Response Plan currently in use at the Mine site can be found in Appendix 17-2. This plan would also be applicable to the ASR.

18.0 FINANCIAL ABILITY

We understand that paragraph 26(5)(d) of the *Waters Act* and paragraph 72.03(5)(d) of the *Mackenzie Valley Resource Management Act* require the Board and Parks Canada to consider an applicant's financial ability to complete the undertaking, any mitigation measures which may be necessary, and maintenance and restoration in the event of closing or abandonment.

Historic Approvals

During the permitting process for MV2008D0014, MV2008T0012 and MV2008L2-002, CZN addressed this requirement to the Board's satisfaction. We have extracted a relevant summary from the June 14, 2013 Reasons for Decision below:

> *"The MVLWB must satisfy itself of the financial responsibility of CZN under paragraph 14(4)(d) of the NWTWA before it can issue the Licence. This matter was addressed by the Board in the May 11, 2012 directive sent to CZN, in which the Board requested that CZN describe, in detail, how they propose to address the costs of construction, operation, and maintenance through the life of the project, and closure and reclamation of the site. In a May 30, 2012 email to Board staff, CZN stated that financial statements and Management Discussion and Analysis (MD&A) reports were publicly available. They noted that past expenditures on the property demonstrate CZN's capacity to raise funds, and that the approach to the raising of further capital would be determined after issuance of permits and a licence.*
>
> *This matter was investigated in the hearing through questioning of CZN's Chief Operating Officer, Mr. Alan Taylor. Mr. Taylor was asked to provide a description of how CZN plans to finance the project throughout its life and through closure. Mr. Taylor assured the Board that because it is in the final stages of the permitting phase, CZN is in a good position to raise funds on the market, and that he was confident they could do so. He further stated that additional options available to CZN included financing through equity debt or a form of joint venture. Mr. Taylor, in response to further questioning, also confirmed that CZN would be amenable to a condition in the Licence requiring the posting of a security bond prior to undertaking any operations under the Licence.*
>
> *The financial security conditions in the Water Licence and the mine site Land Use Permit require an initial deposit shortly after approval, with additional deposits phased to match the increasing liability at the mine as the Project progresses. The initial deposit required by the Licence will ensure that all current and historical liability at the Prairie Creek is secured before new operations begin. The approach adopted by the Board is explained more fully below. It is consistent with the AANDC Mine Site Closure and Reclamation Policy. Consequently, the Board is satisfied that the requirements it has imposed are sufficient to protect the environment and ensure that the Prairie Creek Mine site is restored. In the Board's opinion, paragraph 14(4)(d) of the NWTWA has been satisfied.*
>
> *As is indicated below in these Reasons, the Board has imposed terms and conditions sufficient to protect water resources, the environment, and through the LUP, the land. In addition, the terms and conditions of the Water Licence, including financial security requirements are in the Board's view sufficient to ensure satisfactory closure and reclamation of the project."*

Current Status

We submit that the same reasoning as in 2013 is now applicable to the permitting for the proposed

ASR. We expect that the Board and Parks Canada will impose requirements sufficient to protect the environment and ensure that the ASR is restored, and that the Board and Parks Canada will impose terms and conditions sufficient to protect water resources, the environment, and the land, including financial security.

As a further note on financial capacity, CZN's parent company, NorZinc, has a major shareholder called Resource Capital Funds (RCF). RCF manages assets of over C$5 billion and through one of its funds (RCF VI CAD LLC) it owns approximately 41% of the shares of NorZinc. RCF is a major resource investment company, and the financing of the ASR, and the Prairie Creek Mine development, is well within the capacity of RCF, should it choose to do so.

In addition, at the same time as RCF invested an additional $20 million in CZN in July 2018, Mr. Don MacDonald became NorZinc and CZN CEO. Mr. MacDonald's focus over much of his career has been on financing the development of mines. Over the past 30 years he has been involved in the raising of over $5 billion of development financing for mining projects in Canada, the US and Chile.

19.0 OTHER EVIDENCE

No other evidence is provided here.

SCHEDULE 2 – MACKENZIE VALLEY LAND AND WATER BOARD

20.0 SECURITY ESTIMATE – TERRITORIAL LANDS

Reclamation cost estimates were generated by Allnorth. Their report is provided in Appendix 20-1 which contains the cost estimates and explains the approach and assumptions.

Security estimates in RECLAIM (version 7.0) were completed by Tetra Tech, and were based on the Allnorth estimates. RECLAIM was developed by Brodie Consulting Ltd. on behalf of the Government of the Northwest Territories (GNWT) to assist the GNWT, the Land and/or Water Boards, and other stakeholders (typically proponents) to estimate closure and reclamation costs at mines and advanced mineral exploration projects in the NWT.

The Tetra Tech RECLAIM estimates for the portions of the road on territorial lands are provided in Appendix 20-2. The estimates are sub-divided by ASR stage. Four stages were costed, Phase 1 winter road completion, the end of Y2 and Y3 of ASR construction, and then the ASR after 5 years. The cumulative estimate totals are as follows:

- Phase 1 winter road $789,742
- End of Year 2 $2,494,644
- End of Year 3 $2,573,421
- ASR after 5 years $2,165,903

Winter road reclamation costs are understandably much less than for the ASR. It was necessary to break-down ASR reclamation liabilities by time sequence since, as ASR construction progresses, the liability increases associated with the road, but varies with the sequence of borrow pits as while some new pits are opened, others are closed and partially reclaimed. Reclamation liabilities are less after 5 years as all borrow pits are closed and reclaimed, except those required for road maintenance.

The RECLAIM estimates do not reflect NDDB's currently confirmed preference to not reclaim the ASR section from the Nahanni Butte access road to the Liard River after closure (see section 7.1). In addition, NDDB have discussed constructing and operating a Youth/Wellness Camp at Grainger Gap, although no firm plans have been made. If these plans come to fruition, we understand the Band will want to maintain road access to the Gap long-term. CZN has also discussed use of the Mine site after mine closure with the Band. Some Councillors have said informally that some facilities at the Mine site and road access should remain after mine closure, but no formal NDDB resolution has been made to date.

21.0 SECURITY ESTIMATE – IAB LANDS

The Tetra Tech RECLAIM estimates for the portions of the road on Indian Affairs Branch (IAB) Lands are provided in Appendix 21-1. The estimates are sub-divided by ASR stage. Four stages

were costed, Phase 1 winter road completion, the end of Y2 and Y3 of ASR construction, and then the ASR after 5 years. The cumulative estimate totals are as follows:

- Phase 1 winter road $15,298
- End of Year 2 $135,447
- End of Year 3 $135,447
- ASR after 5 years $94,910

Refer to Appendix 20-1 for supporting information relating to the development of reclamation costs.

The RECLAIM estimates do not reflect NDDB's preference to not reclaim the road section from the Nahanni Butte access road to the Liard River, or the staging area on the south side of the river, after closure (see section 7.1).

22.0 AVALANCHES

Avalanche Solutions performed an avalanche hazard assessment for the ASR. Their report is provided in Appendix 22-1. A summary follows (the item in italics was added by CZN).

This report provides updated avalanche hazard analysis and mapping for the Prairie Creek Mine access road, including the winter route and all-season roads. In addition, this report provides an assessment of avalanche risk to proposed crossing structures, which, according to diagrams provided, are designated to be culverts and associated earthworks. Results of the analysis suggest that avalanches have the potential to temporarily block or damage culvert inlets which could cause associated flood damage to the road.

As indicated in Alpine Solutions (2012), there is avalanche risk to vehicles, and their occupants, travelling the access road at several locations. Revised avalanche hazard maps indicating locations of avalanche hazard are included as an attachment (in Appendix 22-1).

Alpine Solutions provides the following recommendations:

1. CZN should inform the road design team of the potential for temporary avalanche blockage of culverts, to determine if this may pose a flood risk. If necessary, mitigation measures to reduce the chance of avalanches blocking culverts may be necessary (*the hazard assessment was provided to Allnorth prior to completion of the preliminary designs contained in this UPD*).
2. An avalanche risk management plan should be developed for the access road that includes avalanche hazard forecasting and road closures during high hazard. To reduce hazard, the plan should provide options for avalanche hazard mitigation through artificial (e.g. explosive) avalanche release.
3. In order to decrease the uncertainty associated with the avalanche hazard assessment, avalanche paths should be observed for avalanche occurrences at least once per winter. This typically involves coordination by an avalanche professional, and could be achieved though fixed wing aerial observations coinciding with the end of other major avalanche cycles in the region.

Avalanche Solutions also created an Avalanche Safety Plan. This is provided in Appendix 22-2.

A summary follows.

The draft Avalanche Safety Plan (ASP) outlines the framework to manage avalanche risk to workers travelling on the Prairie Creek Mine access road. The plan assumes that Canadian Zinc Corporation (CZN) will engage a qualified avalanche risk management services company(s) to provide risk management services based on the policies and procedures described in this document.

This document includes:

- Avalanche safety training for workers.
- Check-in procedures.
- Avalanche rescue equipment.
- Operational avalanche hazard forecasting and communication by a qualified Avalanche Technician.
- Road closures during periods of high avalanche hazard.
- Optional direct avalanche hazard mitigation through artificial (explosive) triggering.

The draft ASP also specifies infrastructure requirements including:

- Weather stations.
- Avalanche detection system.
- Communications equipment.
- Avalanche area signs.

The scope of the ASP is expected to be expanded as more specific details of the mine operations become available. Furthermore, the draft ASP is a living document and is required to be reviewed on an ongoing basis to reflect improvements and changes as they are implemented.

23.0 RARE PLANT MANAGEMENT PLAN

Suggestion 11-2 of the REA is addressed in the Rare Plant Management Plan discussed in Section 27.

SCHEDULE 3 – PARKS CANADA

24.0 AVALANCHE HAZARD MANAGEMENT

See Section 22.

25.0 HARVEST MONITORING

Suggestion 7-1 calls for wildlife management authorities to develop and implement a harvest monitoring program. Suggestion 7-2 calls for CZN to support the program. As such, it would seem inappropriate for CZN to describe now how the Company will support the program before it is known what the wildlife management authorities propose. Nevertheless, CZN has proposed harvest monitoring initiatives which we describe below.

CZN agreed to provide support to the NDDB to develop and implement a harvest monitoring program to track and report on patterns and levels of harvest associated with the Access Road, and to include this in the WMMP. Access control and monitoring will include operating a checkpoint near the Liard River. We propose to include harvest monitoring as a checkpoint activity.

A voluntary Wildlife Harvest Questionnaire will be issued verbally at the checkpoint. The objective of the Wildlife Harvest Questionnaire is to track harvester observations and harvest pressure along the ASR. This will provide a manageable means of monitoring harvester access and success over the Project life in conjunction with potential changes in wildlife observations. The questions might include: what hunting and trapping practices would be/have been undertaken, approximate effort (number of hours/days spent harvesting), quantity of harvested species, apparent health and/or body condition of the animal harvested, general location of harvest effort (portioned into 10 km blocks and/or map delineation), the participants impression of hunting/trapping pressure (i.e., high, medium, low, negligible) on the harvested species and the overall range condition for that species. The voluntary survey need not record the participant's name. The survey would be augmented by harvesting observations of Environmental Monitors and other ASR staff for those harvesters declining to participate in the survey, and by information from remote cameras operating during periods when the checkpoint isn't staffed.

If harvest levels are observed to increase towards unsustainable levels, as determined by the Technical Advisory Committee (which will include Indigenous group and government representation), timely implementation of adaptive management measures will be discussed.

Measurable parameters from the monitoring program could include: 1) change in harvested species and average monthly harvest, and 2) change in harvesting effort over time (i.e., kills per hunting hours). These measurable parameters may provide an index of harvested species abundance along the ASR over time.

Results of the wildlife harvest effects monitoring program, including any adaptive management responses (as applicable), will be presented and reported on annually.

26.0 SUNDOG CREEK DIVERSION PLAN

A draft Sundog Creek Diversion Plan has been developed addressing REA Measure 9-1. A copy can be found in Appendix 26-1. A summary follows.

The draft diversion plan for Sundog Creek largely represents a compilation of existing information (from the EA); however, a small amount of additional analysis/new supporting information is also provided.

Diversion Description

The proposed ASR follows the Sundog Creek south floodplain between km 32.3 and km 41, and is constrained by adjacent steep topography that often consists of either cliffs or scree slopes. Between km 35.5 and km 37, the topography is such that the road alignment cannot avoid encroachment into the main channel located at the south edge of floodplain. After consideration of an alternative of constructing bridges at the upper and lower extents of the reach to access the opposite (north) floodplain, the preferred approach presented in this plan is to relocate about 1.5 km of the creek main channel from its present location along the south edge of floodplain to a prominent natural braid located in the central portion of the floodplain.

The central braid is a natural past position of the main Sundog Creek channel, and is believed to have been maintained by south bank landslide blockages of the south channel which deflected the flow to the central braid. The proposed diversion of Sundog Creek will include construction of a berm at the upper end of the reach, which will be hydraulically similar to a natural blockage. The central braid – now referred to as the "diversion channel" – will be enhanced by excavation, necessary to contain a design 100-year discharge without overtopping back to the south edge of floodplain, and with habitat features to offset alterations of the existing channel.

The diversion channel will be constructed in the native Sundog Creek alluvial materials, consisting of the sediment gradation that has originated from the upper basin. Channel dimensions (slopes, widths) will be similar to the existing main channel, thereby yielding water depths and velocities also similar to those in the existing channel. Where excavation is proposed, the larger cobble size material encountered will be selectively retained to stabilize steeper reaches. This is similar to the natural processes in which a stream may, over time, develop a pavement layer of coarse materials able to resist stream erosion.

Flows in Sundog Creek are intermittent, with portions of the diversion reach drying out in the open water season each year. Drying out beginning from the upstream end of the diversion reach is most regular in the fall, but portions of the channel have been recorded to be dry in summer months as well.

Hydrologic conditions along the proposed All-Season Road have been evaluated based on a regional analysis considering Water Survey of Canada Stream Gauges in proximity to the project. In addition to the regional analysis, a second, alternative, estimate of surface flow will be made. The rainfall characteristics for nearby climate stations, plus local precipitation data recorded for the Prairie Creek Mine, will be used to develop a hydrologic model of the Sundog Creek basin to validate the reasonableness of flows derived from the regional analysis.

Channel and berm construction will occur in the late summer or fall when the reach is dry and the potential for flows prior to winter is low. It is estimated that work on the channel diversion,

including the diversion berm and installation of habitat features, will take from 5-8 weeks to complete. With most construction being completed under dry conditions, it is proposed to rinse disturbed materials exposed or placed during construction to remove fines, and thereby minimize the supply of fine materials that could be mobilized during freshet.

Monitoring

Hydrology baseline monitoring will include ongoing operation of WSC stream gauging station 10EC003 on Prairie Creek at the Mine, established in October 2013, plus a new stream gauging station to be installed and operated by WSC on Sundog Creek upstream of the diversion reach.

Hydrology and stream morphology monitoring of the Sundog Diversion will consist of: (1) stream flow monitoring just upstream of the diversion reach and (2) periodic observations of the new channel to ensure that it is performing as expected. Flow monitoring results will be used primarily to support interpretation of other monitoring information.

A baseline monitoring program is outlined that will provide the required data to allow CZN to assess whether the re-aligned channel is providing comparable fish habitat quality compared to the existing channel. In addition to the baseline monitoring program, this plan outlines short and long-term monitoring programs for water quality, periphyton, benthic invertebrates and fish, as well as adaptive management approaches to be followed should monitoring programs indicate that an unacceptable change from baseline conditions has occurred. Key aspects of the monitoring programs are as follows:

- Sampling sites – for water, benthic invertebrate community and periphyton monitoring, there will be a minimum of six monitoring sites; two upstream of the re-alignment, two within the re-alignment, and two downstream of the re-alignment. Under certain circumstances, the number of monitoring sites will be increased to nine. The additional monitoring sites are designed to isolate and quantify the potential confounding effects of nearby tributaries.
- Water – the emphasis of water quality monitoring will be on turbidity and total suspended solids (TSS). The emphasis on monitoring will be greatest at the time of the first flush and decrease rapidly afterwards. A turbidity vs. TSS curve will be developed during the baseline study, allowing the use of turbidity as a surrogate for TSS. Turbidity can be measured using field equipment, while TSS is measured in a lab and therefore requires more time before results are known. In-situ water quality variables (i.e., pH, conductivity and temperature) will also be measured when field staff are collecting water quality samples at the re-alignment location. Alkalinity, total dissolved solids, nutrients, major ions, and total and dissolved metals will be collected during the freshet and summer prior to the diversion, and will be used as baseline data should post-diversion conditions warrant concern and therefore analysis of these constituents.
- Benthic Invertebrates – the purpose of the benthic invertebrate study will be to assess if benthic invertebrate community assemblages establish themselves quickly within the new channel. Benthic invertebrates are important food items for fish and therefore are an important component of the Sundog Creek ecology. If the numbers of individuals or species within the new channel does not approximate what used to be in the original channel at the end of the second season post-diversion, then CZN will investigate the underlying cause and may have to take

corrective action.

- Periphyton – the purpose of the periphyton study will be to assess if periphyton biomass downstream of the diversion is affected by the diversion. Localized nutrient inputs into both the existing channel and future channel make it challenging and potentially misleading to compare future biomass in the new channel against biomass that existed in the original channel pre-diversion. Therefore, the emphasis will be on comparing the biomass of periphyton downstream of the planned diversion reach against those located upstream.
- Fish – the emphasis of fish studies will be on comparing the relative ability of grayling to migrate to spawning sites upstream of the diversion reach pre- and post-diversion. Investigations will include assessments of velocities within the new channel, habitat features that provide refuge from flow, as well as freshet and summer distribution assessments of grayling in Sundog Creek upstream of the proposed diversion reach.

For construction monitoring, CZN will contract independent Dene monitors to assist with the execution of monitoring programs.

Diversion Design and Construction

The report also provides a detailed description of the planned re-alignment and diversion berm, as well as a description of the construction plan. Best management practices to be followed during both the construction and operation of the road are also outlined. Key aspects of the design are as follows:

- Setting – as mentioned above, the proposed re-aligned channel will be a pre-existing dry channel within the same alluvial flood plain, having similar qualities as the existing channel. Modelling has confirmed that habitat created should be comparable.
- Berm and Diversion channel – a berm will be constructed at the upstream extent of the diversion reach to re-direct water into the diversion reach. The berm will consist largely of excavated creek alluvium, but the front face will be armoured with heavy rock. It will be designed to withstand a 100-year flood. The diversion channel will require some excavation to reduce the risk of overtopping flows and avulsions.
- Habitat features – five blind channel "fingers" will be created along the north side of the new channel. The purpose of these channels will be to provide temporary refuge from high flows for migrating grayling.
- Timing – all work will be done in the summer and fall when Sundog flows are anticipated to be low. In order to reach the new channel, equipment will only pass through the existing thalweg when it is dry. The new channel will be isolated during all work and therefore will not contain any flow.
- Release of silt – given that equipment will not pass through flowing water and that all work will be done on a dry channel, the release of silt during construction is not anticipated. While some silt (natural bed material) will be released during the first flush after activation, and possibly a small incremental amount above background during the first few weeks of operation, CZN will take steps to reduce the amount of silt released. This will consist of washing off substrates in the new

channel prior to activation with water drawn from pits dug into the new channel alluvium.

- Habitat offsetting – the planned diversion will result in both an alteration as well as some habitat loss. In order to offset for these losses, the creation of a large overwintering pond is proposed. Overwintering habitat appears to be the most limiting habitat in Sundog Creek adjacent to the planned diversion. The report summarizes offsetting, greater detail will be provided in an application for a Fisheries Act Authorization, which will be completed in the Fall of 2019.

27.0 RARE PLANTS

27.1 Field Surveys

Additional rare plant field surveys have been completed as part of project baseline studies to address Measure 11-1, Part 1, notably in 2017. Refer to the Tetra Tech report in Appendix 5-1. The results of this and past surveys are summarized in the Rare Plant Management Plan.

27.2 Rare Plant Management Plan

Four rare plant surveys have been completed as part of project baseline studies A draft Rare Plant Management Plan (RPMP) can be found in Appendix 27-1. A summary follows.

The RPMP was prepared for CZN by Tetra Tech Canada Inc. (Tetra Tech). The RPMP presents management practices to be employed during the construction and operation of the ASR and associated infrastructure.

The RPMP establishes a framework to integrate the protection and management of rare plants identified in the vicinity of the ASR corridor, Prairie Creek Mine, and associated infrastructure with monitoring to determine their condition over the duration of construction and operations. It also provides for the inclusion and management of new rare plant or rare plant assemblage observations.

Four rare plant surveys have been completed as part of project baseline studies:

- July 2009 – along the Prairie Creek Mine winter road, proposed waste rock storage facility, camp and surrounding area, and beaver pond located south of the camp
- August 2010 – along the proposed Polje By-Pass re-alignment
- July 2016 – along the proposed ASR, borrow pits, road realignment areas, and areas supporting unusual landscape features within NNPR (from km 17 to km 101)
- June 2017 – within a 100 m buffer extending from either side of the proposed ASR centreline within NNPR (from km 17 to km 101).

In addition, an invasive plant species survey was conducted in August 2018 that covered where the access road overlapped with the historic winter road and exploration cut-lines, the Nahanni Butte community access road that overlaps with the ASR, areas cleared by the Nahanni Butte community in 2017, some of which cover the proposed ASR alignment, and spot checks of undisturbed areas in the vicinity of the broader invasive plant survey areas. While the survey focused on the identification and establishment of invasive plant species, incidental observations of other plant species, particularly those considered rare, were made as well. No rare plants were

identified during the invasive species survey.

During the 2009 rare plant survey, nine rare species were identified: few flower meadow rue *(Thalictrum sparsiflorum)*, Hornemann willowherb *(Epilobium hornemanni)*, linear-leaved willowherb *(Epilobium leptophyllum)*; alpine anemone *(Anemone drummondii)*, Northern bog birch *(Betula pumila)*, lesser black-scaled sedge *(Carex atrosquama)*, one-glume spikerush *(Eleocharis uniglumis)*, alpine groundsel *(Packera pauciflora)*, and yellow mountain heather *(Phyllodoce glanduliflora)*. With the exception of one-glume spikerush and alpine groundsel (both still listed as Sensitive), these species have since been delisted.

In 2017, 21 meandering transects were carried out within a 100 m buffer extending from either side of the road centreline. Two rare plant species were identified over multiple locations: spleenwort *(Asplenium trichomanes-ramosum, formerly A. viride)* listed as May Be At Risk and small round-leaved bog orchid *(Platanthera orbiculata)* listed as Sensitive.

The management goals and objectives with respect to rare plants are as follows:

- Protect, manage, and monitor rare plant species and their habitat that may be affected by Project construction and/or operations
    - Data collection (e.g., descriptions of plant distribution (locally and more broadly within the NWT), relative abundance, and habitat quality), will allow for the efficient and repeatable detection of changes over time.
- Provide CZN and regulatory agencies with a process and framework for rare plant management and rare plant assemblages within the Project area.

The RPMP applies to rare plants located adjacent to project infrastructure, as rare plants that intersect with project disturbance footprints are to be collected and donated to various herbaria. The management strategy is based, in part, on the identification of management units (MUs), which are ecologically distinct areas of land that focus on populations of rare plants. MUs are assigned a set of goals and objectives, a desired future condition, and will be used to gauge the overall success of the management plan.

Monitoring will be conducted in individual MUs to verify whether the management strategy is having the expected effect on rare plants. Permanent plots or transects will be established within each MU to facilitate consistent, long term collection of data (e.g., the duration of the project).

Monitoring will be conducted at regular time intervals (e.g., during the growing season – June to August) following repeatable methods. MUs will be established and surveyed in the summer prior to the initiation of construction. Following construction, MUs will be surveyed at regular intervals. If rare plant densities are shown to be declining over time, habitat degradation (e.g., from dust) or disturbance is evident, or there is increased encroachment by invasive species, more intensive monitoring and adjustments to the management plan and project operations may be required.

28.0 SECURITY ESTIMATE – NNPR LANDS

The Tetra Tech RECLAIM estimates for the portions of the road on Park lands are provided in Appendix 28-1. The estimates are sub-divided by ASR stage. Four stages were costed, Phase 1

winter road completion, the end of Y2 and Y3 of ASR construction, and then the ASR after 5 years. The cumulative estimate totals are as follows:

- Phase 1 winter road $1,199,718
- End of Year 2 $3,289,677
- End of Year 3 $3,289,677
- ASR after 5 years $2,911,860

Refer to Appendix 20-1 for supporting information relating to the development of reclamation costs.