APPENDIX A

Proposed Prairie Creek Mine Access Road

Supplement to Original Submission

Response to Mackenzie Valley Review Board Adequacy Review of Developer's Assessment Report

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1 BACKGROUND

Canadian Zinc Corporation (CZN) is seeking to begin operation of the Prairie Creek Mine located in the south west corner of the Northwest Territories approximately 555 kilometers west of Yellowknife, 330 kilometres north of Fort Nelson, B.C. In July, 2014, CZN requested Allnorth Consultants Limited (Allnorth) define a route for an "all season" access road connecting the mine site to Highway 7. Allnorth completed an evaluation and submitted a final "Proposed Prairie Creek Mine Access Road" report to CZN on February 27, 2015. CZN utilized this report within their "Developers Assessment Report" (DAR) submitted to the Mackenzie Valley Environmental Impact Review Board (MVEIRB) on April 23, 2015.

MVEIRB completed an "Adequacy Review" of the submission and presented their findings on May 22, 2015. CZN coordinated a response with involvement of the participating consultants including Allnorth, and presented a preliminary response to MVEIRB on June 16, 2015. MVEIRB issued a reply dated June 24, 2015, providing clarification on the comments and/or concerns presented by CZN.

This report addresses Allnorth's component of CZN's response to the Adequacy Review (AR). In addition, this report also provides an alternate alignment option from KP 103 to 124 and additional borrow sources proximal to the alternate alignment and between KP 126 to 159.

2 ADEQUACY REVIEW RESPONSE

Allnorth's response item by item as listed in the original MVEIRB Adequacy Review and June 24, 2015 response is provided below.

2.1 Considerations of alternatives to the Development

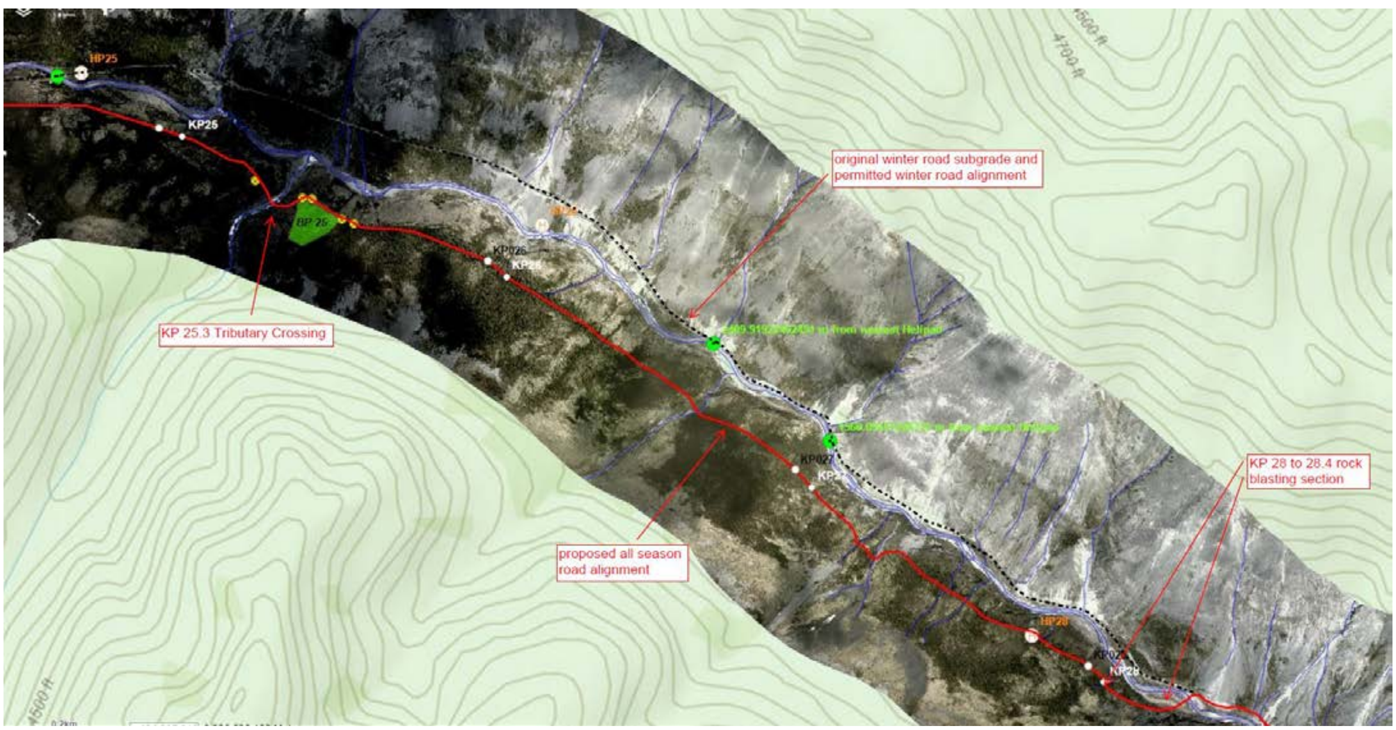
References: ToR – 3.5, 6.1; **DAR** 3.3, 6.2, 6.3.2; **AR** – 3.1; **June 24** – pg1, paragraph 3,pg 4, paragraph 2, pg8, paragraph 1

The AR requires a detailed account of the selection procedures and processes Allnorth applied to determine the best route for the all season road location.

CZN provided Allnorth with the permitted winter road alignment which was largely based on the original winter road alignment constructed in the early 1980's, with realignments approved in a previous environmental assessment. This route provided the basic alignment approach for the all season road. The initial desktop review identified a number of concerning/critical sections or control points which required review in the field investigation. These included all major stream crossings, bedrock, slope stability, avalanche/rock fall, stream riparian encroachments, wet soils, permafrost potential, road grades/alignment, switchbacks, and borrow locations focusing on surface aggregate. An initial, high level field investigation was completed July 26 to 29, 2014, followed by a more intense field investigation from September 15 to 30, 2014. The field investigation was completed by three senior road location/construction specialists with more than 80 years combined experience in B.C and supported by a geotechnical engineer from Tetra Tech EBA.

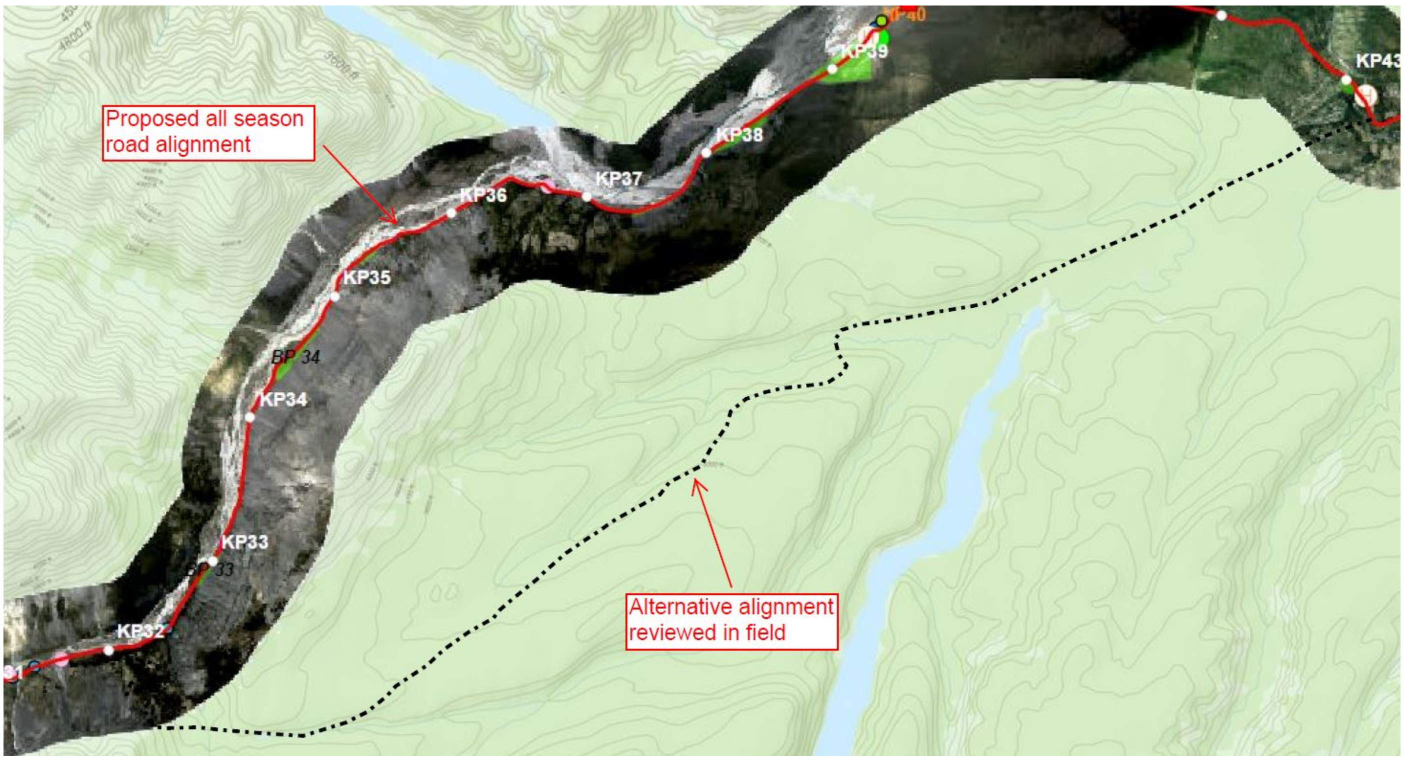
Table 1 below summarizes the various sections under review and alternatives considered during the routing process. A detailed account of major stream crossings is located in Section 2.2 below:

Table 1: Routing Options Alternatives

<table>
<tr><th>Section</th><th>Comments</th></tr>
<tr><td>KP 15.8 to 16.8</td><td>Reviewed option to eliminate switchback at KP 16 and directly route from KP 15.8 to 16.8. Option was rejected because of excessive road grades.</td></tr>
<tr><td>KP 24.3 to 28.4</td><td>The original road location and winter road alignment followed along the north side of Sundog Creek which had significant concerns/issues related to rock fall, avalanche, talus slope management, construction, long term road maintenance, and close proximity to Sundog Creek.
The alternative and preferred route stays on the south side, on an upper bench above Sundog Creek. This location is anticipated to significantly reduce rock fall/avalanche risk and long-term road maintenance, and greater clearances from Sundog Creek should reduce potential environmental risks. This alternative route does have construction challenges at the KP 25.3 non-fish stream crossing and expected rock blasting from KP 28.0 to 28.4. However, these sections are confined, short, and manageable. Dolostone, including the presence of possible sinkholes, appears to be present along the preferred route, but the risks posed are considered to be less than those along the original route. Tetra Tech EBA notes that the same bedrock types have been mapped on both sides of the creek, but features north of the creek may be obscured by the other terrain features, e.g. talus slopes. (See Figures 2 & 3 in Tetra Tech EBA geotech report (p. 19-20 of report, p. 29-30 of pdf). GSC Map 1378A shows bedrock geology for this area.)</td></tr>
<tr><td colspan="2">

A map view of the alternative section from KP 24.3 to 28.4.</td></tr>
<tr><td>KP 32 to 43</td><td>An alternative route was considered to avoid constructing a road along the south edge of the Sundog Creek floodplain where a channel realignment is required, and talus slopes exist. The alternative route would climb south-east out of the valley at KP 32 through a small pass, then head north-easterly</td></tr>
</table>

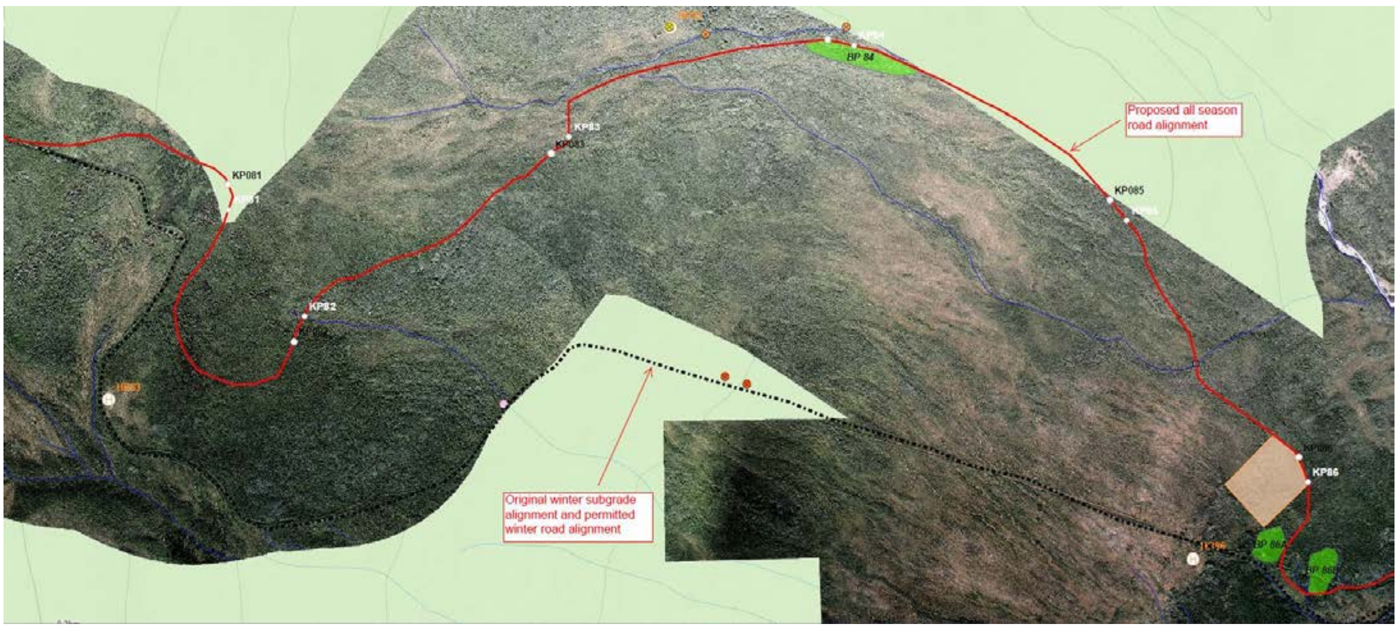
Section	Comments
	crossing a series of high plain ridges, several significant streams and reconnecting between KP 42 to 43. An aerial reconnaissance combined with a review of LiDAR contour data revealed the section from KP 32 climbing out of the valley would be a considerable construction challenge, involving steep grades and switch-backs. It is our professional opinion and judgement that the original route along Sundog Creek offers the least risk overall and is the most constructible option.



A map view of the alternative section from KP 32 to 43 reviewed in the field.

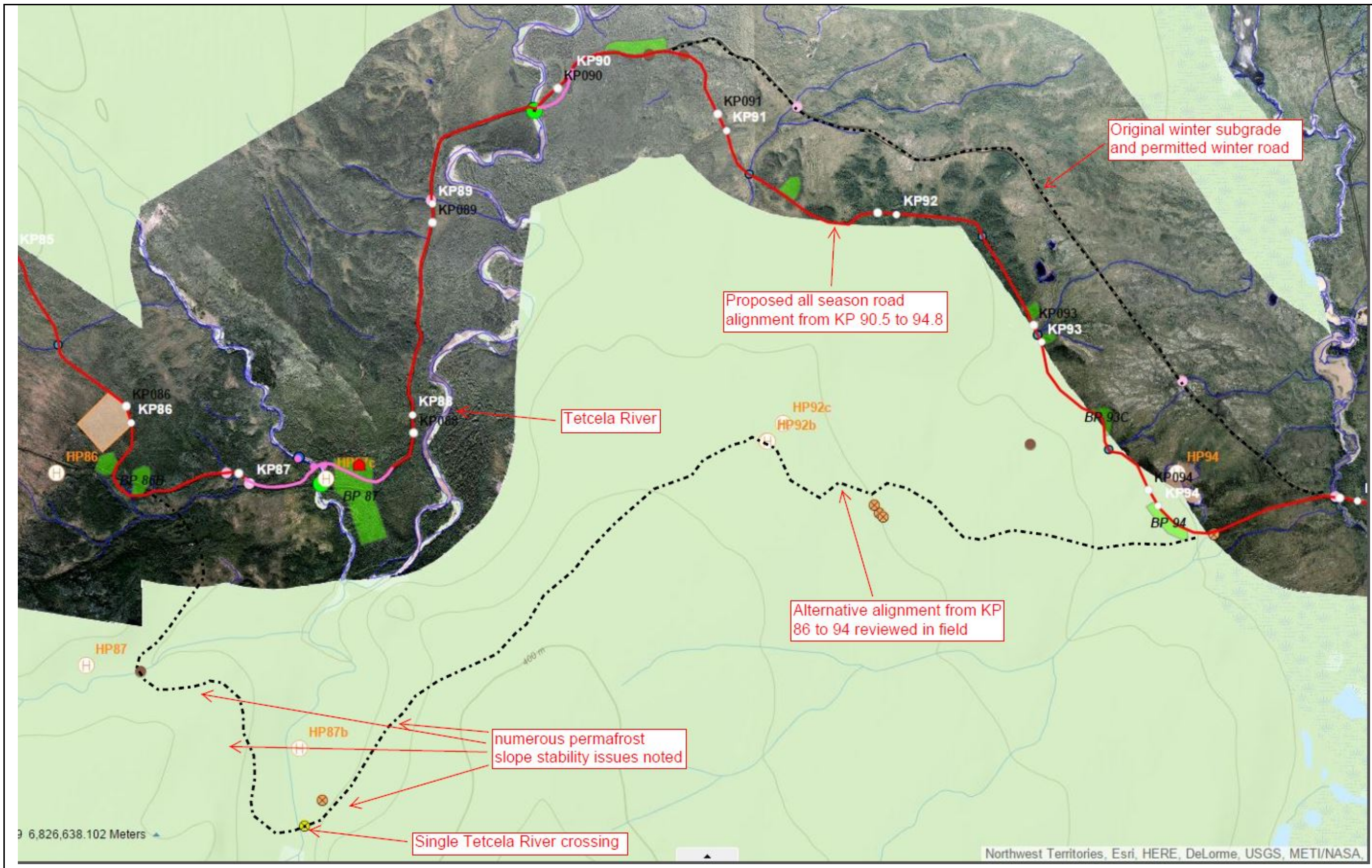
KP 49.5 to 50.5	This section was re-aligned from the permitted winter alignment in favour of a more direct approach which also improved the stream crossing location at KP 49.7 by avoiding some unstable seeping slopes on the west side of the original crossing further upstream. (See Figure 4 in Tetra Tech EBA geotech report (p.27 of report, p. 37 of pdf). BH-01 is at location of rejected crossing. See also Appendix C p. 28 (p. 229 of pdf) for photo of rejected crossing area)
KP 56 to 57	This section was re-aligned from the permitted winter road alignment to improve overall road alignment while maintaining consistent road grades, and eliminating a switchback, thereby reducing the effects of the road on a potentially unstable slope, avoiding the lower slopes in the gully leading to the Third Poljie while also avoiding a sinkhole area downslope of the new route. (See Figure 6 on p. 31 of Tetra Tech EBA geotech report (p. 41 of pdf), and p. 32 of Appendix C (p. 233 of pdf).
KP 80 to 86.5	The winter road alignment utilized the original road location. It was determined that this route option had to cross over a large, wet section not preferred for an all season road. Some old slope instabilities

Section	Comments
	were also noted in this area. In addition, some sections of the original route had road grades at or above the defined road design specifications of 8%-10% sustained. The all season road alignment avoids crossing the large, wet section by skirting around the northern edge following drier, preferred aspen/jack pine stands. This detour also avoids the steeper sections of the winter alignment with a less steep, more gradual, consistent grade from KP 80 to 86.5. The detour is also aligned to avoid the potentially unstable slopes below to the north and north-east and to mitigate effects from development of the road on those slopes. (See Tetra Tech EBA geotech report, Figures 7 and 8 on p. 34 and 37 (p. 44 and 47 of pdf)



A map view of KP 80 to 86 proposed re-alignment.

KP 86.5 to 94	An alternative route was considered which followed south-east from KP 86.5, crossing the Tetcela River, then east to re-connect at approximately KP 94. This option was initially conceived because it offered a single major crossing over the Tetcela River instead of two crossings on the original route and it appeared that this option could be significantly shorter. After an intense field review, it was concluded that although this alternative did offer advantages, some portions of the route had greater permafrost and slope stability risks than the original route. Consequently, the original route was favoured.



Alternative alignments considered from KP 86.5 to 94 and proposed re-alignment section from KP 90.5 to 94.8.

KP 90.5 to 94.8	The winter road alignment follows the original route across flat, extremely wet swamps/bogs where thermokarst terrain has been noted. The all season road alignment is shifted onto an upland area to the south-west, crossing a series of large, dry ridges and humps covered in jack pine, thus avoiding the wet swamps and bogs in the valley below.

<table>
<tr><td>KP 97.8 to 101</td><td>The permitted winter road route was conceived and developed previously by SNC Lavalin.
Tetra Tech EBA's geotechical engineer and terrain scientists identified potential concerns with slope instabilities, debris flow channels, and sinkholes along the winter alignment for the all season road. Upon further consultation and discussion with the engineer, and after field checks for grades, an alternative route was defined to reduce the exposure to the identified geohazards. In addition to reducing the geohazard-related risks, the revised alignment offers reduced overall length and eliminates 2 of the 4 switchbacks of the winter alignment.</td></tr>
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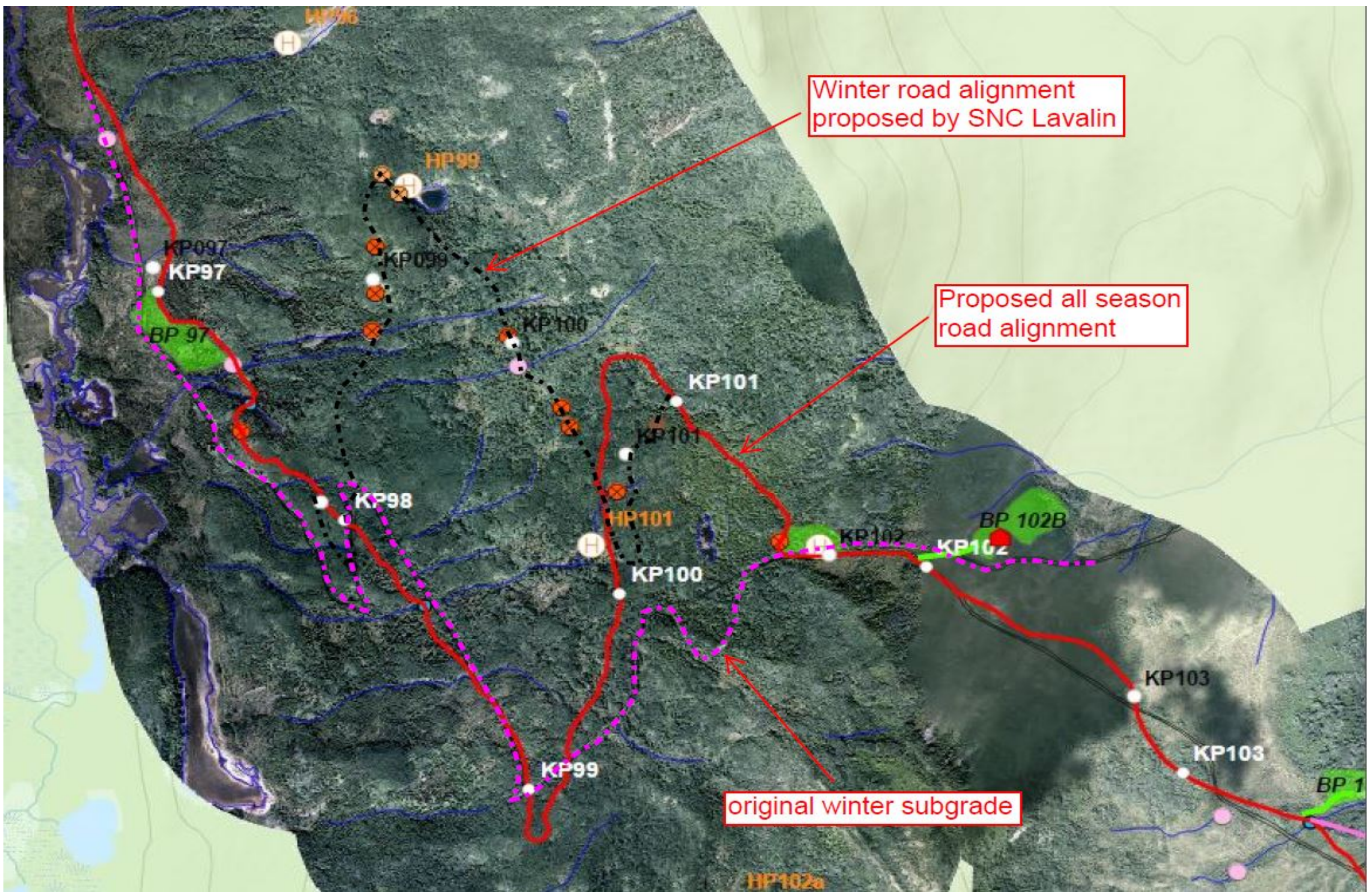
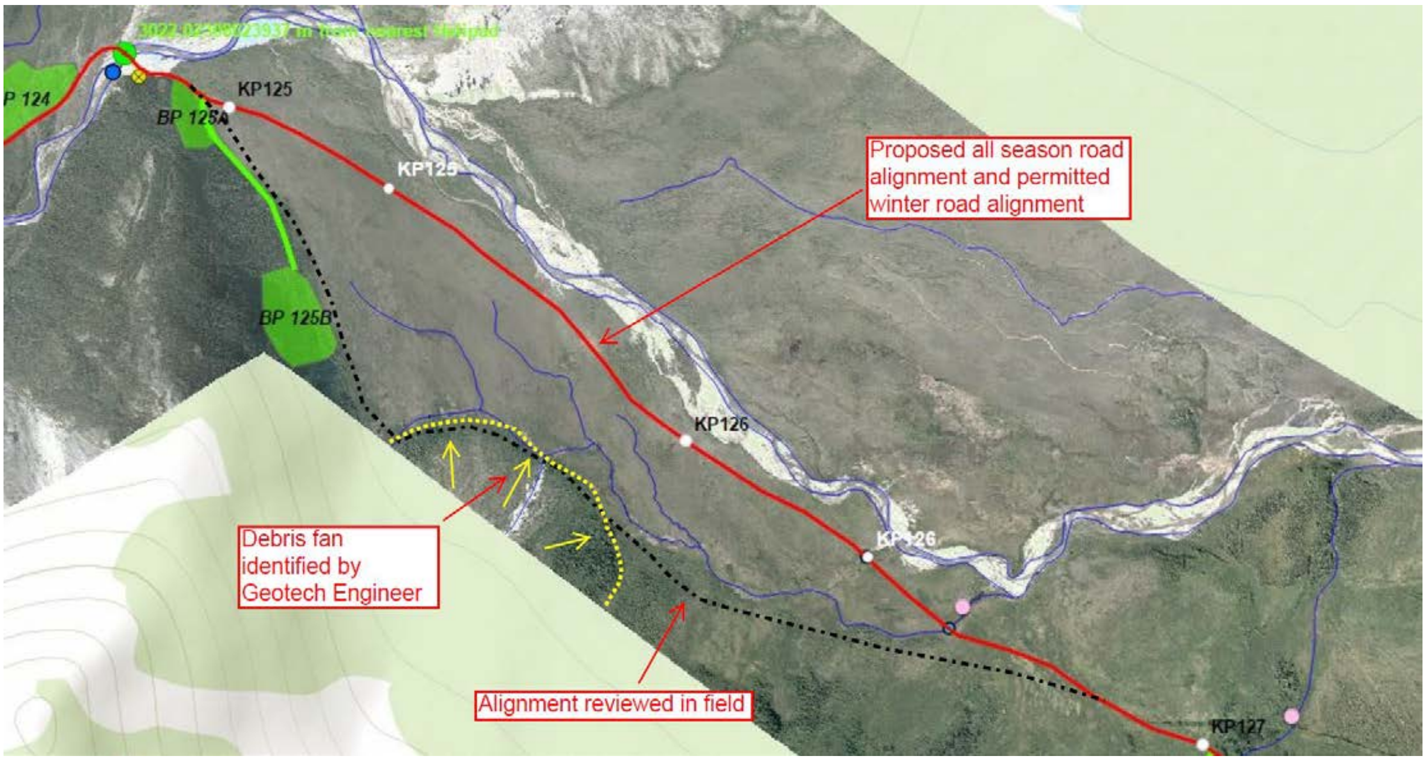


Proposed re-alignment of all season road between KP 97.8 to 101.

</td></tr>
<tr><td>KP 122 to 123.2</td><td>The permitted winter alignment and original winter road crosses a large, wet fan and southern tip of Gap Lake (acceptable for a winter option). The all season alignment was shifted south and upslope to avoid this undesirable location.</td></tr>
</table>

KP 125 to 127	The permitted winter alignment utilized the original road alignment crossing the old floodplain of Grainger River. Early in defining the alignment of the all season road, it was thought that shifting the road west off the old floodplain (which appears wet) would be beneficial and therefore this became the preferred alignment. Tetra Tech EBA noted that while geohazards related to ice-rich permafrost, thermokarst and possible flooding would be reduced with the west realignment, geohazards related to placing the alignment along a potentially active debris fan and adjacent rock fall hazard zones would increase. Therefore, the all season road alignment will primarily utilize the permitted winter alignment, and the routing has been optimized to avoid both thermokarst areas and upslope hazards.



Re-alignment option reviewed in the field from KP 125 to 127.

The sections detailed above account for the significant or larger alternative alignments which were reviewed and considered. Numerous other smaller re-alignments and adjustments were adopted to improve the overall road constructability and environmental footprint. The detailed design process would add additional refinement and improvement to the alignment.

2.2 Freeboard at watercourse crossings, estimated peak flow rates, and water surface elevations

References: ToR – 5.1.3, 6.1, 6.2, ,7.3.5; 7.3.7 **DAR**, 4.3, 6.7,11.5.1,11.5.2, 11.5.3, 11.6, 16.5 Appendix 1; **AR** – 4.1, 4.8, 4.9; 4.10, 7.6 14.2, 14.3 14.4, 16.5, **June 24** – pg3, paragraph 5, pg4, paragraph 1-3, pg7, paragraph 3, pg8, paragraph 5, pg10, paragraph 7, pg 12 Section 21.3

The AR requested additional information on each major watercourse crossing describing:

- risks to infrastructures and stream integrity
- crossing selection process and alternatives
- calculated Q100 flows and freeboard included in the preliminary designs
- channel stability and changes to morphology resulting from crossing structure or constricting channels
- erosion/scouring/riprap armour and sediment risk, control, and management

A total of 18 major stream crossings were identified in the original report. A "revised" preliminary design has been completed on 7 of the major crossings considered to be at greater risk related to infrastructure, channel, morphology, high water flows, and general stream integrity. These revised designs were updated with calculated Q100 flow elevations and site specific measures to be applied to ensure long term protection of stream integrity and road infrastructure. After applying the calculated Q100 flow levels, 3 of the original preliminary bridge designs (KP 39.8, 53.7, and 89.8) were considered under-designed for sufficient freeboard, and were therefore raised in elevation, necessitating increased span lengths. Appendix B includes revised preliminary designs for the following streams:

- KP 28.3 - KP 28.9 - KP 39.8
- KP 53.7 - KP 87.4 - KP 89.8
- KP 124.8

Below is a summary, with detail, of all the major watercourse crossings. This explains the crossing selection process and design considerations. Additional descriptions have been included for the alternate alignment option from KP 103 to 124.

Table 2: Summary of Major Watercourse Crossings (Table 10 of original report)

Casket Creek K.P. 6.2
Proposed Structure: 14.2 m clear span bridge (Replace existing 7m span bridge).
Site Description: Steep mountain slopes dictate south approach and road alignment. The north approach/alignment crosses historical floodplain which at times looks active. The stream is determined as potentially fish bearing.
Risks and Mitigation: Crossing a broad alluvial floodplain is not preferred, but there are no feasible alternatives since the valley sides are steep, confining the road location and alignment. The chosen location offers a defined, relatively stable main channel. The selected crossing structure will a clear span bridge across the identified active high water level including calculated freeboard and designed to accommodate Q100 (100 year) flood levels. All bridge foundations and stream banks at crossing will be armoured with rip rap. The premise of the approach and design is to maintain the main channel in its current location. The main channel is confined on the south side by a rock wall. The north bank will be stabilized by constructing an upstream dike (with armouring) extended as

necessary with the intention to maintain a stable, main channel. In addition, a downstream dike (with armouring) would also be constructed with the intention to maintain the stable, main channel flow downstream and eliminate potential "back-eddy" effects which could undermine road subgrade.

The north approach crosses a secondary (overflow) channel along the north bank which develops water flow during high water seasons (such as spring run-off). An existing 1600 mm CMP (corrugated metal pipe) will be utilized at this crossing. In addition, 2 overflow culverts (one presently existing) will be added on the floodplain. During extreme or peak flood conditions, it is expected excess water may flow over the remaining northern floodplain and several minor channels may develop. The high water channels will be managed by directing water flow through additional overflow culverts to allow the free flow of excess water downstream.

Other measures taken include constructing final road elevation significantly lower than bridge elevation to ensure high water levels are not significantly backed-up (or dammed), allowing excess water to free flow over the road surface. This approach would provide an outlet for excess water to flow, reducing overall water velocity and pressure, minimizing it's potential to damage road structure and bridge foundations. The upstream side of the road structure will be armoured to provide secondary protection from water/debris flood/flow scouring.

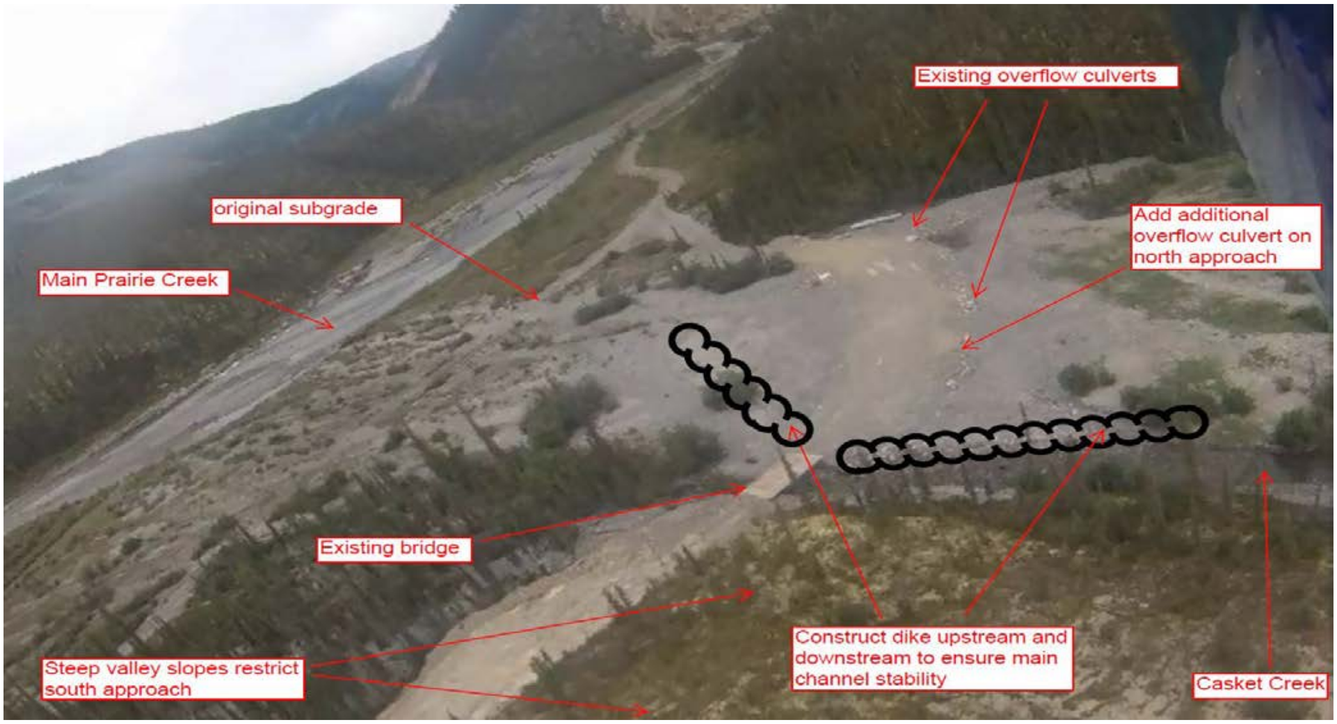
Long term road performance would be continually assessed following high water events and changes made accordingly. Ditches will be cleaned as required and maintained, culverts will be cleaned out and restored to ensure full capacity. Additional cross drainage culverts may be installed if required. From time to time, some minor breakdown of the road subgrade may occur, and would be restored.

The bridge foundation of choice is a pre-cast spread footing which will complement the coarse gravel based native materials

These measures will minimize sedimentation during high water events, although the high water will already have a high amount of suspended solids from bed load mobilization.

(See p. 5 of Appendix C in Tetra Tech EBA geotech report (p. 206 of pdf)).

Erosion and Sediment Control: The road subgrade would be constructed with suitable granular material found off floodplain locally. The majority of this material consists of clean gravels and cobbles and is not expected to introduce or expose the stream to greater levels of sedimentation above the typical natural cycle. Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



A view of the proposed stream crossing at KP 6.2, July, 2014.

Sundog Tributary K.P. 20.3

Proposed Structure: 29.4 m clear span bridge or multiple large culverts

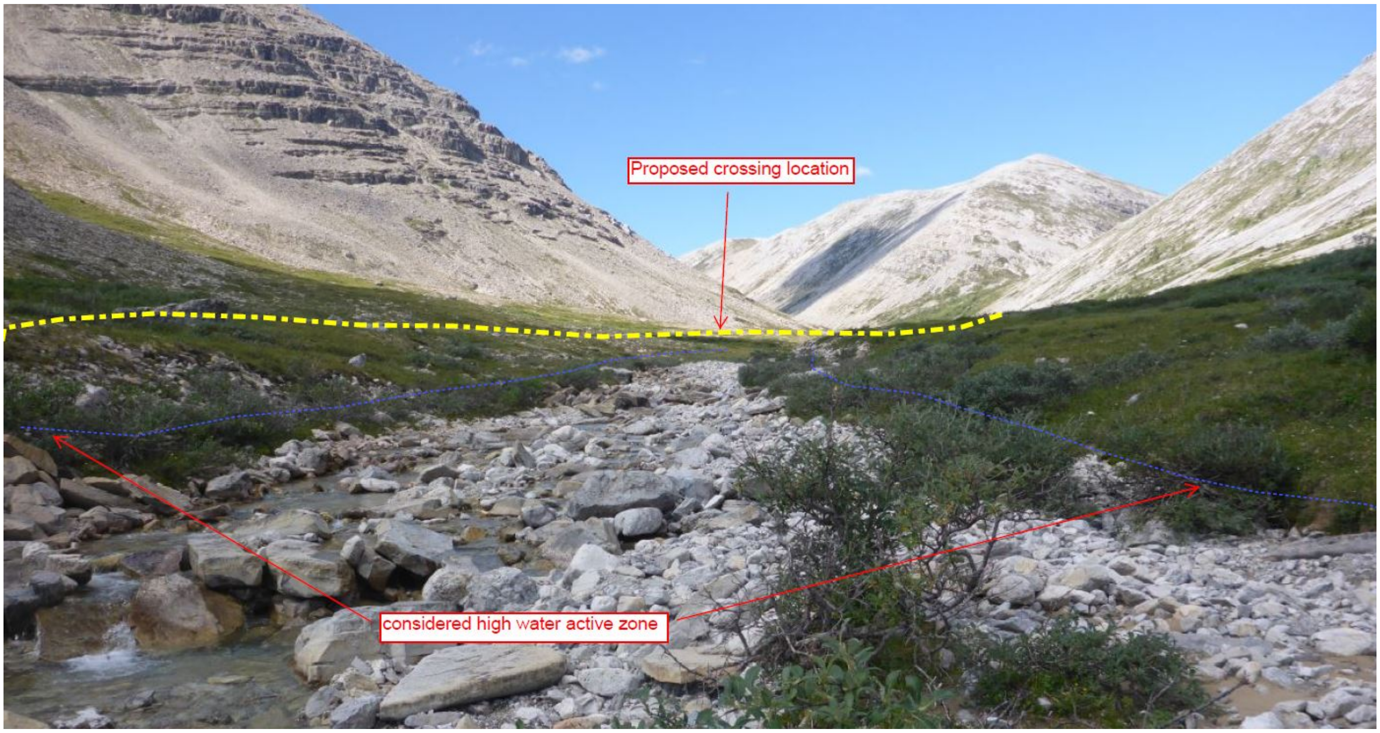
Site Description: Single main stream channel stable and defined, offers flexible and comparable crossing locations 100 m upstream or downstream. It has been determined this tributary is non-fish bearing.

The proposed crossing location attempts to utilize most of the existing road subgrade with an adjusted alignment. The adjusted alignment permits a more direct crossing approach, reducing crossing span length and overall impact to main stream channel.

Risks and Mitigation: This location is not fish-bearing due to a large waterfall located 5 km downstream. Stream channel is straight, confined in valley, stable, and vegetated.

The selected crossing structure will either be: (i) a clear span bridge across the identified active high water level including calculated freeboard and designed to Q100 (100 year) flood levels: or (ii) multiple large diameter culverts (calculated to Q100). Selected structure type will be armoured with rip rap protecting bridge structures, stream channel, and culvert inlet/outlets.

Erosion and Sediment Control: The road subgrade and approaches would be constructed with suitable granular material found locally. The majority of this material consists of clean gravels and cobbles originally deposited by the stream and are not expected to introduce or expose the stream to greater levels of sedimentation above the typical natural cycle. Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



A ground profile view of the stream crossing at KP 20.3, July, 2014.

An aerial view of the stream crossing at KP 20.3, July, 2014.

Sundog Creek K.P. 23.5

Proposed Structure: 68 m Multi-span bridge

Site Description: Well defined, steep walled main stream channel has been determined as non-fish bearing.

Risks and Mitigation: The proposed re-location improves alignment significantly compared to original subgrade. The 68 m multi-span structure is suspended more than 8 m above valley bottom utilizing common, conventional steel girders. The foundation locations and design consider the unique terrain and minimize potential earthworks spill of fill at foundations.

This location is prone to icing and high spring water, evidenced by scoured channel walls on the canyon. However, the bridge span elevation will be well above the determined high water elevation. With the shallow soils, bridge foundation will be secured in bedrock which will provide excellent long term stability. The design minimizes abutment and road fills to avoid fill material from spilling downslope to the stream.

Erosion and Sediment Control: The road subgrade and bridge approaches require "cuts" to conform to bridge elevations. The native material consists of a shallow layer of exposed gravels, cobbles, and large rocks overlaying carbonate/limestone bedrock. Consequently, this material will have minimal fine sands, silt, and clay so sedimentation risk is low. Excess waste material will not be spilled over as it will impact the stream integrity. Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.

An aerial view of the Upper Sundog Creek at KP 23.5, fall, 2012.

Sundog Tributary K.P. 25.3

Proposed Structure: 64 m Multi-span bridge

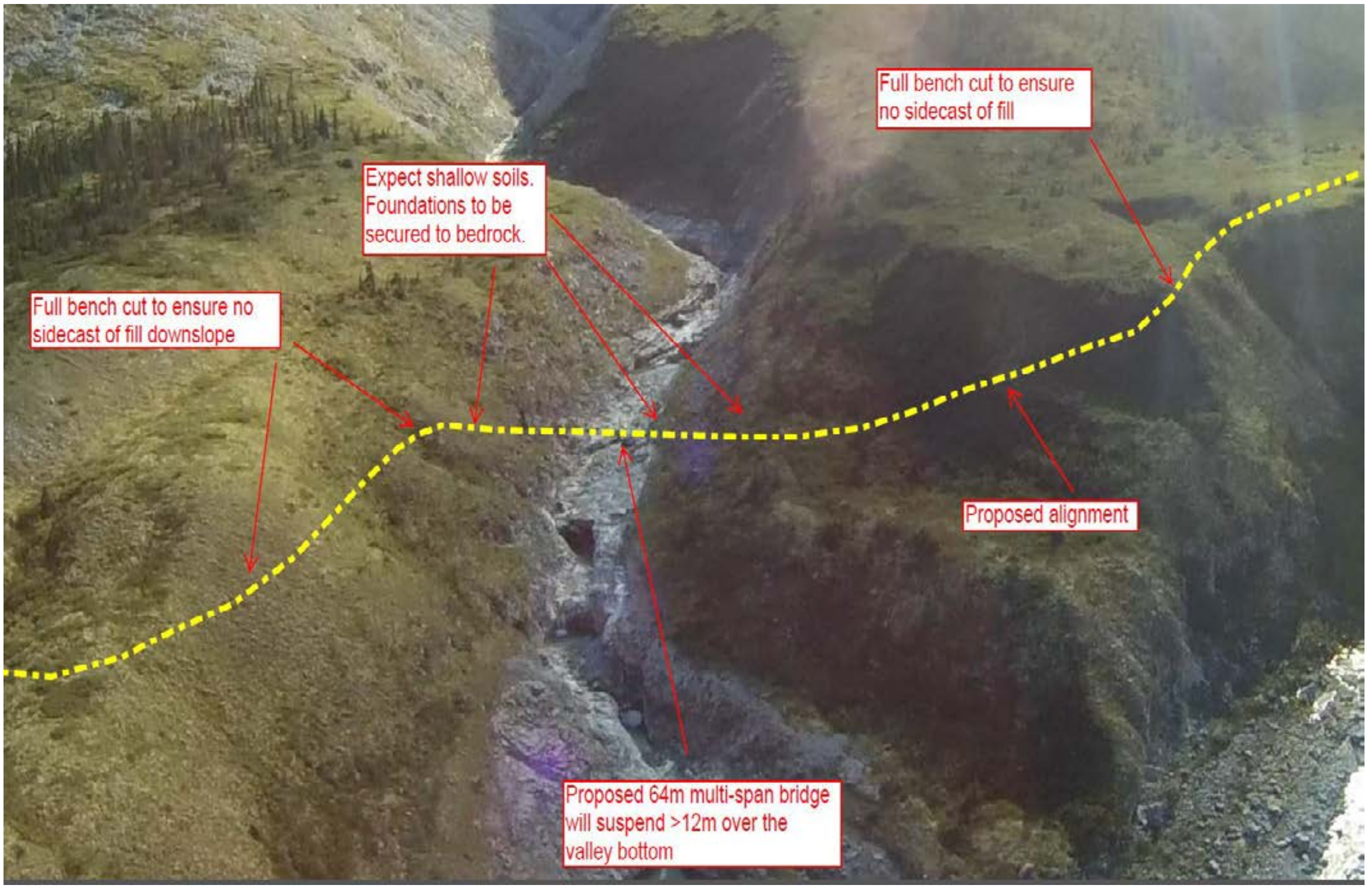
Site Description: Well defined, steep walled single stream channel has been determined as non-fish bearing. This location is prone to icing and high spring water, evidenced by scoured channel walls on the canyon. However, the bridge span elevation will be well above the determined high water elevation.

A combination of terrain, road grades, and alignment control the crossing location. As this crossing is considered challenging and difficult, several site investigations were completed.

Risks and Mitigation: The proposed re-location improves alignment and avoids significant rock fall/avalanche risk associated with original subgrade. The 64 m multi-span structure is suspended more than 12 m above valley bottom utilizing common, conventional steel girders. The foundation locations and design consider the unique terrain and minimize potential earthworks spill of fill at foundations. With shallow soils, it is expected the foundations will be placed and secured on bedrock which will provide long term stability. The design minimizes abutment and road fills to avoid fill material from spilling downslope to stream.

Sections of road with steeper side slopes (with expected bedrock) will entail full bench cut construction to avoid fill material from spilling downslope to stream. (See also Figure 2 in Tetra Tech EBA geotech report (p. 19 of report, p. 29 of pdf) and Appendix C, p. 16 (p. 217 of pdf).

Erosion and Sediment Control: Similar to the crossing at KP 23.5, the road subgrade and bridge approaches require larger "cuts" to conform to bridge elevations. The native material consists of a shallow layer of exposed gravels, cobbles, and large rocks overlaying carbonate/limestone bedrock. Consequently, this material will have minimal fine sands, silt, and clay so sedimentation risk is low. Excess waste material will not be spilled over as so it will impact the stream integrity. Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



An aerial view of stream crossing at KP 25.3, July, 2014.

Sundog Creek K.P. 28.3

Proposed Structure: 30.5m clear span bridge

Site Description: Steep mountain slopes dictate south approach, road alignment, and crossing location.

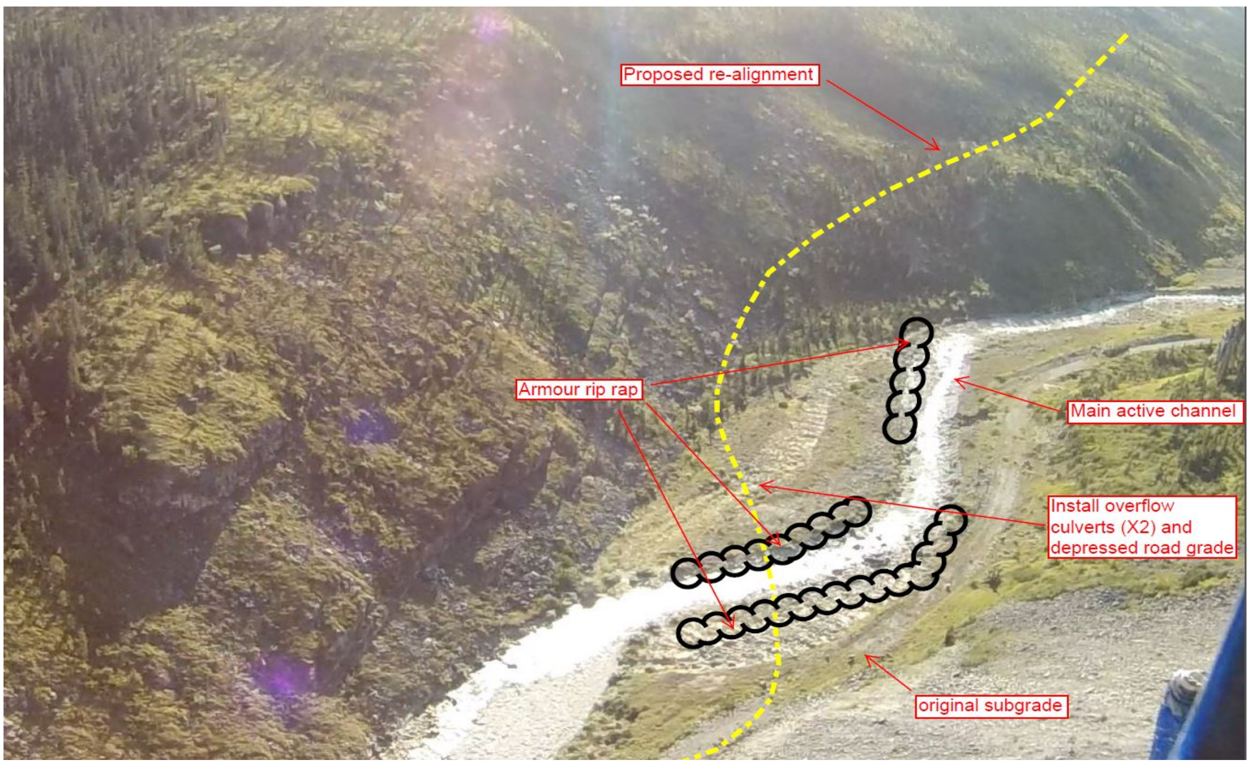
The road crosses the main Sundog Creek channel plus a portion of the floodplain. The established vegetation cover on the floodplain and the condition of the original road subgrade suggests the single defined main channel has remained stable over recent history and the floodplain is only active during extreme seasonal periods perhaps every 5 to 10 years.

Risks and Mitigation: It is recognized there is a minor potential for main stream channel to re-locate upstream of proposed crossing utilizing an older back channel (overflow) channel along the south side. Place rip rap as shown to maintain existing channel stability and minimize potential of the main stream channel to shift.

During extreme periods of high water levels, the south approach floodplain may experience surface water flow. To allow the relative free flow of water during these periods, install two 700mm CMP overflow culverts. In addition, construct final road elevation significantly lower than bridge elevation to ensure high water levels are not significantly backed-up (or dammed), allowing excess water to free flow over the road surface. This approach would provide an outlet for excess water to flow, reducing overall water velocity and pressure, minimizing it's potential to damage road structure and bridge foundations. (The south approach geometry may not permit this approach)

The selected crossing structure will be a clear span bridge across the identified active high water level including calculated freeboard and designed to accommodate Q100 (100 year) flood levels. All bridge foundations and stream banks at crossing will be armoured with rip rap. The bridge foundation of choice is a pre-cast spread footing which will complement the coarse gravel based native materials. (See Tetra Tech EBA geotech report Appendix C, p. 19 (p. 220 of pdf for some commentary)

Erosion and Sediment Control: The road subgrade and approaches would be constructed with suitable granular material. The majority of his material consists of clean gravels and cobbles and is not expected to introduce or expose the stream to greater levels of sedimentation above the typical natural cycle. Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



An aerial view of stream crossing at KP 28.3, July, 2014.

Sundog Creek K.P. 28.9

Proposed Structure: 30.5m clear span bridge

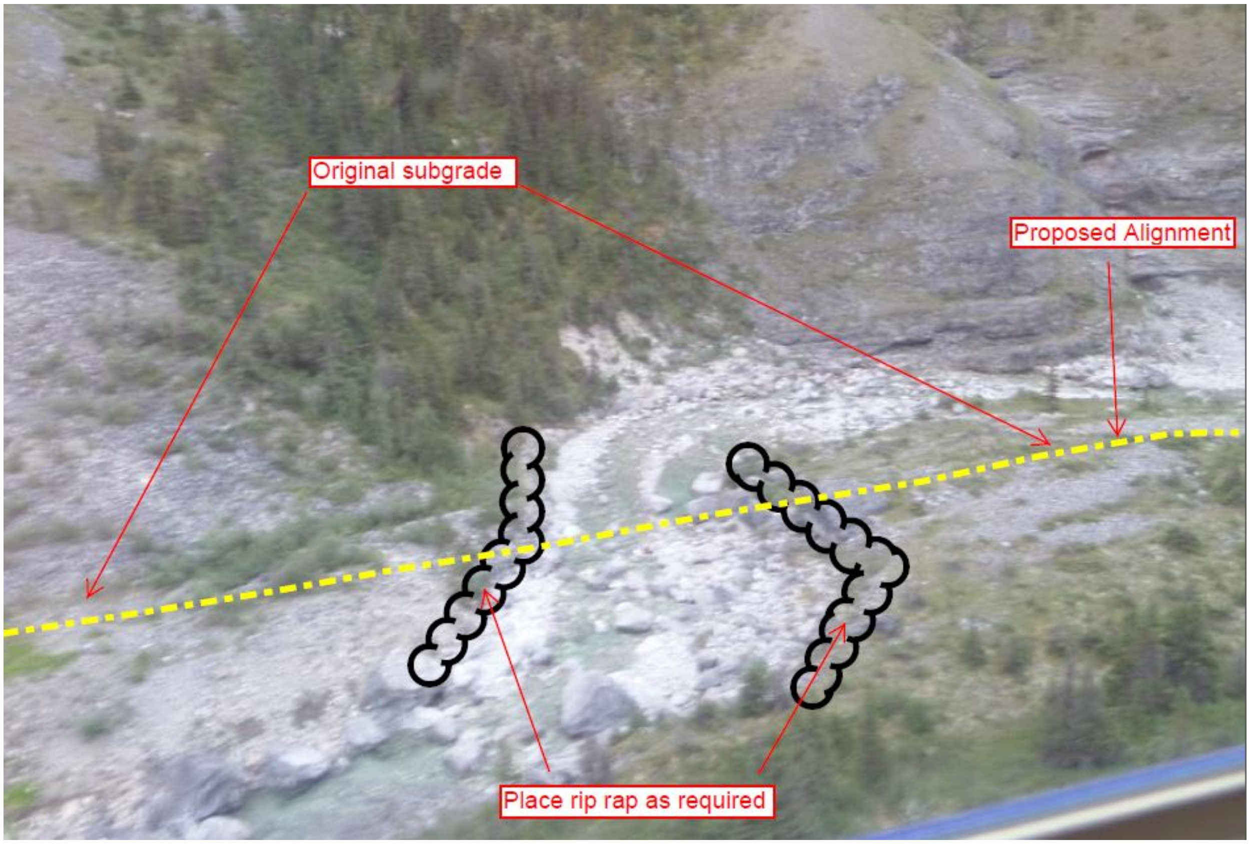
Site Description: Utilizes the original road crossing, the single main stream channel is stable and confined and will be clear spanned with a bridge.

The road and bridge structures remain outside the floodplain.

Risks and Mitigation: As the stream channel is confined and stable, there is little risk associated with hydrology effecting road structures. Place rip rap as shown to provide additional protection of bridge foundations and ensure long term channel.

The selected crossing structure will a clear span bridge across the identified active high water level including calculated freeboard and designed to accommodate Q100 (100 year) flood levels. The bridge foundation of choice is a pre-cast spread footing which will complement the coarse gravel based native materials. (See Tetra Tech EBA geotech report Appendix C, p. 19 (p. 220 of pdf).

Erosion and Sediment Control: The road subgrade and approaches would be constructed with suitable granular material. The majority of his material consists of clean gravels and cobbles and is not expected to introduce or expose the stream to greater levels of sedimentation above the typical natural cycle. Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



An aerial view of stream crossing at KP 28.9, July, 2014.

Sundog Creek Tributary K.P. 39.8

Proposed Structure: **42.7** m clear span bridge. ***The calculated Q100 flow levels determined the original preliminary design was not adequate; a revised preliminary design has been created.***

Site Description: The road subgrade and bridge crossing is located on an older, very large, floodplain near the confluence of a tributary of Sundog and Sundog Creek. The proposed road alignment utilizes primarily the original winter road subgrade on the eastern approach. However, the original road subgrade on the western side has been eroded by the historical water flows since the original road subgrade was constructed in early 1980. Consequently, the proposed all-season road is re-aligned to avoid these historical flows. Within the proposed re-alignment, the vegetation cover suggests this portion of the floodplain has remained relatively unaffected within the same time period.

Based on several site visits, it appears this portion of the floodplain becomes only active during extreme or peak flood conditions. July, 2014 site visit only the main channel of Sundog Creek had significant water flow and the tributary only minor flow. Later that year, the surface water flow with both creeks was interrupted and scattered. On the July 8, 2015 field visit active surface water flow was difficult to locate. As this floodplain is very wide and vast, it appears the water flows are dispersed across the flood plain, limiting the overall water velocity and hydrological force outside the main channel.

The flood plain consists of very coarse, porous, clean gravels and rock so immediately after peak seasonal flows, as would be expected, water quickly infiltrates into the porous gravels and disappear from the surface.

Risks and Mitigation: Crossing a broad alluvial floodplain is not preferred, but given the restricted terrain of the valley, it offers the least overall impact to the environment. The premise of the approach and design is to:

(1) Maintain the main channel of the tributary in its current location. Dikes would be constructed upstream and downstream as shown in figures below to ensure the existing main channel remains in its current location and is stable.

(2) Not adversely affect the potential high seasonal water flows across the floodplain. The road location occupies only a limited area of the large floodplain and only within the floodplain which experience surface water flow during extreme flood events. Therefore, it is thought the road infrastructure would only present a minor disruption, nearly insignificant impact on overall surface water flows across the floodplain. Surface water flows across this area of the floodplain would be weak; the potential threat to the road subgrade would be limited and manageable. Portions of the road subgrade would be armoured as shown on the figures below. Overflow culverts/cross drainages would be placed as required at natural secondary (backchannel) surface channels. The final road subgrade would be constructed with coarse, large gravels elevated only 30 to 60 cm above the overall natural, native terrain but significantly lower than bridge elevation to ensure high water flows do not significantly back-up during extreme or unique 10 or 50 year flood events. With this approach the road structure would not significantly hold back (or dam) water volumes; excess water would flow over the road surface, if necessary, rather than eroding the road base. The very porous gravel/coarse rock road subgrade will allow water to percolate through.

    It is also worth noting a borrow source (BP 39) has been identified within this floodplain. The development and approach taken to extract borrow aggregates will integrate the plan presented within. Aggregates will be extracted to enhance the approach taken, ensuring the natural high water surface flow and the overall protection of the road infrastructure.

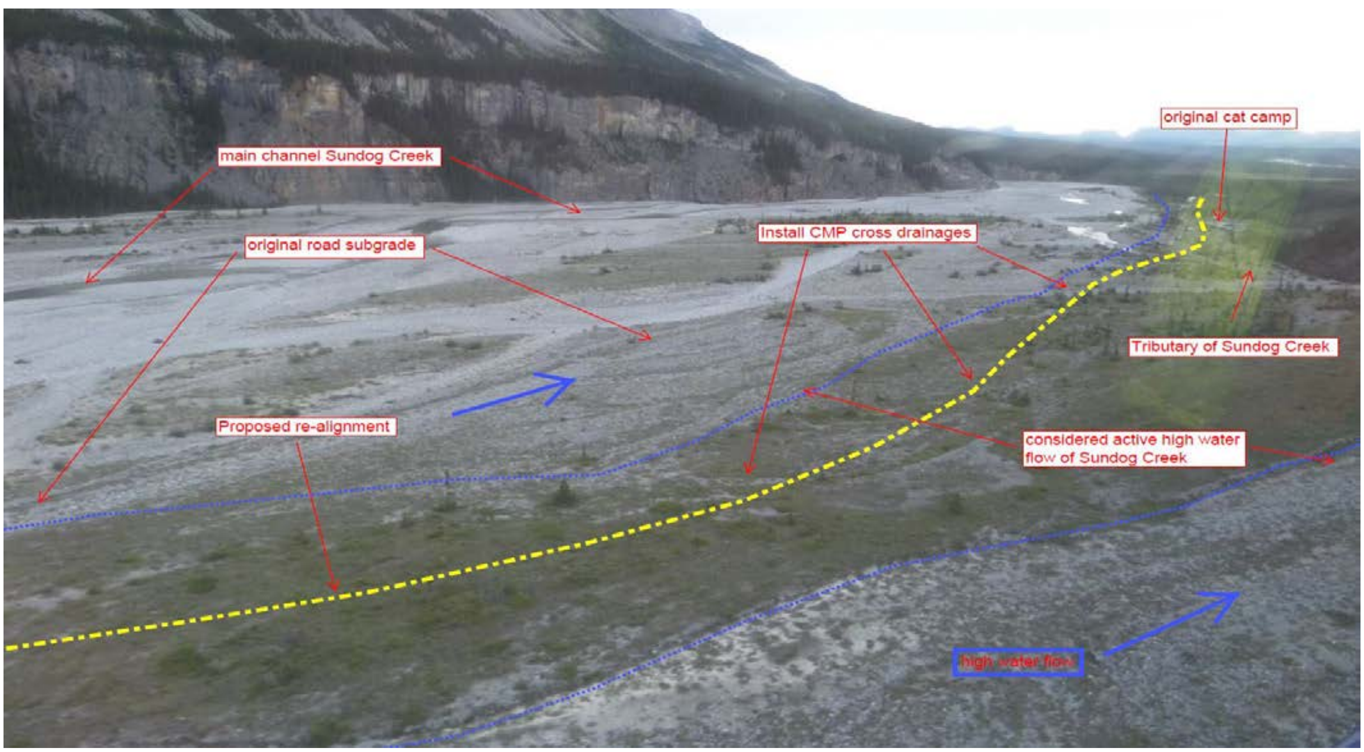
    The long term road maintenance would continually assess the impacts of high water events and plan accordingly. Ditches will be cleaned as required and maintained, culverts will be cleaned out and restored to ensure full capacity. Additional cross drainage culverts maybe installed if required. It is expected, from time to time, some minor breakdown of the road subgrade will occur and road subgrade would be easily restored with the excellent native gravel base material.

(3) The integrity of the road and bridge infrastructure is protected and maintained. Bridge approach and foundations will be constructed and protected with heavily armoured rip rap and elevated well above the remaining road infrastructure and floodplain. Naturally, water flow would occur at lower elevated portions of the floodplain and avoid impacting the valuable bridge infrastructure.

The selected crossing structure will a clear span bridge across the identified active high water level including calculated freeboard and designed to accommodate Q100 (100 year) flood levels. All bridge foundations and stream banks at crossing will be armoured with rip rap. The bridge foundation of choice is the pre-cast spread footing which will complement the coarse gravel based native materials.

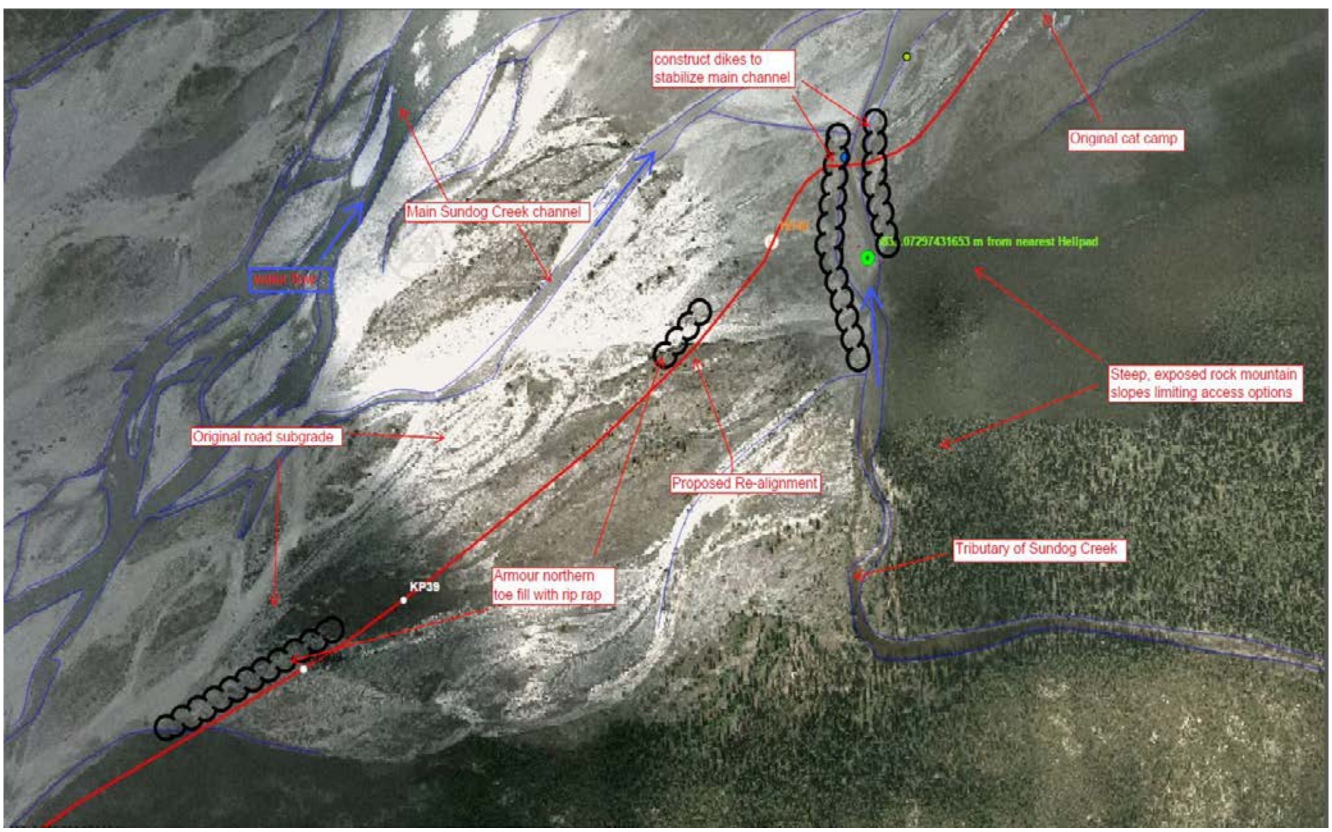
(See Tetra Tech EBA geotech report Appendix C, p. 22 (p. 223 of pdf).

Erosion and Sediment Control: The road subgrade and approaches would be constructed with suitable granular material found locally. The majority of his material consists of clean gravels and cobbles originally deposited by the stream and shouldn't introduce or expose the stream to greater levels of sedimentation above the typical natural cycle. Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied



An aerial view of stream crossing at KP 39.8, July, 2014.

An aerial view of stream crossing at KP 39.8, July, 2014, 2014.



An aerial view with the ortho photo describing the approach to be taken from KP 39 to 40.

Sundog Tributary K.P. 43.4

Proposed Structure: 24.2 m clear span bridge or multiple large culverts

Site Description: Single main stream channel stable and defined. It has been determined this portion of the tributary is non-fish bearing.

The proposed crossing location attempts to utilize most of the existing road subgrade with an adjusted alignment on the east approach to avoid wet section associated with the original winter road subgrade. Based on the original subgrade, the stream has remained largely unchanged since early 1980's.

Within this portion of the stream, the channel is meandering with a gentle gradient.

Risks and Mitigation: The stream at this location has been surveyed and determined not to be fish-bearing. The gentle, meandering nature of the stream suggests the hydrological force is low and will have minimal impact on the crossing structures if standard protection measures such as rip rap armouring road structures is implemented.

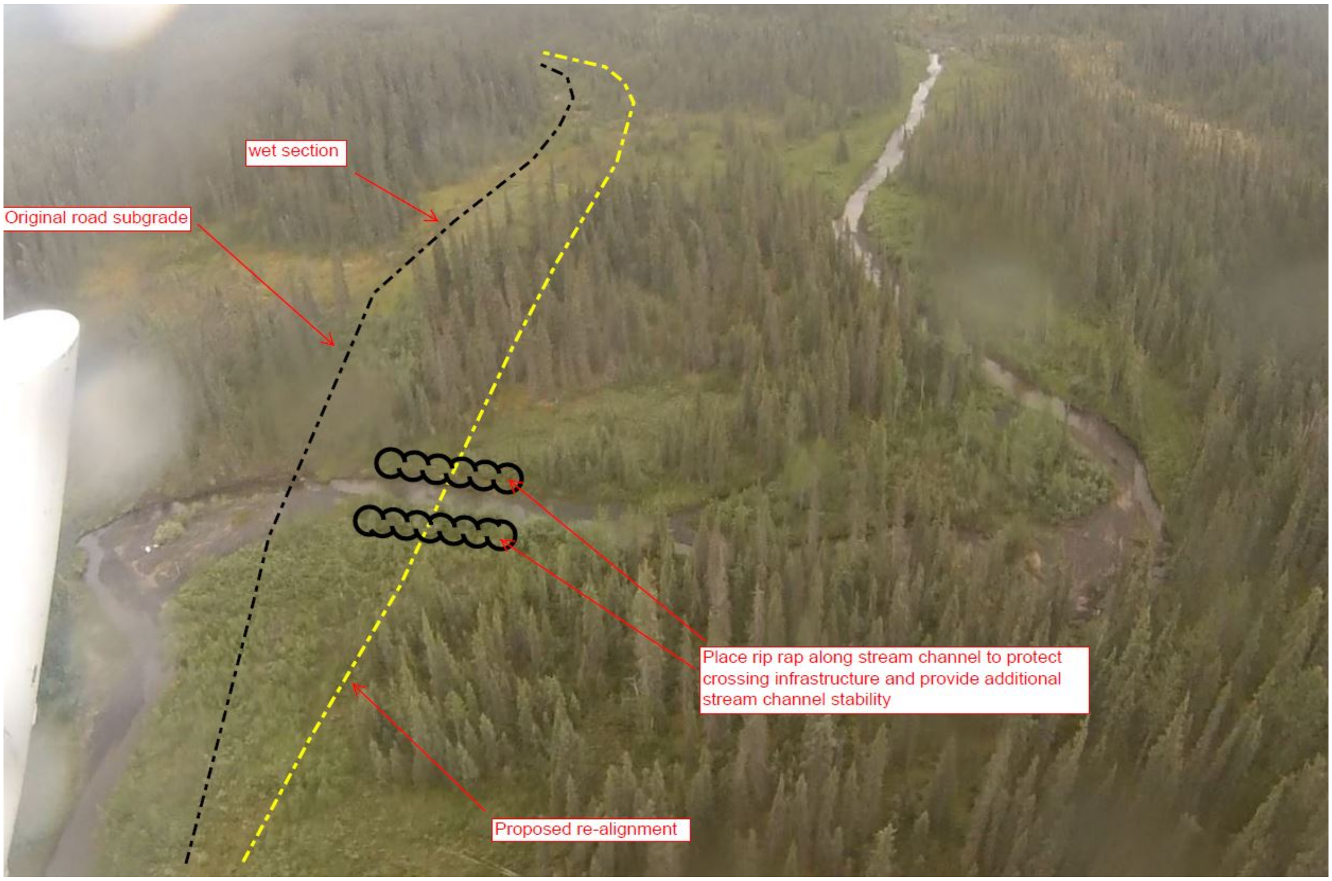
The selected crossing structure will either be: (i) a clear span bridge across the identified active high water level including calculated freeboard and designed to Q100 (100 year) flood levels: or (ii) multiple large diameter culverts (calculated to Q100). Selected structure type will be armoured with rip rap protecting bridge structures, stream channel, and culvert inlet/outlets.

(See Tetra Tech EBA geotech report, Appendix C, p.24 (p. 225 of pdf).

Erosion and Sediment Control: The native soils at and around this location are considered sand, sandy/silt/clay which will have significant sediment and erosion potential. Preventative measures will be taken to minimize or eliminate this potential and will include:

- Use of silt fencing combined with clean gravel berms (as required) at the construction site to filter water prior to entering the main stream channel.
- Use of settling ponds to allow suspended solids to settle
- Direct drainage water away from main stream channel and into natural filtering areas.
- Construct during periods offering reduced siltation risk and with appropriate supervision.

Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied



An aerial view of stream crossing at KP 43.4, July, 2014

Poljie Creek K.P. 53.7

Proposed Structure: 42.7 m clear span bridge. ***The calculated Q100 flow levels determined the original preliminary design was not adequate; a revised preliminary design has been created.***

Site Description: Single main stream channel stable and defined. Water levels can fluctuate year to year.

The proposed crossing location is all new construction. The original winter road subgrade follows a different alignment. Within this portion of the stream, the channel is meandering with a gentle gradient.

Risks and Mitigation: The gentle, meandering nature of the stream suggests the hydrological force is low and will have minimal impact on the crossing structure. Standard protection measures such as rip rap armouring road structures will be implemented.

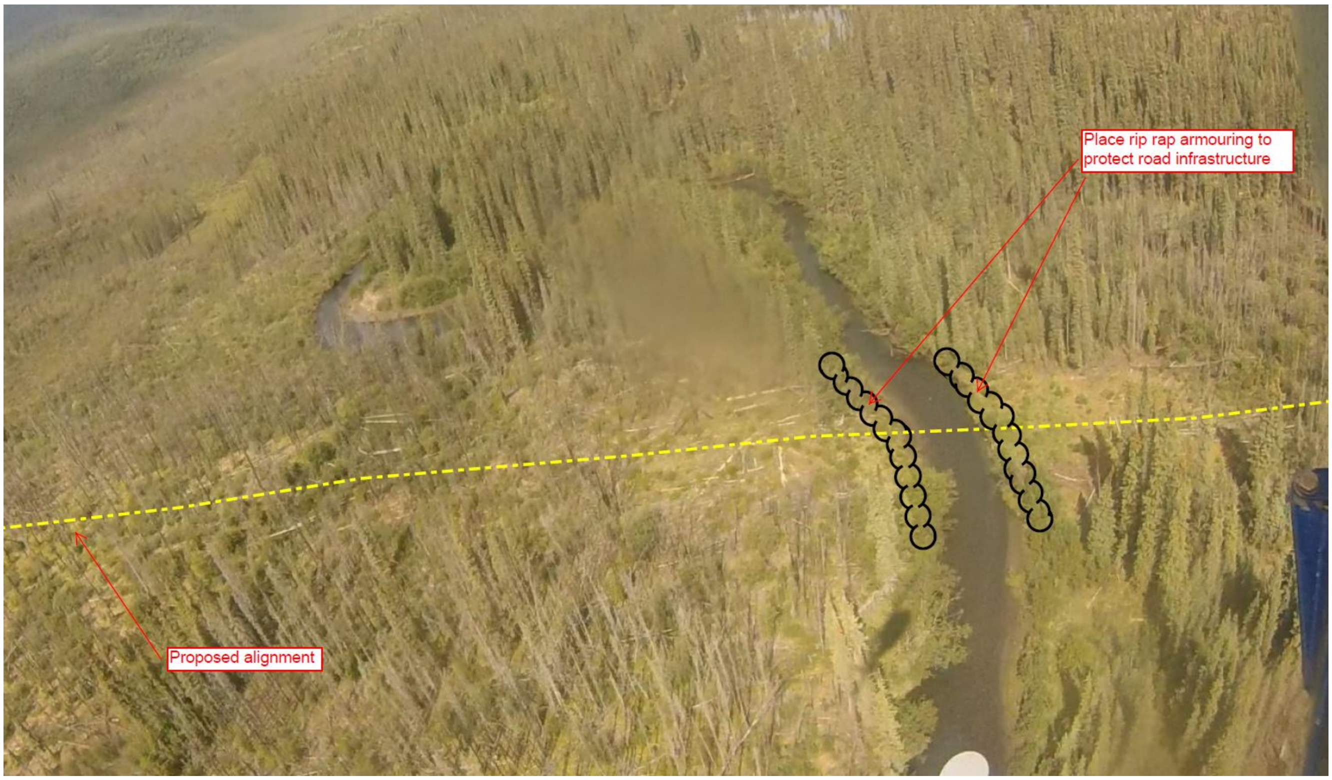
The selected crossing structure will be a clear span bridge across the identified active high water level including calculated freeboard and designed to accommodate Q100 (100 year) flood levels. All bridge foundations and stream banks at crossing will be armoured with rip rap. The bridge foundation of choice is a pre-cast spread footing although a pile type foundation could also be utilized.

(See Figure 5 in Tetra Tech EBA geotech report (p. 28 of report, p. 38 of pdf), and Appendix C p. 31 (p. 232 of pdf)

Erosion and Sediment Control: The native soils at and around this location are considered sand, sandy/silt/clay which will have significant sediment and erosion potential. Preventative measures will be taken to minimize or eliminate this potential and will include:

- Use of silt fencing combined with clean gravel berms (as required) at the construction site to filter water prior to entering the main stream channel
- Use of settling ponds to allow suspended solids to settle
- Direct drainage water away from main stream channel and into natural filtering areas.
- Construct during periods offering reduced siltation risk and with appropriate supervision.

Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



July 27, 2014 aerial view of Poljie crossing with expected normal water flow.

July 8, 2015 aerial view of Polgie crossing with no surface water flow.

Tetcela River K.P. 87.4

Proposed Structure: 30.5 m clear span bridge

Site Description: Single main stream channel stable and defined.

The proposed crossing location is re-aligned from the original crossing to a location offering much improved stream stability and a much narrower, defined channel. This portion of the channel has remained historically stable over the years.

Risks and Mitigation: The straight (upstream), stable, single defined main channel will have minimal impact on the crossing structures if standard protection measures such as rip rap armouring at road structures are implemented.

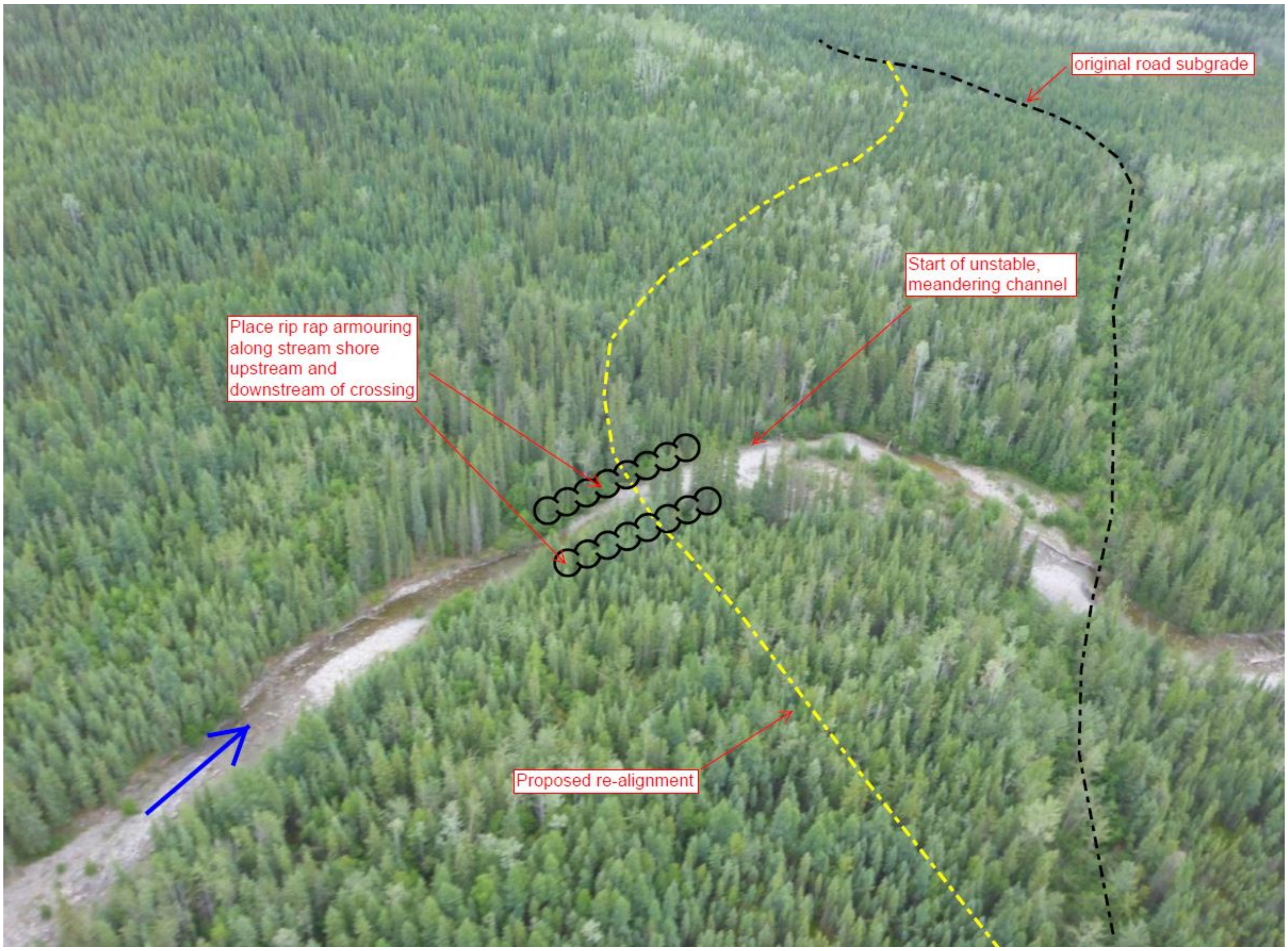
The selected crossing structure will be a clear span bridge across the identified active high water level including calculated freeboard and designed to accommodate Q100 (100 year) flood levels. All bridge foundations and stream banks at crossing will be armoured with rip rap. The bridge foundation of choice is a pre-cast spread footing which will complement the coarse gravel based native materials.

(See Figure 8 in Tetra Tech EBA geotech report (p. 37 of report, p. 47 of pdf).

Erosion and Sediment Control: With proximity to the crossing location, the native material is coarse gravel type which would have minimal sedimentation issues however standard construction protocols include adequate preventive silt fencing. Outside old deposited gravel floodplain, the native soils are considered sand, sandy/silt/clay which will have significant sediment and erosion potential. Preventative measures will be taken to minimize or eliminate this potential and will include:

- Use of silt fencing combined with clean gravel berms (as required) at the construction site to filter water prior to entering the main stream channel
- Use of settling ponds to allow suspended solids to settle
- Direct drainage water away from main stream channel and into natural filtering areas.
- Construct during periods offering reduced siltation risk and with full environment monitoring supervision.

Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



Aerial view of crossing at KP 87.4, July, 2015.

Tetcela River K.P. 89.8

Proposed Structure: 61.0 m multi span bridge. ***The calculated Q100 flow levels determined the original preliminary design was not adequate; a revised preliminary design has been created.***

Site Description: The proposed crossing location generally utilizes the original winter road alignment which crosses a broad, old floodplain of the Tetcela River. Throughout this section of the river, the single, main channel meanders north-easterly with low gradient flow. Although many old and overgrown channels are evident, this

portion of the channel has remained historically stable over the years, based on the original road subgrade constructed in 1980/81 and the re-vegetated backchannels.
Risks and Mitigation: The main stream channel has remained stable since 1980 and applying standard construction approaches should provide adequate protection to road infrastructure and ensure future stream integrity/stability. Construction approaches would include the rip rap armouring of stream banks at crossing and foundations. To offer longer term protection, the rip rap armouring on the east side, downstream of the bridge, will be sufficiently extended into a "dike" like feature to ensure downstream flows remain stable and cannot back-eddy to undermine road base on the east approach (see diagram below). In addition, the road fill on the east approach will also be armoured. The stream banks of the Tetcela River are heavily vegetated with larger diameter, mature spruce, pine, aspen, and cottonwood. A significant debris loading risk could be created under certain extreme flood events. Although sudden environmental effects are unpredictable and largely unavoidable, an annual inspection of the main stream channel will be incorporated into the *Road Construction and Maintenance Plan*. The selected crossing structure will be a multi-span bridge across the identified active high water level including calculated freeboard and designed to accommodate Q100 (100 year) flood levels. The proposed 61.0m conventional multi span bridge incorporates 2 short 9.1m spans at each end and a 42.7m span in the middle. This large span is considered the maximum practical given the limitations for structural steel I-beam design, but is required to fully span the active high water flow. The bridge foundation of choice is a pre-cast spread footing which will complement the coarse gravel based native materials. A pile type foundation could also be utilized. (See Figure 9 in Tetra Tech EBA geotech report (p. 39 of report, p. 49 of pdf), p. 45 of Appendix C (p. 246 of pdf)
Erosion and Sediment Control: Similar to the upstream crossing at KP 87.4, within proximity to the crossing location, the native material is coarse gravel type which would have minimal sedimentation issues however standard construction protocols include adequate preventive silt fencing. Outside old deposited gravel floodplain, the native soils are considered sand, sandy/silt/clay which will have significant sediment and erosion potential. Preventative measures will be taken to minimize or eliminate this potential and will include: • Use of silt fencing combined with clean gravel berms (as required) at the construction site to filter water prior to entering the main stream channel • Use of settling ponds to allow suspended solids to settle • Direct drainage water away from main stream channel and into natural filtering areas. • Construct during periods offering reduced siltation risk and with full environment monitoring supervision. Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.

Aerial view of Tetcela River proposed crossing at KP 89.8.

Fishtrap Creek K.P. 95.0

Proposed Structure: Large diameter culvert

Site Description: Single main stream channel stable and defined; connects a series of wetlands, ponds, and small lakes. The large, flat valley bottom terrain with little stream gradient translates into very little hydrological flow or force. It has been determined this portion of the tributary is non-fish bearing.

The proposed crossing location utilizes existing original winter road subgrade. As this section is very wet, an overland construction approach will be applied throughout the section.

Risks and Mitigation: The little hydrological flow or force will minimize the erosion risk to the road structure.

The very wet, expected boggy, organic native material may make it difficult to properly install a large oversized culvert. Any unsuitable organic base material will be removed and replaced with suitable base material. The geotech engineer identified this location as potential thermokarst and therefore drilling may be required to assist and direct the final detailed design.

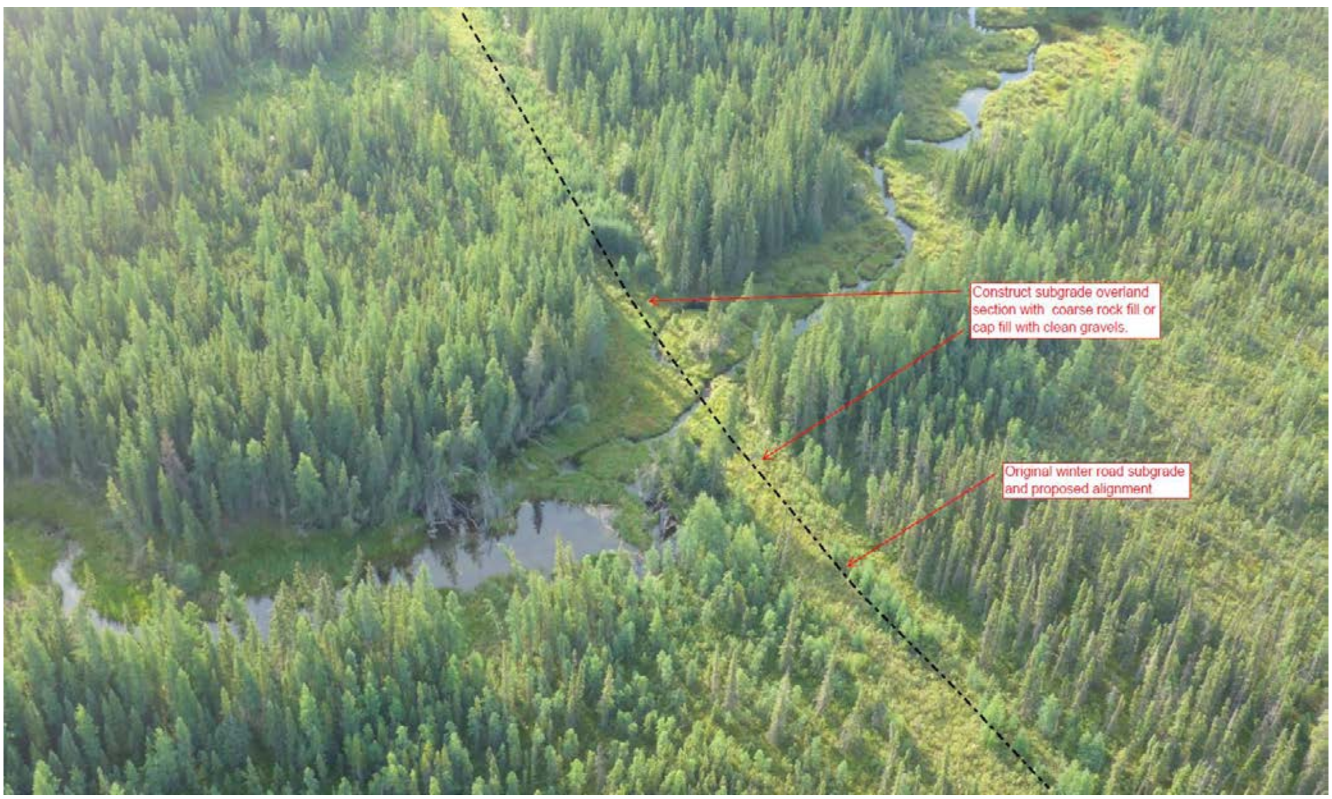
The *Road Construction and Maintenance Plan* would include annual inspection to identify potential problems developing. Maintenance may include cleanout of culvert.

Culvert sizing will be calculated to accommodate Q100 (100 year) flood levels.

Erosion and Sediment Control: The fill material for the overland construction at the crossing would preferably utilize coarse rock or the fill material would be fully capped with clean gravel material to prevent added sedimentation into the stream system. The native soils are considered sand, sandy/silt/clay which will have significant sediment and erosion potential. Preventative measures will be taken to minimize or eliminate this potential and will include:

- Use of silt fencing combined with clean gravel berms (as required) at the construction site to filter water prior to entering the main stream channel
- Use of settling ponds to allow suspended solids to settle
- Direct drainage water away from main stream channel and into natural filtering areas.
- Construct during periods offering reduced siltation risk and with full environment monitoring supervision.

Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



An aerial view of the crossing at KP 95.0, July, 2014.

Grainger Tributary K.P. 122.3

Proposed Structure: 15.2 m clear span bridge (not required if alternate road alignment is selected

Site Description: Single main stream channel stable and defined; connects a series of wetlands, ponds, and small lakes draining into Gap Lake which forms part of the upper Grainger River. The flat valley bottom terrain with little stream gradient translates into very little hydrological flow or force. This is an ideal crossing location, a narrow, defined channel with excellent road alignment.

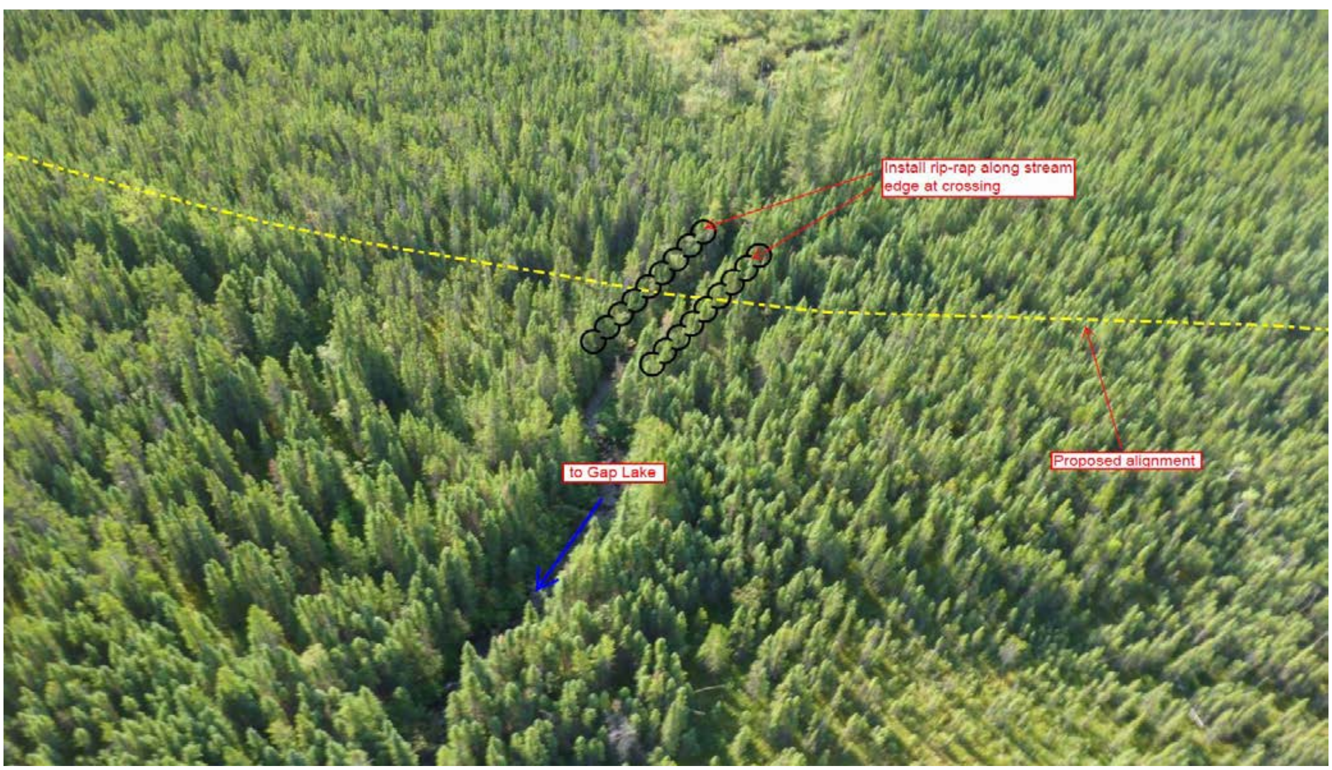
Risks and Mitigation: The little hydrological flow or force will minimize the erosion risk to the road structure. Standard protection measures such as rip rap armouring road structures will be implemented.

The selected crossing structure will be a bridge clear spanned across the identified active high water level including calculated freeboard and designed to accommodate Q100 (100 year) flood levels. The bridge foundation of choice is a pre-cast spread footing which will complement the coarse gravel based native materials. A pile type foundation could also be considered.

Erosion and Sediment Control: The native soils are considered sand, sandy/silt/clay which will have significant sediment and erosion potential. Preventative measures will be taken to minimize or eliminate this potential and will include:

- Use of silt fencing combined with clean gravel berms (as required) at the construction site to filter water prior to entering the main stream channel
- Use of settling ponds to allow suspended solids to settle
- Direct drainage water away from main stream channel and into natural filtering areas.
- Construct during periods offering reduced siltation risk and with full environment monitoring supervision.

Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



An aerial view of crossing at KP 122.3, July, 2014.

Upper Grainger River K.P. 123.3

Proposed Structure: 30.5 m clear span bridge, (not required if alternate road alignment is selected

Site Description: Single main stream channel stable and defined. Based on the original road subgrade constructed in 1980/81 and the re-vegetated floodplain, this portion of the channel has remained historically stable over the years.

The crossing location is tightly controlled by the exposed rock face and steep slope breaks on the south-west approach. The north-east approach is located on old floodplain of Grainger River.

Risks and Mitigation: The stream channel is confined on the south bank, the north bank occupies the large, old floodplain which extends north. As stated above, historically the main stream channel has remained stable since 1980 and has minimal risk of de-stabilizing. The stream flow originates from Gap Lake 100 m upstream, the stream flow is generally steady but the mild stream gradient has limited hydrological force. To eliminate or minimize potential risk to road structure or stream stability, standard protection measures such as rip rap armouring road structures and along the stream banks will be implemented.

The construction of the south bank approach will require blasting to establish road subgrade and final approach to the bridge. Tight control measures will be implemented during the blasting to ensure blast material does not get displaced into the waterbody. No material will be sidecast into the waterbody, excess material will be end hauled and utilized in the road subgrade.

Recent and historical beaver activity was observed. Future beaver activity could significantly impact the stream channel stability. An active debris "outwash" fan from a northern stream comes within 50m north-west of the crossing location. This crossing location was chosen to keep the crossing outside this active zone and therefore presents minimal risk to the road structure. The *Road Construction and Maintenance Plan* would annually assess the beaver activity and the active fan and respond as required to ensure the future stability of the stream.

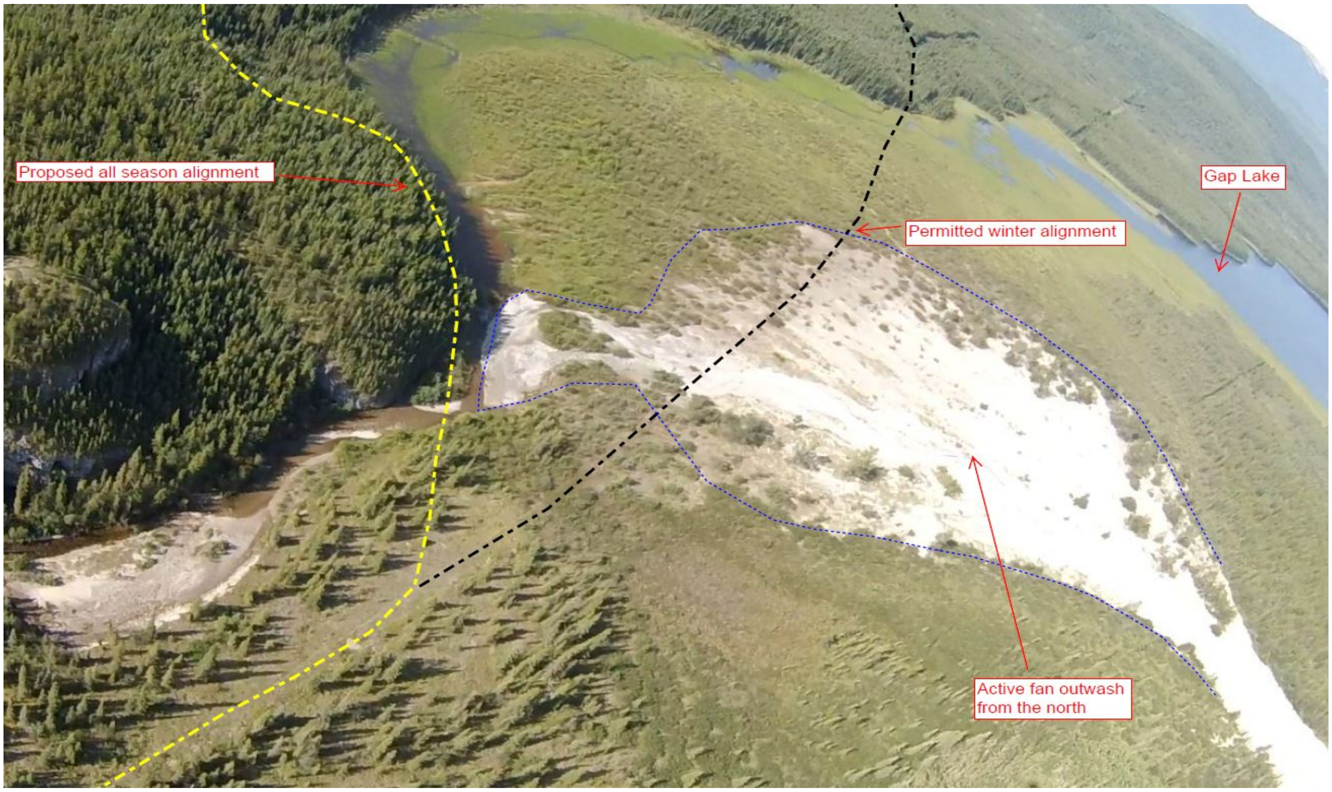
The selected crossing structure will a bridge clear spanned across the identified active high water level including calculated freeboard and designed to accommodate Q100 (100 year) flood levels. The bridge foundation of choice is a pre-cast spread footing which will complement the coarse gravel based native materials.

(See Figure 13 in Tetra Tech EBA geotech report (p. 53 of report or p. 63 of pdf).

Erosion and Sediment Control: It is expected the native material at this crossing will be primarily a combination of clean, sorted gravels/rocks and bedrock and will have minimal risk of sedimentation and erosion during/after construction. However, standard preventative measures to be taken to minimize or eliminate potential sedimentation/erosion include:

- Use of silt combined with clean gravel berms (as required) at the construction site to filter water prior to entering the main stream channel
- Use of settling ponds to allow suspended solids to settle
- Direct drainage water away from main stream channel and into natural filtering areas.
- Construct during periods offering reduced siltation risk and with full environment monitoring supervision.

Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



Aerial view of crossing at KP 123.3 looking southwest, July, 2014

Aerial view of crossing at KP 123.3 looking southeast, July, 2014.

Grainger River K.P. 124.8

<u>Proposed Structure:</u> 24.4m clear span bridge

<u>Site Description:</u> Steep slopes with exposed bedrock restrict access options on the south side. Consequently, the road subgrade and bridge crossing is located on the large Grainger River floodplain. Based on the vegetated floodplain and the original road subgrade constructed in 1980, the main river channel has remained relatively stable and defined upstream of proposed crossing, however becomes wider at the crossing location.

At the crossing location, the south approach of the road could potentially occupy a portion of the floodplain which may become active during peak flows. All three of our site investigations (July, September, 2014; July 8, 2015) viewed surface water flows confined to the main channel. As expected, the floodplain consists of very coarse, porous, clean gravels and rock, so immediately after peak flows, water will quickly disperse into the porous gravels and disappear from the surface.

<u>Risks and Mitigation:</u> Crossing a broad alluvial floodplain is not preferred, but given the steep mountain slopes along the south bank, suitable crossing locations are limited. The premise of the approach and design is to:

(1) Maintain the main channel in its current location. Dikes would be constructed upstream and downstream as shown in figure below to ensure the existing main channel remains in its current location and is stable.

(2) Not adversely affect the potential high seasonal water flows across the floodplain. The road location occupies only a limited area of the large floodplain and only within the floodplain which experiences surface water flow during extreme flood events. As such, it is thought the road infrastructure would only present a minor disruption, nearly insignificant impact on overall surface water flows across the floodplain. Surface water flows across this area of the floodplain would be weak; the potential threat to the road subgrade would be limited and manageable. Overflow culverts/cross drainages would be placed at all natural secondary (backchannel) surface channels. The final road elevation would be elevated only 30 to 60 cm above the overall natural, native terrain but significantly lower than bridge elevation. This will ensure high water flows do not significantly back-up during extreme or unique 10 or 50 year flood events. With this approach, the road structure would not significantly hold back (or dam) water volumes; excess water would flow over the road surface, if necessary, rather than eroding the road base. The road subgrade will be constructed with very porous material constructed with large fragmented rock gravel/coarse rock allowing water to percolate through.

    Long term road performance would be continually assessed in terms of impacts of high water events. Adjustments would be made accordingly. Ditches will be cleaned as required and maintained, culverts will be cleaned out and restored to ensure full capacity. Additional cross drainage culverts may be installed if required. It is expected, from time to time, that some minor breakdown of the road subgrade will occur and would need to be restored.

(3) The integrity of the road and bridge infrastructure is protected and maintained. Bridge approach and structure would be elevated well above the remaining road infrastructure and floodplain and foundations/approaches will be heavily armoured. With this approach, the, water flow would naturally occur at lower elevated portions of the floodplain and avoid impacting the valuable bridge infrastructure.

As part of the *Road construction and Maintenance Plan*, annual assessment of the road structure and stream stability/integrity would occur. Maintenance would be conducted accordingly.

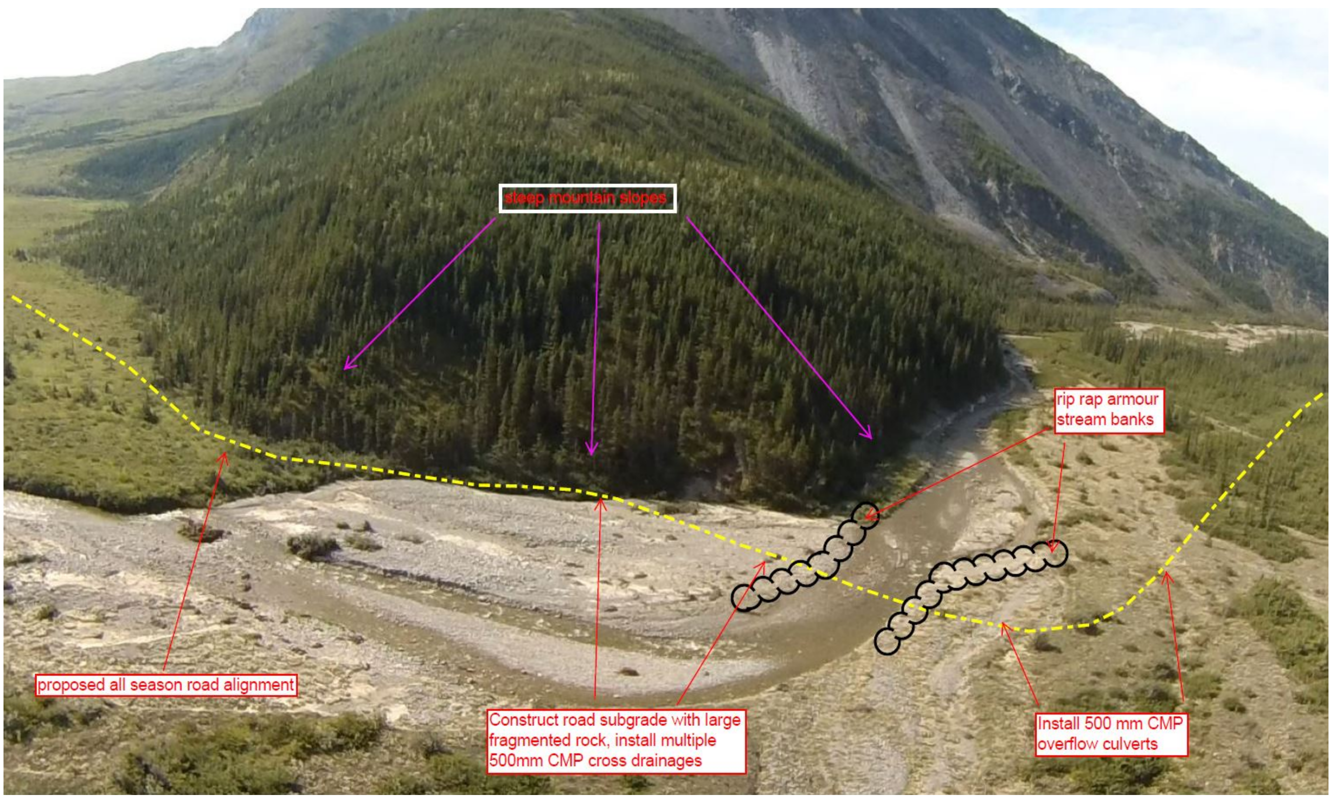
The selected crossing structure will be a bridge clear spanned across the identified active high water level including calculated freeboard and designed to accommodate Q100 (100 year) flood levels. All bridge foundations and stream banks at crossing will be armoured with rip rap. The bridge foundation of choice is a pre-cast spread footing which will complement the coarse gravel based native materials.

(See Figure 13 in Tetra Tech EBA geotech report (p. 63 of pdf) and Appendix C p. 61-62 (p. 262-263 of pdf).

Erosion and Sediment Control: It is expected the native material at this crossing will be primarily a combination of clean, sorted gravels/rocks and bedrock and will have minimal risk of sedimentation and erosion during/after construction. However, standard preventative measures to be taken to minimize or eliminate potential sedimentation/erosion include:

- Use of silt fencing combined with clean gravel berms (as required) at the construction site to filter water prior to entering the main stream channel
- Use of settling ponds to allow suspended solids to settle
- Direct drainage water away from main stream channel and into natural filtering areas.
- Construct during periods offering reduced siltation risk and with appropriate supervision.

Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



South-west aerial view of the Grainger River crossing at KP 124.8, July, 2014.

Unnamed Creek Preferred Alignment Option KP 111.7

Proposed Structure: Large diameter culvert

Site Description: Single main stream channel stable and defined; connects a series of wetlands, ponds, and small lakes. The large, flat valley bottom terrain with little stream gradient translates into very little hydrological flow or force. The north-flowing system is assumed to be non-fish bearing due to extensive beaver dams and poor fish habitat.

As the proposed crossing location is very wet, an overland construction approach will be applied throughout the section.

Risks and Mitigation: The little hydrological flow or force will minimize the erosion risk to the road structure.

The very wet, expected boggy, organic native material may be difficult to properly install a large oversized culvert. Any unsuitable organic base material will be removed and replaced with suitable base material. Similar crossing characteristics found at KP 95.0, the geotech engineer identified this location as potential thermokarst and therefore drilling may be required to assist and direct the final detailed design.

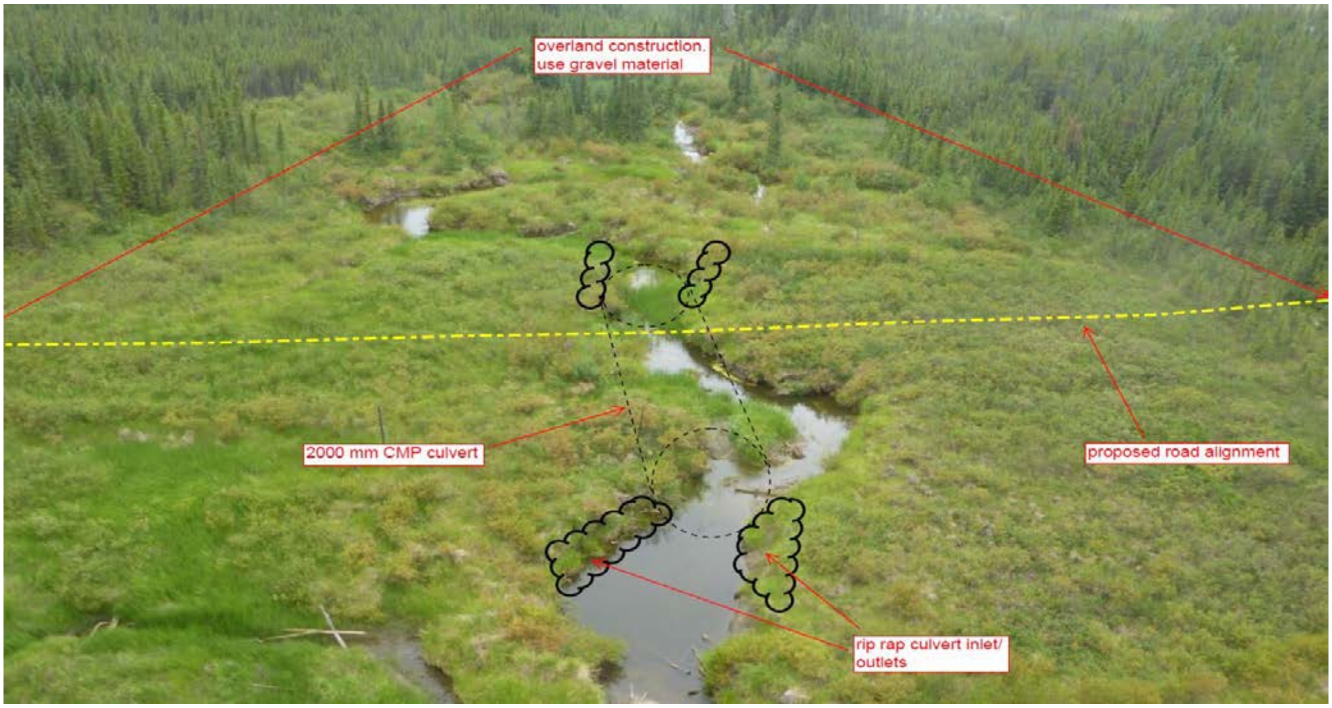
As part of the *Road Construction and Maintenance Plan*, annual inspection to identify any potential problems will occur. Maintenance may include cleanout of culvert.

Culvert sizing will be calculated to accommodate Q100 (100 year) flood levels.

Erosion and Sediment Control: The fill material for the overland construction at the crossing would preferably utilize coarse rock or the fill material would be fully capped with clean gravel material to prevent added sedimentation into the stream system. The native soils are considered sand, sandy/silt/clay which will have significant sediment and erosion potential. Preventative measures will be taken to minimize or eliminate this potential and will include:

- Use of silt fencing combined with clean gravel berms (as required) at the construction site to filter water prior to entering the main stream channel
- Use of settling ponds to allow suspended solids to settle
- Direct drainage water away from main stream channel and into natural filtering areas.
- Construct during periods offering reduced siltation risk and with full environment monitoring supervision.

Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



An aerial view of crossing at , July, 2015.

Tributary of Grainger River Preferred Alignment Option KP 118.1

Proposed Structure: Multi large diameter culverts with overflow culverts

Site Description: The proposed alignment crosses a flat, 70m wide active "outwash" zone. Surface water flows only occur during peak runoff. The floodplain consists of very coarse, porous, clean gravels and rock, so immediately after peak flows, water will quickly disperse into the porous gravels and disappear from the surface.

The 70 m wide active floodplain is confined by a valley and generally cannot expand outside this zone at the proposed crossing location.

Risks and Mitigation: Although surface water flows occur only during a limited period, the volume of gravel and rocks displaced by the water flow (over time) suggests that intense water flows can occur.

The premise of the approach and design is to:

(1) Maintain and confine surface water flows to the naturally established active floodplain downstream from the crossing. Several large diameter culverts will be installed in the current established natural channels. These channels will be cleaned, trenched, and extended across the active floodplain to direct surface water flow to the prescribed culvert. Larger rocks would line the channel edges to help maintain trench stability. Additional smaller overflow culverts will be installed to allow excess water flow that may not have been confined to the established trenches. At the inlets, a small reservoir will be established to allow gravel/rock debris to settle prior to entering the culvert and potentially restricting or plugging the culvert.

(2) Long term protection of the road structure. The final road elevation would be elevated only 30 to 60 cm above the natural, native terrain of the floodplain. Lower elevation points would be designed to ensure high water flows do not significantly back-up during extreme or unique 10 or 50 year flood events or if culverts get plugged. With this approach, excess water would flow over the road surface, if necessary,

rather than eroding the road base. The road subgrade will be constructed with a gravel base so as not to cause sedimentation. It is expected, from time to time, some minor breakdown of the road subgrade will occur and road subgrade would need to be restored with gravel.

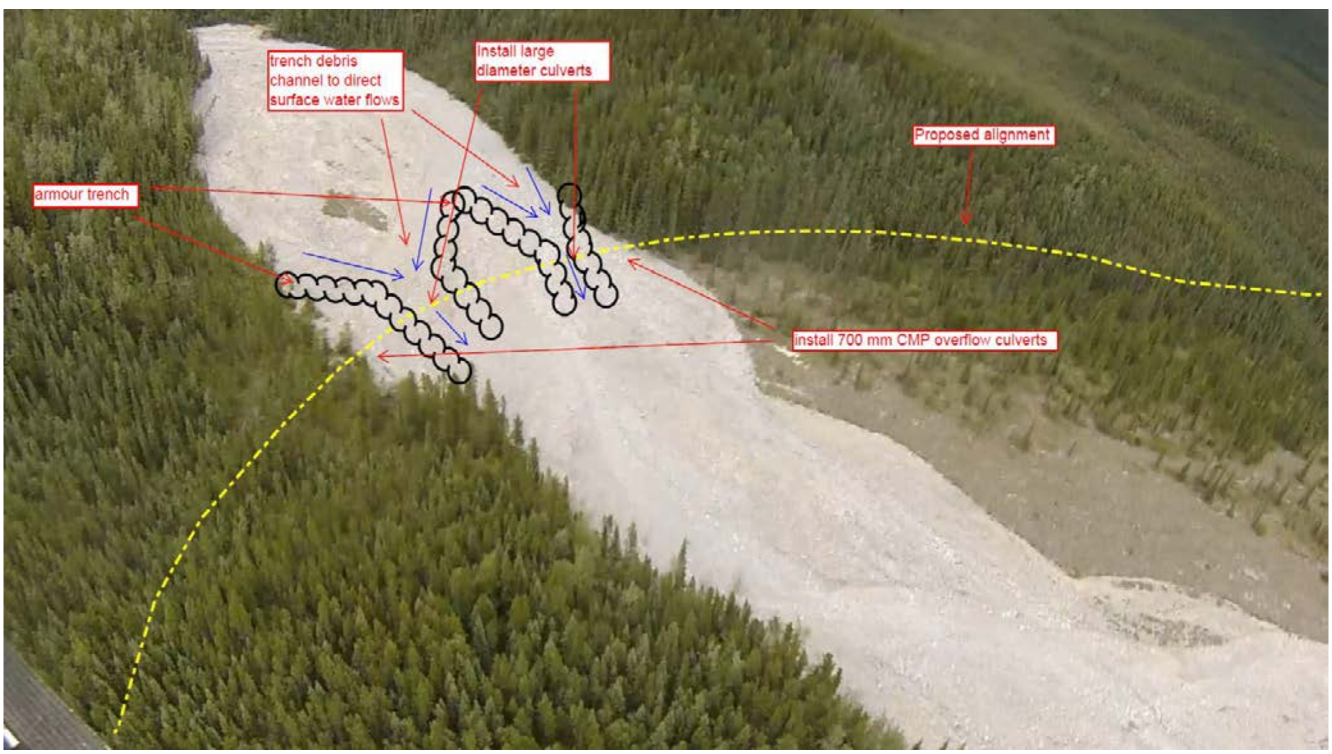
As extreme surface water flow likely only occurs occasionally and briefly , it should not adversely affect road operations. As part of the *Road Construction and Maintenance Plan*, annual assessment of the road structure and stream stability/integrity would occur. Maintenance would be conducted accordingly.

The selected crossing structure will be large multi culverts spaced across the floodplain design to accommodate Q100 (100 year) flood levels.

Erosion and Sediment Control: It is expected the native material at this crossing will be primarily a combination of clean, sorted gravels/rocks and bedrock and will have minimal risk of sedimentation and erosion during/after construction. However, standard preventative measures to be taken to minimize or eliminate potential sedimentation/erosion include:

- Use of silt fencing combined with clean gravel berms (as required) at the construction site to filter water prior to entering the main stream channel
- Use of settling ponds to allow suspended solids to settle
- Direct drainage water away from main stream channel and into natural filtering areas.
- Construct during periods offering reduced siltation risk and with appropriate supervision.

Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



An aerial view of the alternative crossing at KP July, 2015.

Unnamed Stream K.P. 151.3

Proposed Structure: Large Diameter Culvert

Site Description: The proposed road alignment contours the toe of a significant slope break and crosses the stream at the bottom edge of a defined gully which the stream channel occupies. Confined by this gully, the stream channel is defined and stable.

The stream only experiences seasonal flows. No surface water was identified near the crossing on the September, 2014 field investigation however surface water was evident 400 m downstream. The very porous gravel and rock stream bed allows surface water to disappear as water volume decreases. Although this stream only experiences seasonal flows, given the displacement of material, both large size and volume, it suggests that significant hydrological force does occur during peak flows.

Risks and Mitigation: The stream channel is 100% confined by the gully directly above the proposed crossing and is very unlikely to destabilize. This crossing location was selected for that reason.

As stated above, this stream appears to have some hydrological force at given times. A settling pond would be established upstream to allow gravel debris to settle prior to entering the culvert. In addition, an overflow culvert would be added to assist if the main culvert is not fully functioning.

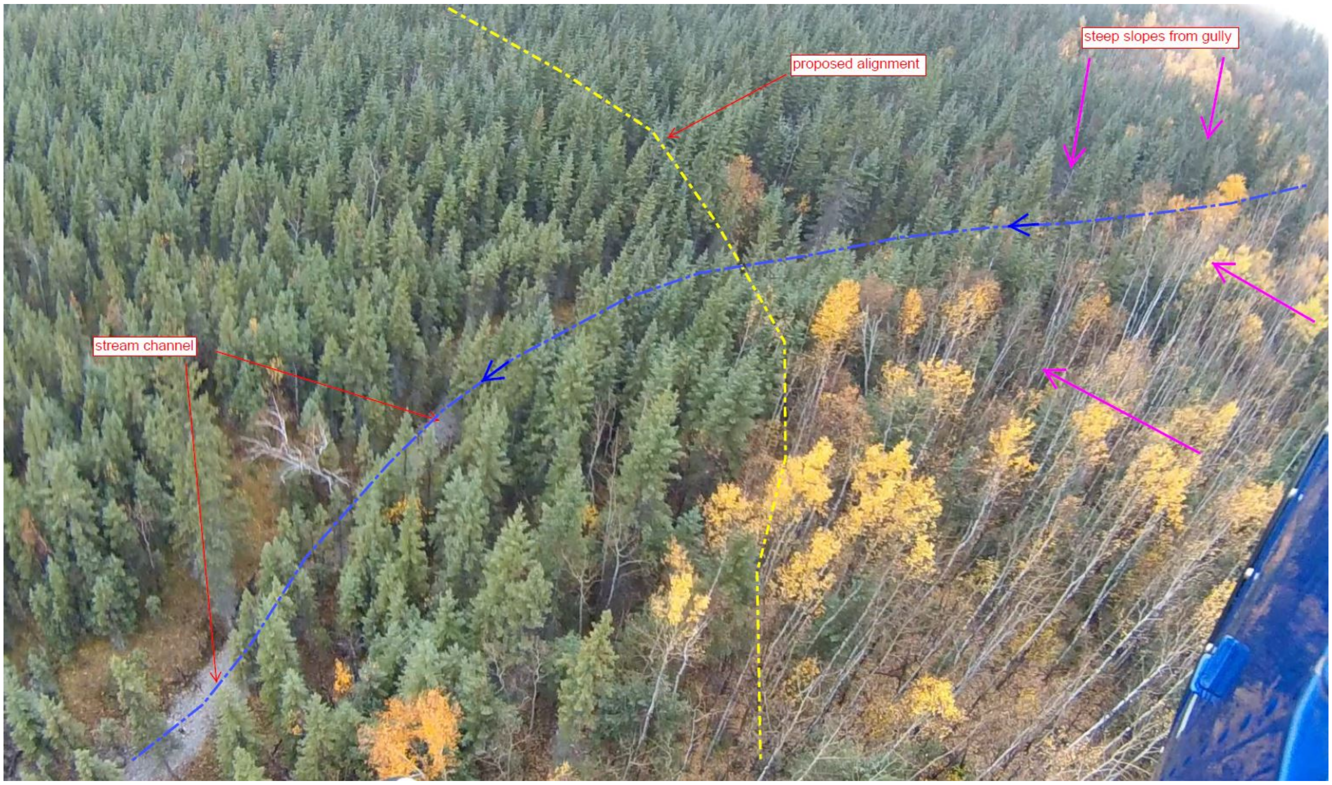
As part of the *Road Construction and Maintenance Plan*, annual assessment of the road structure and stream stability/integrity would occur. Maintenance would be conducted accordingly. The upstream settling pond would be cleaned out as necessary to ensure future capability

Culvert sizing will be calculated to accommodate Q100 (100 year) flood levels.

Erosion and Sediment Control: It is expected the native material at this crossing will be primarily a combination of clean, sorted gravels/rocks and bedrock and will have minimal risk of sedimentation and erosion during/after construction. However, standard preventative measures to be taken to minimize or eliminate potential sedimentation/erosion include:

- Use of silt fencing combined with clean gravel berms (as required) at the construction site to filter water prior to entering the main stream channel
- Use of settling ponds to allow suspended solids to settle
- Direct drainage water away from main stream channel and into natural filtering areas.
- Construct during periods offering reduced siltation risk and with appropriate supervision.

Erosion control will be managed by the placement of suitable rip rap along vulnerable portions of the stream bank and road fills. Standard construction practices utilizing silt fences, settling ponds, and surface water diversion will be applied.



Aerial view looking down at the crossing at KP 151.3, October, 2014.

An upstream veiw from the proposed crossing location. Note the gravel/large rock stream bottom. October, 2014.

Liard River Crossing KP 159.4 to 160.0

Proposed Structure: Barge service in summer; alternative routing with ice bridge crosing in winter

Site Description: The proposed Liard River **summer** crossing is located at a section of the river which is relatively narrow and deep, with what seems to be reduced current speed. The ramp approaches on each side will extend from the *defined high water mark to 1.0 m below the low water mark* with an 8 m running surface at a maximum grade of 6%. The base of the ramp will be constructed with large coarse angular rock and capped with a 3" minus coarse rock surface material.

The proposed **winter** ice bridge crossing is 1.5 km downstream from the summer barge crossing. This crossings location was considered the most suitable based on available aerial pictures taken in early winter which identifies the most probable ice covered section within proximity to the all season road location. The crossing will involve a primary across the main channel of the Liard and a secondary across a back channel.

Risks and Mitigation: Summer. It will take several years for the rock base ramp to settle and will require additional placement and re-building of the structure until a balance is achieved. The 45 degree skew design will provide ample barge landing approach and docking, the upstream dike offers protection from fast, turbulent water which may undermine the base of the ramp.

Winter: A "winter only" access road would be constructed annually along the exposed riverbank parallel to the tree line connecting the ice bridge crossings to the north and south ramps. This road would be constructed with local snow and ice with some component of river deposited material. No additional right of way clearing will be required. The following spring runoff would completely remove any evidence of the access road. There is an inherit risk with an ice bridge crossing over a large waterbody. The Liard River crossing is no different. Appropriate procedures will be inplace and enforced regarding ice bridge construction and operation. Speed limits of 15km/hr will be inforce, only one vehicle crossing at given time, and no stopping permited.
<u>Erosion and Sediment Control:</u> Summer: The native material along the Liard River consists of fine sands, silts, and clay. To minimize disturbed area at the crossing and potential erosion of exposed soils, cut and fill slopes are been designed at 1.5:1, covered with geotextile fabric, and capped with coarse gravels/rock to provide protection from .erosion. The ditches will also be lined with geotextile fabric and covered with coarse granular rock. Check dams combined with culvert cross drainages will be placed at regular intervals to reduce water velocities and volume in ditches. Use of silt fencing combined with clean gravel berms (as required) at the construction site to filter water prior to entering the main stream channel. Other options include: • Use of settling ponds to allow suspended solids to settle • Direct drainage water away from main stream channel and into natural filtering areas. • Construct during periods offering reduced siltation risk and with appropriate supervision. Refer to preliminary designs of the Liard River barge crossing in the original report. **Winter:** The subgrade would be constructed with native snow, ice, and deposited Liard River material. No significant impacts related to erosion and sediment is expected. The large Liard River itself naturally contains high levels of suspended solids from bed load mobilization so the small amounts of sedimentation which could be generated at this site would have insignificant impact.
<u>Impacts of Barge to navigable waters and recreational users:</u> The transportation study concluded 6 round trips (equals 12 crossing) per day would be required to meet the production requirements of the mine. It is possible that up to two additional crossing would be required for other mine transportation of goods. The barge would operate in two periods of the day, early to mid-morning and again later afternoon into evening at a frequency of 1 round crossing per hour. Given the frequency of crossings, this barge operation would present minimal impact to recreational or other users of the resource. The Liard River is considered navigable waters and under Navigable Waters Act requires the river to remain free and clear for all users and this is the situation with the barge operation.

A view of the Liard River Crossing

2.3 Borrow

References: ToR –3.3 Table 2, 5.1.1, 6.1; **DAR –** Appendix 1A & 2; **AR** 4.13; **June 24** – 4.13

The AR requested information related to borrow locations. CZN noted that this information was in Allnorth's report, and the MVEIRB subsequently rescinded that request in their June 24 letter.

There has been two additions since the original "Proposed Prairie Creek Mine Access Road" report was released in early March, 2015. An alternative route between KP 103.3 to 123.8 (Section 3 below) has been identified, and additional borrow sources have been identified from KP 103 to 154.

CZN identified a lack of borrow sources for subgrade and surfacing material between KP 123 to KP 151, and requested that Allnorth further evaluate borrow potential. Following fieldwork on July 8, 2015 an additional 8 borrow locations have been identified, 6 for subgrade, 2 for surfacing.

The original report identified that, between KP 127 to 159.4, subgrade borrow would be extracted primarily from within the existing road right of way. This will remain the primary approach, however to provide greater construction flexibility, the use of external borrows sources maybe required. Overall, it is thought that should external borrow sources are utilized, the total disturbed area would remain comparable as right of way clearing widths could be reduced to offset the increase in external borrow source disturbance. To reduce greater hauling distances and cycle times, an additional aggregate borrow source, BP 139, (back-up BP 138) has been identified. This source will offset borrow volumes originally planned to be extracted from BP 123A and 151. With the additional borrow identified, the net disturbed area actually decreases slightly from 41.71 to 40.95 ha due to location efficiency.

The alternative route identified between KP 103.3 to 123.8 (called "Preferred Alignment Option") will also change borrow locations relative to that route adjustment. If this option is selected, there will be a total of 86 borrow locations identified, 30 of which are back-up, for a total net disturbance of 40.84 ha.

A revised "Table 14: Borrow Pit Summary" have been created to reflect both options. Similarly, a revised *"Table 15 Borrow Access Roads Outside Right of Way"* has also been created for both options. These tables are located in Appendix A.

An additional 3 soil samples were taken on the July 8, 2015 field investigation and sent for analysis. Laboratory results are included in Appendix F.

2.3.1 Granular Materials

References: **ToR** –7.3.2 Item 2; **DAR** - Appendix 1; **AR** –11.1 **June 24** – no reference

Based on the samples collected to date, the prevalent limestone/carbonate base geology, and various professional opinions, the likelihood of acid generating rock being encountered in cuts and borrows is considered to be low. The "Proposed Prairie Creek Mine Access Road" report stated that "All proposed borrow sites will require additional investigation using an excavator or drill to determine more accurate quality, quantity, depths, and area before they can be confirmed and used for construction " This would include further evaluation of the potential for acid generating materials. With the additional data, borrow areas will be selected, a detailed borrow site plan will be created, and any borrow sources with potentially acid generating material will be avoided.

A number of identified borrow sources will utilize talus cobble rock, particularly from KP 0 to 40. Regarding talus slope stability, the additional investigation work, which would be followed by a detailed site plan, would include an assessment of slope stability for each site, and the extraction plan would reflect the risk associated with slope stability. The site plan would ensure safe extraction of material from these locations and mitigate any long term stability issues.

2.4 Traffic Estimates

References: **ToR** –6.1 Item 22; **DAR** – 6.3.1; **AR** –4.3 **June 24** – no reference

For the transportation of materials for mine operations, the preferred tractor/trailer configuration will consist of specialized trailer units designed to carry bulk concentrate, with capability to haul limited supplies to the Mine. For bagged concentrates, an optional tractor/trailer combination would utilize a modified standard Super B "flat deck" trailer configuration which would haul 2 tonne bags. Figure 1 below is a photo of such a configuration. Examples of mining operations which utilize either haul configuration is identified in Table 3 below. The Prairie Creek Mine bag haul would include a tarped cover.

Table 3: Examples of Mine Operations Utilizing Bulk Transport Systems of Concentrate

Bulk Concentrate Trailers	Bulk Bagged super B trailer
Yukon Zinc, Yukon	Yukon Zinc, Yukon
Huckleberry Mine, B.C.	Pretium, B.C.
Mt. Polley, B.C.	Target, B.C.

Figure 1: Pictures of Typical Concentrate Load (tarped and non-tarped)

The single biggest item the mine operation requires is diesel fuel. The proposed truck configuration provides sufficient space for up to a 5,000 l fuel tank behind the cab or on the forward bridge of the trailer. With this configuration, the mine site can be re-supplied with fuel during hauling operations. It may also be possible to place heavy, bulky items such as heavy equipment parts, mill balls and reagents in the bulk box but that will have to be determined on a case by case basis. The projected total additional capacity of back haul beyond the fuel would be 97,000 tonnes annual backhaul capacity.

All vehicles, in particular commercial vehicles, operating on public roads must be in compliance with all federal, provincial, and territorial DOT laws. The tractor and trailer configurations proposed for this haul are no exception.

The transportation of concentrate and supplies to/from Fort Nelson will fall under two different provincial/territorial jurisdictions, and the final truck configuration must be compatible to both jurisdictions.

2.5 Runaway Lanes

References: **ToR** –6.2 Item 3; **DAR** – 6.4; **AR** –4.5 **June 24** – no reference

There is no published road design criterion that explicitly states the requirements for runaway lane use. The following design guides have been reviewed for reference:

1. Northern Land Use Guidelines – no commentary provided with respect to the use or implementation of runaway lanes.
2. BC Ministry of Forest, Lands and Natural Resource Operations – Engineering Manual - no commentary provided with respect to the use or implementation of runaway lanes.
3. Health, Safety and Reclamation Code for Mines in British Columbia – Under Part 6, Section 6.9.2 the code states "On roadways where the grade exceeds 5%, the manager shall have installed and maintained runaway lanes or retardation barriers where conditions and/or risk warrant". Risk is assessed based on a combination of road grades, alignment, traffic volume, terrain, environmental, and human life or infrastructure factors.
4. Geometric Design Guide for Canadian Roads (TAC Manual) - Under Section 2.1.10 Truck Escape Ramps, many of the design features are discussed and detailed in the event that a run-away lane is warranted. Further in Section 2.1.10.2, the manual states "Current sources do not provide a consensus on when truck escape ramps are needed. There is no uniform, widely accepted procedure to determine when a truck ramp is appropriate, and it appears generally accepted that each situation presents enough unique variables to warrant independent means resolving whether an escape ramp is necessary".

At this time, it is our professional opinion that runaway lanes need not be incorporated within the design and construction of the haul road to remain consistent with typical resource road requirements. Once in operation, the need for specific runaway lanes may be reviewed and could lead to some being constructed for specifically defined safety concerns.

2.6 Safety Railings

References: **ToR** –7.3.2 Item 8; **DAR** – 6.4; **AR** –4.6 **June 24** – no reference

With regards to the design of Safety railings, there is little published road design criteria that explicitly states the requirements for use, and guidance available is generally only for public transportation networks. The following design guides have been reviewed for reference;

1. Northern Land Use Guidelines – no commentary provided with respect to the use or implementation of roadway barriers.
2. BC Ministry of Forest, Lands and Natural Resource Operations – Engineering Manual - no commentary provided with respect to the use or implementation of roadway barriers.
3. Health, Safety and Reclamation Code for Mines in British Columbia – Under Part 6, Section 6.9.1 the code indicates that barriers are required to be located and maintained along the edge of the "haulage road" wherever a drop-off greater than 3 m exists, with the understanding that a "haulage road" is within the operational mine site area and excludes the industrial/resource access road network such as the Prairie Creek access road.
4. BC MoT Supplement to TAC Geometric Design Guide for Canadian Roads - Under Section 600 a Road Barrier Index nomograph has been provided that identifies the roadside barrier requirements starting at a 50km/h design speed as well as the applicable design details for the installation of barriers along a public road network.

At this time, we do not consider that roadside barriers need be incorporated within the design and construction of the of haul road to remain consistent with typical resource road requirements. Once in operation, the need for barriers may be reviewed and could lead to some being installed for specifically defined safety concerns.

2.7 Pull-outs

References: **ToR** –6.2, item 4; **DAR** - Appendix 1; **AR** –4.7 **June 24** – no reference.

To help clarify the original report, the preliminary design provides for up to 3 pull-outs per km, with at least 1 per km. A pullout will be constructed with an additional 3m road width running surface (8m total width) for total length of 40m plus approaches. This will provide ample room for 2 full length tractor/trailer units to pass safely. This approach would be considered standard for B.C. resource roads and is consistent with B.C. MoFLNR. Figure 1 below shows a typical pullout design.

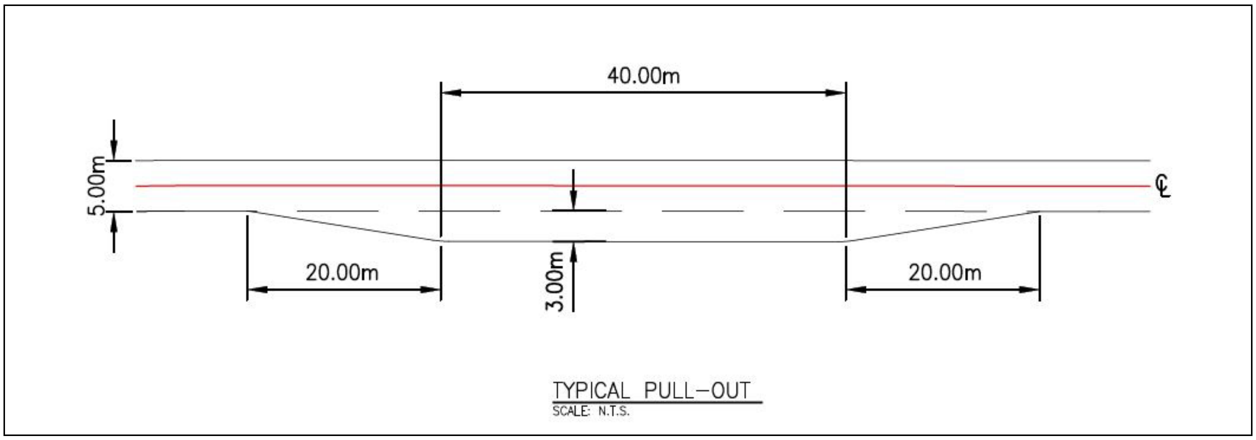


Figure 2: Typical Pullout Design to be Applied to the Prairie Creek Mine Access Road

2.8 Scope of Development (TTF, Emergency Shelters)

References: **ToR** –3.1 **DAR** – 6.3.2; **AR** –4.1 **June 24** – no reference

2.8.1 Tetcela Transfer Facility (TTF)

The Tetcela Transfer Facility (TTF) is proposed at KP 86 near the geographic center of the access road. The original proposed location was located on a large, wet black spruce bog which the winter route traversed and is no longer the route selected for the all season road. The all season access road alignment has shifted north to divert around the large, wet section (see section 2.1 above). The selected TTF location offers much improved dry/stable, reasonably flat terrain and closer proximity to a major gravel source (BP 87).

The TTF will serve as a multi-use area. During road construction, it will provide a staging/laydown area plus camp facility for road construction crews. As the construction is complete, the area can transform into the TTF, if required, which would be utilized for a combination of storage /transfer facility of bagged concentrate, staging area and camp for road maintenance operations, and, if required, a temporary emergency shelter for road users.

If used for concentrate storage, the TTF would include 2 large concentrate storage buildings (4,100 sq. m, 4,961 sq. m), a loading/unloading apron area, fuel storage and fueling location (10,000 litres), an 8 man camp, and adequate parking for several concentrate trucks, 2 graders, 2 sand trucks, crew transportation, and transfer equipment (loaders, etc.). A revised TTF layout plan can be found in Appendix G. The revised layout accommodates all these features within the original location and area. The fuel storage and fueling location would comply with all regulatory requirements, would include ane above ground tank, with all spill prevention/protection/containment measures in place.

2.8.1.1 De-activation/Reclamation of TTF

Following mine closure, all buildings/structures at the TTF will be dismantled and removed. Compacted material will be ripped with a bulldozer, and any stockpiled overburden material would be dispersed over the site to assist vegetation re-establishment. Refer to the Road Closure and Reclamation Plan in Appendix C for additional details.

2.8.2 Emergency Shelters

The tractor/trailer units would provide emergency assistance if mechanical issues or adverse weather conditions occur. In addition, all trucks will have 24 hour communications with road operations and dispatch using either 2 way radio or GPS tracking devices. Should all these systems fail, emergency shelter could be found at the nearest location, either the TTF, South bank Liard River crossing, or the LTF. It is also assumed that small, self-contained mobile trailer units would be placed around permanent road maintenance borrow sources between KP 40 to 45 and 120 to 125 which would serve as “break huts” for road maintenance crews. These could also serve as emergency shelters, and locations for spill response equipment.

With all these systems in place, operators utilizing the road will have the necessary level of safety.

2.9 Construction Phases and Schedule

References: **ToR** –6.3; **DAR** – 6.5, Appendix 1; **AR** –4.15 **June 24** – no reference

A detailed and thorough plan is required for the successful construction completion of the 174 km access road. The schedule (Table 4) below is an outline of the approach taken to successfully complete this major road construction project.

The construction schedule reflects the following:

- Establishing reliable summer and winter crossings over the Liard River as initial priority
- Winter access road would be established annually (or on those remaining portions not yet constructed) connecting Nahanni Bute Access Road to the mine site
- Most vegetation clearing would be conducted in winter, including road right of way clearing, borrow pit development, bridge site clearing and preparation, camps, TTF, LTF.
- Some road right of way clearing would be required during late summer/fall KP 0 to 39 and KP 95 to 102.
- During right of way clearing, when segments of road are off limits to clearing (for example, identified nesting birds, animal den, fish spawning) for a period of time, the operations would leave that short segment and proceed beyond and continue construction operations. Those segments would be constructed when situations permit.

- Any vegetation clearing completed outside of winter season would conform to permits regarding ground conditions (support of vehicle weights) and standard mitigation procedures regarding nesting birds, occupation of wildlife (Dall sheep, Caribou, bear dens, Collared Pika, etc.) and trumpeter swans.
- Full right of way clearing would be completed as required to support all season subgrade construction. This would reduce potential erosion and sedimentation along the right of way.
- The winter of Year 2 would include the mobilization of equipment and supplies to KP 39 to permit summer/fall construction from KP 0 to 39.
- If possible, road and quarry blasting will occur in winter, however it may also occur during snow free conditions as access permits. All blasting outside of the winter season would conform to standard mitigation procedures regarding occupation of wildlife (Dall sheep, Caribou, bear dens, Collared Pika, etc.) and trumpeter swans.
- Crushing operations would be conducted at pre-determined borrow pits during the summer/fall season.
- The schedule generally provides one summer season without activity for each newly constructed subgrade of road to settle.
- By the middle of the 3rd year, some limited hauling of concentrate can occur.
- The all season road would be fully operational in the fall of the 3rd year.
- The schedule would comply with restrictions under the Migratory Birds Convention Act applicable from May 15 to August 15.
- A revised Table 6 in Appendix C provides a breakdown of the road into specific segments with restrictions/concerns and construction seasons.

Camps will be required to support the construction. Allnorth's original report, (Appendix 1 DAR), identified the location and footprint of camps. The schedule below identifies where and when camps will be assembled. Generally, the winter road construction crew and the all season construction crew will operate independently. Initially, the camp on the north side of the Liard River will host both crews. As the winter road construction advances, a self-contained 12 man camp would follow to support the winter road construction. The subgrade construction camps would follow a year or later occupying the same locations used previously for the winter construction camps. After establishing the winter road grade in the first winter season, a much smaller crew will be required for a shorter period of time to re-establish the winter road grade in subsequent years. The subgrade construction camps will utilize 50 man self-contained, mobile units used commonly in the oil and gas sector. The units can be rapid deployed and are self-contained which offers flexibility to the crews and schedule.

Table 4: Road Construction Schedule

Season	Mine Activity	Road Activity
Year 0		
Spring		- Planning summer field program detailed road location and major stream crossing - Tentative award of road construction contract for winter and all season road

Season	Mine Activity	Road Activity
Summer		- Complete detailed road location and site survey of major stream crossings (helicopter) -Complete detailed field investigation of BP 151 A, B, 158, 159 A, B. This would include test sampling with drill or small excavator -Detailed road design and stream crossing site plans starting from Nahanni Access Road to Liard. Complete section KP 160 to 174.1 Complete development plan for selected borrow source(s) from BP 151 A, B, 158, 159 A, B
Fall		- Award road construction contract (using updated designs) Detailed road design and stream crossing site plans starting from Liard to Grainger. Complete section KP 160 to 125. -Right of way clearing Nahanni Access Road to Liard River Crossing – KP 174.1 to 160, (14 Km) - Start subgrade construction as permitted by weather KP 174.1 to 160, (14 Km) - **Camp.** Small 12 man self-contained unit utilizing existing Nahanni Bute Access Road cleared borrow area close proximity to junction with Prairie Creek Mine Access Road (KP 177.5)
Year 1		
Winter	- Late winter with established winter road, haul fuel and short lead construction items to mine -site prep and clearing Liard Transfer Facility (LTF)	- Install/construct winter ice bridge over Liard River - Complete subgrade construction KP 174.1 to 160, (14 Km) -**Camp**. Install temporary 50 man self-contained camp utilizing north side landing and BP 159B. This camp would support initially winter road construction crews up to Grainger Gap, subgrade construction crews, and Liard River construction crews. - Complete north and south barge approaches at Liard crossing - Develop selected BP 151 A, B, 158, 159 A, B. Complete blasting (if required) at selected borrow pits -Stockpile sufficient aggregate material (gravel, rip rap, coarse rock) at north and south banks of Liard crossing -Surface construction KP 174.1 to 160, 159.4 (North Barge crossing)to initial borrow source - Subgrade construction Liard to Grainger Gap (KP 159.4 to 125)

Season	Mine Activity	Road Activity
		- Construct winter road from Liard crossing to Mine. Full right of way clearing Liard to Grainger Gap, minimal right of way clearing from Grainger Gap to Mine. - Conduct field investigations, including drilling, on remainder of route as necessary - Complete the full road design and stream crossing site plans Grainger to mine, KP 125 to 0. -**Camp**. Install temporary 12 man self-contained camp as winter road construction advances. Camps near KP 124, 102, 87, 65, & 40. These locations will later support the all season road construction. -Conduct borrow investigation with test pits or drill as winter road access permits - Complete mine plans for all selected borrow sources. -Late season, stockpile sufficient fuel and equipment on north side of the Liard River for summer construction -Late season, mobilize any required crushing operations at selected BP 151 A, B, 158, 159 A, B. for summer crushing operations
Spring		- No construction activities
Summer	- Develop LTF	-Complete south and north ramps for Liard barge crossing - Liard to Grainger Gap allowed to settle over summer -Crushing operations at selected BP 151 A, B, 158, 159 A, B - spot gravel as required KP 174.1 to 160, 159.4 to initial borrow source
Fall	- Mobilize long lead construction equipment at LTF	- If conditions compatible, surfacing Liard to Grainger Gap - If conditions compatible and accessible, develop borrow sources from Liard to Grainger Gap - If conditions compatible and accessible, blasting and crushing at borrow sources from Liard to Grainger Gap
Year 2		
Winter	-Transport construction equipment into mine	- Ice bridge over Liard and Grainger -re-establish winter road from KP 125 to Mine, full right of clearing from KP 125 to 102, and KP 95 to 59 (leave KP 95-102 in Silent Hills) - **Camp.** Install temporary 50 man self-contained camp at KP

Season	Mine Activity	Road Activity
		124 for Subgrade Construction crews. - Subgrade construction from Grainger Gap to KP 102, and KP 95 to 59 - Develop selected aggregate borrow sources KP 125 to 59. -Late winter, mobilize required crushing operations to selected borrow sites -Late winter, if conditions compatible, mobilize and conduct required blasting at select pits -Mobilize and install major crossing structures at KP 87.4, 89.8, 95, 122.3, 123.3, 124.8 - Develop the Tetcela Transfer Facility (TTF), as necessary -Late winter, mobilize equipment and supplies to mine site to support road construction upgrades from Mine, KP 0 to 33. This would include drills and supplies for required blasting at KP 23.5, 25.3, 28 and major bridge structures. - Late winter, mobilize equipment and supplies to stage from KP 39 for late summer/early fall construction of lower Sundog re-alignment and subgrade construction KP 39 to 33. This would include a self-contained 12 man camp to be located at KP 40.
Summer	-Complete mine construction	- Continuation of crushing and surfacing operations from Liard to Grainger Gap, plus additional surfacing from Grainger Gap to KP 102. - Blasting operations at prescribed borrow sites KP 159 to 102 - Subgrade construction and upgrading from Mine to KP 28. Includes site prep and installation of structures for two major crossings KP 25.3 and 23.5. - Late summer, start subgrade construction of KP 102 to 95 Late summer, start subgrade construction (re-alignment of Sundog Creek) KP 28 to 39 working from both ends
Fall	_- Commission Mill	- - Continuation of subgrade construction (re-alignment of Sundog Creek) KP 28 to 39 working from both ends - Continuation of subgrade construction KP 102 to 95 - Surfacing KP 102 to 86 (TTF)
Year 3		
Winter	- haul of concentrate	- re-establish winter road from KP 59 to 39 including right of way clearing. - **Camp.** Install temporary 50 man self-contained camp at KP

Season	Mine Activity	Road Activity
		65for Subgrade Construction crews. - subgrade construction KP 59 to 39 - Mobilize and install all remaining major crossing structures between Mine to TTF (KP 0 to 86) - Develop required aggregate borrow sites. Stockpile any required borrow material from BP 47A (if required). - Late winter, mobilize required crushing operations to selected borrow sites -Late winter, if conditions compatible, mobilize and conduct required blasting at select pits
Summer	- Limited concentrate haul.	-Surfacing from KP 95 to 39 (if not completed earlier) -final road improvements prior to full operation. -spot graveling KP 0 to 40.
Fall	- Road fully operational, mine supplies and concentrate haul	- Complete any required maintenance

2.10 Existing Management Plans

References: **ToR** –6.1, items 11, 16, 24, 27; 6.2, item 11; 6.5; **DAR** -6.7, 6.56 Appendix 1; **AR** –4.10, 4.17 **June 24** – 4.17

Specific management plans have been developed and are located in Appendix C. These include:

- Road Operations Plan (ROP)
- Road Construction and Maintenance Plan (RCMP)
- Road Closure and Reclamation Plan (RCRP)
- Borrow Pit Management and Reclamation Plan (BPMRP)
- Sediment and Erosion Control Plan (SECP)

2.11 Channel Morphology and Stability

References: **ToR** –5.1.3,7 iv, v **DAR** –4.3 **AR** –7.6 Item (4 & 5) **June 24** –Section 22.2, page 13

In reference to the Sundog re-alignment, the roadway will be constructed to avoid vertical scour at the toe of rip rap armour by re-aligning the main channel away from the road prism. In other site specific areas where main channel flow may impact the stability of the road, scour calculations will be completed to determine the appropriate embedment of rip rap armour below the existing stream bed elevation. This approach will result in a slightly wider subgrade road base below the existing stream bed elevation; however above the natural stream bed elevation the road structure footprint would be consistent with the standard road subgrade design.

2.12 Additional Roadway Use

References: **ToR** –7.3.12 **DAR** –11.11 **AR** –21.2Item (3) **June 24** –page 12

The Impact on Traffic Volumes

The most current traffic study information provided by the NWT includes traffic counts which were completed in2011. As there has been minimal commercial and industrial development in the geographic region of the study since that time it is believed that these numbers would be relevant and consistent with current annual daily traffic counts if the information was available.

Traffic Attributable to the Mine Operations

The total increase in traffic attributed to the operation of the Mine has been determined to be approximately 11-15 vehicles per day carrying concentrate, freight and fuel. These numbers are based on the mill production, expected payload of the units and the inbound freight to support the operation of the Mine. It should be noted that the concentrate trucks will back haul fuel and bulk consumables to reduce the total traffic into the mine site, and reduce the cost of in and out bound materials. These traffic numbers will occur when the Ice Bridge or Barge over the Liard River is operational which is estimated at 210 days per year. During the remainder of the year, there will be no increase in traffic.

Traffic Increases

When viewed as a percentage increase over the current traffic levels (Table 5), it would appear that the increases on Highway 7 could be up to 28% with the increases on the Nahanni Butte road being up to 39%. These increases are real as a percentage, however the actual increase is less significant when looked at as absolute values. These infrastructure assets are significantly underutilized with a total average annual daily traffic count ranging from 36-110 units. Specifically, for the Fort Liard region, the increase will be negligible as it represents a 10-13 % increase in the total traffic volume, due in part to that corridor currently being the greatest utilized along the haul route. North of Fort Liard, the increases are more significant as a percentage of the current traffic volume, 22-28%, but as indicated above, this is due to the minimal traffic which is currently utilizing the road system. In addition, as the haul is constrained by the seasonal load restriction and the access discontinuity of the Liard Crossing, these traffic volumes will only be realized approximately 210 days per year.

Table 5: Annual Traffic Count Increase

Highway / Road	Traffic Count Locations	Average Annual Daily Traffic*	Lower End Increase (Average Annual Daily Traffic)	Lower End Increase (Average Annual Daily Traffic)	Increase (minimum)	Increase (Maximum)
Highway 7	2.6 Km south of Fort Liard	110	11.1	13.9	10%	13%
Highway 7	North of Fort Liard	50	11.1	13.9	22%	28%

Highway / Road	Traffic Count Locations	Average Annual Daily Traffic*	Lower End Increase (Average Annual Daily Traffic)	Lower End Increase (Average Annual Daily Traffic)	Increase (minimum)	Increase (Maximum)
Nahanni Butte	Undisclosed 1997	36	11.1	13.9	31%	39%

*- 2011 Traffic Data Information

2.13 Changes to Permafrost and Subsidence

References: **ToR** –8, item 2, 5, 7 **DAR** –Section 12 Appendix 2 Section 6 Appendix 2, Section 8 **AR** –22.2 Item (3) **June 24** –Section 22.2, page 13

It is expected that, with any newly established road structure constructed in the environment and terrain conditions found in this location, segments of the road will break down and require additional maintenance. It may be as simple as repeated grading of the road surface to rebuilding the affected section. This will be an ongoing maintenance of the road, but it is expected that after 5 years of operations the road structure would stabilize and these issues would be greatly reduced. The Road Operations Plan found in Appendix C outlines the processes and procedures followed to maintain the road over its project 20 year life. However, it is not possible to reliably estimate how much additional granular material will be required

A sufficient quantity of aggregate material must be available to support the long term maintenance of the road. The borrow pits or locations currently identified, both preferred or back-up, are expected to provide more than an ample supply of material. Further, it is likely that additional sources will be identified during road construction, when clearing activities will expose the underlying soils.

2.14 Closure Plans and Timing

References: **ToR** –12, item 1, 2; **DAR** –16; **AR** –24.2; **June 24** –no reference

A Road Closure and Reclamation Plan (RCRP) can be located in Appendix C. The plan outlines the procedures and process which will be applied following the projected 20 year life of the road. The reclamation of the main access road and supporting infrastructure is required to enhance the natural re-vegetative process and help establish a stable landform. This process will be conducted in a manner that is environmentally sound; will reduce erosion and transport of sediment-bearing water; and is consistent with sustainable development.

The main points of this plan include:

- Complete removal and disposal of all imported, man-made, non-biodegradable materials.
- Removal of all culverts and bridges.
- Maintain all natural drainages. Restore drainages to natural contour when beneficial
- Re-contour road sections within slope stability concerns

- Facilitate the natural re-vegetative process within the disturbed areas

Table 6 below segments the road into sections with similar site characterises and field prescriptions to be followed for the reclamation of the access road.

Table 6: Breakdown of Reclamation Work to be Completed for the 174 km Access Road

Road Section	Prescription	Comments
KP 0 to 25	**A**	Consists of very granular, gravel material mostly utilizing an established road structure. Expect minimal sediment or erosion control problems.
KP 25 to 28	**B**	New constructed section with mostly granular, gravel type material but may contain some short sections with finer soils and greater cut/fills
KP 28 to 40	**A**	Consists of very granular, gravel material mostly utilizing an established road structure. Expect minimal sediment or erosion control problems
KP 40 to 60	**B**	Generally, this section contains fine sand silt /clay base materials with some portions containing steeper side slopes 10 to 30 %, some up to 50%. These sections will require partial or full pullback of road structure.
KP 60 to 86	**A**	Rolling terrain and following primarily the original winter road location. Mix of soil types but primarily sand, silt, clay base. Minimal watercourses as road generally follows the height of land so little sediment and erosion concerns.
KP 86 to 90	**B**	Soil types consist of sand, silt, clay within proximity to Tetcela River. Some exposed cut/fills expected which may require partial or full road pullback.
KP 90 to 96	**A**	Soil types consist of sand, silt, clay over rolling terrain however adjacent to large, flat terrain with streams considered to have no or little fish value. Little risk related to sediment and erosion. Some partial or full pullback or road may be required on larger cuts/fills.
KP 96 to 102	**C**	Soil types consist of sand, silt, clay and the general topography is considered to have some slope stability concerns. Partial or full pullback of road structure may be required.
KP 102 to 112	**B**	Soil types consist of sand, silt, clay over rolling terrain however adjacent to large, flat terrain with streams considered to have no or little fish value. Little risk related to sediment and erosion. Some partial or full pullback or road may be required on larger cuts/fills.
KP 112 to 126	**A**	Consists of very granular, gravel material. Expect minimal sediment or erosion control problems
KP 126 to 159	**B**	Soil types consist of sand, silt, clay over rolling terrain however adjacent to large, flat terrain with streams considered to have no or little fish value. Little risk related to sediment and erosion. Some partial or full pullback or road may be required on larger cuts/fills.
KP 159 to 160.5	**C**	Liard River Ramps. Soils consist of sand, silt, clay. Pullback of ramps required as necessary.
KP 160.5 to 174.1	**A**	Soil types consist of sand, silt, clay over flat terrain. Little risk associated with sediment and erosion. Local residence may continue to utilize access road. Ensure full de-activation to discourage access.
A - Removal of all drainage structures including bridges and culverts.		

- Re-contour stream crossings to reassemble the natural landscape - Scarify the main road structure - Cover with readily available soil / organics – 0 to 20% length. - Partial or full pullback of road structure < 10% length - Install waterbars as required to maintain natural drainage patterns.
B - Re-contour stream crossings to reassemble the natural landscape - Scarify the main road structure - Cover with readily available soil / organics – 20%.to 50% length - Partial or full pullback of road structure 10% to 50% length - Install waterbars as required to maintain natural drainage patterns
C - Re-contour stream crossings to reassemble the natural landscape - Scarify the main road structure - Cover with readily available soil / organics – 50 to 100% length. - Partial or full pullback of road structure 50% to 100% length - Install water-bars as required to maintain natural drainage patterns -

2.14.1 Non-reclaimable Road Sections

Due to the nature of the physical environment in which the road exists there will be sections where reclamation of the road may not be possible. These sections will include areas of rock cut and blast construction. Several areas of the road where this condition exists are highlighted in the table below.

Table 7: Non-reclaimable Road Sections

Road Section (KM)	Condition
2.6-2.8	Rock Cut / Fill
3.4-4.8	Rock Cut / Fill
6.6-6.8	Rock Cut / Fill
7.4-7.5	Rock Cut / Fill
13.0-13.5	Rock Cut / Fill
16-16.3	Rock Cut / Fill
23.0-23.8	Rock Cut / Fill
25.1-25.6	Rock Cut / Fill
28.0-28.4	Rock Cut / Fill
29.5-30	Rock Cut / Fill
122.9-123.1	Rock Cut / Fill

This RCRP will be a “living document”, evolving to reflect design details, future performances and outcomes, and changing environment conditions.

2.15 Long Term Integrity of Permanent Features

References: **ToR** –12, item 4, 2; **DAR** –16; **AR** –24.3; **June 24** –no reference

All stream crossing structures (culverts and bridges), buildings, camps, road signs, and any man made items, not biodegradable will be removed and disposed of. Bridge foundations will be removed and disposed when and where possible, if the removal does not add additional adverse effects to the environment. The basic road prism (subgrade) would be left mostly intact except in those sections with slope instability issues, in which case the road would be partially or fully pulled back (de-constructed) and the natural slopes re-contoured. Road Surface would be scarified, as necessary, to allow natural vegetation to colonize and stabilize.

2.16 Reclamation of In-stream and Riparian Areas

References: **ToR** –7.3.7 Item 19; **DAR** –11.6.3; **AR** –24.4; **June 24** –no reference

Approaches taken to reclaim disturbed areas within the stream and riparian areas can be found in Appendix C; the ROP, RCMP, and SECP. Generally, the best approach to reclamation of riparian areas is to initially minimize the disturbance of the works and restore/repair unavoidable disturbance as quickly as possible. In summary, the approach taken toward the reclamation of in stream and riparian areas includes:

- clearly identify the riparian/stream area prior to works commencing, develop a site specific plan, and communicate with all personnel involved
- complete work activities during favourable weather/site conditions, to the extent possible
- establish and install erosion and sediment control procedures
- equipment operations to be conducted outside the existing active channel
- use of temporary crossings over open surface water until permanent structures can be installed
- if equipment is required to cross open water, and a temporary crossing is not an option, a one-time over and back ford crossing may be approved by the Inspector
- any damaged stream banks/channels will be restored, under the direction of the Inspector
- complete works in a sustained, steady manner to limit the time the disturbed area is exposed
- stockpile overburden/stripped material at secure locations, within a reasonable time and when conditions permit, replace stripped organics/overburden within the riparian area to accelerate the re-vegetation process.
- continue to monitor riparian areas until vegetation has re-established and a stable environment is achieved

3 ALTERNATIVE ALIGNMENT OPTION – KP 103.3 TO 123.8

Subsequent to our original report, an alternative route connecting KP 103 to 124 was identified and discussed. The route was reviewed in the field on July 8, 2015. The option appears favourable and is now identified as an "Alternative Alignment" option. The advantages of this optional alignment include:

- Reduced overall road length, by 2.9 km for this road segment, or 14% (17.6 km vs. 20.5 km).
- 8.9 km or 51% of the road segment is located within preferential site conditions which will reduce risks related to permafrost and improve constructability. The route follows along the south-west

aspect of the Nahanni Range which offers better/drier well drained soils and less probability of permafrost.
- Greater availability of higher quality borrow, particularly surfacing material.
- Eliminating two fish-bearing stream crossings on the original route, one major (which includes rock removal for one abutment) and one minor, in favour of two simpler crossings on the alternative route considered to be non-fish bearing.

The length of road crossing the valley wetlands to the Silent Hills is also shorter. The one potential drawback of the alternative is the ground hosting the wetland crossing may be very soft, and warrants investigation. For this reason, while this alignment option is preferred, it is subject to investigation, and if results are negative, the previously defined alignment will be retained. The field investigation identified a suitable, narrow crossing location of the wetland, utilizing nearby timber stands on the approaches which indicate firm ground.

In considering this alternative alignment, a number of calculations and items must be revised and updated. Adjustments to the tables mentioned below have been completed and can be located in Appendix E of this document:

- Summary of Right of Way Clearing Widths and Areas – Table 2
- Road Construction Types – Table 5
- Road Summary – Table 7
- Earthworks Summary – Table 8
- Major Stream Crossing Summary – Table 10 –additional detail provided in Section 2.2 above. See Table 2 of this report.
- Minor Stream Crossing Summary – Table 11
- Borrow Pit Summary – Table 14 original report
- Borrow Access Roads Outside Right of Way – Table 15
- Land Requirements – Table 16

We trust this report satisfies your requirements at this time and thank you for the opportunity to work with you on the project. If you have questions or concerns do not hesitate to contact our office.

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Yours truly,

ALLNORTH CONSULTANTS LIMITED

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Appendix A Revised Tables 14 and 15 (from original submission)

Table 14: Borrow Pit Summary – Alternate Alignment

Label	Material Type	Road KP	Application	UTM X/Y	Potential Volume (m^3)	Demand Volume (m^3)	Gross Area (ha)	Net Area (ha)	Comments
BP 1	Colluvium Siltstone	0.5	Subgrade	404168 6826241	100,000	Back-up	2.14	0.0	Existing pit utilized by original road. More volume available if required.
BP 2	Calcareous Mudstone Bedrock	2.7	Subgrade, Rip rap Surfacing	403340 6827765	80,000	10,000 (rip rap) 25,000 (surfacing)	1.41	0.68	Existing pit utilized by original road. More volume available if required. Durable crushed surfacing possible but constrained work areas.
BP 4A	Bedrock Limestone/Mudstone	4.01	Subgrade	403032 6828909	15,000	Back-up	1.83	0.0	Steep rock cut adjacent to the road which may be removed to widen existing road base and could be utilized nearby. Geotechnical concern due to slope angle.
BP 4B	Colluvium Limestone/Mudstone	4.5	Subgrade, Surfacing	403102 6829344	58,000	Back-up	2.64	0.0	Volume could easily be doubled if required. Existing pit utilized by original road. Moderately durable as surfacing.
BP 6	Bedrock/Talus Mudstone	6.8	Subgrade, Rip rap	402812 6831448	5,200	Back-up	0.63	0.0	Volume could easily be doubled if required.
Bp 10	Argillite Colluvium	10.2	Rip rap	405709 6831914	5,000	Back-up	0.35	0.0	Possible source of rip-rap material adjacent to the road. Potential permafrost so additional testing required if utilized.
BP 14	Colluvium Limestone	14.9	Subgrade, Rip-rap	409766 6831761	27,000	15,000 (rip rap)	1.08	0.66	Adjacent to the road. Some riprap in talus.
BP 16	Glacialfluvial Gravel	15.8	Surfacing	410382 6832295	75,000	20,000	0.78	0.51	Moraine deposit left by glaciers. Large volume available and appears of good quality.
BP 25	Glacialfluvial Gravel	25.5	Surfacing	417891 6828651	25,000	25,000	1.0	1.0	Moraine deposit left by glaciers.

Label	Material Type	Road KP	Application	UTM X/Y	Potential Volume (m^3)	Demand Volume (m^3)	Gross Area (ha)	Net Area (ha)	Comments
BP 33	Large fragmented talus rock	33.5	Subgrade, Rip rap	423842 6826838	10,000	7,500	0.88	0.66	Deposit of fragmented talus rock adjacent to the road. Little or no stripping involved, easy access.
BP 34	Large fragmented talus rock	34.5	Subgrade Rip rap armoring	424443 6828239	35,000	12,500	2.15	0.84	Large deposit of fragmented talus rock parallel to the road. Little or no stripping involved, easy access.
BP 35	Large fragmented talus rock	35.5	Subgrade, Rip rap armoring	424951 6828894	7,500	7,500	0.57	0.63	Deposit of fragmented talus rock parallel to the road. Little or no stripping involved, easy access.
BP 37	Large fragmented talus rock	37.5	Subgrade, Rip rap armoring	426826 6829170	7,500	7,500	0.65	0.65	Deposit of fragmented talus rock parallel to the road. Little or no stripping involved, easy access.
BP 38	Large fragmented talus rock	38.3	Subgrade, Rip rap armoring	427451 6829653	30,000	10,000	2.15	1.97	Large deposit of fragmented talus rock parallel to the road. Little or no stripping involved, easy access.
BP 39	Alluvium Gravel/Cobble	39.2	Subgrade, surfacing	428396 6830388	144,000	10,000	8.27	0.63	Old floodplain adjacent to the road.
BP 40	Alluvium Gravel/Cobble	40.0	Subgrade, surfacing	428707 6830599	50,000	10,000	2.05	0.45	Old floodplain adjacent to the road. Similar to BP 39 but some stripping and less influence from Sundog Creek.
BP 40A	Glaciofluvial Sand - Fine	40.5	Subgrade	429155 6830820	3,500	Back-up	0.22	0.0	Not field confirmed. Assume similar material as identified at BP 43A. Back-up borrow volume available for localized subgrade requirements.
BP 41	Glaciofluvial Sand - Fine	41.0	Subgrade	429606 6830685	3,500	Back-up	0.56	0.0	Not field confirmed. Assume similar material as identified at BP 43A. Back-up borrow volume available for localized subgrade requirements.

Label	Material Type	Road KP	Application	UTM X/Y	Potential Volume (m^3)	Demand Volume (m^3)	Gross Area (ha)	Net Area (ha)	Comments
BP 41B	Glaciofluvial Sand - Fine	40.9	Subgrade	429426 6830794	5,000	Back-up	0.31	0.0	Not field confirmed. Assume similar material as identified at BP 43A. Back-up borrow volume available for localized subgrade requirements.
BP 43A	Glaciofluvial Sand – Fine	43.1	Road sand, Subgrade	431491 6829886	28,000	25,000	0.96	0.94	More volume available. Volume to be extracted for long term road sanding operations.
P 43B	Glaciofluvial Sand – Medium	43.7	Road sand, Subgrade	431868 6829691	21,000	5,000	0.87	0.23	More volume available.
BP 47A	Colluvium and Bedrock Limestone	47.0	Subgrade, Riprap, Surfacing	434745 6828744	23,000	Back-up	0.77	0.0	More volume available with increased blasting. A 400 meter access road required.
BP 47B	Alluvium Gravel/Cobble	47.0	Subgrade, Surfacing	434939 6828665	49,000	20,000	3.37	0.76	Alluvial floodplain – assumes 2m depth only.
BP 47C	Colluvium and Bedrock Limestone	47.7	Surfacing, Rip rap armoring	435550 6828997	20,000	5,000	0.38	0.1	Assume similar material as BP 47A however adjacent to the road. Requires blasting.
BP 50	Fine Sand	50.9	Subgrade	438216 6829974	55,000	5,000	2.1	0.21	More volume available.
BP 50B	Fine Sand	50.2	Subgrade	437641 6829946	10,000	2,000	0.91	0.20	More volume available but expected to be small borrow area and shallow.
BP 51	Fine Sand	51.7	Subgrade	438858 6830441	43,000	20,000	1.36	0.69	More volume available.
BP 53	Fine Sand with minor Gravels	53.4	Subgrade	440459 6830858	60,000	10,000	2.53	0.46	Possible limited expansion.
BP 54	Carbonate Rock Exposure	54.6	Subgrade, Surfacing	441383 6830556	16,000	Back-up	2.1	0.0	Two large exposed rock humps. Potential surfacing source for proposed airstrip.
BP 55	Shale-Rock Exposure	55.3	Subgrade, Surfacing?	441450 6830055	10,000	10,000	0.38	0.42	Shale rock knobs comparable to BP 54 however the road passes thru them.

Label	Material Type	Road KP	Application	UTM X/Y	Potential Volume (m^3)	Demand Volume (m^3)	Gross Area (ha)	Net Area (ha)	Comments
BP 56	Shale Colluvium/Bedrock	55.9	Subgrade, Surfacing?	441918 6829766	50,000	10,000	0.84	0.19	Exposed shale rock along the upper cut slope of the proposed road. Could be excellent subgrade material and possibly for surfacing. Minor chance of acid generating.
BP 56B	Shale Colluvium/Bedrock	56.6	Subgrade, Surfacing?	442390 6829649	20,000	10,000	0.68	0.37	Shale rock knob close proximity to road. Excellent subgrade material or possibly surfacing. Minor chance of acid generating.
BP 59	Gravel – sub-rounded shale & sand	59.4	Subgrade, Surfacing	443934 6828136	40,000	20,000	1.94	1.07	Potential use for airstrip construction. More volume available.
BP 61	Shale Colluvium/Bedrock	61.4	Subgrade	445409 6827254	5,900	5,900	0.40	0.40	More volume available.
BP 64	Glaciofluvial Gravel – Fine	64.9	Subgrade, Surfacing	447360 6824430	116,000	10,000	4.52	0.43	More volume available. Alternate to BP 65 source. The sample taken indicated a slightly silty gravel.
BP 65	Glaciofluvial Gravel – Fine	65.2	Subgrade, Surfacing	447427 6824337	22,000	22,000	1.39	1.53	Small hump.
BP 67	Colluvium – Shale	67.5	Subgrade	448634 6822644	6,200	5,000	0.57	0.35	Main face only.
BP 70	Fine Sand	70.9	Subgrade	449549 6819884	9,600	5,000	0.7	0.40	More volume available.
BP 72	Fine Sand	72.9	Subgrade	450288 6818270	8,100	5,000	0.88	0.60	Maximum volume available. No expansion possible.
BP 76	Fine Sand	76.2	Subgrade	451871 6815634	12,700	5,000	0.89	0.38	Small hump.
BP 77A	Sandy till	77.2	Subgrade	452840 6815788	13,500	Back-up	1.51	0.0	Small hump.

Label	Material Type	Road KP	Application	UTM X/Y	Potential Volume (m^3)	Demand Volume (m^3)	Gross Area (ha)	Net Area (ha)	Comments
BP 77B	Sandy till	77.5	Subgrade	453210 6815603	3,500	Back-up	0.36	0.0	Small hump.
BP 78	Sandy till	78.5	Subgrade	453921 6815218	4,500	4,500	0.36	0.36	Maximum volume available. No expansion possible.
BP 84	Sandy till	84.2	Subgrade	458159 6815538	30,000	Back-up	1.61	0.0	Possibly could be expanded. Borrow material for expected localized overland sections.
BP86A	Medium sand	86.4	Subgrade, Winter sand	459373 6814018	13,500	5,000	0.8	0.32	Some limited expansion possible.
BP86B	Medium sand with gravels	86.5	Subgrade, Winter sand	459520 6813948	37,900	5,000	1.0	0.14	Maximum volume available is indicated. No additional volume is available.
BP 87	Alluvial Cobble and Gravels	87.5	Subgrade, surfacing	460468 6813925	120,000	55,000	5.98	3.99	Maximum volume available. No expansion possible. Old flood plain - unlikely to have permafrost.
BP 90	Fine sand / silt mixtures	90.5	Subgrade	461865 6815956	52,500	5,000	1.53	0.16	Borrow volume required for localized overland sections. Could be easily expanded.
BP 92	Fine sand / silt mixtures	91.5	Subgrade	462569 6815294	20,000	5,000	0.71	0.20	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections. Could be easily expanded.
BP 93A, 93B	Fine sand / silt mixtures	93.0	Subgrade	463686 6814714 463751 6814584	15,000	5,000	0.62	0.22	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections. Could be easily expanded.

Label	Material Type	Road KP	Application	UTM X/Y	Potential Volume (m^3)	Demand Volume (m^3)	Gross Area (ha)	Net Area (ha)	Comments
BP 93C	Fine sand / silt mixtures	93.6	Subgrade	464015 6814213	2,500	Back-up	0.53	0.0	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections.
BP 94	Fine sand / silt mixtures	94.2	Subgrade	464295 6813722	20,000	10,000	1.1	0.61	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections. Could be easily expanded.
BP 96	Silty sand	96.0	Subgrade	465958 6813509	45,000	12,500	3.52	1.72	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections. Could be easily expanded.
BP 97	Silty sand	97.2	Subgrade	466244 6812298	45,000	15,000	2.74	0.9	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections. Could be easily expanded.
BP 102	Fine sand	102.0	Subgrade	467969 6811664	55,000	10,000	1.31	0.5	Borrow volume required for localized overland sections. Could be easily expanded.
BP 102B	Silty sand	102.3	Subgrade	468544 6811716	60,000	Back-up	2.79	0.0	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections. Could be easily expanded. Short 175m access road required.

Label	Material Type	Road KP	Application	UTM X/Y	Potential Volume (m^3)	Demand Volume (m^3)	Gross Area (ha)	Net Area (ha)	Comments
BP 103	Clay based overburden with carbonate based rock	103.7	Subgrade, Surfacing, Rip Rap	469432 6810903	30,000	20,000	1.51	1.11	Large elevated knob with potential clay till type material overlaying a probable carbonate rock type layer underneath. The clay could be utilized for subgrade overland base material, the rock could be blasted/crushed and utilized for road surfacing. Short access road required.
BP 104	Clay based overburden with carbonate based rock	104.1	Subgrade Surfacing	469655 6810510	100,000	Back-up	5.54	0.0	Large elevated knob with potential clay till type material overlaying a probable carbonate rock type layer underneath. The clay could be utilized for subgrade overland base material; the rock could be blasted/crushed and utilized for road surfacing. Future test pits will determine the precise shape and size (probably less than 2.5 ha).
BP 107 Alter.	Clay based overburden with carbonate based rock	106.2	Subgrade, Surfacing	470605 6808474	100,000	Back-up	3.29	0.0	Large elevated knob with potential clay till type material overlaying a probable carbonate rock type layer underneath. The clay could be utilized for subgrade overland base material; the rock could be blasted/crushed and utilized for road surfacing. Requires 350m access road Future test pits will determine the precise shape and size.

Label	Material Type	Road KP	Application	UTM X/Y	Potential Volume (m^3)	Demand Volume (m^3)	Gross Area (ha)	Net Area (ha)	Comments
BP 108 Alter.	Shale rock quarry and Clay based overburden with carbonate based rock	107.8	Subgrade, Surfacing	470892 6806779	50,000	25,000	1.78	0.8	Part of the same geological formation as BP 104, 107 108 Alter. Could serve as borrow for overland subgrade base material (any overburden clay/silt/sand and the rock quarry for crushing/surfacing. Requires 450m access road. Future test pits will determine the precise shape and size
BP 109 Alter.	Shale rock quarry and Clay based overburden with carbonate based rock	108.8	Subgrade, Surfacing	471072 6805816	50,000	Back-up	4.87	0.0	Part of the same geological formation as BP 104 and 111. Could serve as borrow for overland subgrade base material (any overburden clay/silt/sand) and the rock quarry for crushing/surfacing. Requires 650m access road.
BP 112 Alter.	Clay based overburden with carbonate based rock	112.0	Subgrade,	474048 6805656	50,000	5,000	1.0	0.2	Large elevated knob/ridge with potential clay till type material overlaying a probable carbonate rock type layer underneath. The clay could be utilized for subgrade overland base material.
BP 112.3 Alter.	Alluvial Cobble and Gravels	112.3	Subgrade, Surfacing	474353 6805428	100,000	36,000	4.47	1.20	Old flood plain, unlikely to have permafrost. Additional volume could be available. Surfacing material from KP 97 to 115.
BP 118 Alter.	Alluvial Cobble and Gravels	118.3	Subgrade, Surfacing	477111 6800906	75,000	7,500	3.48	0.5	Old flood plain, unlikely to have permafrost. Additional volume could be available.
BP 119 Alter.	Alluvial Cobble and Gravels	119.2	Subgrade, Surfacing	477736 6800337	100,000	Back-up	5.30	0.0	Old flood plain, unlikely to have permafrost. Additional volume could be available.

Label	Material Type	Road KP	Application	UTM X/Y	Potential Volume (m^3)	Demand Volume (m^3)	Gross Area (ha)	Net Area (ha)	Comments
BP 123A	Alluvial Cobble and Gravels	123.7	Subgrade Surfacing	478153 6799135	214,000	Back-up	10.87	0.0	Maximum volume available. No expansion possible. Old flood plain, unlikely to have permafrost.
BP 123B	Bedrock Limestone	123.7	Surfacing, Rip rap	477960 6799174	90,000	10,000	2.34	0.29	Exposed rock outcrop knob. Blast rock.
BP 124	Alluvial Cobble and Gravels	124.4	Subgrade Surfacing	479,031 6,799,520	30,000	30,000	1.48	1.48	Old flood plain, unlikely to have permafrost. Considered the main surfacing source from KP 125 to 133.
BP 125A BP 125B	Bedrock Limestone	125	Surfacing, Rip rap Subgrade	479315 6799489 479483 6799159	160,000	Back-up	2.04	0.0	Exposed rock outcrop knob for rock quarry. Would work excellent for overland subgrade borrow from KP 124.8 to 126.8.
BP 126	Colluvium Limestone	126.4	Subgrade, Rip rap	480215 6798190	76,000	Back-up	7.64	0.0	Could be rock glacier. Requires additional testing to confirm material and check any potential geotechnical concerns.
BP 129	Alluvial Cobble and Gravels	129.0	Subgrade, Surfacing	481684 6797072	75,000	5,000	3.14	0.23	Potential good source of surfacing gravel. Close proximity to the proposed road location.
BP 132	Clay/silt glacial till	132.2	Subgrade	482506 6793456	100,000	Back-up	7.1	0.0	Back-up borrow volume.
BP 136	Clay/silt glacial till	136.2	Subgrade	483,136 6789603	100,000	Back-up	14.55	0.0	Back-up borrow volume.
BP 138	Bedrock Limestone	138.2	Surfacing, Rip rap	484,101 6788499	100,000	Back-up	3.89	0.0	Exposed rock outcrop knob for rock quarry. A 1.2 km access road is required.
BP 139	Alluvial Cobble and Gravels	139.6	Surfacing, Subgrade	484578 6786662	250,000	24,000	18.05	1.0	Large fan with excellent gravel material. A 2.0 access road is required. Surfacing material from KP 133 to 145. Sample extracted from similar fan formation north west of

Label	Material Type	Road KP	Application	UTM X/Y	Potential Volume (m^3)	Demand Volume (m^3)	Gross Area (ha)	Net Area (ha)	Comments
									location.
BP 140	Clay/silt glacial till	140.2	Subgrade	486011 6787740	100,000	Back-up	3.43	0.0	Back-up borrow volume.
BP 143	Clay/silt glacial till	143.8	Subgrade	486691 6784624	140,000	Back-up	8.36	0.0	Back-up borrow volume.
BP 146	Clay/silt glacial till	146.5	Subgrade	486671 6781913	140,000	Back-up	8.62	0.0	Back-up borrow volume.
BP 151 A BP 151B	Alluvial Cobble and Gravels	151.5	Surfacing, Rip rap armoring	487108 6777912 487058 6777645	250,000	25,000	15.8	2.5	Must confirm depth and area but expect shallow source (2m deep) spread over a large fan. A potential S3 seasonal stream divides the two defined patches. Surfacing material from KP 145 to 155
BP 154	Clay/silt glacial till	154.0	Subgrade	485734 6775155	140,000	Back-up	2.97	0.0	Available back-up subgrade borrow if volume not available within R/W.
BP 158	Limestone/Carbonate Talus rock deposit	158.2	Surfacing, Rip rap armoring	483731 6772187	250,000	110,000	29.31	4.0	Final area must be defined and will be much smaller. Excellent source of mixed talus rumble at the base of limestone/carbonate rock face. A very strategic source to supply from KP 155 to 184. Requires 1.5 km access road.
BP 159A , B	Carbonate Rock	159.3	Surfacing, Rip rap armoring	484123 6771167 484080 6770474	30,000	Back-up	4.3	0.0	More investigation required but looks like excellent source of large deposit of fragmented carbonate/limestone rock (part of an old landslide broken off mountain face). Geotechnical concerns will regulate and limit the availability.
TOTALS	**86 Borrow Identified, 52 Borrow Required, 30 Back-up**				**4,749,600**	**789,400**	**259.81**	**40.84**	

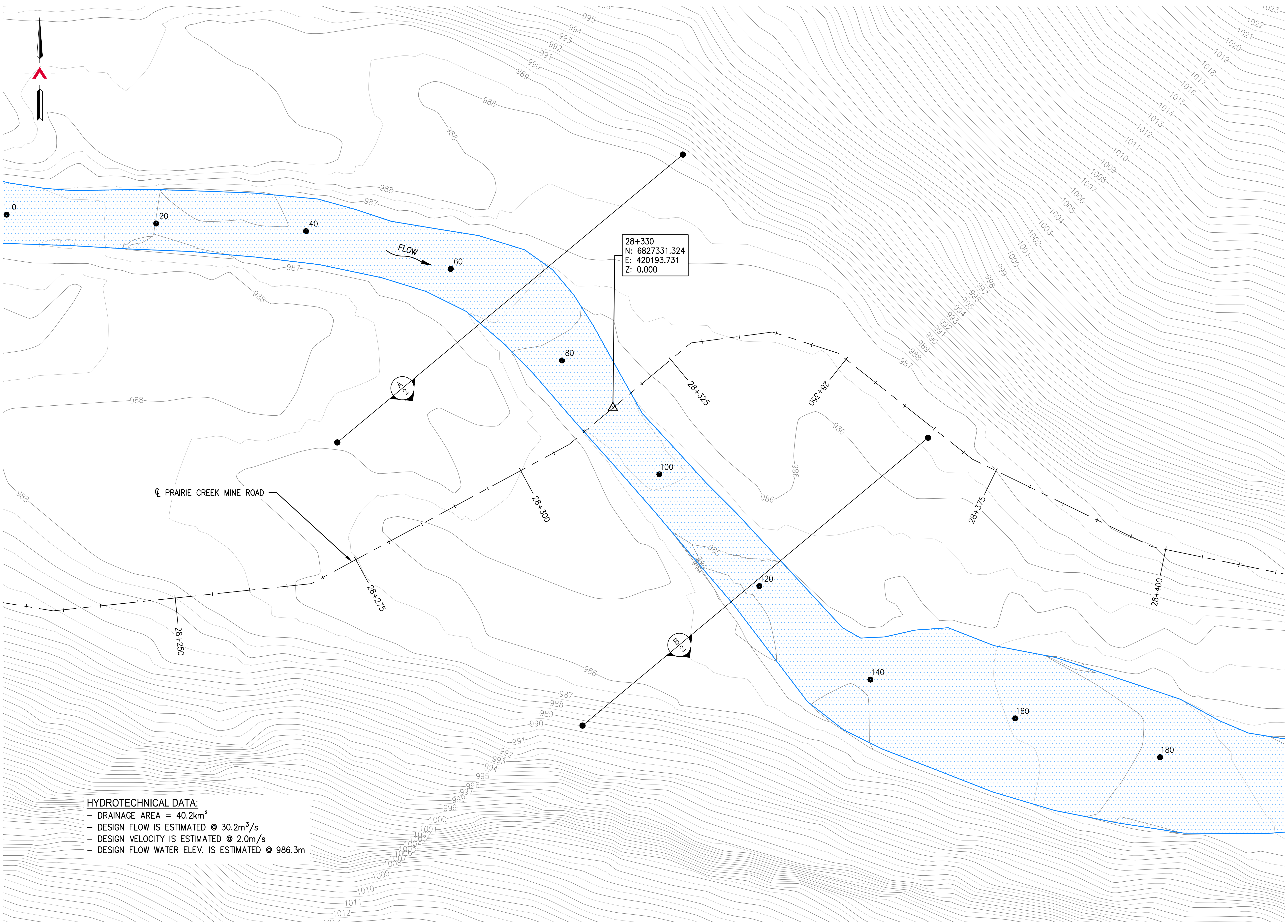
Note: Identifies borrow with field samples taken.

Table15: Borrow Access Roads Outside Right of Way –Alternate Alignment Option

Borrow Label	Access Road Length (KM)	Area (ha)	Duration	Seasonal Limitations
BP 47A & 47B Access	0.38	0.57	Temporary	Winter, ice bridge over upper Poljie Creek required for access.
BP 64 Access	0.32	0.48	Temporary	Summer or Winter
BP 102B Access	0.19	0.29	Temporary	Summer or Winter
BP 103 Access	0.16	0.24	Temporary	Summer or Winter
BP 107 Alter. Access	0.34	0.51	Temporary	Summer or Winter
BP 108 Alter. Access	0.44	0.67	Temporary	Summer or Winter
BP 109 Alter. Access	0.62	0.92	Temporary	Summer or Winter
BP 125 Access	0.33	0.49	Temporary	Summer or Winter
BP 126 Access	1.12	1.68	Temporary	Summer or Winter
BP 138 Access	1.15	1.72	Temporary	Summer or Winter
BP 139 Access	2.11	3.17	Long Term	Summer or Winter
BP 158 Access	1.26	1.89	Long Term	Summer or Winter, Provide material for long term road maintenance
TOTALS	**4.86 (3.56)**	**7.31 (5.32)**	**N/A**	**N/A**

Borrow sources identified as back-up and is excluded from total length and area.

Appendix B Preliminary Major Stream Crossing Designs (Revised)



SITE PLAN
SCALE: 1:500

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	14/11/14	ISSUED FOR REVIEW	TJB	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO: -	DRWN: TJB	DATE: 14/11/20	
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 14/11/20	
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -	
SCALE: AS NOTED	APVD: -	DATE: -	

PROJECT:

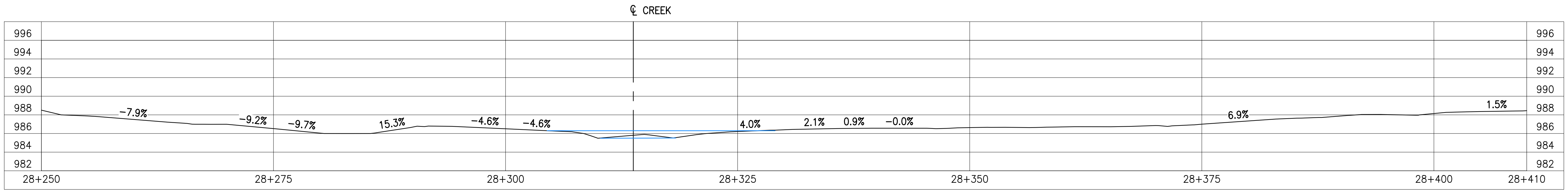
**STREAM CROSSING
UPPER SUNDOG CREEK
PRAIRIE CREEK MINE ROAD
AT STA. 28+330**

TITLE:

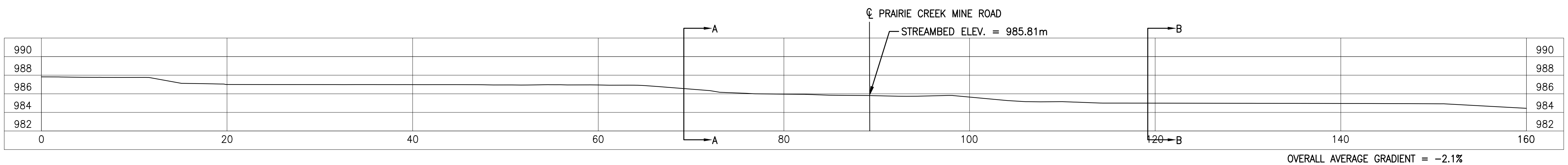
SITE PLAN

DWG NO: **15GP0091-28.3-1960-001** REV: **1**

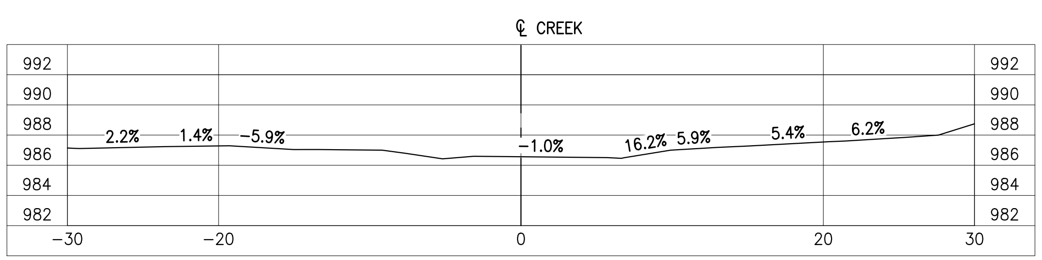
Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-028-1960_28+320 | Layout: 001 | Paper Size: 558.8mm x 431.8mm



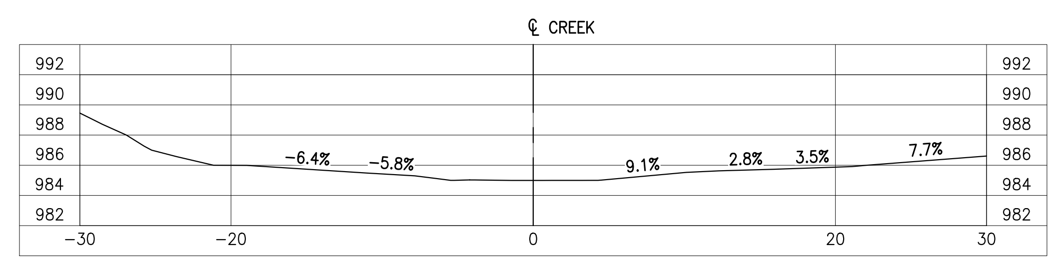
GROUND PROFILE ALONG PRAIRIE CREEK MINE ROAD CENTRELINE ALIGNMENT
SCALE: 1:500



CREEK PROFILE
SCALE: 1:500



SECTION A/1
SCALE: 1:500



SECTION B/1
SCALE: 1:500

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
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0	14/11/14	ISSUED FOR REVIEW	TJB	WBM

CLIENT:
CANADIAN ZINC CORPORATION

Allnorth

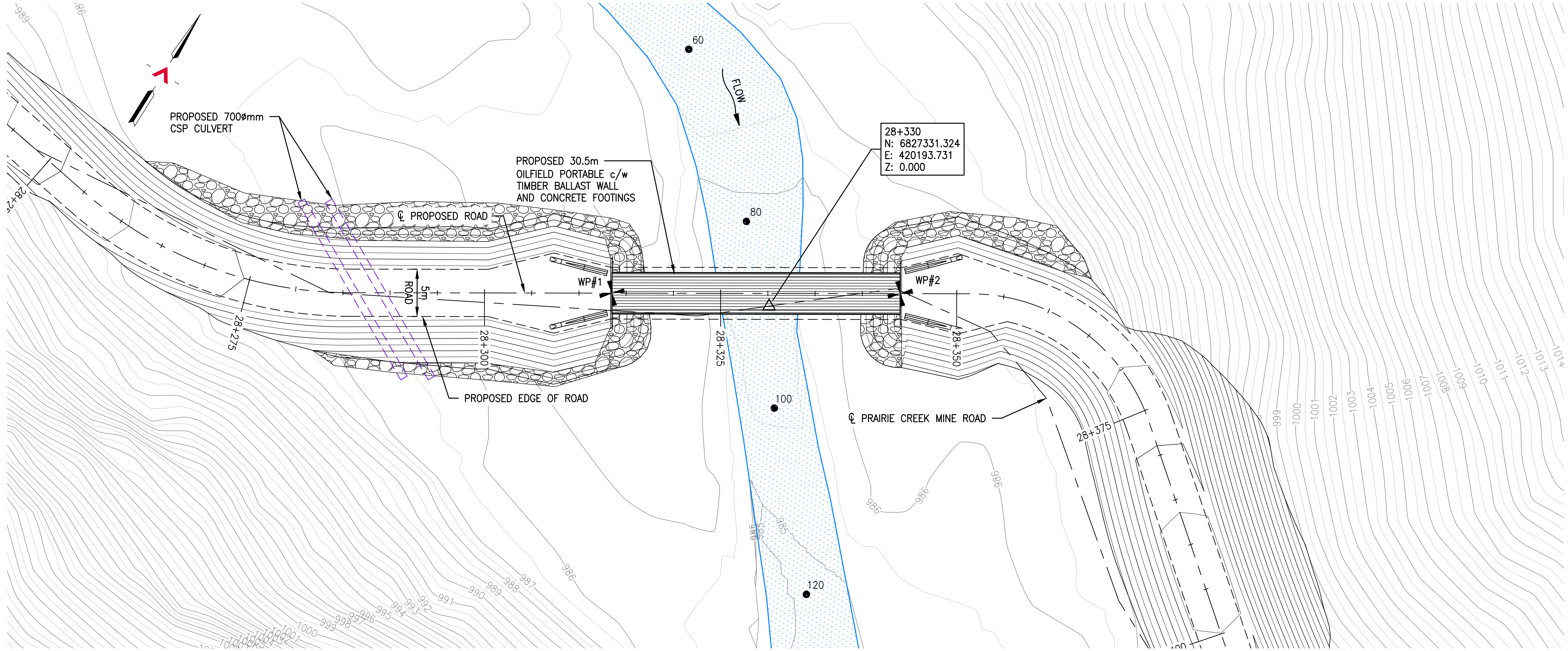
CLIENT NO: -	DRWN: TJB	DATE: 14/11/20
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 14/11/20
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -
SCALE: AS NOTED	APVD: -	DATE: -

PROJECT:
STREAM CROSSING
UPPER SUNDOG CREEK
PRAIRIE CREEK MINE ROAD
AT STA. 28+330

TITLE:
PROFILES
AND
SECTION VIEWS

DWG NO: **15GP0091-28.3-1960-002** REV: **1**

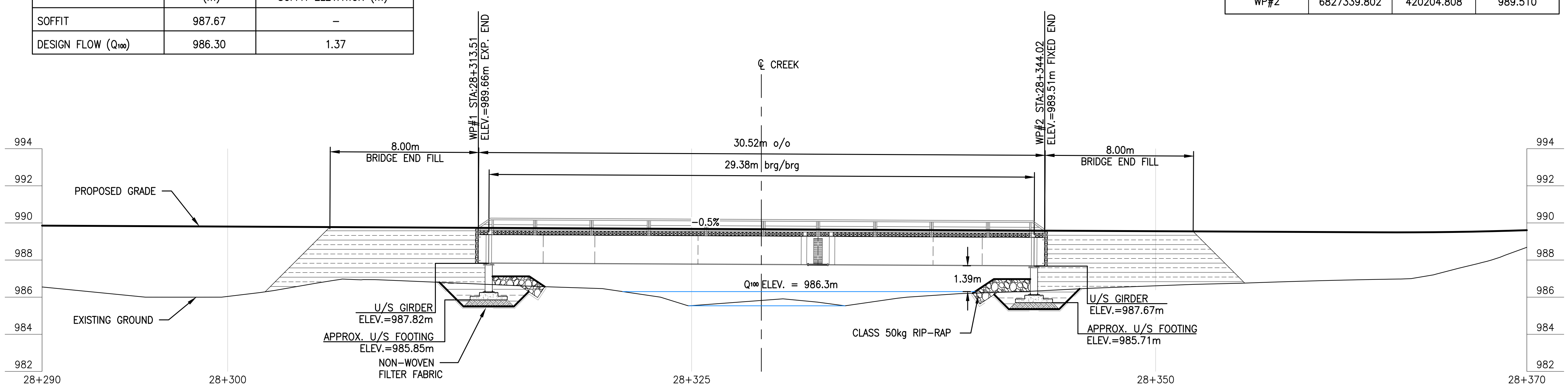
Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-028-1960_28+320 | Layout: 002 | Paper Size: 558.8mm x 431.8mm



GENERAL ARRANGEMENT PLAN
SCALE: 1:500

SURVEY CONTROL			
DESCRIPTION	NORTHING	EASTING	ELEVATION
WP#1	6827323.674	420178.902	989.660
WP#2	6827339.802	420204.808	989.510

CLEARANCE INFORMATION		
	ELEVATION (m)	CLEARANCE TO MINIMUM SOFFIT ELEVATION (m)
SOFFIT	987.67	–
DESIGN FLOW (Q100)	986.30	1.37



BRIDGE PROFILE
SCALE: 1:250

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	14/11/14	ISSUED FOR REVIEW	TJB	WBM

CLIENT:
CANADIAN ZINC CORPORATION

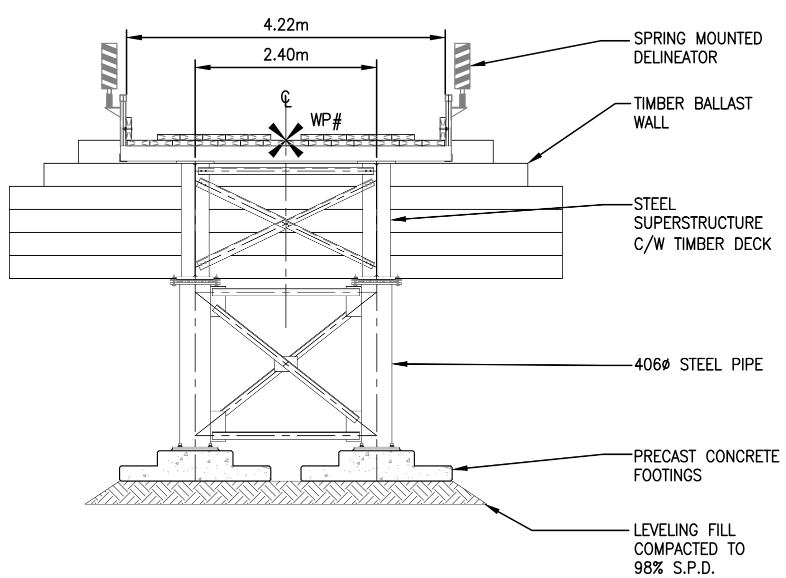
Allnorth

CLIENT NO: -	DRWN: TJB	DATE: 14/11/20
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 14/11/20
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -
SCALE: AS NOTED	APVD: -	DATE: -

PROJECT:
STREAM CROSSING UPPER SUNDOG CREEK PRAIRIE CREEK MINE ROAD AT STA. 28+330

TITLE:
GENERAL ARRANGEMENT PLAN AND BRIDGE PROFILE

DWG NO: **15GP0091-28.3-1960-003** REV: **1**



ABUTMENT ELEVATIONS
SCALE: 1:100

NOTES:

1. THESE DRAWINGS ARE INTENDED FOR CONCEPTUAL PURPOSES ONLY.

2. BRIDGE STRUCTURE SHOWN ON GENERAL ARRANGEMENT PLAN AS MANUFACTURED BY RAPID-SPAN STRUCTURES LTD.

3. RIPRAP SHALL EXTEND AROUND ABUTMENTS AS SHOWN ON THE PLAN. THE RIPRAP SHALL BE CLASS 50kg. AND SHALL HAVE A MINIMUM DEPTH OF 550mm.

CLASS OF RIPRAP (kg.)	NOMINAL THICKNESS OF RIPRAP (mm)	ROCK GRADATION PERCENTAGE SMALLER THAN GIVEN ROCK MASS (kg)			APPROXIMATE AVERAGE DIMENSION (mm)		
		15%	50%	85%	15%	50%	85%
10	350	1	10	30	90	195	280
25	450	2.5	25	75	120	260	380
50	550	5	50	150	155	330	475
100	700	10	100	300	195	415	600
250	1000	25	250	750	260	565	815
500	1200	50	500	1500	330	715	1030

4. NO SITE SPECIFIC GEOTECHNICAL INVESTIGATION HAS BEEN COMPLETED AT THE SITE TO DATE. THEREFORE, THIS CONCEPTUAL DESIGN HAS BEEN PREPARED WITHOUT THE BENEFIT OF GEOTECHNICAL ADVICE. GROUND CONDITIONS MAY VARY AND THE FOUNDATION CONCEPT MAY NEED TO BE MODIFIED TO ACCOMMODATE ACTUAL SITE CONDITIONS.

5. BACK FILL OF APPROACHES SHALL GENERALLY CONFORM TO THE LINES SHOWN ON THE DRAWINGS AND SHALL BE PLACED IN LIFTS NOT EXCEEDING 305mm THICK, COMPACTED TO 95% STANDARD PROCTOR DENSITY. MATERIAL SHALL BE NON-FROZEN, CLEAN, FREE DRAINING, WELL GRADED GRANULAR FILL OF 75mm MAXIMUM SIZE. USE LIGHT MECHANICAL TAMPERS ONLY.

6. CONSTRUCTION SHALL BE CARRIED OUT IN SUCH A MANNER AS TO ENSURE WATER QUALITY IS MAINTAINED BY KEEPING SOIL EROSION AND RUN-OFF TO A MINIMUM DURING INCLEMENT WEATHER AND BY TAKING MEASURES TO PREVENT SEDIMENTATION, LEACHATE, AND CONSTRUCTION MATERIALS FROM ENTERING THE STREAM.

7. OPERATE MACHINERY IN A MANNER THAT MINIMIZES DISTURBANCE TO THE BANKS OF THE WATERCOURSE. MACHINERY IS TO ARRIVE ON SITE IN CLEAN CONDITION AND IS TO BE MAINTAINED FREE OF FLUID LEAKS. REFUEL AND SERVICE MACHINERY AT MINIMUM 100m AWAY FROM THE WATERCOURSE. ENSURE EMERGENCY SPILL KIT IS ON SITE IN CASE OF FLUID LEAKS OR SPILLS FROM MACHINERY.

8. ALL EXPOSED MINERAL SOILS MUST BE SEEDED USING AN APPROVED RECLAMATION GRASS SEED MIXTURE AND COVERED WITH AN APPROVED EROSION CONTROL BLANKET.

9. MAINTAIN EFFECTIVE SEDIMENT AND EROSION CONTROL MEASURES UNTIL COMPLETE RE-VEGETATION OF DISTURBED AREA IS ACHIEVED.

10. ENVIRONMENTAL MANAGEMENT PLAN TO BE PREPARED FOR PROJECT BY OTHERS. COMPLETION OF WORKS TO COMPLY WITH MITIGATION RECOMMENDATIONS OUTLINED IN ENVIRONMENTAL MANAGEMENT PLAN.

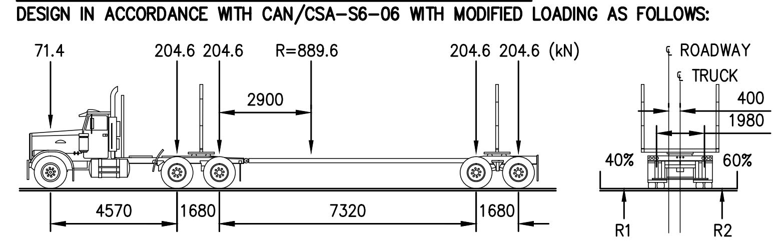
11. ALL PERMITS AND REGULATORY APPROVALS TO BE IN PLACE PRIOR TO COMMENCING WORK. INSTALLATION OF WORKS TO COMPLY WITH BEST MANAGEMENT PRACTICES.

12. DESIGN SPEED OF APPROACH ROAD SHOWN IS 30 km/hr. LOCAL CHAINAGE SHOWN RELATIVE TO APPROXIMATE CENTRE OF STREAM.

13. STRUCTURE DESIGN SHALL BE COMPLETED IN ACCORDANCE WITH CAN/CSA-S6-06 CANADIAN HIGHWAY BRIDGE DESIGN CODE, WITH VARIATIONS IN THE DESIGN LOADING VEHICLE TO MEET ANTICIPATED VEHICLE LOADING.

LOADING DIAGRAM L-100 OFF HIGHWAY G.V.W. = 90 680kg:

DESIGN IN ACCORDANCE WITH CAN/CSA-S6-06 WITH MODIFIED LOADING AS FOLLOWS:



REFERENCE DRAWINGS

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0	14/11/14	ISSUED FOR REVIEW	TJB	WBM

CLIENT:
CANADIAN ZINC CORPORATION

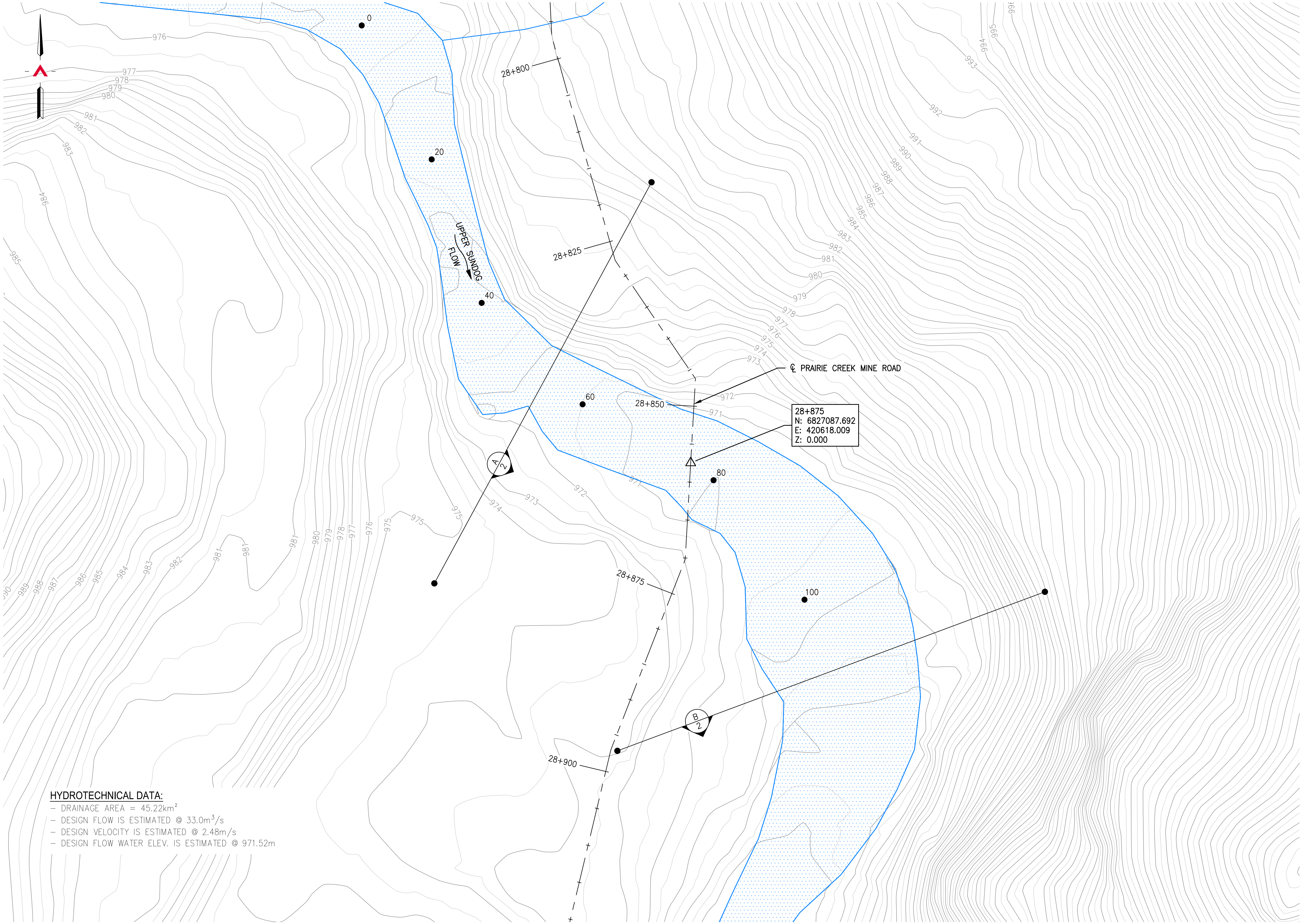
Allnorth

CLIENT NO: -	DRWN: TJB	DATE: 14/11/20	
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 14/11/20	
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -	
SCALE: AS NOTED	APVD: -	DATE: -	

PROJECT:
**STREAM CROSSING
UPPER SUNDOG CREEK
PRAIRIE CREEK MINE ROAD
AT STA. 28+330**

TITLE:
**ABUTMENT ELEVATIONS
AND
GENERAL NOTES**

DWG NO: **15GP0091-28.3-1960-004**
REV: **1**



HYDROTECHNICAL DATA:

- DRAINAGE AREA = 45.22km^2
- DESIGN FLOW IS ESTIMATED @ 33.0m^3/s
- DESIGN VELOCITY IS ESTIMATED @ 2.48m/s
- DESIGN FLOW WATER ELEV. IS ESTIMATED @ 971.52m

SITE PLAN
SCALE: 1:500

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	2015/07/23	ISSUED FOR REVIEW	IHY	WBM
0	2014/11/24	ISSUED FOR REVIEW	TJB	WBM

CLIENT: CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:	-	DRWN:	TJB	DATE:	14/11/21
PROJECT NO:	15-GP-0091	DSGN:	WBM	DATE:	14/11/21
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	AS NOTED	APVD:	-	DATE:	-

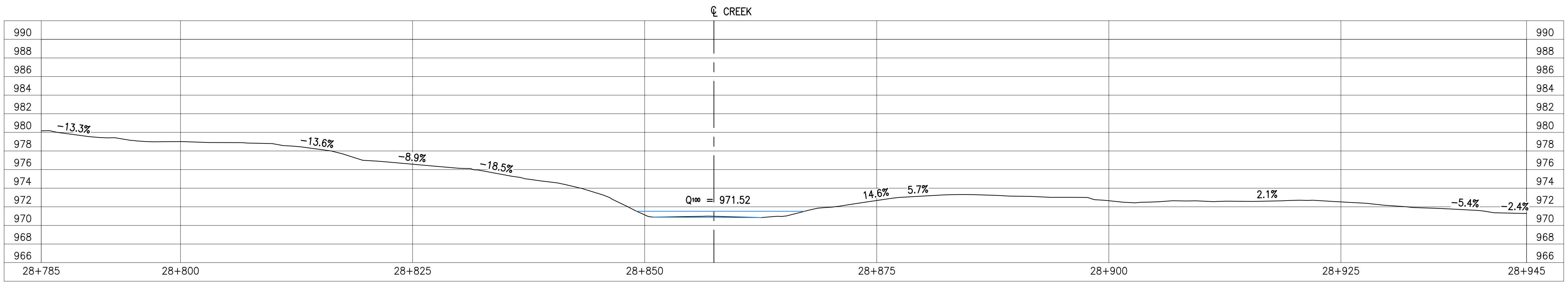
PROJECT:

**STREAM CROSSING
UPPER SUNDOG CREEK
PRAIRIE CREEK MINE ROAD
AT STA. 28+875**

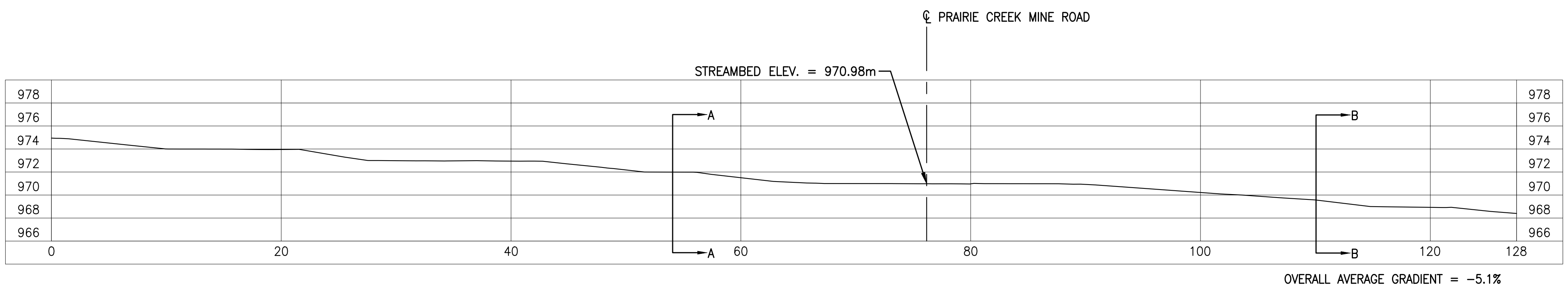
TITLE:

SITE PLAN

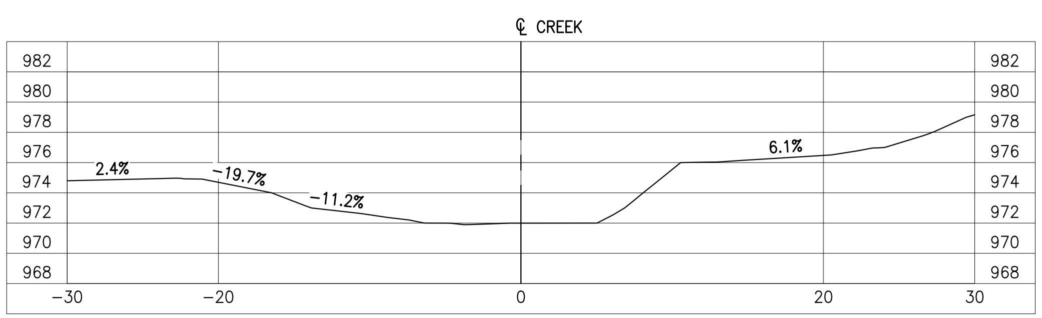
DWG NO: **15GP0091-28.8-1960-001** REV: **1**



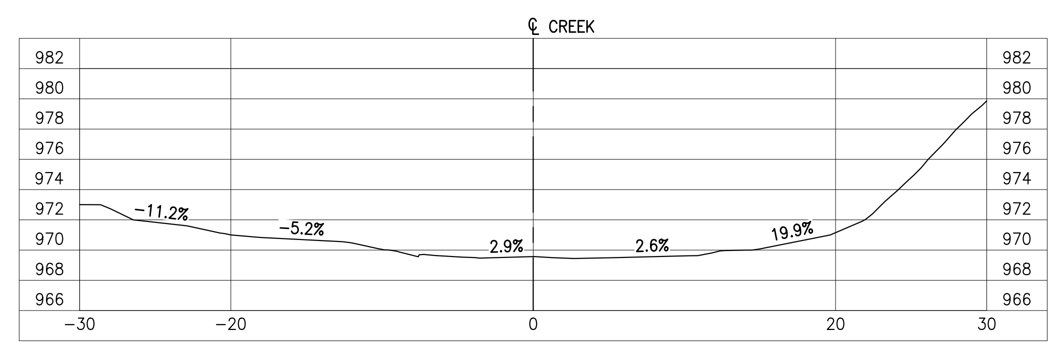
GROUND PROFILE ALONG PRAIRIE CREEK MINE ROAD CENTRELINE ALIGNMENT
SCALE: 1:500



CREEK PROFILE
SCALE: 1:500



SECTION A/1
SCALE: 1:500



SECTION B/1
SCALE: 1:500

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
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0	2014/11/24	ISSUED FOR REVIEW	TJB	WBM

CLIENT: CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO: -	DRWN: TJB	DATE: 14/11/24
PROJECT NO: 15-GP-0091	DSGN: WBM	DATE: 14/11/24
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -
SCALE: AS NOTED	APVD: -	DATE: -

PROJECT:

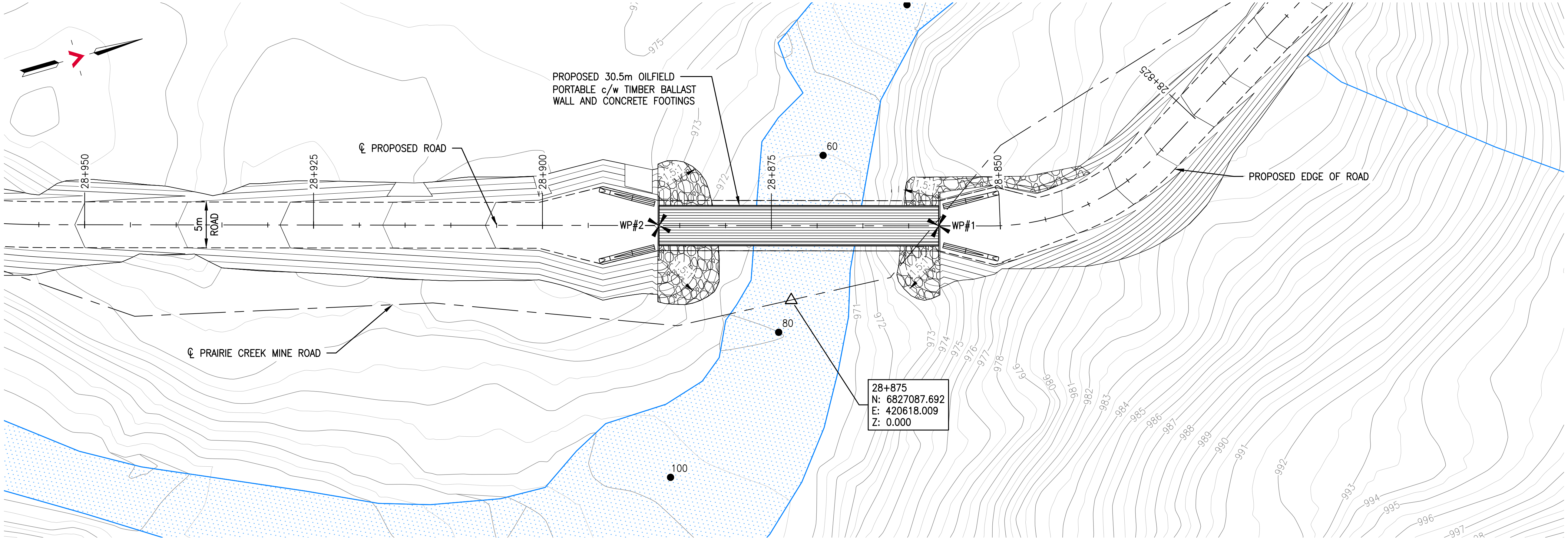
**STREAM CROSSING
UPPER SUNDOG CREEK
PRAIRIE CREEK MINE ROAD
AT STA. 28+875**

TITLE:

**PROFILES
AND
SECTION VIEWS**

DWG NO: **15GP0091-28.8-1960-002** REV: **1**

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-028-1960_28+800 | Layout: 002 | Paper Size: 558.8mm x 431.8mm

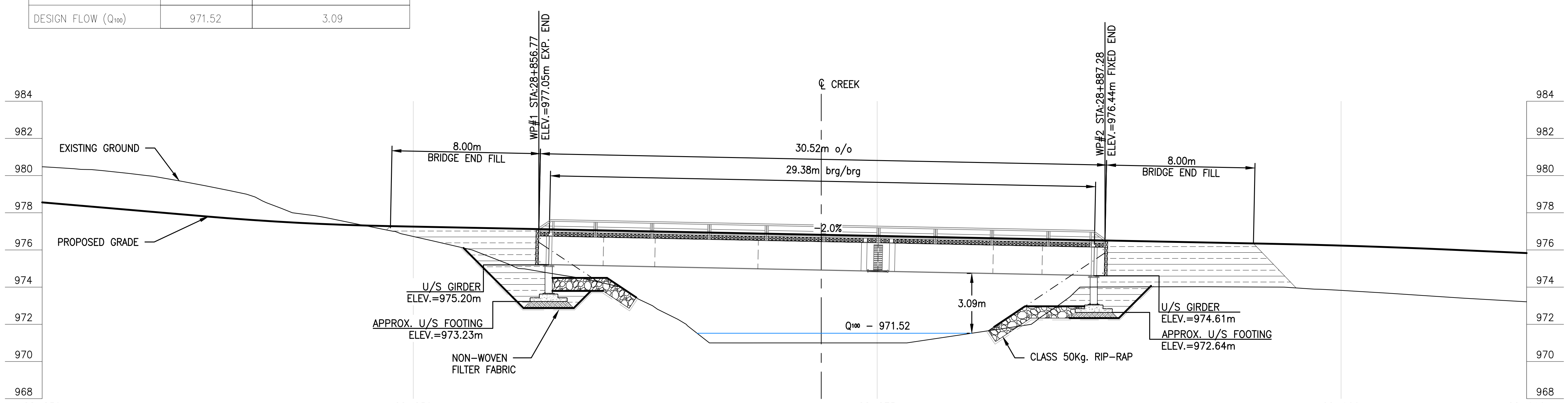


GENERAL ARRANGEMENT PLAN

SCALE: 1:500

SURVEY CONTROL			
DESCRIPTION	NORTHING	EASTING	ELEVATION
WP#1	6827105.398	420614.668	974.858
WP#2	6827076.076	420606.218	974.008

CLEARANCE INFORMATION		
	ELEVATION (m)	CLEARANCE TO MINIMUM SOFFIT ELEVATION (m)
SOFFIT	974.61	–
DESIGN FLOW (Q_{100})	971.52	3.09



BRIDGE PROFILE

SCALE: 1:250

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	2015/07/23	ISSUED FOR REVIEW	IHY	WBM
0	2014/12/02	ISSUED FOR REVIEW	TJB	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:	-	DRWN:	TJB	DATE:	14/12/01
PROJECT NO:	15-GP-0091	DSGN:	WBM	DATE:	14/12/01
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	AS NOTED	APVD:	-	DATE:	-

PROJECT:

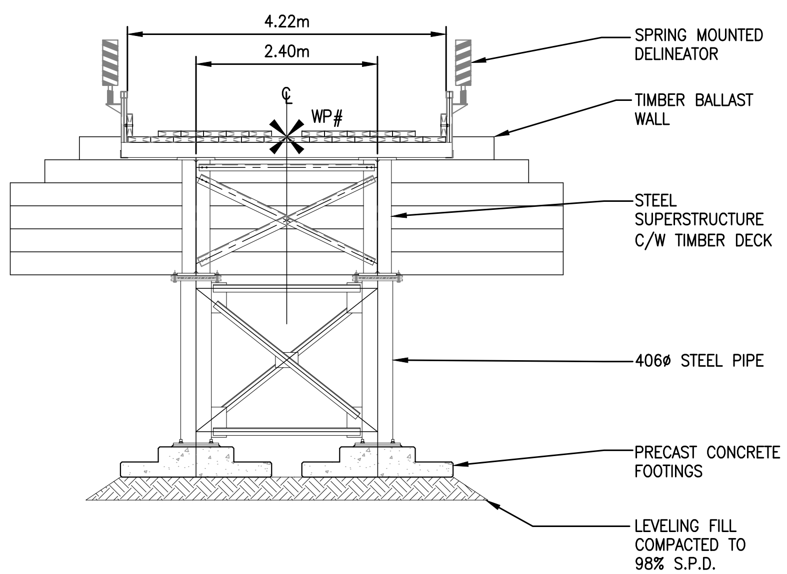
**STREAM CROSSING
UPPER SUNDOG CREEK
PRAIRIE CREEK MINE ROAD
AT STA. 28+875**

TITLE:

**GENERAL ARRANGEMENT PLAN
AND
BRIDGE PROFILE**

DWG NO: 15GP0091-28.8-1960-003

REV: 1



ABUTMENT ELEVATION
SCALE: 1:100

NOTES:

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2. BRIDGE STRUCTURE SHOWN ON GENERAL ARRANGEMENT PLAN AS MANUFACTURED BY RAPID–SPAN STRUCTURES LTD.
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100	700	10	100	300	195	415	600
250	1000	25	250	750	260	565	815
500	1200	50	500	1500	330	715	1030

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7. OPERATE MACHINERY IN A MANNER THAT MINIMIZES DISTURBANCE TO THE BANKS OF THE WATERCOURSE. MACHINERY IS TO ARRIVE ON SITE IN CLEAN CONDITION AND IS TO BE MAINTAINED FREE OF FLUID LEAKS. REFUEL AND SERVICE MACHINERY AT MINIMUM 100m AWAY FROM THE WATERCOURSE. ENSURE EMERGENCY SPILL KIT IS ON SITE IN CASE OF FLUID LEAKS OR SPILLS FROM MACHINERY.
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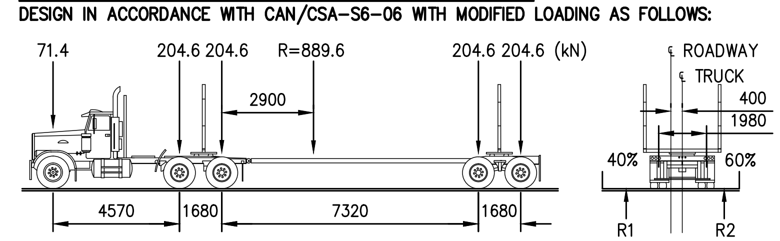
9. MAINTAIN EFFECTIVE SEDIMENT AND EROSION CONTROL MEASURES UNTIL COMPLETE RE–VEGETATION OF DISTURBED AREA IS ACHIEVED.
10. ENVIRONMENTAL MANAGEMENT PLAN TO BE PREPARED FOR PROJECT BY OTHERS. COMPLETION OF WORKS TO COMPLY WITH MITIGATION RECOMMENDATIONS OUTLINED IN ENVIRONMENTAL MANAGEMENT PLAN.
11. ALL PERMITS AND REGULATORY APPROVALS TO BE IN PLACE PRIOR TO COMMENCING WORK. INSTALLATION OF WORKS TO COMPLY WITH BEST MANAGEMENT PRACTICES.
12. DESIGN SPEED OF APPROACH ROAD SHOWN IS 30 km/hr. LOCAL CHAINAGE SHOWN RELATIVE TO APPROXIMATE CENTRE OF STREAM.
13. STRUCTURE DESIGN SHALL BE COMPLETED IN ACCORDANCE WITH CAN/CSA–S6–06 CANADIAN HIGHWAY BRIDGE DESIGN CODE, WITH VARIATIONS IN THE DESIGN LOADING VEHICLE TO MEET ANTICIPATED VEHICLE LOADING.

LOADING DIAGRAM L-100 OFF HIGHWAY G.V.W. = 90 680kg:
DESIGN IN ACCORDANCE WITH CAN/CSA–S6–06 WITH MODIFIED LOADING AS FOLLOWS:



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DRAWING NO	DRAWING DESCRIPTION/TITLE	REF

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
0	2015/07/23	ISSUED FOR REVIEW	IHY	WBM
0	2014/12/02	ISSUED FOR REVIEW	TJB	WBM

CLIENT:
CANADIAN ZINC CORPORATION

Allnorth

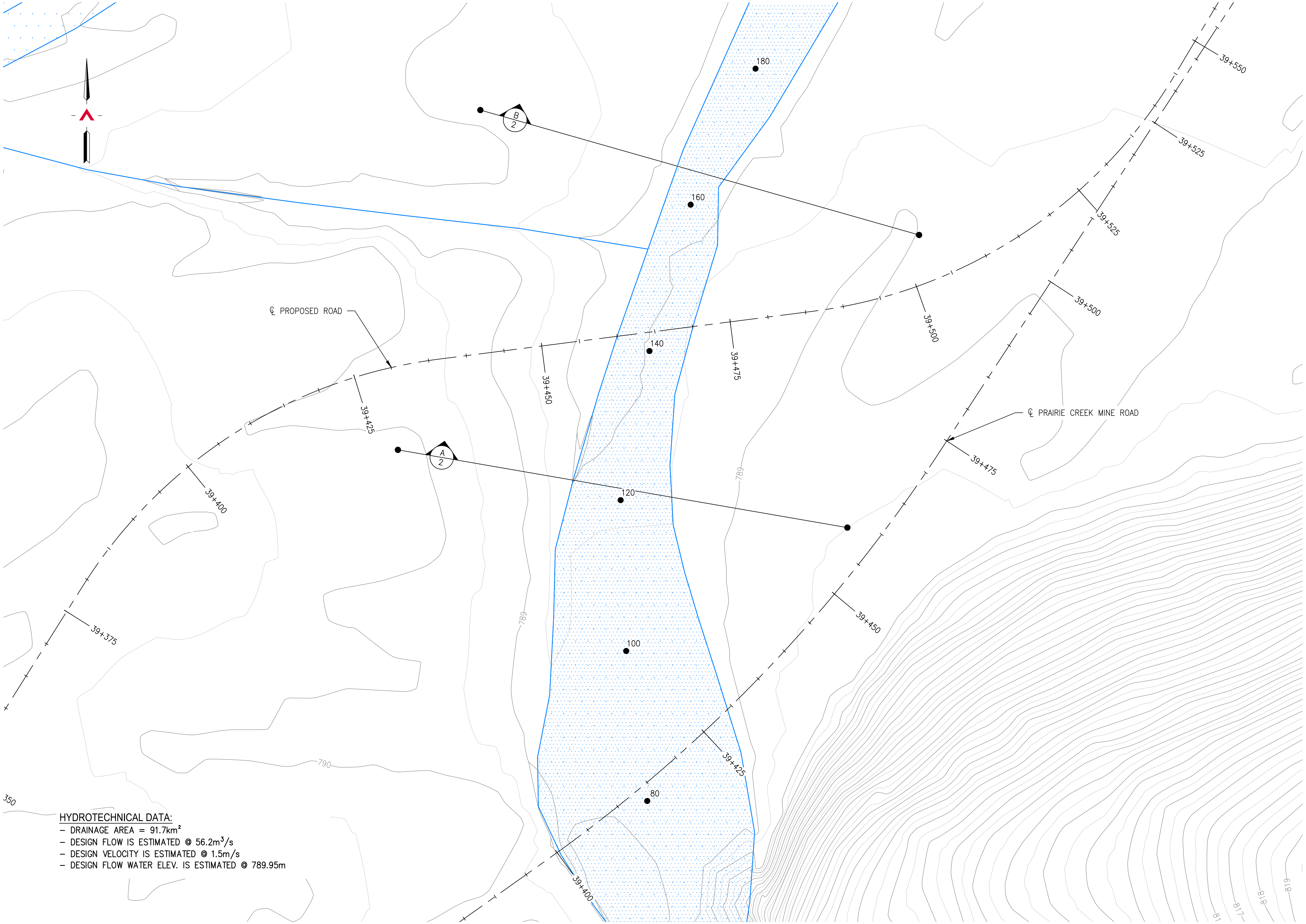
CLIENT NO: -	DRWN: TJB	DATE: 14/12/01	
PROJECT NO: 15-GP-0091	DSGN: WBM	DATE: 14/112/01	
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -	
SCALE: AS NOTED	APVD: -	DATE: -	

PROJECT:
STREAM CROSSING
UPPER SUNDOG CREEK
PRAIRIE CREEK MINE ROAD
AT STA. 28+875

TITLE:
ABUTMENT ELEVATIONS
AND
GENERAL NOTES

DWG NO: **15GP0091-28.8-1960-004** REV: **1**

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091-028-1960_28+800 | Layout: 004 | Paper Size: 558.8mm x 431.8mm



HYDROTECHNICAL DATA:
- DRAINAGE AREA = 91.7km²
- DESIGN FLOW IS ESTIMATED @ 56.2m³/s
- DESIGN VELOCITY IS ESTIMATED @ 1.5m/s
- DESIGN FLOW WATER ELEV. IS ESTIMATED @ 789.95m

SITE PLAN
SCALE: 1:500

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	14/12/11	ISSUED FOR REVIEW	IHY	WBM

CLIENT:
CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:		DRWN: TJB	DATE: 14/11/24
PROJECT NO: 15GP0091		DSGN: WBM	DATE: 14/11/24
DRAWING SIZE: ANSI "B"		CHKD:	DATE:
SCALE: AS NOTED		APVD:	DATE:

PROJECT:

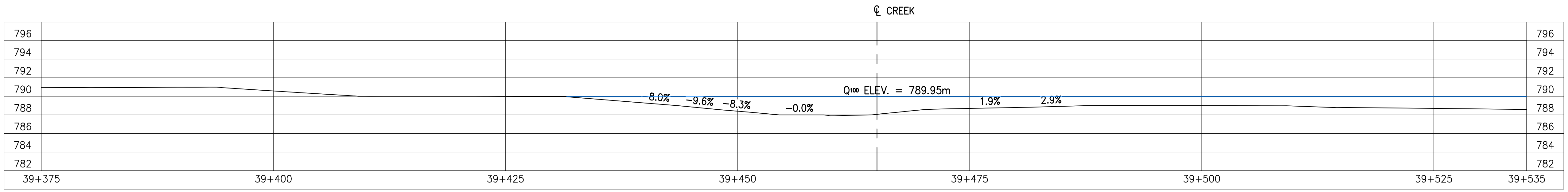
**STREAM CROSSING
UPPER SUNDOG CREEK
PRAIRIE CREEK MINE ROAD
AT STA. 39+465
OPTION 'B'**

TITLE:

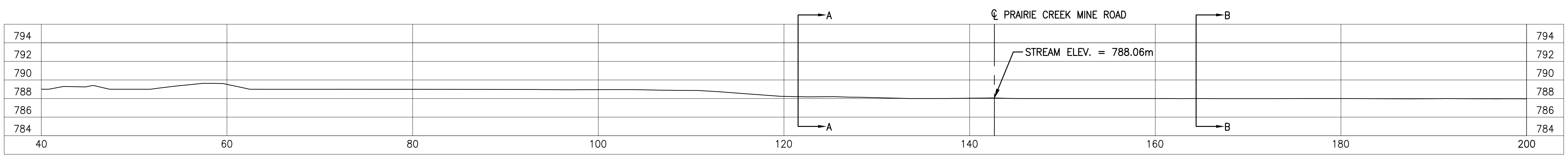
SITE PLAN

DWG NO: **15GP0091-039-1960-001** REV: **1**

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091-039-1960_39+800_Option B | Layout: 001 | Paper Size: 558.8mm x 431.8mm

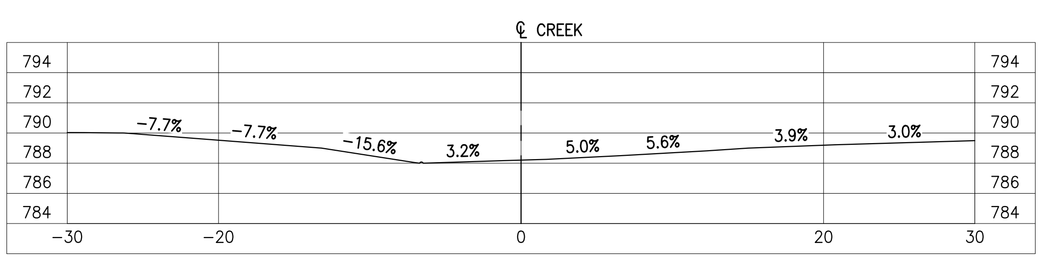


GROUND PROFILE ALONG PRAIRIE CREEK MINE ROAD CENTRELINE ALIGNMENT
SCALE: 1:500

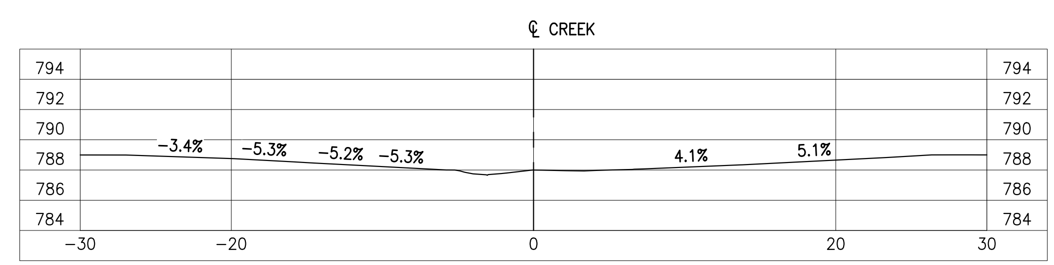


OVERALL AVERAGE GRADIENT = −1.0%

CREEK PROFILE
SCALE: 1:500



SECTION A/1
SCALE: 1:500



SECTION B/1
SCALE: 1:500

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	14/12/11	ISSUED FOR REVIEW	IHY	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:	DRWN: TJB	DATE: 14/11/26
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 14/11/26
DRAWING SIZE: ANSI "B"	CHKD:	DATE:
SCALE: AS NOTED	APVD:	DATE:

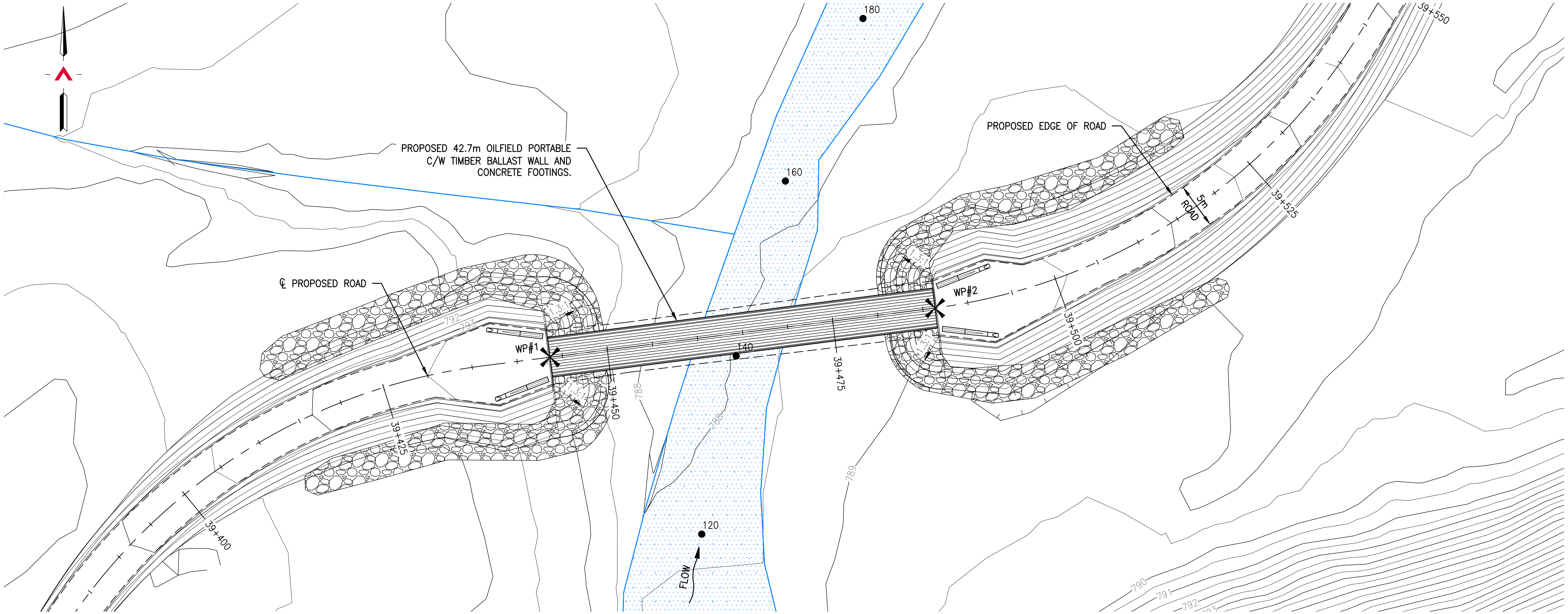
PROJECT:

**STREAM CROSSING
UPPER SUNDOG CREEK
PRAIRIE CREEK MINE ROAD
AT STA. 39+465
OPTION 'B'**

TITLE:

**PROFILES
AND
SECTION VIEWS**

DWG NO: **15GP0091-039-1960-002** REV: **1**

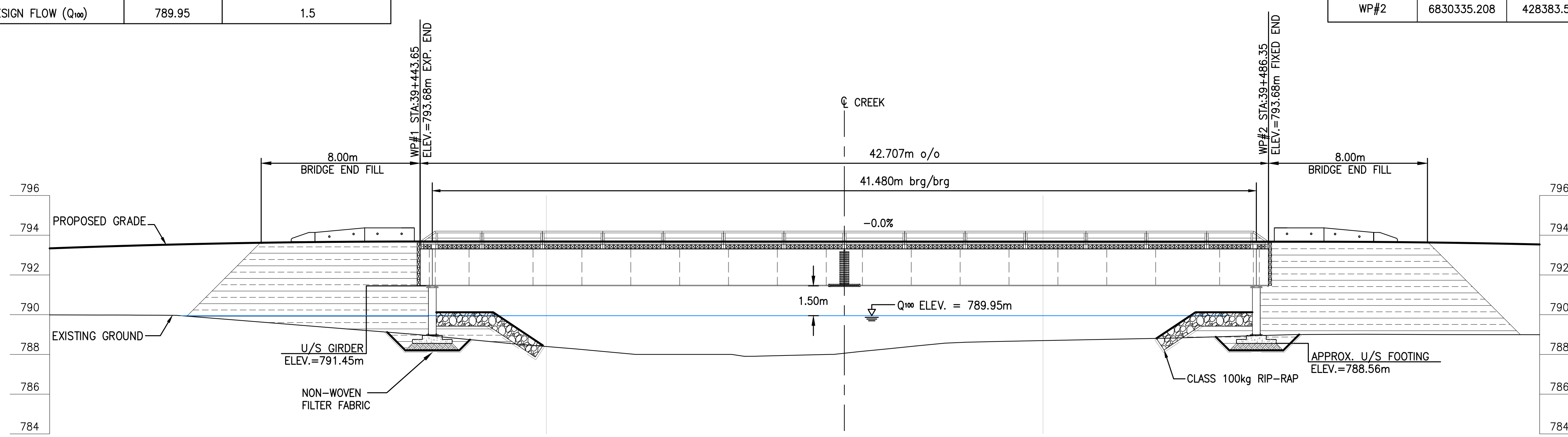


GENERAL ARRANGEMENT PLAN

SCALE: 1:500

CLEARANCE INFORMATION		
	ELEVATION (m)	CLEARANCE TO MINIMUM SOFFIT ELEVATION (m)
SOFFIT	791.45	-
DESIGN FLOW (Q_{100})	789.95	1.5

SURVEY CONTROL			
DESCRIPTION	NORTHING	EASTING	ELEVATION
WP#1	6830329.811	428341.187	793.680
WP#2	6830335.208	428383.551	793.680



BRIDGE PROFILE

SCALE: 1:250

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	14/12/11	ISSUED FOR REVIEW	IHY	WBM

CLIENT: CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:		DRWN: IHY	DATE: 14/12/11
PROJECT NO:	15GP0091	DSGN: WBM	DATE: 14/12/10
DRAWING SIZE:	ANSI "B"	CHKD:	DATE:
SCALE:	AS NOTED	APVD:	DATE:

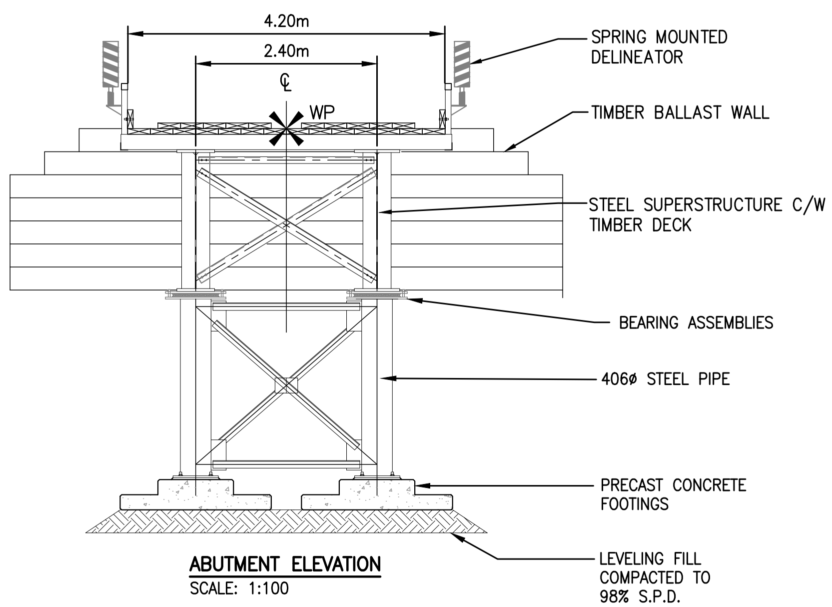
PROJECT:

STREAM CROSSING UPPER SUNDOG CREEK PRAIRIE CREEK MINE ROAD AT STA. 39+465 OPTION 'B'

TITLE:

GENERAL ARRANGEMENT PLAN AND BRIDGE PROFILE

DWG NO: 15GP0091-039-1960-003 REV: 1



ABUTMENT ELEVATION
SCALE: 1:100

NOTES:

1. THESE DRAWINGS ARE INTENDED FOR CONCEPTUAL PURPOSES ONLY.

2. BRIDGE STRUCTURE SHOWN ON GENERAL ARRANGEMENT PLAN AS MANUFACTURED BY RAPID–SPAN STRUCTURES LTD.

3. RIPRAP SHALL EXTEND AROUND ABUTMENTS AS SHOWN ON THE PLAN. THE RIPRAP SHALL BE CLASS 100kg. AND SHALL HAVE A MINIMUM DEPTH OF 700mm.

CLASS OF RIPRAP (kg.)	NOMINAL THICKNESS OF RIPRAP (mm)	ROCK GRADATION PERCENTAGE SMALLER THAN GIVEN ROCK MASS (kg)			APPROXIMATE AVERAGE DIMENSION (mm)		
		15%	50%	85%	15%	50%	85%
10	350	1	10	30	90	195	280
25	450	2.5	25	75	120	260	380
50	550	5	50	150	155	330	475
100	700	10	100	300	195	415	600
250	1000	25	250	750	260	565	815
500	1200	50	500	1500	330	715	1030

4. NO SITE SPECIFIC GEOTECHNICAL INVESTIGATION HAS BEEN COMPLETED AT THE SITE TO DATE. THEREFORE, THIS CONCEPTUAL DESIGN HAS BEEN PREPARED WITHOUT THE BENEFIT OF GEOTECHNICAL ADVICE. GROUND CONDITIONS MAY VARY AND THE FOUNDATION CONCEPT MAY NEED TO BE MODIFIED TO ACCOMMODATE ACTUAL SITE CONDITIONS.

5. BACK FILL OF APPROACHES SHALL GENERALLY CONFORM TO THE LINES SHOWN ON THE DRAWINGS AND SHALL BE PLACED IN LIFTS NOT EXCEEDING 305mm THICK, COMPACTED TO 95% STANDARD PROCTOR DENSITY. MATERIAL SHALL BE NON–FROZEN, CLEAN, FREE DRAINING, WELL GRADED GRANULAR FILL OF 75mm MAXIMUM SIZE. USE LIGHT MECHANICAL TAMPERS ONLY.

6. CONSTRUCTION SHALL BE CARRIED OUT IN SUCH A MANNER AS TO ENSURE WATER QUALITY IS MAINTAINED BY KEEPING SOIL EROSION AND RUN–OFF TO A MINIMUM DURING INCLEMENT WEATHER AND BY TAKING MEASURES TO PREVENT SEDIMENTATION, LEACHATE, AND CONSTRUCTION MATERIALS FROM ENTERING THE STREAM.

7. OPERATE MACHINERY IN A MANNER THAT MINIMIZES DISTURBANCE TO THE BANKS OF THE WATERCOURSE. MACHINERY IS TO ARRIVE ON SITE IN CLEAN CONDITION AND IS TO BE MAINTAINED FREE OF FLUID LEAKS. REFUEL AND SERVICE MACHINERY AT MINIMUM 100m AWAY FROM THE WATERCOURSE. ENSURE EMERGENCY SPILL KIT IS ON SITE IN CASE OF FLUID LEAKS OR SPILLS FROM MACHINERY.

8. ALL EXPOSED MINERAL SOILS MUST BE SEEDED USING AN APPROVED RECLAMATION GRASS SEED MIXTURE AND COVERED WITH AN APPROVED EROSION CONTROL BLANKET.

9. MAINTAIN EFFECTIVE SEDIMENT AND EROSION CONTROL MEASURES UNTIL COMPLETE RE–VEGETATION OF DISTURBED AREA IS ACHIEVED.

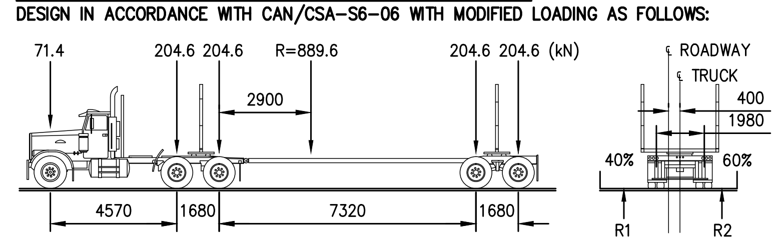
10. ENVIRONMENTAL MANAGEMENT PLAN TO BE PREPARED FOR PROJECT BY OTHERS. COMPLETION OF WORKS TO COMPLY WITH MITIGATION RECOMMENDATIONS OUTLINED IN ENVIRONMENTAL MANAGEMENT PLAN.

11. ALL PERMITS AND REGULATORY APPROVALS TO BE IN PLACE PRIOR TO COMMENCING WORK. INSTALLATION OF WORKS TO COMPLY WITH BEST MANAGEMENT PRACTICES.

12. DESIGN SPEED OF APPROACH ROAD SHOWN IS 30 km/hr. LOCAL CHAINAGE SHOWN RELATIVE TO APPROXIMATE CENTRE OF STREAM.

13. STRUCTURE DESIGN SHALL BE COMPLETED IN ACCORDANCE WITH CAN/CSA–S6–06 CANADIAN HIGHWAY BRIDGE DESIGN CODE, WITH VARIATIONS IN THE DESIGN LOADING VEHICLE TO MEET ANTICIPATED VEHICLE LOADING.

LOADING DIAGRAM L-100 OFF HIGHWAY G.V.W. = 90 680kg:
DESIGN IN ACCORDANCE WITH CAN/CSA–S6–06 WITH MODIFIED LOADING AS FOLLOWS:



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REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
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0	14/12/11	ISSUED FOR REVIEW	IHY	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:		DRWN: IHY	DATE: 14/12/11
PROJECT NO:	15GP0091	DSGN: WBM	DATE: 14/12/10
DRAWING SIZE:	ANSI "B"	CHKD:	DATE:
SCALE:	AS NOTED	APVD:	DATE:

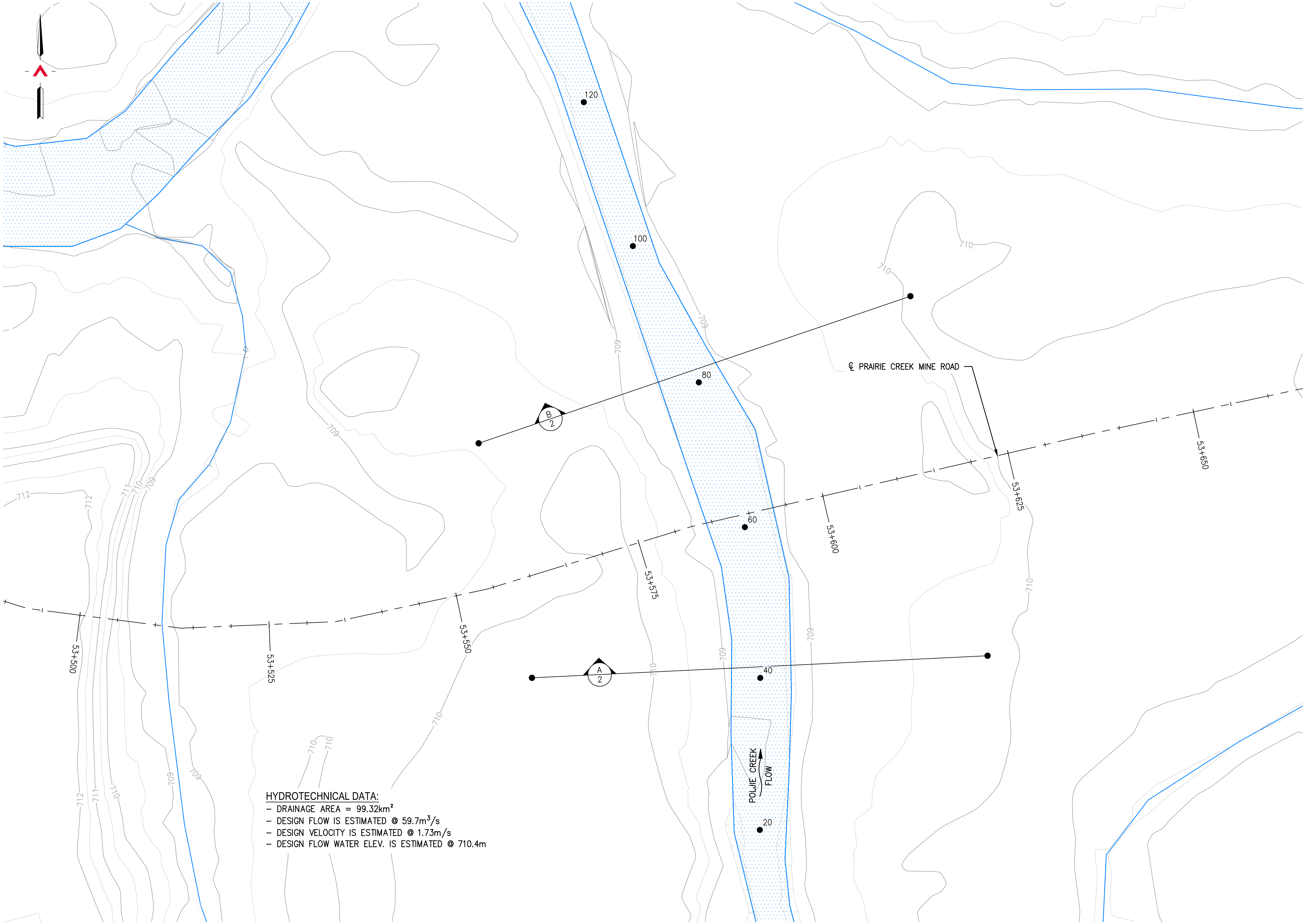
PROJECT:

STREAM CROSSING
UPPER SUNDOG CREEK
PRAIRIE CREEK MINE ROAD
AT STA. 39+465
OPTION 'B'

TITLE:

ABUTMENT ELEVATION AND NOTES

DWG NO: **15GP0091-039-1960-004**
REV: **1**



SITE PLAN
SCALE: 1:500

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-053-1960_53+500 | Layout: 001 | Paper Size: 558.8mm x 431.8mm

REFERENCE DRAWINGS

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-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	14/12/19	ISSUED FOR REVIEW	TJB	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO: -	DRWN: TJB	DATE: 14/12/19	
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 14/12/19	
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -	
SCALE: AS NOTED	APVD: -	DATE: -	

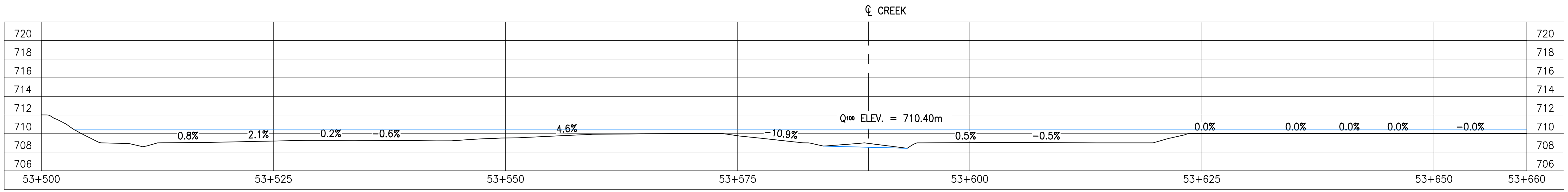
PROJECT:

STREAM CROSSING
POLJIE CREEK
PRAIRIE CREEK MINE ROAD
AT STA.53+500

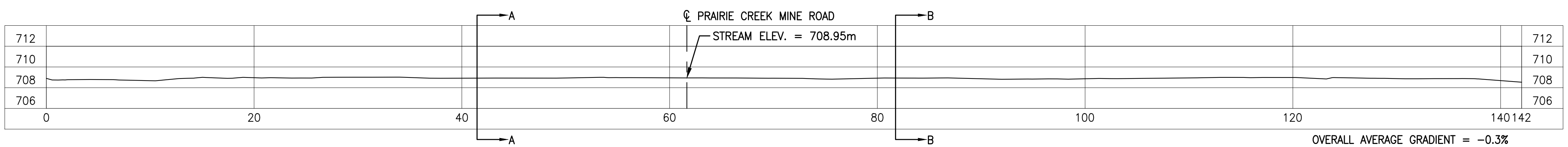
TITLE:

SITE PLAN

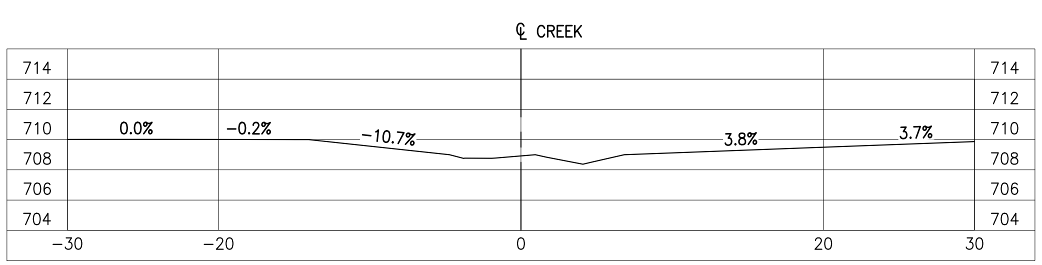
DWG NO: **15GP0091-053-1960-001** REV: **1**



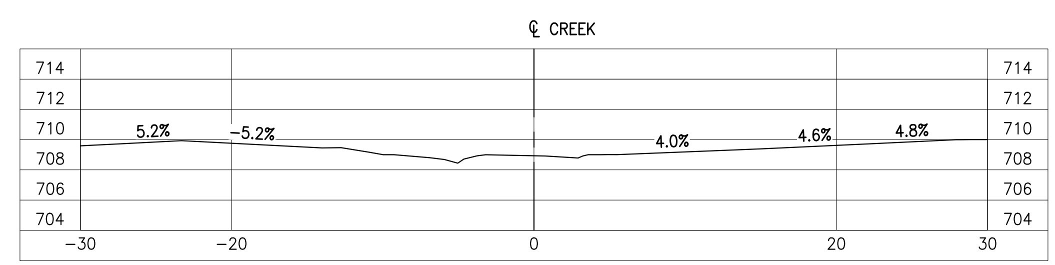
GROUND PROFILE ALONG PRAIRIE CREEK MINE ROAD CENTRELINE ALIGNMENT
SCALE: 1:500



CREEK PROFILE
SCALE: 1:500



SECTION A/1
SCALE: 1:500



SECTION B/1
SCALE: 1:500

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	14/12/19	ISSUED FOR REVIEW	TJB	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:	-	DRWN:	TJB	DATE:	14/12/19
PROJECT NO:	15GP0091	DSGN:	WBM	DATE:	14/12/19
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	AS NOTED	APVD:	-	DATE:	-

PROJECT:

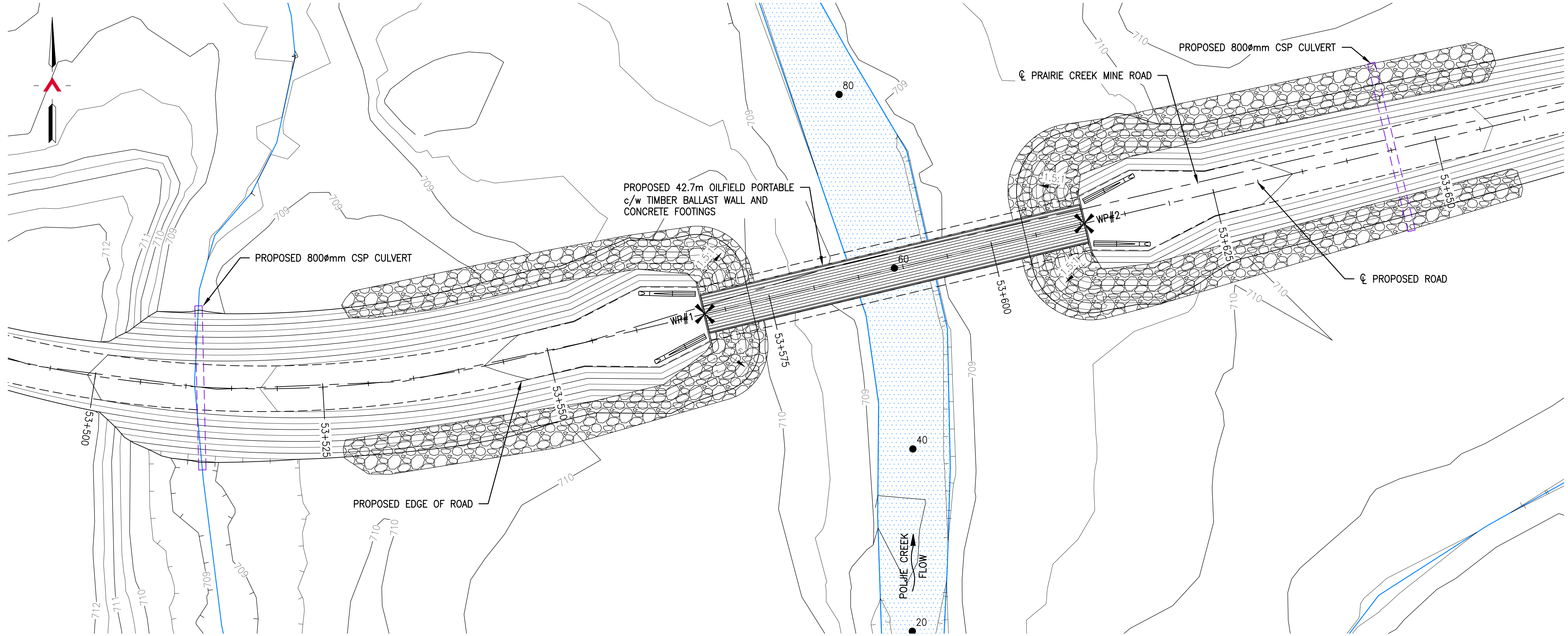
STREAM CROSSING
POLJIE CREEK
PRAIRIE CREEK MINE ROAD
AT STA.53+500

TITLE:

PROFILES
AND
SECTION VIEWS

DWG NO: **15GP0091-053-1960-002** REV: **1**

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-053-1960_53+500 | Layout: 002 | Paper Size: 558.8mm x 431.8mm



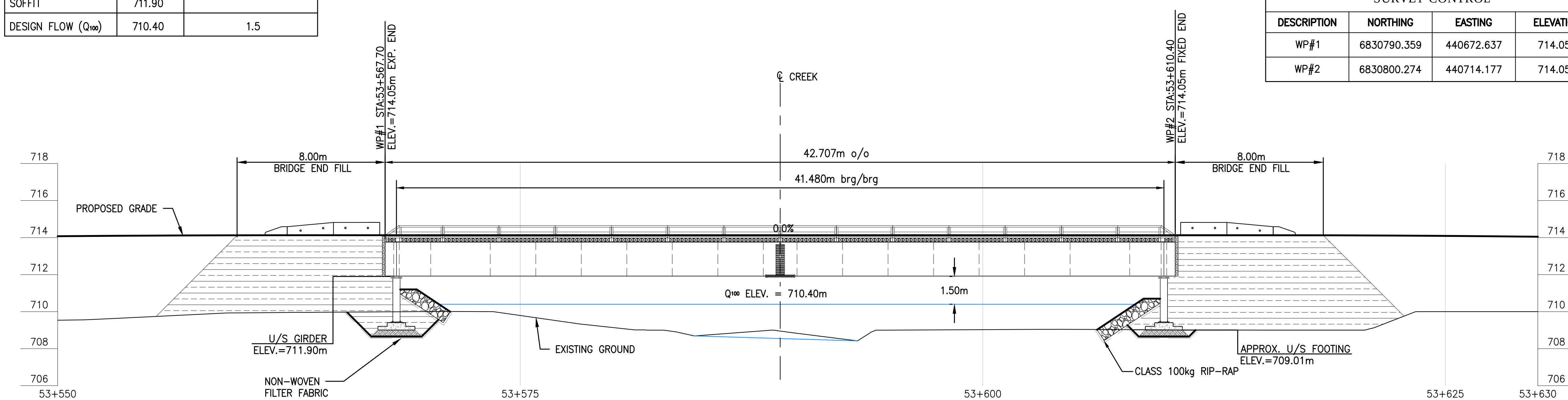
GENERAL ARRANGEMENT PLAN
SCALE: 1:500

CLEARANCE INFORMATION

	ELEVATION (m)	CLEARANCE TO MINIMUM SOFFIT ELEVATION (m)
SOFFIT	711.90	
DESIGN FLOW (Q_{100})	710.40	1.5

SURVEY CONTROL

DESCRIPTION	NORTHING	EASTING	ELEVATION
WP#1	6830790.359	440672.637	714.050
WP#2	6830800.274	440714.177	714.050



BRIDGE PROFILE
SCALE: 1:250

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	15/01/06	ISSUED FOR REVIEW	TJB	WBM

CLIENT: CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:	-	DRWN:	TJB	DATE:	14/12/19
PROJECT NO:	15GP0091	DSGN:	WBM	DATE:	14/12/19
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	AS NOTED	APVD:	-	DATE:	-

PROJECT:

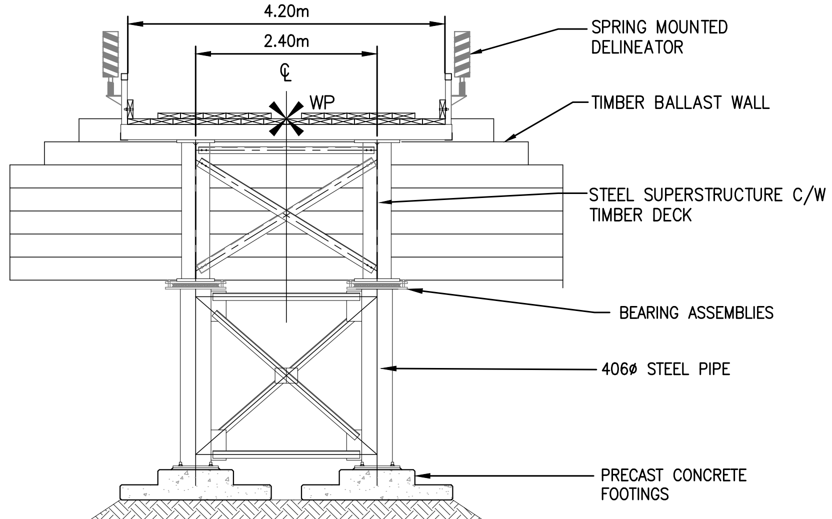
STREAM CROSSING POLJIE CREEK PRAIRIE CREEK MINE ROAD AT STA.53+500

TITLE:

GENERAL ARRANGEMENT PLAN AND BRIDGE PROFILE

DWG NO: 15GP0091-053-1960-003 REV: 1

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\1001\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-053-1960_53+500 | Layout: 003 | Paper Size: 558.8mm x 431.8mm



ABUTMENT ELEVATION
SCALE: 1:100

NOTES:

1. THESE DRAWINGS ARE INTENDED FOR CONCEPTUAL PURPOSES ONLY.

2. BRIDGE STRUCTURE SHOWN ON GENERAL ARRANGEMENT PLAN AS MANUFACTURED BY RAPID-SPAN STRUCTURES LTD.

3. RIPRAP SHALL EXTEND AROUND ABUTMENTS AS SHOWN ON THE PLAN. THE RIPRAP SHALL BE CLASS 100kg. AND SHALL HAVE A MINIMUM DEPTH OF 700mm.

CLASS OF RIPRAP (kg.)	NOMINAL THICKNESS OF RIPRAP (mm)	ROCK GRADATION PERCENTAGE SMALLER THAN GIVEN ROCK MASS (kg)			APPROXIMATE AVERAGE DIMENSION (mm)		
		15%	50%	85%	15%	50%	85%
10	350	1	10	30	90	195	280
25	450	2.5	25	75	120	260	380
50	550	5	50	150	155	330	475
100	700	10	100	300	195	415	600
250	1000	25	250	750	260	565	815
500	1200	50	500	1500	330	715	1030

4. NO SITE SPECIFIC GEOTECHNICAL INVESTIGATION HAS BEEN COMPLETED AT THE SITE TO DATE. THEREFORE, THIS CONCEPTUAL DESIGN HAS BEEN PREPARED WITHOUT THE BENEFIT OF GEOTECHNICAL ADVICE. GROUND CONDITIONS MAY VARY AND THE FOUNDATION CONCEPT MAY NEED TO BE MODIFIED TO ACCOMMODATE ACTUAL SITE CONDITIONS.

5. BACK FILL OF APPROACHES SHALL GENERALLY CONFORM TO THE LINES SHOWN ON THE DRAWINGS AND SHALL BE PLACED IN LIFTS NOT EXCEEDING 305mm THICK, COMPACTED TO 95% STANDARD PROCTOR DENSITY. MATERIAL SHALL BE NON-FROZEN, CLEAN, FREE DRAINING, WELL GRADED GRANULAR FILL OF 75mm MAXIMUM SIZE. USE LIGHT MECHANICAL TAMPERS ONLY.

6. CONSTRUCTION SHALL BE CARRIED OUT IN SUCH A MANNER AS TO ENSURE WATER QUALITY IS MAINTAINED BY KEEPING SOIL EROSION AND RUN-OFF TO A MINIMUM DURING INCLEMENT WEATHER AND BY TAKING MEASURES TO PREVENT SEDIMENTATION, LEACHATE, AND CONSTRUCTION MATERIALS FROM ENTERING THE STREAM.

7. OPERATE MACHINERY IN A MANNER THAT MINIMIZES DISTURBANCE TO THE BANKS OF THE WATERCOURSE. MACHINERY IS TO ARRIVE ON SITE IN CLEAN CONDITION AND IS TO BE MAINTAINED FREE OF FLUID LEAKS. REFUEL AND SERVICE MACHINERY AT MINIMUM 100m AWAY FROM THE WATERCOURSE. ENSURE EMERGENCY SPILL KIT IS ON SITE IN CASE OF FLUID LEAKS OR SPILLS FROM MACHINERY.

8. ALL EXPOSED MINERAL SOILS MUST BE SEEDED USING AN APPROVED RECLAMATION GRASS SEED MIXTURE AND COVERED WITH AN APPROVED EROSION CONTROL BLANKET.

9. MAINTAIN EFFECTIVE SEDIMENT AND EROSION CONTROL MEASURES UNTIL COMPLETE RE-VEGETATION OF DISTURBED AREA IS ACHIEVED.

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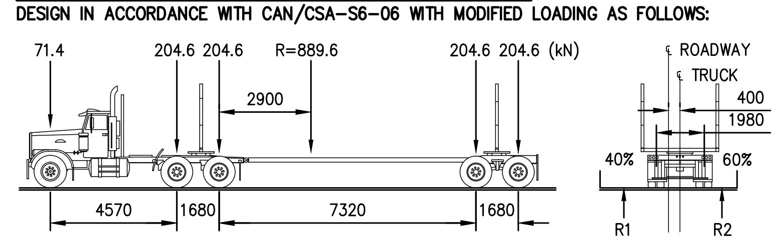
11. ALL PERMITS AND REGULATORY APPROVALS TO BE IN PLACE PRIOR TO COMMENCING WORK. INSTALLATION OF WORKS TO COMPLY WITH BEST MANAGEMENT PRACTICES.

12. DESIGN SPEED OF APPROACH ROAD SHOWN IS 30 km/hr. LOCAL CHAINAGE SHOWN RELATIVE TO APPROXIMATE CENTRE OF STREAM.

13. STRUCTURE DESIGN SHALL BE COMPLETED IN ACCORDANCE WITH CAN/CSA-S6-06 CANADIAN HIGHWAY BRIDGE DESIGN CODE, WITH VARIATIONS IN THE DESIGN LOADING VEHICLE TO MEET ANTICIPATED VEHICLE LOADING.

LOADING DIAGRAM L-100 OFF HIGHWAY G.V.W. = 90 680kg:

DESIGN IN ACCORDANCE WITH CAN/CSA-S6-06 WITH MODIFIED LOADING AS FOLLOWS:



1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	15/01/06	ISSUED FOR REVIEW	TJB	WBM
REV	YY/MM/DD	DESCRIPTION	DRWN	APVD

CLIENT: CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:	-	DRWN:	TJB	DATE:	14/12/19
PROJECT NO:	15GP0091	DSGN:	WBM	DATE:	14/12/19
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	AS NOTED	APVD:	-	DATE:	-

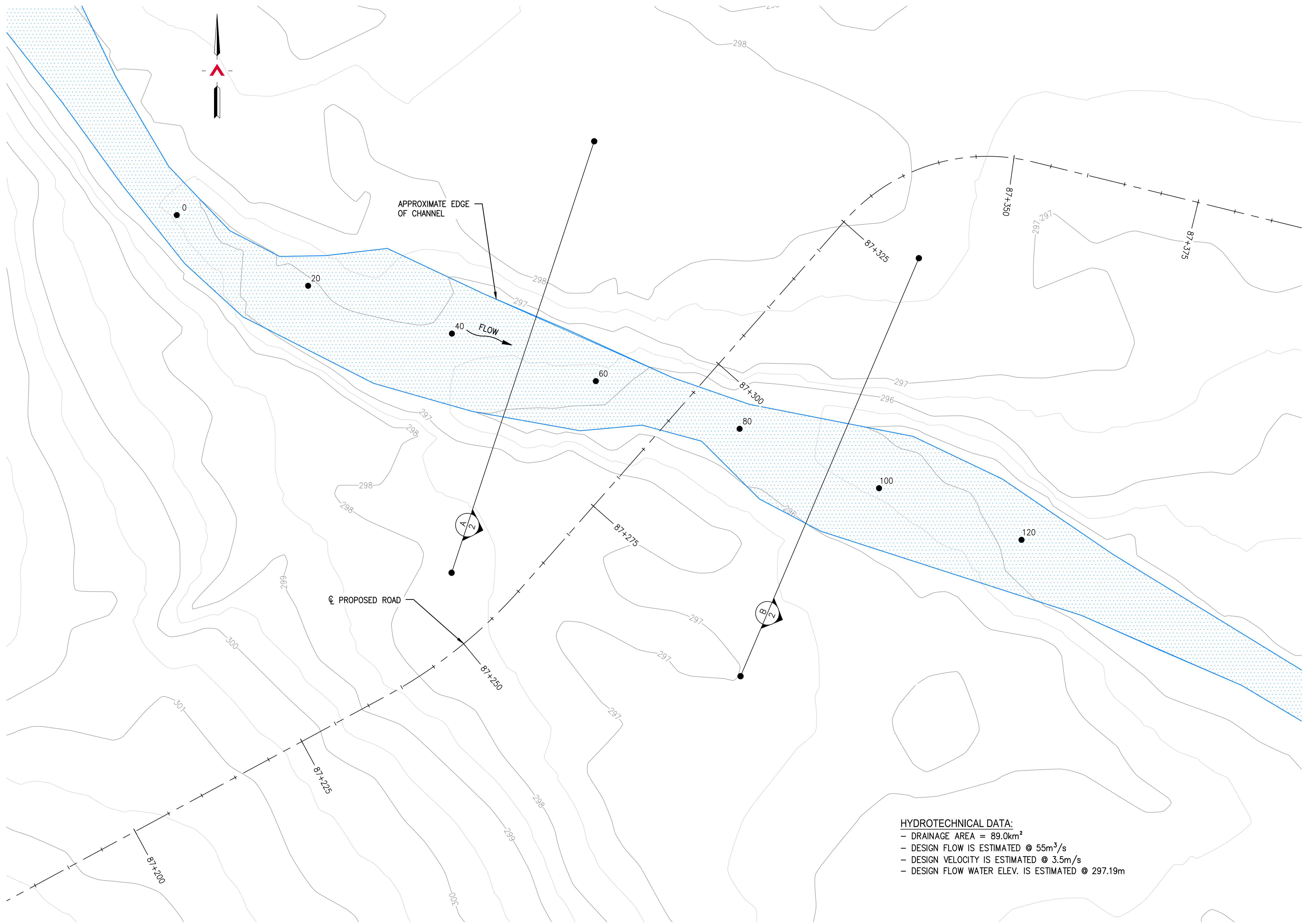
PROJECT:

STREAM CROSSING
POLJIE CREEK
PRAIRIE CREEK MINE ROAD
AT STA.53+500

TITLE:

ABUTMENT ELEVATIONS
AND
GENERAL NOTES

DWG NO: **15GP0091-053-1960-004** REV: **1**



HYDROTECHNICAL DATA:
- DRAINAGE AREA = 89.0km²
- DESIGN FLOW IS ESTIMATED @ 55m³/s
- DESIGN VELOCITY IS ESTIMATED @ 3.5m/s
- DESIGN FLOW WATER ELEV. IS ESTIMATED @ 297.19m

SITE PLAN
SCALE: 1:500

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	14/11/26	ISSUED FOR REVIEW	TJB	WBM
REV	YY/MM/DD	DESCRIPTION	DRWN	APVD

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO: -	DRWN: TJB	DATE: 14/11/26
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 14/11/26
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -
SCALE: AS NOTED	APVD: -	DATE: -

PROJECT:

**STREAM CROSSING
TETCALA RIVER
PRAIRIE CREEK MINE ROAD
AT STA. 87+375**

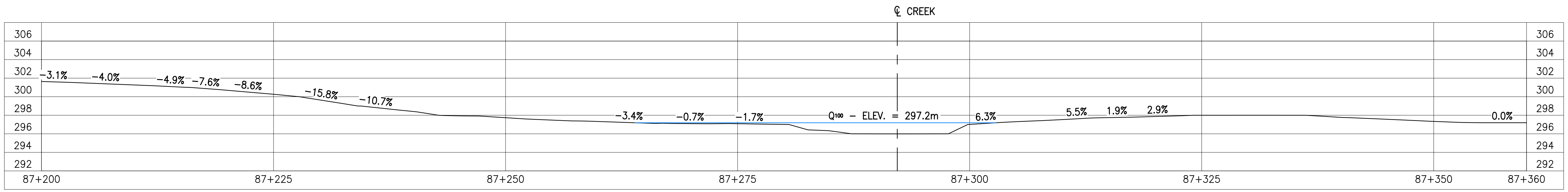
TITLE:

SITE PLAN

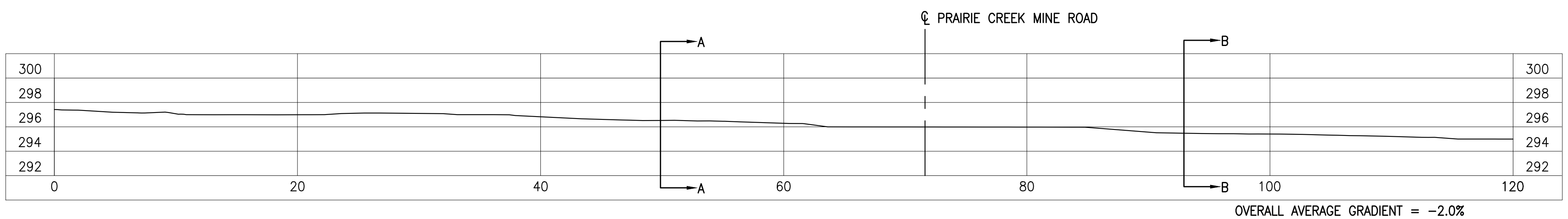
DWG NO: **15GP0091-087-1960-001** REV: **1**

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-087-1960_87+400_alternate | Layout: 001 | Paper Size: 558.8mm x 431.8mm

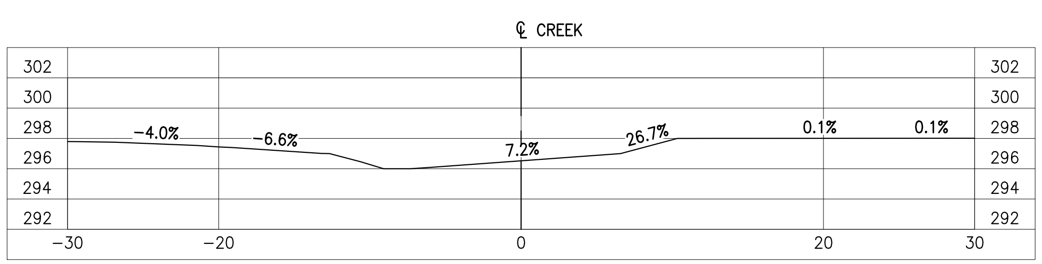
Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-087-1960_87+400_alternate | Layout: 002 | Paper Size: 558.8mm x 431.8mm



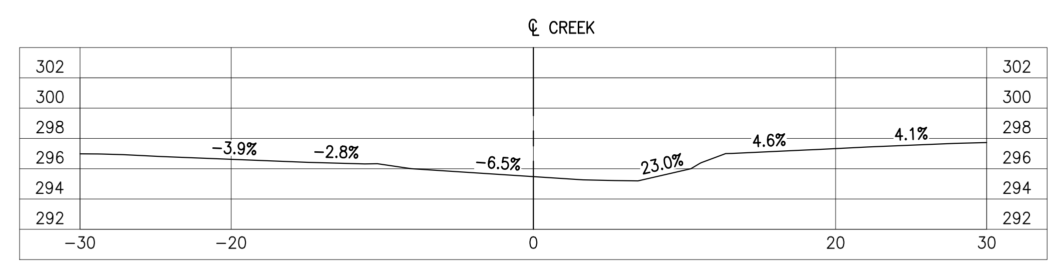
GROUND PROFILE ALONG PRAIRIE CREEK MINE ROAD CENTRELINE ALIGNMENT
SCALE: 1:500



CREEK PROFILE
SCALE: 1:500



SECTION A/1
SCALE: 1:500



SECTION B/1
SCALE: 1:500

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
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REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	14/11/26	ISSUED FOR REVIEW	TJB	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:	-	DRWN:	TJB	DATE:	14/11/26
PROJECT NO:	15GP0091	DSGN:	WBM	DATE:	14/11/26
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	AS NOTED	APVD:	-	DATE:	-

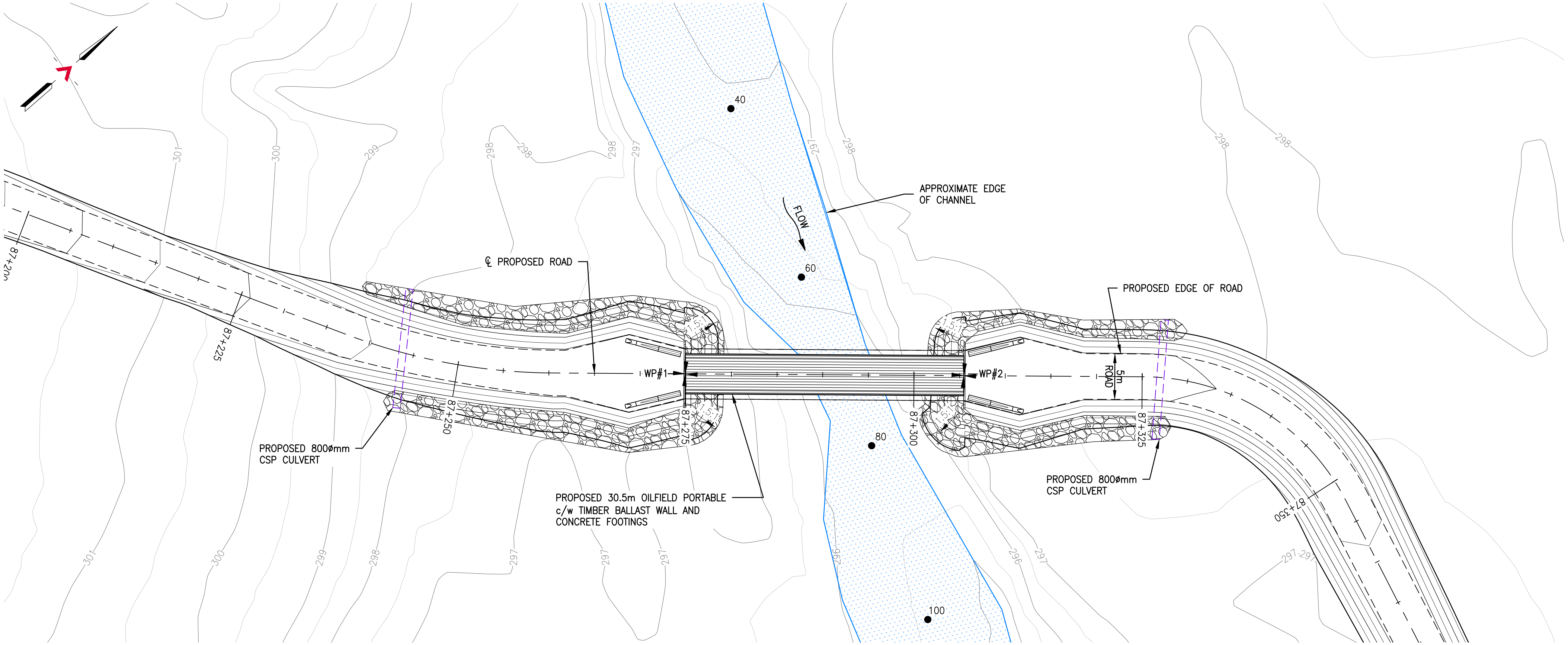
PROJECT:

STREAM CROSSING
TETCALA RIVER
PRAIRIE CREEK MINE ROAD
AT STA. 87+375

TITLE:

PROFILES
AND
SECTION VIEWS

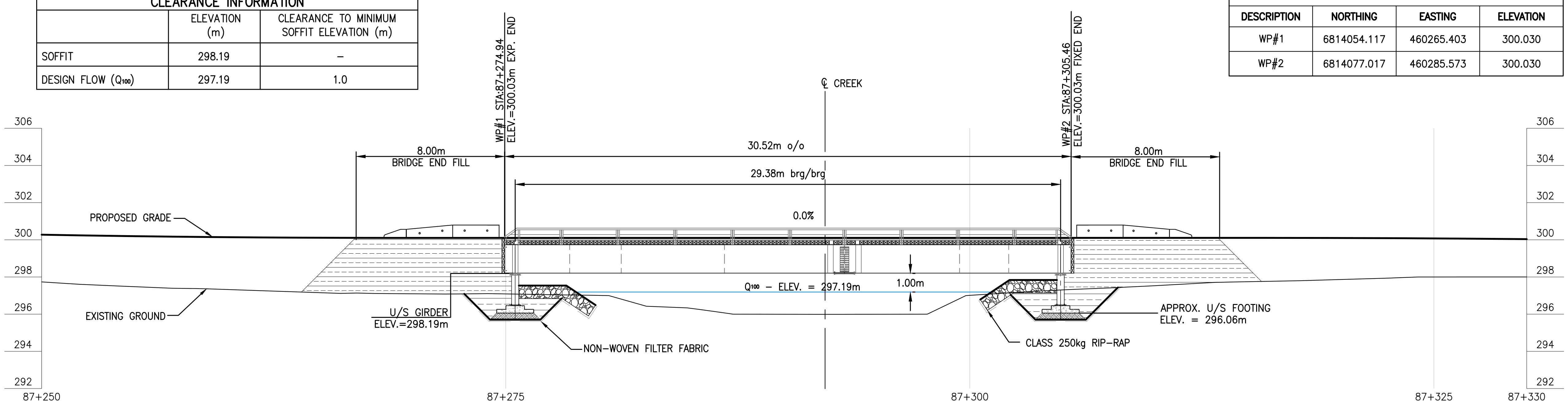
DWG NO: **15GP0091-087-1960-002** REV: **1**



GENERAL ARRANGEMENT PLAN
SCALE: 1:500

CLEARANCE INFORMATION		
	ELEVATION (m)	CLEARANCE TO MINIMUM SOFFIT ELEVATION (m)
SOFFIT	298.19	–
DESIGN FLOW (Q_{100})	297.19	1.0

SURVEY CONTROL			
DESCRIPTION	NORTHING	EASTING	ELEVATION
WP#1	6814054.117	460265.403	300.030
WP#2	6814077.017	460285.573	300.030



BRIDGE PROFILE
SCALE: 1:250

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	14/12/05	ISSUED FOR REVIEW	TJB	WBM

CLIENT:
CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO: -	DRWN: TJB	DATE: 14/12/04	
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 14/12/04	
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -	
SCALE: AS NOTED	APVD: -	DATE: -	

PROJECT:
STREAM CROSSING TETCALA RIVER PRAIRIE CREEK MINE ROAD AT STA. 87+375

TITLE:
GENERAL ARRANGEMENT PLAN AND BRIDGE PROFILE

DWG NO: **15GP0091-087-1960-003** REV: **1**

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\1001\4-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-087-1960_87+400_alternate | Layout: 003 | Paper Size: 558.8mm x 431.8mm

NOTES:

1. THESE DRAWINGS ARE INTENDED FOR CONCEPTUAL PURPOSES ONLY.

2. BRIDGE STRUCTURE SHOWN ON GENERAL ARRANGEMENT PLAN AS MANUFACTURED BY RAPID-SPAN STRUCTURES LTD.

3. RIPRAP SHALL EXTEND AROUND ABUTMENTS AS SHOWN ON THE PLAN. THE RIPRAP SHALL BE CLASS 250kg. AND SHALL HAVE A MINIMUM DEPTH OF 1000mm.

CLASS OF RIPRAP (kg.)	NOMINAL THICKNESS OF RIPRAP (mm)	ROCK GRADATION PERCENTAGE SMALLER THAN GIVEN ROCK MASS (kg)			APPROXIMATE AVERAGE DIMENSION (mm)		
		15%	50%	85%	15%	50%	85%
10	350	1	10	30	90	195	280
25	450	2.5	25	75	120	260	380
50	550	5	50	150	155	330	475
100	700	10	100	300	195	415	600
250	1000	25	250	750	260	565	815
500	1200	50	500	1500	330	715	1030

4. NO SITE SPECIFIC GEOTECHNICAL INVESTIGATION HAS BEEN COMPLETED AT THE SITE TO DATE. THEREFORE, THIS CONCEPTUAL DESIGN HAS BEEN PREPARED WITHOUT THE BENEFIT OF GEOTECHNICAL ADVICE. GROUND CONDITIONS MAY VARY AND THE FOUNDATION CONCEPT MAY NEED TO BE MODIFIED TO ACCOMMODATE ACTUAL SITE CONDITIONS.

5. BACK FILL OF APPROACHES SHALL GENERALLY CONFORM TO THE LINES SHOWN ON THE DRAWINGS AND SHALL BE PLACED IN LIFTS NOT EXCEEDING 305mm THICK, COMPACTED TO 95% STANDARD PROCTOR DENSITY. MATERIAL SHALL BE NON-FROZEN, CLEAN, FREE DRAINING, WELL GRADED GRANULAR FILL OF 75mm MAXIMUM SIZE. USE LIGHT MECHANICAL TAMPERS ONLY.

6. CONSTRUCTION SHALL BE CARRIED OUT IN SUCH A MANNER AS TO ENSURE WATER QUALITY IS MAINTAINED BY KEEPING SOIL EROSION AND RUN-OFF TO A MINIMUM DURING INCLEMENT WEATHER AND BY TAKING MEASURES TO PREVENT SEDIMENTATION, LEACHATE, AND CONSTRUCTION MATERIALS FROM ENTERING THE STREAM.

7. OPERATE MACHINERY IN A MANNER THAT MINIMIZES DISTURBANCE TO THE BANKS OF THE WATERCOURSE. MACHINERY IS TO ARRIVE ON SITE IN CLEAN CONDITION AND IS TO BE MAINTAINED FREE OF FLUID LEAKS. REFUEL AND SERVICE MACHINERY AT MINIMUM 100m AWAY FROM THE WATERCOURSE. ENSURE EMERGENCY SPILL KIT IS ON SITE IN CASE OF FLUID LEAKS OR SPILLS FROM MACHINERY.

8. ALL EXPOSED MINERAL SOILS MUST BE SEEDED USING AN APPROVED RECLAMATION GRASS SEED MIXTURE AND COVERED WITH AN APPROVED EROSION CONTROL BLANKET.

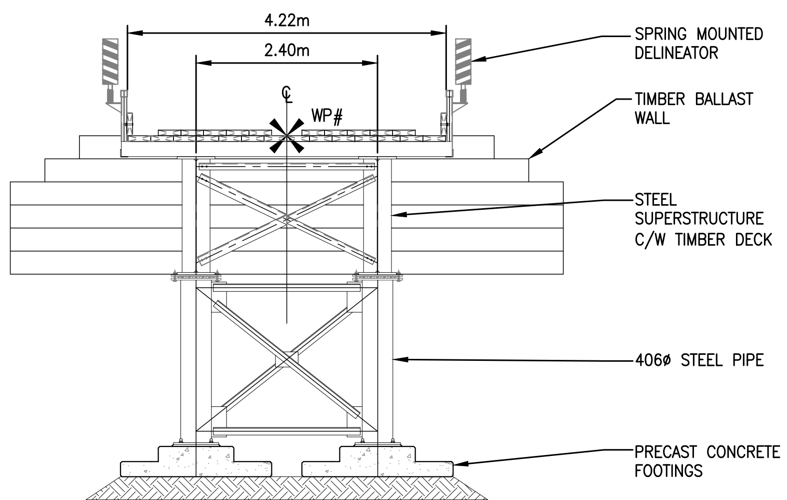
9. MAINTAIN EFFECTIVE SEDIMENT AND EROSION CONTROL MEASURES UNTIL COMPLETE RE-VEGETATION OF DISTURBED AREA IS ACHIEVED.

10. ENVIRONMENTAL MANAGEMENT PLAN TO BE PREPARED FOR PROJECT BY OTHERS. COMPLETION OF WORKS TO COMPLY WITH MITIGATION RECOMMENDATIONS OUTLINED IN ENVIRONMENTAL MANAGEMENT PLAN.

11. ALL PERMITS AND REGULATORY APPROVALS TO BE IN PLACE PRIOR TO COMMENCING WORK. INSTALLATION OF WORKS TO COMPLY WITH BEST MANAGEMENT PRACTICES.

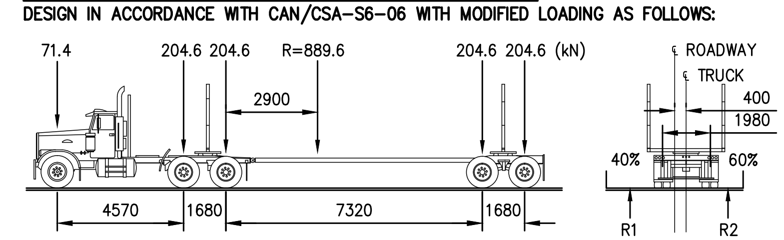
12. DESIGN SPEED OF APPROACH ROAD SHOWN IS 30 km/hr. LOCAL CHAINAGE SHOWN RELATIVE TO APPROXIMATE CENTRE OF STREAM.

13. STRUCTURE DESIGN SHALL BE COMPLETED IN ACCORDANCE WITH CAN/CSA-S6-06 CANADIAN HIGHWAY BRIDGE DESIGN CODE, WITH VARIATIONS IN THE DESIGN LOADING VEHICLE TO MEET ANTICIPATED VEHICLE LOADING.



ABUTMENT ELEVATION
SCALE: 1:100

LOADING DIAGRAM L-100 OFF HIGHWAY G.V.W. = 90 680kg:
DESIGN IN ACCORDANCE WITH CAN/CSA-S6-06 WITH MODIFIED LOADING AS FOLLOWS:



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REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
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0	14/12/05	ISSUED FOR REVIEW	TJB	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO: -	DRWN: TJB	DATE: 14/12/05
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 14/12/05
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -
SCALE: AS NOTED	APVD: -	DATE: -

PROJECT:

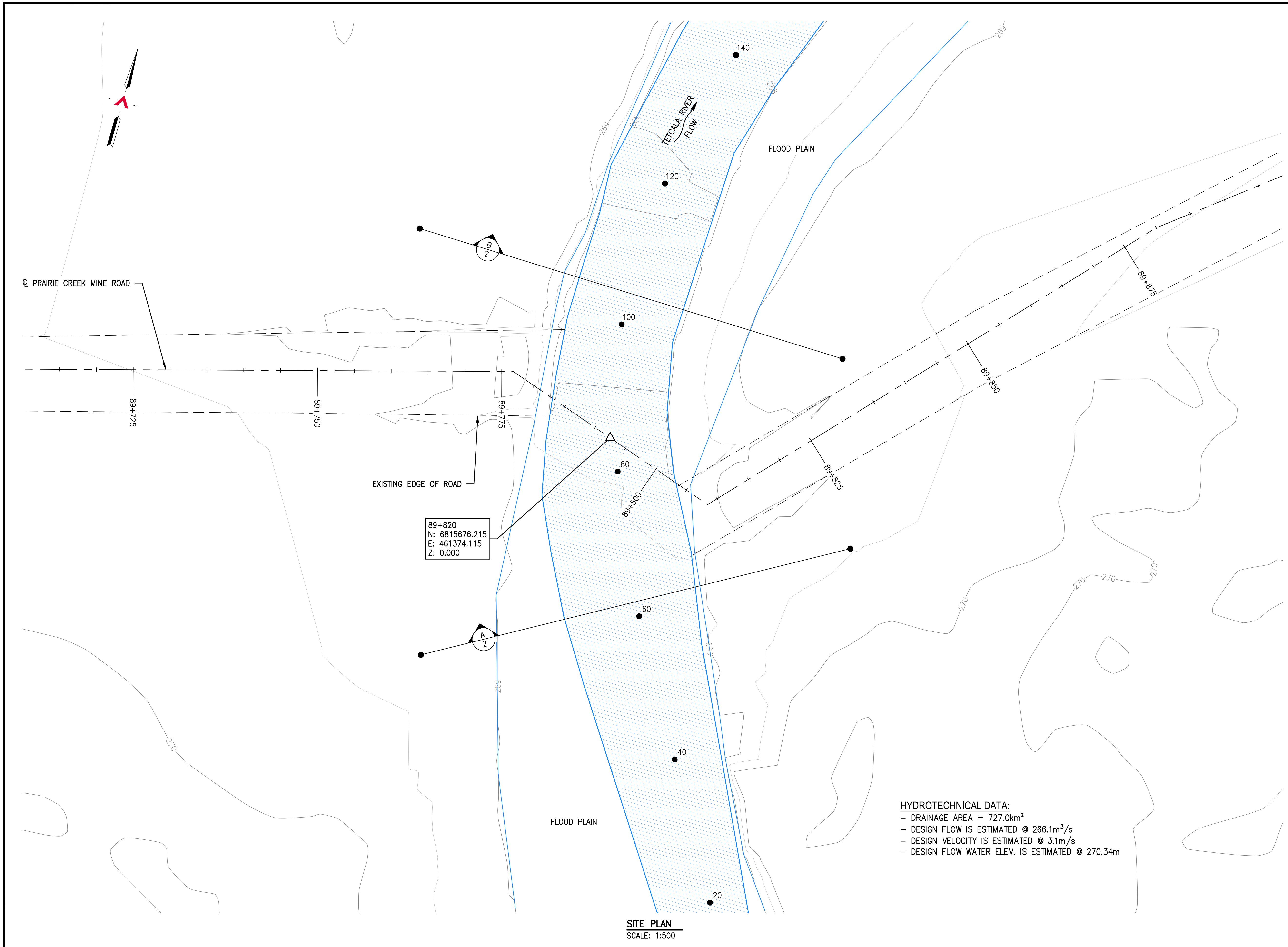
STREAM CROSSING TETCALA RIVER PRAIRIE CREEK MINE ROAD AT STA. 87+375

TITLE:

ABUTMENT ELEVATIONS AND GENERAL NOTES

DWG NO: **15GP0091-087-1960-004** REV: **1**

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-087-1960_87+400_alternate | Layout: 004 | Paper Size: 558.8mm x 431.8mm



HYDROTECHNICAL DATA:
- DRAINAGE AREA = 727.0km²
- DESIGN FLOW IS ESTIMATED @ 266.1m³/s
- DESIGN VELOCITY IS ESTIMATED @ 3.1m/s
- DESIGN FLOW WATER ELEV. IS ESTIMATED @ 270.34m

SITE PLAN
SCALE: 1:500

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091-089-1960_89+820 | Layout: 001 | Paper Size: 558.8mm x 431.8mm

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
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REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	14/11/26	ISSUED FOR REVIEW	TJB	WBM

CLIENT: CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO: -	DRWN: TJB	DATE: 14/11/26
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 14/11/26
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -
SCALE: AS NOTED	APVD: -	DATE: -

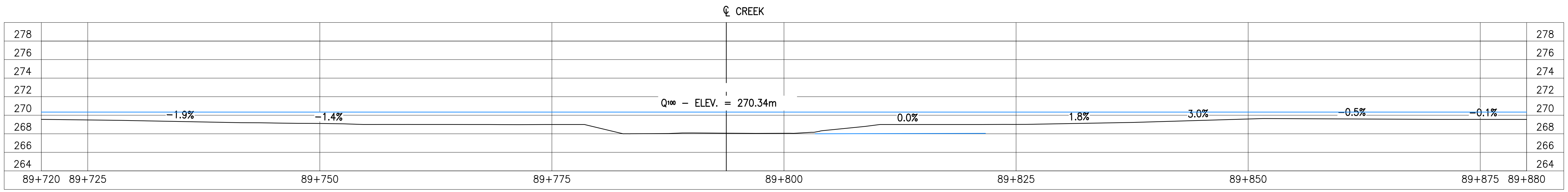
PROJECT:

**STREAM CROSSING
TETCALA RIVER
PRAIRIE CREEK MINE ROAD
AT STA. 89+820**

TITLE:

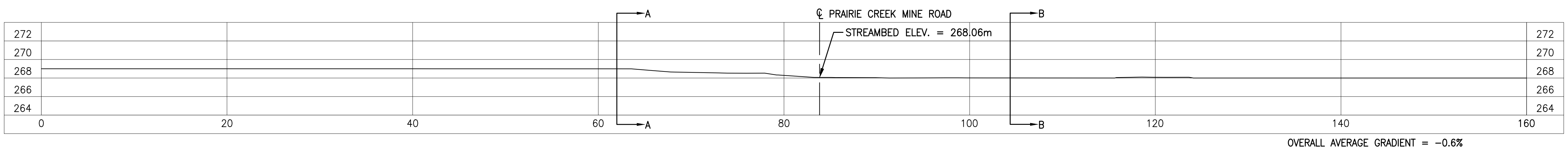
SITE PLAN

DWG NO: **15GP0091-089-1960-001**
REV: **1**



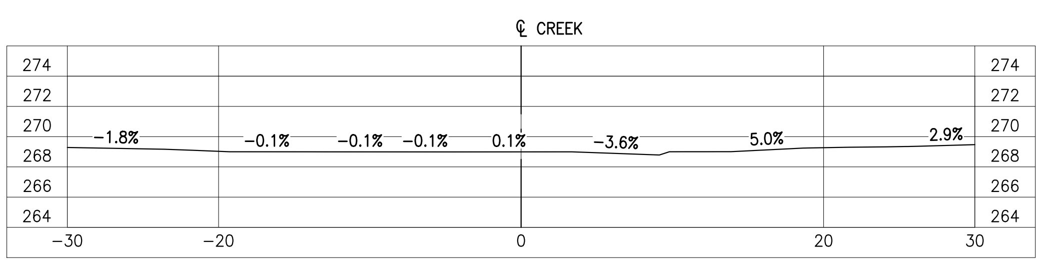
GROUND PROFILE ALONG PRAIRIE CREEK MINE ROAD CENTRELINE ALIGNMENT

SCALE: 1:500



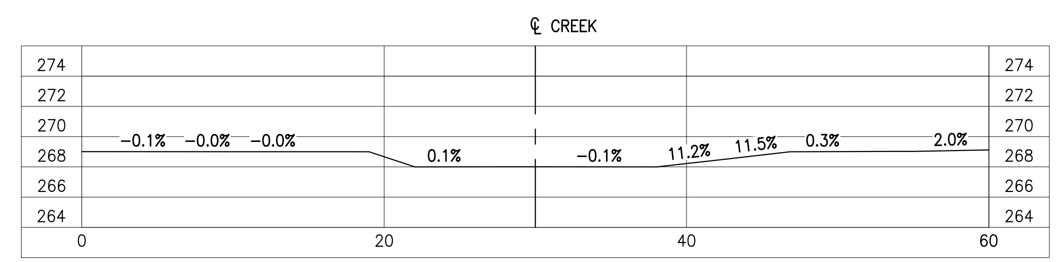
CREEK PROFILE

SCALE: 1:500



SECTION A/1

SCALE: 1:500



SECTION B/1

SCALE: 1:500

REFERENCE DRAWINGS

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-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
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0	14/11/26	ISSUED FOR REVIEW	TJB	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO: -	DRWN: TJB	DATE: 14/11/26	
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 14/11/26	
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -	
SCALE: AS NOTED	APVD: -	DATE: -	

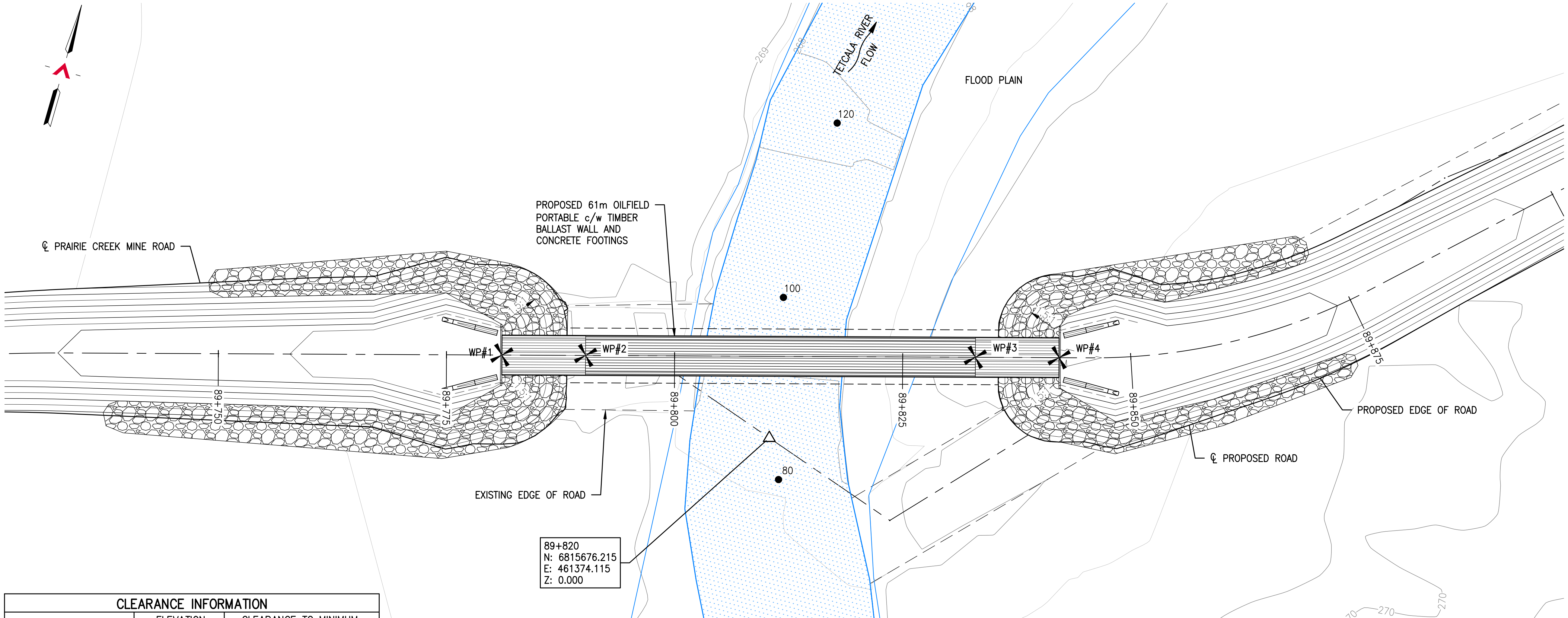
PROJECT:

STREAM CROSSING
TETCALA RIVER
PRAIRIE CREEK MINE ROAD
AT STA. 89+820

TITLE:

PROFILES AND SECTION VIEWS

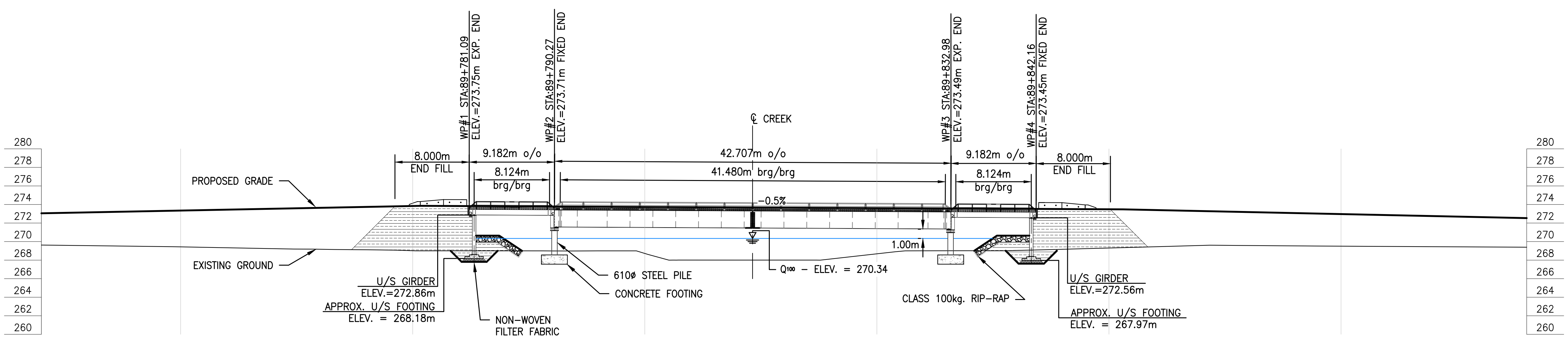
DWG NO: **15GP0091-089-1960-002** REV: **1**



CLEARANCE INFORMATION		
	ELEVATION (m)	CLEARANCE TO MINIMUM SOFFIT ELEVATION (m)
SOFFIT	271.34	–
DESIGN FLOW (Q_{100})	270.34	1.00

GENERAL ARRANGEMENT PLAN
SCALE: 1:500

SURVEY CONTROL			
DESCRIPTION	NORTHING	EASTING	ELEVATION
WP#1	6815676.864	461343.437	273.750
WP#2	6815679.353	461352.275	273.710
WP#3	6815690.931	461393.383	273.490
WP#4	6815693.419	461402.221	273.450



BRIDGE PROFILE
SCALE: 1:250

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
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REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
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0	14/12/08	ISSUED FOR REVIEW	TJB	WBM

CLIENT: CANADIAN ZINC CORPORATION

Allnorth

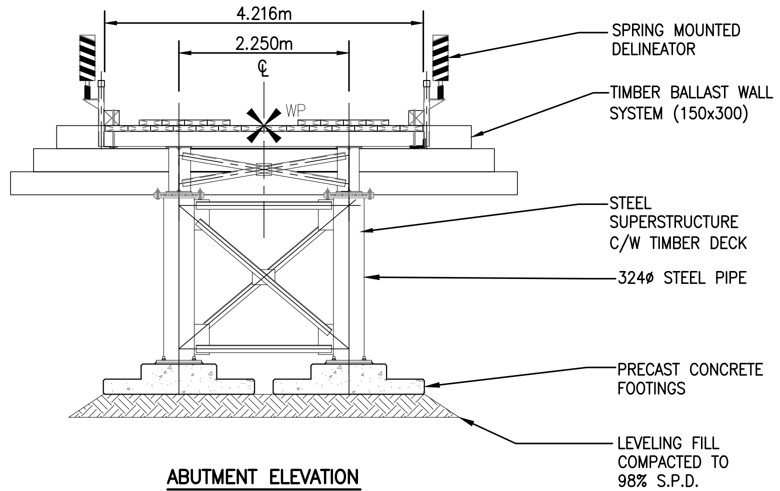
CLIENT NO: -	DRWN: TJB	DATE: 14/12/05
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 14/12/05
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -
SCALE: AS NOTED	APVD: -	DATE: -

PROJECT:
STREAM CROSSING TETCALA RIVER PRAIRIE CREEK MINE ROAD AT STA. 89+820

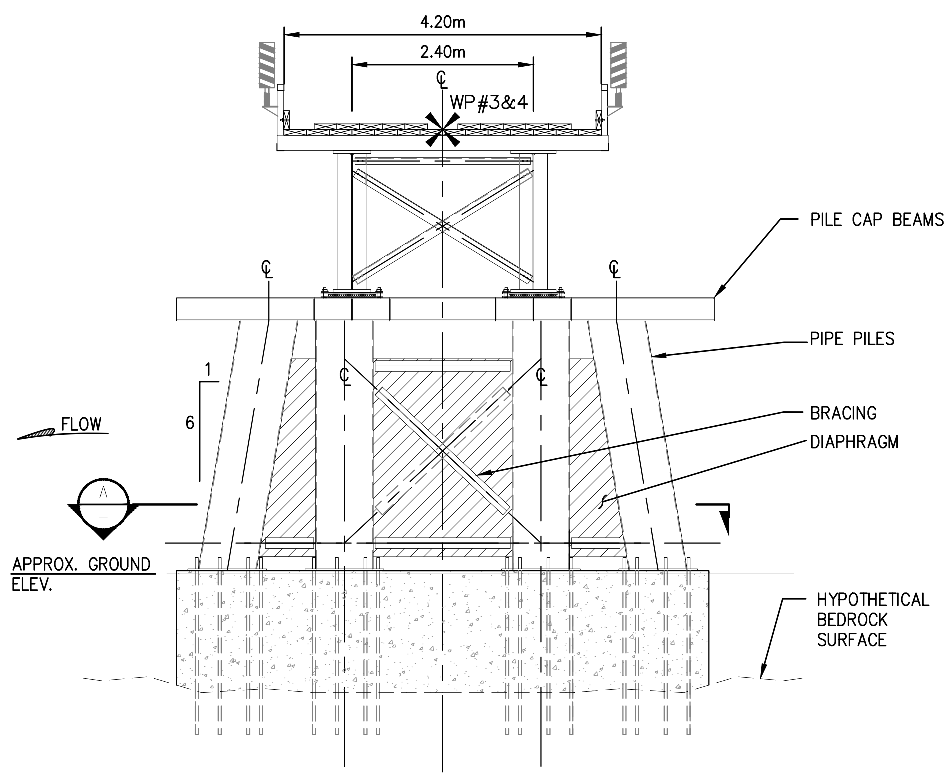
TITLE:
GENERAL ARRANGEMENT PLAN AND BRIDGE PROFILE

DWG NO: 15GP0091-089-1960-003
REV: 1

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-089-1960_89+820 | Layout: 003 | Paper Size: 558.8mm x 431.8mm



ABUTMENT ELEVATION
SCALE: 1:100



ABUTMENT ELEVATION
SCALE: 1:100

NOTES:

1. THESE DRAWINGS ARE INTENDED FOR CONCEPTUAL PURPOSES ONLY.

2. BRIDGE STRUCTURE SHOWN ON GENERAL ARRANGEMENT PLAN AS MANUFACTURED BY RAPID-SPAN STRUCTURES LTD.

3. RIPRAP SHALL EXTEND AROUND ABUTMENTS AS SHOWN ON THE PLAN. THE RIPRAP SHALL BE CLASS 100kg. AND SHALL HAVE A MINIMUM DEPTH OF 700mm.

CLASS OF RIPRAP (kg.)	NOMINAL THICKNESS OF RIPRAP (mm)	ROCK GRADATION PERCENTAGE SMALLER THAN GIVEN ROCK MASS (kg)			APPROXIMATE AVERAGE DIMENSION (mm)		
		15%	50%	85%	15%	50%	85%
10	350	1	10	30	90	195	280
25	450	2.5	25	75	120	260	380
50	550	5	50	150	155	330	475
100	700	10	100	300	195	415	600
250	1000	25	250	750	260	565	815
500	1200	50	500	1500	330	715	1030

4. NO SITE SPECIFIC GEOTECHNICAL INVESTIGATION HAS BEEN COMPLETED AT THE SITE TO DATE. THEREFORE, THIS CONCEPTUAL DESIGN HAS BEEN PREPARED WITHOUT THE BENEFIT OF GEOTECHNICAL ADVICE. GROUND CONDITIONS MAY VARY AND THE FOUNDATION CONCEPT MAY NEED TO BE MODIFIED TO ACCOMMODATE ACTUAL SITE CONDITIONS.

5. BACK FILL OF APPROACHES SHALL GENERALLY CONFORM TO THE LINES SHOWN ON THE DRAWINGS AND SHALL BE PLACED IN LIFTS NOT EXCEEDING 305mm THICK, COMPACTED TO 95% STANDARD PROCTOR DENSITY. MATERIAL SHALL BE NON-FROZEN, CLEAN, FREE DRAINING, WELL GRADED GRANULAR FILL OF 75mm MAXIMUM SIZE. USE LIGHT MECHANICAL TAMPERS ONLY.

6. CONSTRUCTION SHALL BE CARRIED OUT IN SUCH A MANNER AS TO ENSURE WATER QUALITY IS MAINTAINED BY KEEPING SOIL EROSION AND RUN-OFF TO A MINIMUM DURING INCLEMENT WEATHER AND BY TAKING MEASURES TO PREVENT SEDIMENTATION, LEACHATE, AND CONSTRUCTION MATERIALS FROM ENTERING THE STREAM.

7. OPERATE MACHINERY IN A MANNER THAT MINIMIZES DISTURBANCE TO THE BANKS OF THE WATERCOURSE. MACHINERY IS TO ARRIVE ON SITE IN CLEAN CONDITION AND IS TO BE MAINTAINED FREE OF FLUID LEAKS. REFUEL AND SERVICE MACHINERY AT MINIMUM 100m AWAY FROM THE WATERCOURSE. ENSURE EMERGENCY SPILL KIT IS ON SITE IN CASE OF FLUID LEAKS OR SPILLS FROM MACHINERY.

8. ALL EXPOSED MINERAL SOILS MUST BE SEEDED USING AN APPROVED RECLAMATION GRASS SEED MIXTURE AND COVERED WITH AN APPROVED EROSION CONTROL BLANKET.

9. MAINTAIN EFFECTIVE SEDIMENT AND EROSION CONTROL MEASURES UNTIL COMPLETE RE-VEGETATION OF DISTURBED AREA IS ACHIEVED.

10. ENVIRONMENTAL MANAGEMENT PLAN TO BE PREPARED FOR PROJECT BY OTHERS. COMPLETION OF WORKS TO COMPLY WITH MITIGATION RECOMMENDATIONS OUTLINED IN ENVIRONMENTAL MANAGEMENT PLAN.

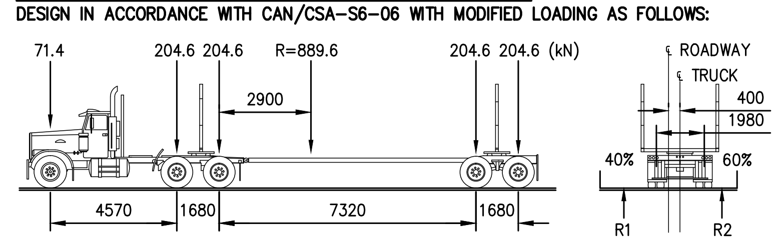
11. ALL PERMITS AND REGULATORY APPROVALS TO BE IN PLACE PRIOR TO COMMENCING WORK. INSTALLATION OF WORKS TO COMPLY WITH BEST MANAGEMENT PRACTICES.

12. DESIGN SPEED OF APPROACH ROAD SHOWN IS 30 km/hr. LOCAL CHAINAGE SHOWN RELATIVE TO APPROXIMATE CENTRE OF STREAM.

13. STRUCTURE DESIGN SHALL BE COMPLETED IN ACCORDANCE WITH CAN/CSA-S6-06 CANADIAN HIGHWAY BRIDGE DESIGN CODE, WITH VARIATIONS IN THE DESIGN LOADING VEHICLE TO MEET ANTICIPATED VEHICLE LOADING.

LOADING DIAGRAM L-100 OFF HIGHWAY G.V.W. = 90 680kg:

DESIGN IN ACCORDANCE WITH CAN/CSA-S6-06 WITH MODIFIED LOADING AS FOLLOWS:



REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	15/07/22	ISSUED FOR REVIEW	TJB	WBM
0	14/12/08	ISSUED FOR REVIEW	TJB	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO: -	DRWN: TJB	DATE: 14/12/05
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 14/12/05
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -
SCALE: AS NOTED	APVD: -	DATE: -

PROJECT:

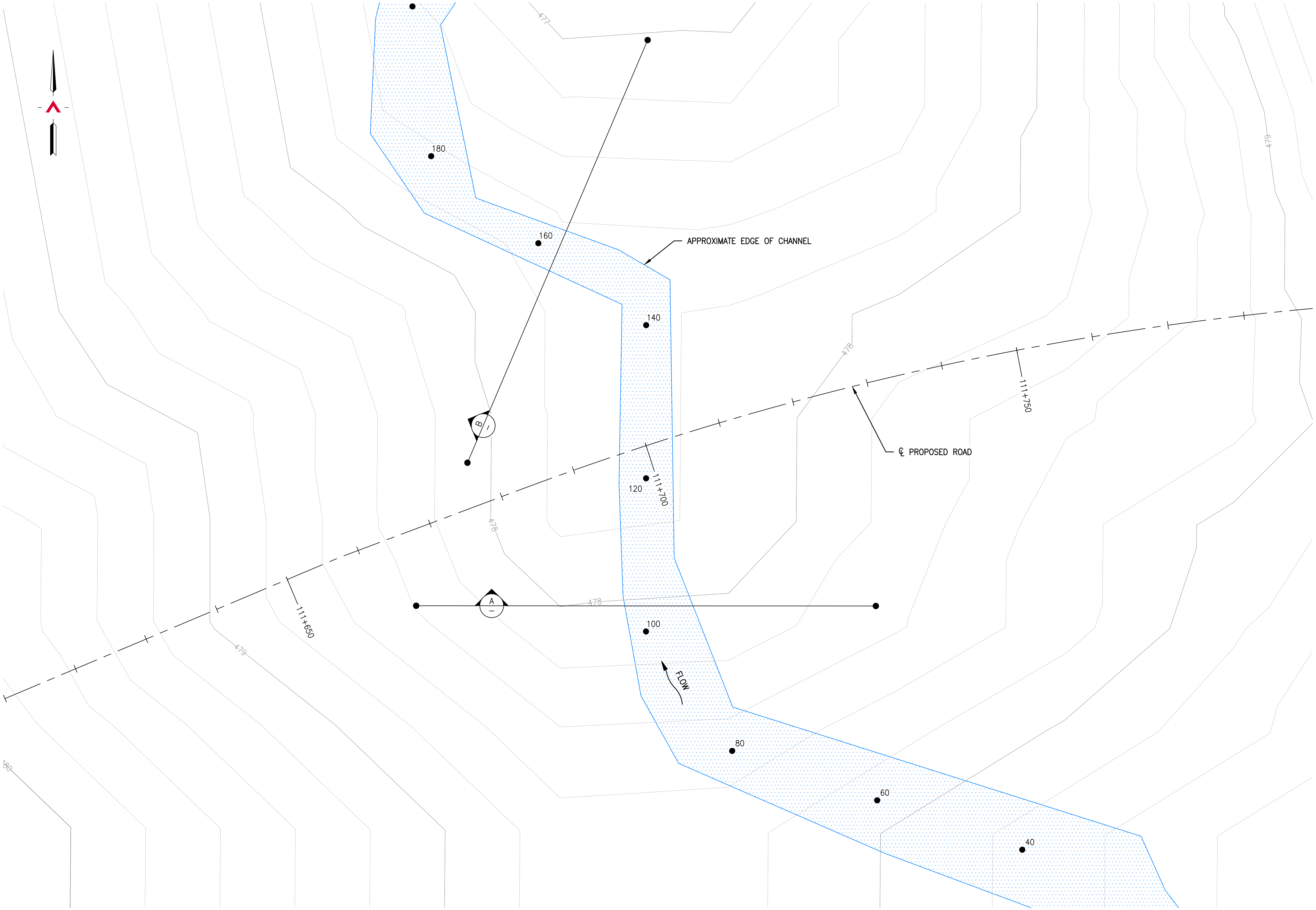
STREAM CROSSING
TETCALA RIVER
PRAIRIE CREEK MINE ROAD AT STA. 89+820

TITLE:

ABUTMENT ELEVATIONS AND GENERAL NOTES

DWG NO: **15GP0091-089-1960-004** REV: **1**

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-089-1960_89+820 | Layout: 004 | Paper Size: 558.8mm x 431.8mm



SITE PLAN
SCALE: 1:500

REFERENCE DRAWINGS

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REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
0	15/07/31	ISSUED FOR REVIEW	TJB	WBM

CLIENT:
CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:	-	DRWN:	TJB	DATE:	15/07/30
PROJECT NO:	15GP0091	DSGN:	WBM	DATE:	15/07/30
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	AS NOTED	APVD:	-	DATE:	-

PROJECT:

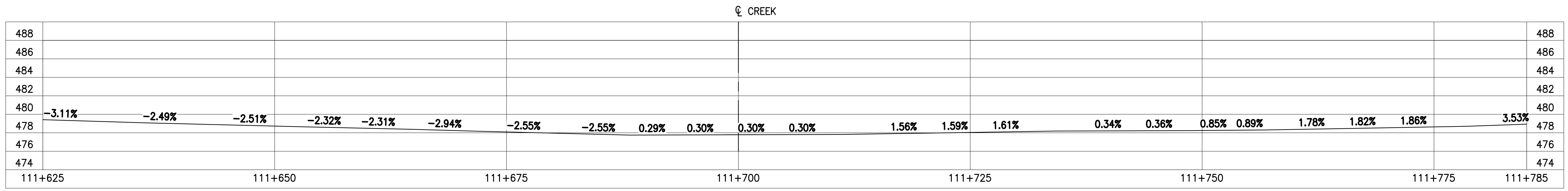
STREAM CROSSING
UNNAMED CREEK
PRAIRIE CREEK MINE ROAD
AT STA. 111+700

TITLE:

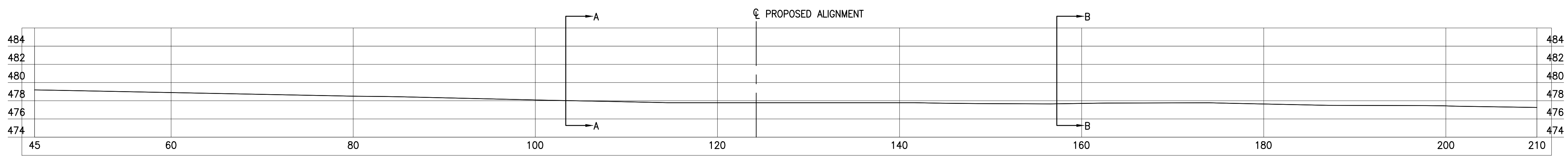
SITE PLAN

DWG NO: **15GP0091-111-1960-001**
REV: **0**

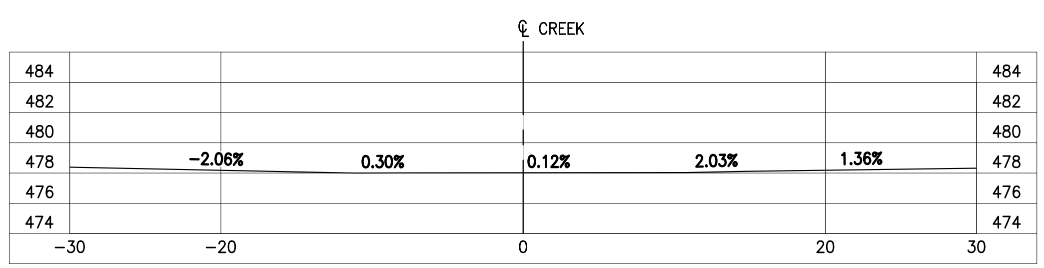
Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15gp0091-111-1960_111+700 | Layout: 111.7_001 | Paper Size: 558.8mm x 431.8mm



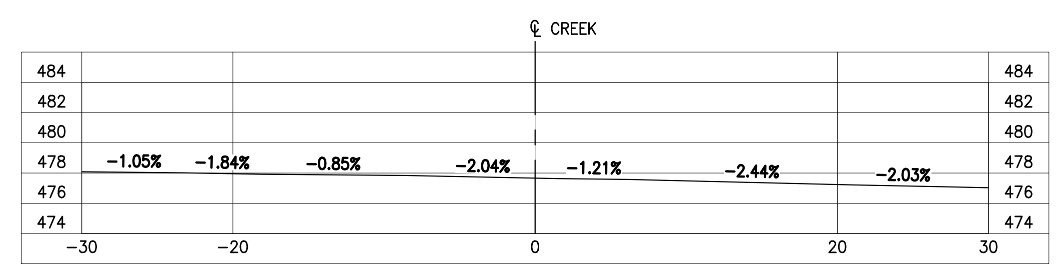
GROUND PROFILE ALONG PRAIRIE CREEK MINE ROAD CENTRELINE ALIGNMENT
SCALE: 1:500



CREEK PROFILE
SCALE: 1:500



SECTION A/1
SCALE: 1:500



SECTION B/1
SCALE: 1:500

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
0	15/07/31	ISSUED FOR REVIEW	TJB	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:	-	DRWN:	TJB	DATE:	15/07/30
PROJECT NO:	15GP0091	DSGN:	WBM	DATE:	15/07/30
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	AS NOTED	APVD:	-	DATE:	-

PROJECT:

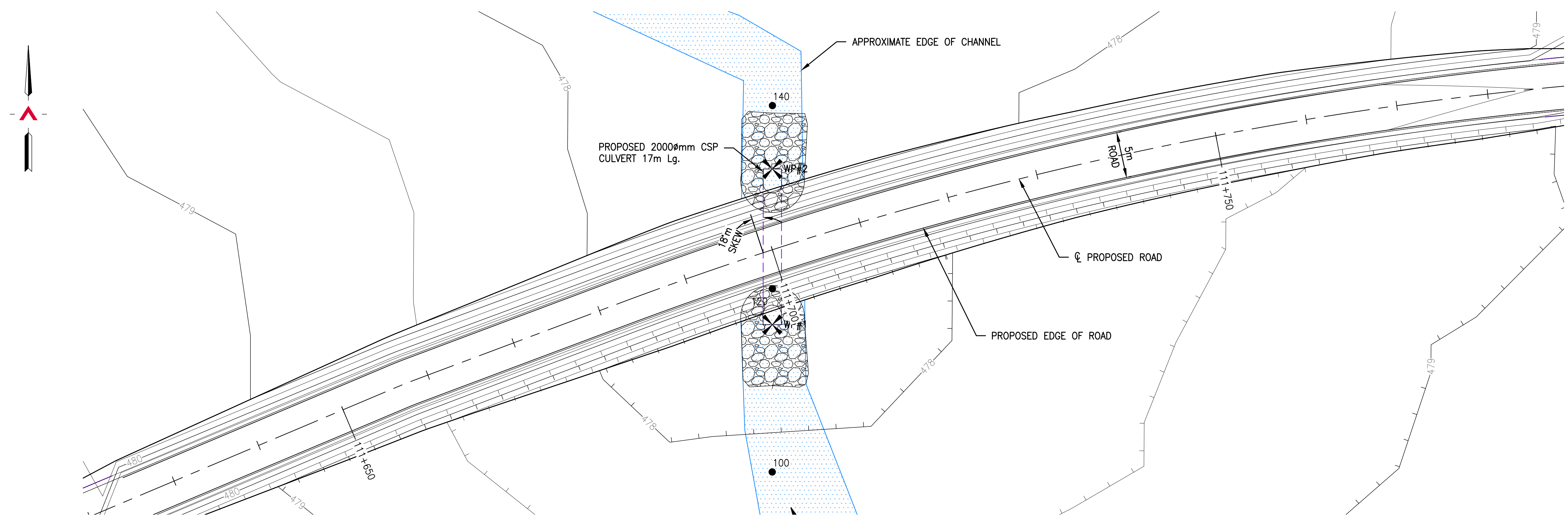
STREAM CROSSING UNNAMED CREEK PRAIRIE CREEK MINE ROAD AT STA. 111+700

TITLE:

PROFILES AND SECTION VIEWS

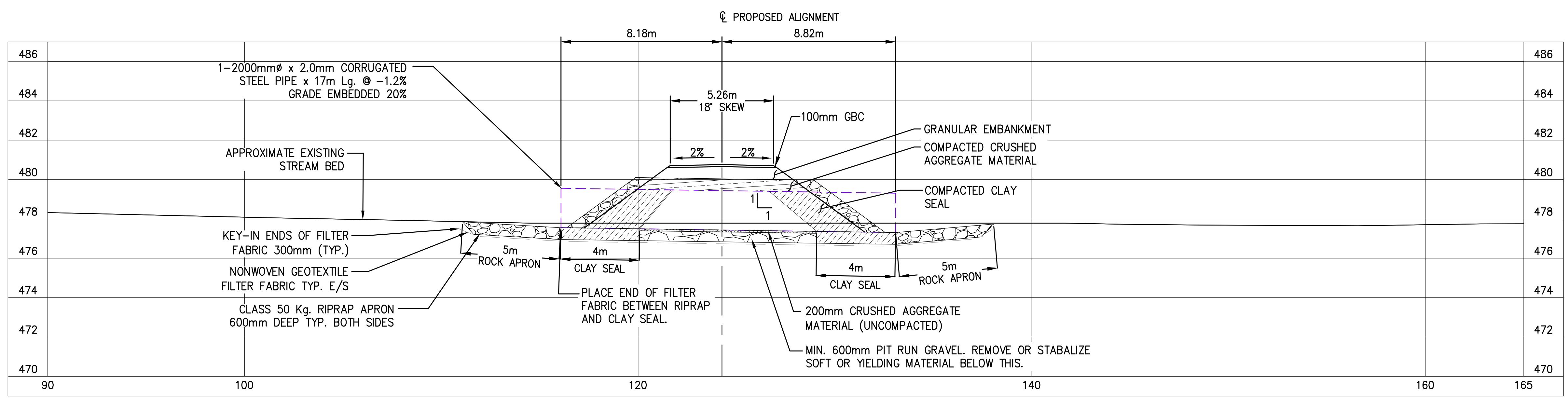
DWG NO: **15GP0091-111-1960-002** REV: **0**

Date: 2015/08/06 | User: Tammy Beer | Layout: 111.7_002 | Paper Size: 558.8mm x 431.8mm



GENERAL ARRANGEMENT PLAN
SCALE: 1:500

SURVEY CONTROL			
DESCRIPTION	NORTHING	EASTING	ELEVATION
WP#1	6805628.026	473724.269	477.550
WP#2	6805645.027	473724.277	477.290



CULVERT PROFILE
SCALE: 1:250

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
0	15/07/31	ISSUED FOR REVIEW	TJB	WBM

CLIENT: CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO: -	DRWN: TJB	DATE: 15/07/30
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 15/07/30
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -
SCALE: AS NOTED	APVD: -	DATE: -

PROJECT:

STREAM CROSSING
UNNAMED CREEK
PRAIRIE CREEK MINE ROAD
AT STA. 111+700

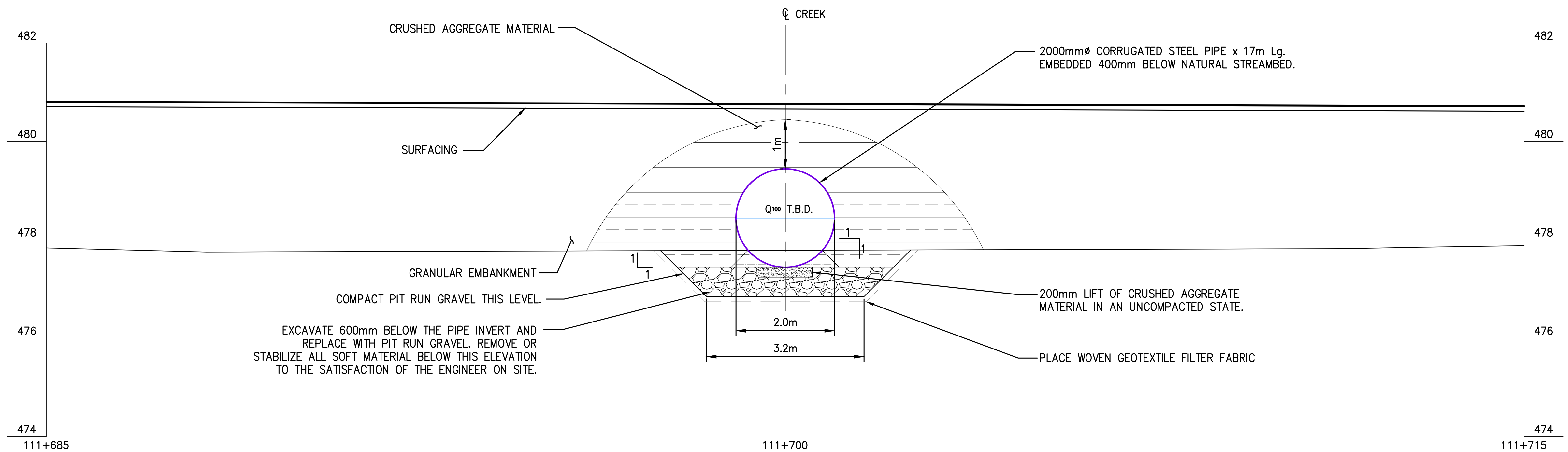
TITLE:

GENERAL ARRANGEMENT PLAN AND CULVERT PROFILE

DWG NO: 15GP0091-111-1960-003 REV: 0

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15gp0091-111-1960_111+700 | Layout: 111.7_003 | Paper Size: 558.8mm x 431.8mm

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF



NOTES:

1. THESE DRAWINGS ARE INTENDED FOR CONCEPTUAL PURPOSES ONLY.
2. 1–2000mmø x 17m Lg. @ 18° SKEW CULVERT OR APPROVED EQUAL. WALL THICKNESS TO BE SPECIFIED BY CULVERT SUPPLIER.
3. RIPRAP SHALL EXTEND AROUND CULVERT INLET AND OUTLET AS SHOWN ON THE PLAN.
4. FOUNDATION, BEDDING, AND BACKFILL MATERIAL SHALL BE WELL GRADED AND FREE DRAINING AS APPROVED BY THE ENGINEER. IT SHALL NOT CONTAIN FROZEN SOIL, CHUNKS OF CLAY, OR ANY OTHER DELETERIOUS MATERIAL WITHIN 1000mm OF THE STRUCTURE.
5. MAINTAIN EFFECTIVE SEDIMENT AND EROSION CONTROL MEASURES UNTIL COMPLETE RE–VEGETATION OF DISTURBED AREA IS ACHIEVED.
6. ALL PERMITS AND REGULATORY APPROVALS TO BE IN PLACE PRIOR TO COMMENCING WORK.
7. ENVIRONMENTAL MANAGEMENT PLAN TO BE PREPARED FOR PROJECT BY OTHERS. COMPLETION OF WORKS TO COMPLY WITH MITIGATION RECOMMENDATIONS OUTLINED IN ENVIRONMENTAL MANAGEMENT PLAN.

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
0	15/07/31	ISSUED FOR REVIEW	TJB	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:	-	DRWN:	TJB	DATE:	15/07/30
PROJECT NO:	15GP0091	DSGN:	WBM	DATE:	15/07/30
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	AS NOTED	APVD:	-	DATE:	-

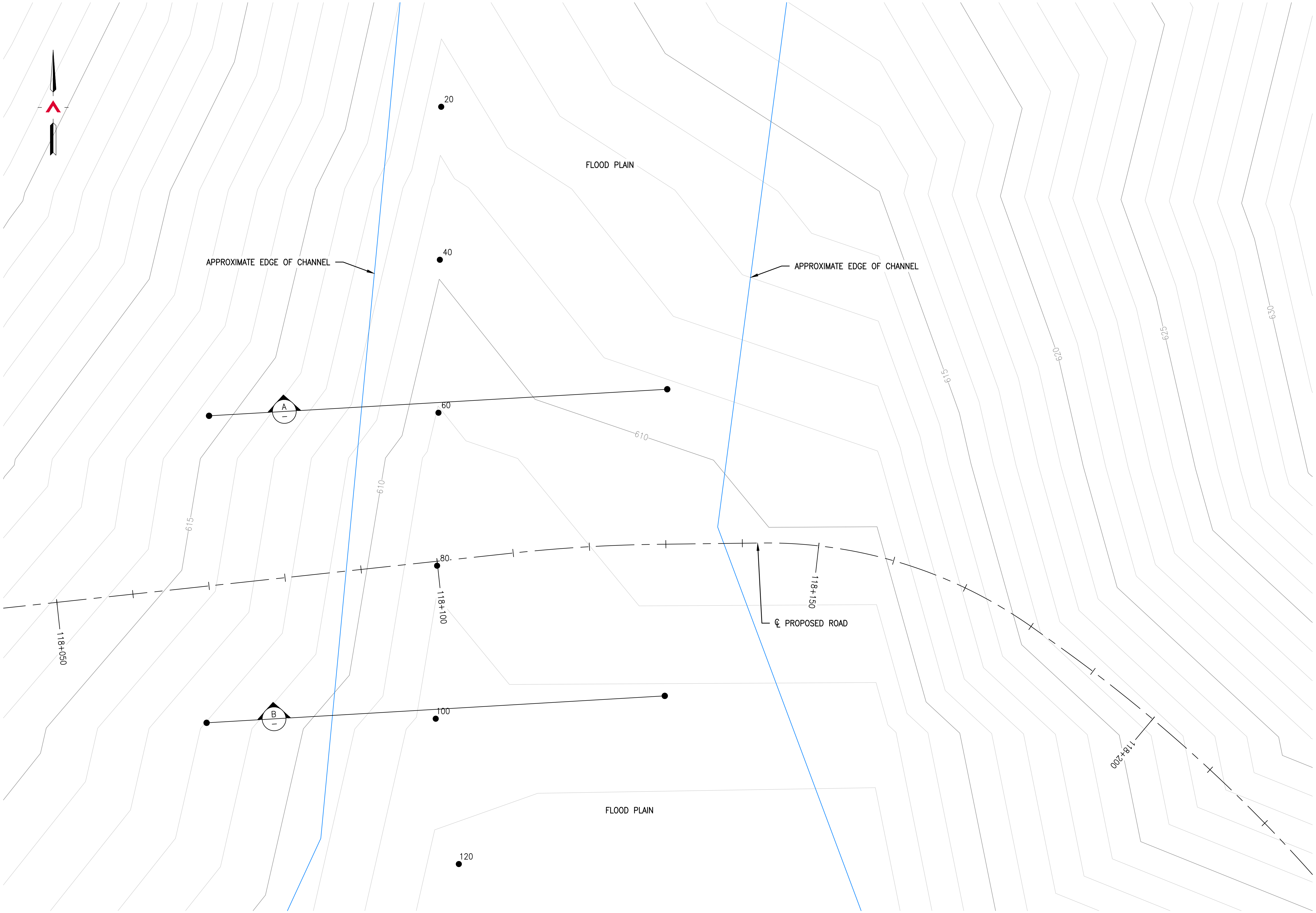
PROJECT:

**STREAM CROSSING
UNNAMED CREEK
PRAIRIE CREEK MINE ROAD
AT STA. 111+700**

TITLE:

**CULVERT ELEVATION
AND
GENERAL NOTES**

DWG NO: **15GP0091-111-1960-004** REV: **0**



SITE PLAN
SCALE: 1:500

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
0	15/07/31	ISSUED FOR REVIEW	TJB	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:	-	DRWN:	TJB	DATE:	15/07/30
PROJECT NO:	15GP0091	DSGN:	WBM	DATE:	15/07/30
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	AS NOTED	APVD:	-	DATE:	-

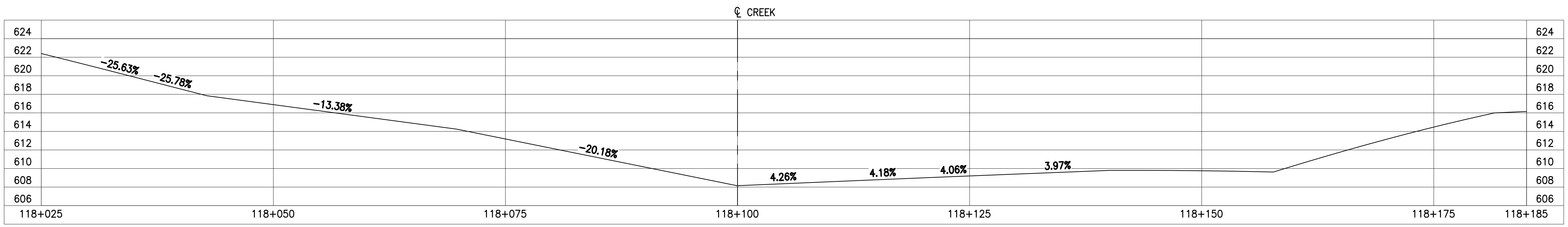
PROJECT:

STREAM CROSSING TRIBUTARY TO GRAINGER RIVER PRAIRIE CREEK MINE ROAD AT STA. 118+100

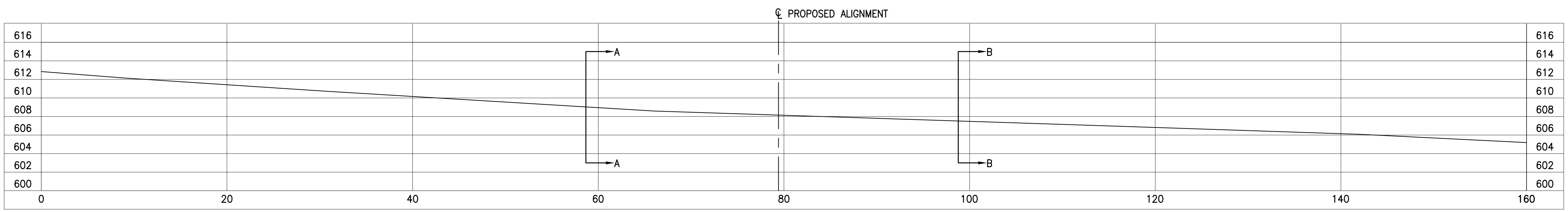
TITLE:

SITE PLAN

DWG NO: **15GP0091-118-1960-001** REV: **0**

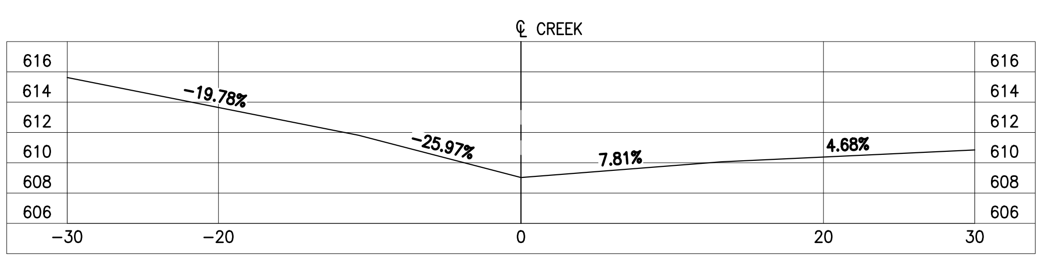


GROUND PROFILE ALONG PRAIRIE CREEK MINE ROAD CENTRELINE ALIGNMENT
SCALE: 1:500

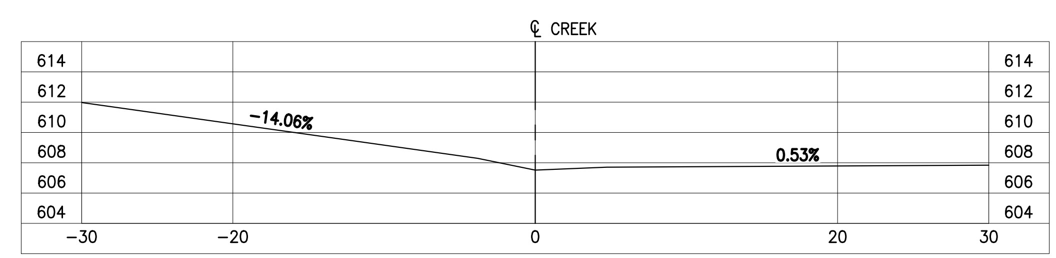


OVERALL AVERAGE GRADIENT = 4.8%

CREEK PROFILE
SCALE: 1:500



SECTION A/1
SCALE: 1:500



SECTION B/1
SCALE: 1:500

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
0	15/07/31	ISSUED FOR REVIEW	TJB	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO: -	DRWN: TJB	DATE: 15/07/30
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 15/07/30
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -
SCALE: AS NOTED	APVD: -	DATE: -

PROJECT:

STREAM CROSSING TRIBUTARY TO GRAINGER RIVER PRAIRIE CREEK MINE ROAD AT STA. 118+100

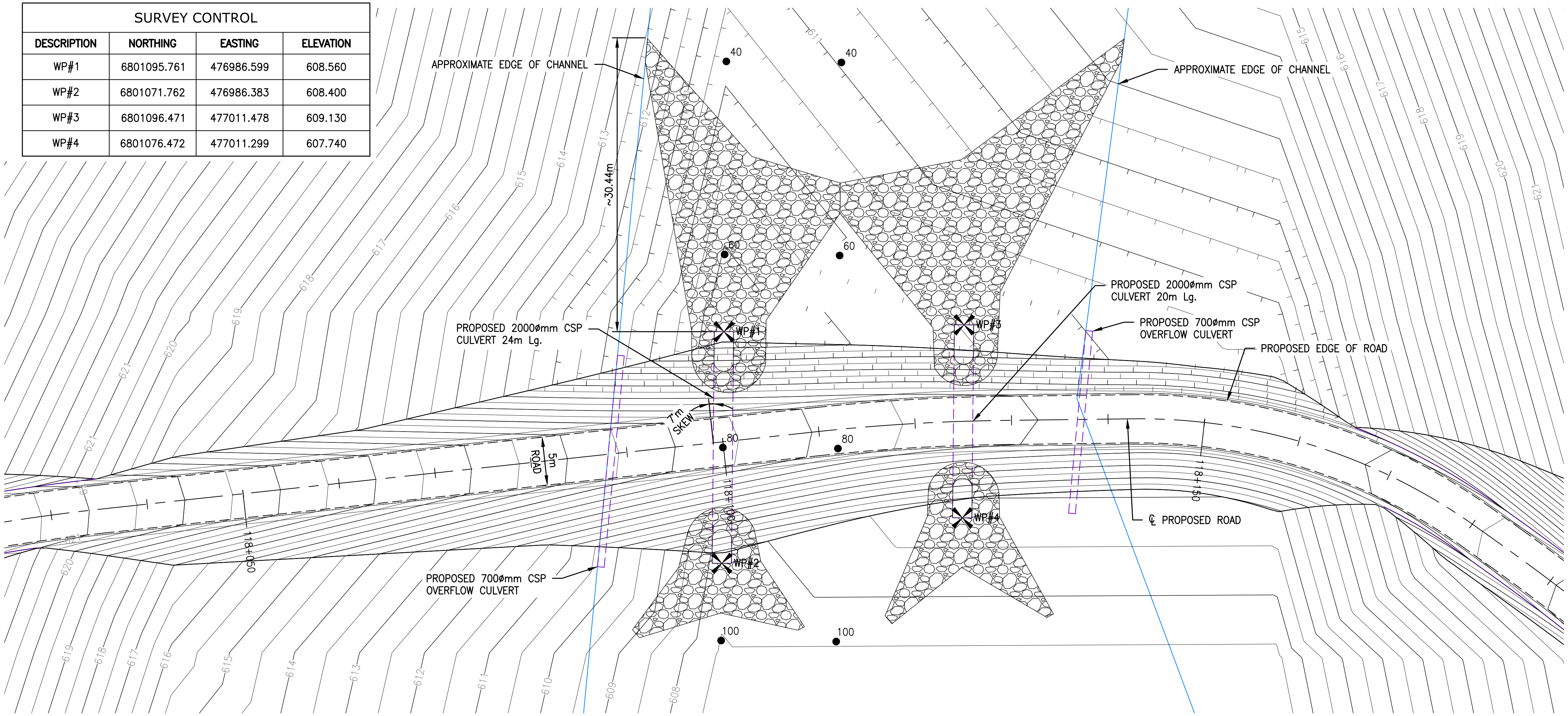
TITLE:

PROFILES AND SECTIONS

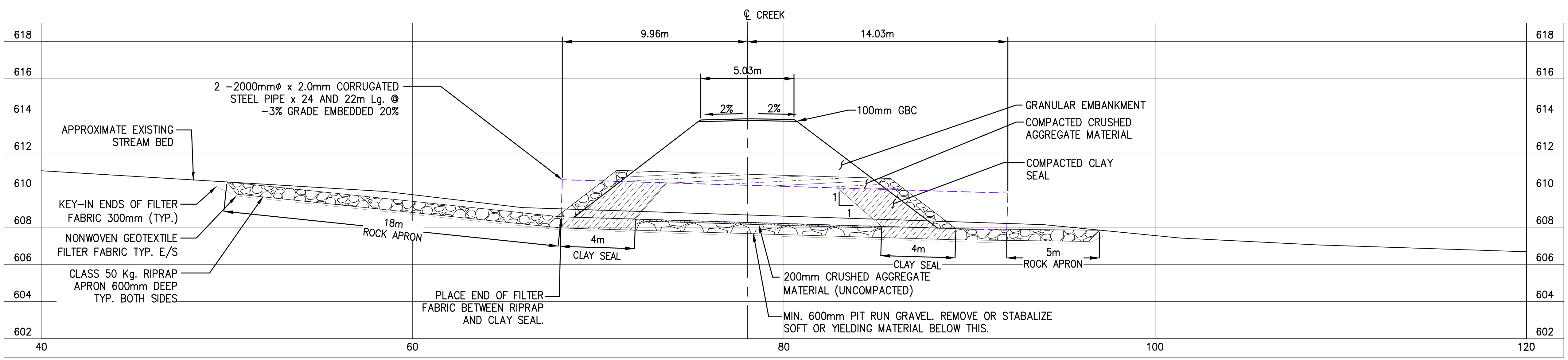
DWG NO: **15GP0091-118-1960-002** REV: **0**

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15gp0091-111-1960_111-700 | Layout: 118.1_002 | Paper Size: 558.8mm x 431.8mm

SURVEY CONTROL			
DESCRIPTION	NORTHING	EASTING	ELEVATION
WP#1	6801095.761	476986.599	608.560
WP#2	6801071.762	476986.383	608.400
WP#3	6801096.471	477011.478	609.130
WP#4	6801076.472	477011.299	607.740



GENERAL ARRANGEMENT PLAN
SCALE: 1:500



CULVERT PROFILE
SCALE: 1:250

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
0	15/07/31	ISSUED FOR REVIEW	TJB	WBM

CLIENT: CANADIAN ZINC CORPORATION

Allnorth

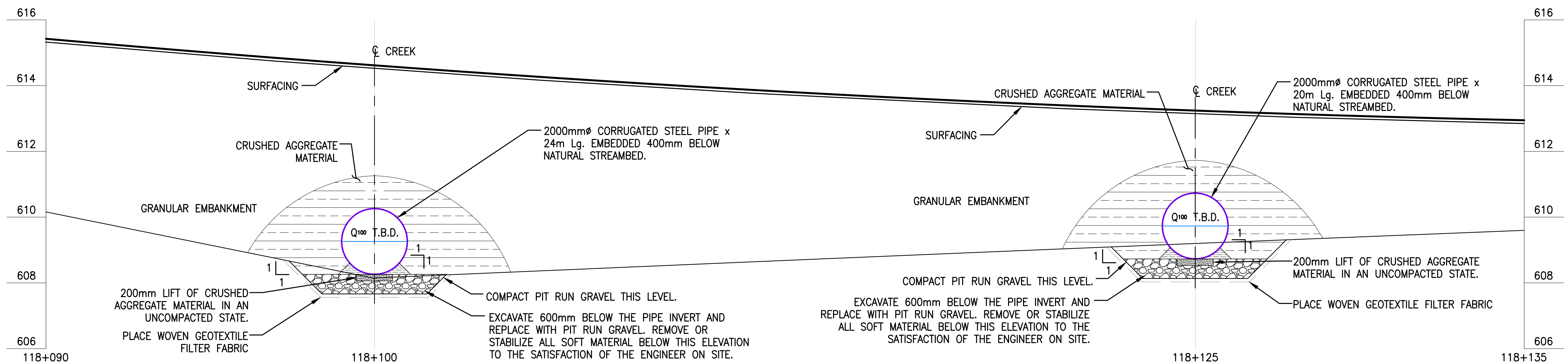
CLIENT NO: -	DRWN: TJB	DATE: 15/07/30	
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 15/07/30	
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -	
SCALE: AS NOTED	APVD: -	DATE: -	

PROJECT:
STREAM CROSSING TRIBUTARY TO GRAINGER RIVER PRAIRIE CREEK MINE ROAD AT STA. 118+100

TITLE:
GENERAL ARRANGEMENT PLAN AND CULVERT PROFILE

DWG NO: **15GP0091-118-1960-003** REV: **0**

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15gp0091-111-1960_111+700 | Layout: 118.1_003 | Paper Size: 558.8mm x 431.8mm



CULVERT ELEVATION
SCALE: 1:150

NOTES:

1. THESE DRAWINGS ARE INTENDED FOR CONCEPTUAL PURPOSES ONLY.
2. 2–2000mmø x 24&20m Lg. CULVERT OR APPROVED EQUAL. WALL THICKNESS TO BE SPECIFIED BY CULVERT SUPPLIER.
3. RIPRAP SHALL EXTEND AROUND CULVERT INLET AND OUTLET AS SHOWN ON THE PLAN.
4. FOUNDATION, BEDDING, AND BACKFILL MATERIAL SHALL BE WELL GRADED AND FREE DRAINING AS APPROVED BY THE ENGINEER. IT SHALL NOT CONTAIN FROZEN SOIL, CHUNKS OF CLAY, OR ANY OTHER DELETERIOUS MATERIAL WITHIN 1000mm OF THE STRUCTURE.
5. MAINTAIN EFFECTIVE SEDIMENT AND EROSION CONTROL MEASURES UNTIL COMPLETE RE–VEGETATION OF DISTURBED AREA IS ACHIEVED.
6. ALL PERMITS AND REGULATORY APPROVALS TO BE IN PLACE PRIOR TO COMMENCING WORK.
7. ENVIRONMENTAL MANAGEMENT PLAN TO BE PREPARED FOR PROJECT BY OTHERS. COMPLETION OF WORKS TO COMPLY WITH MITIGATION RECOMMENDATIONS OUTLINED IN ENVIRONMENTAL MANAGEMENT PLAN.

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
0	15/07/31	ISSUED FOR REVIEW	TJB	WBM

CLIENT: CANADIAN ZINC CORPORATION

Allnorth

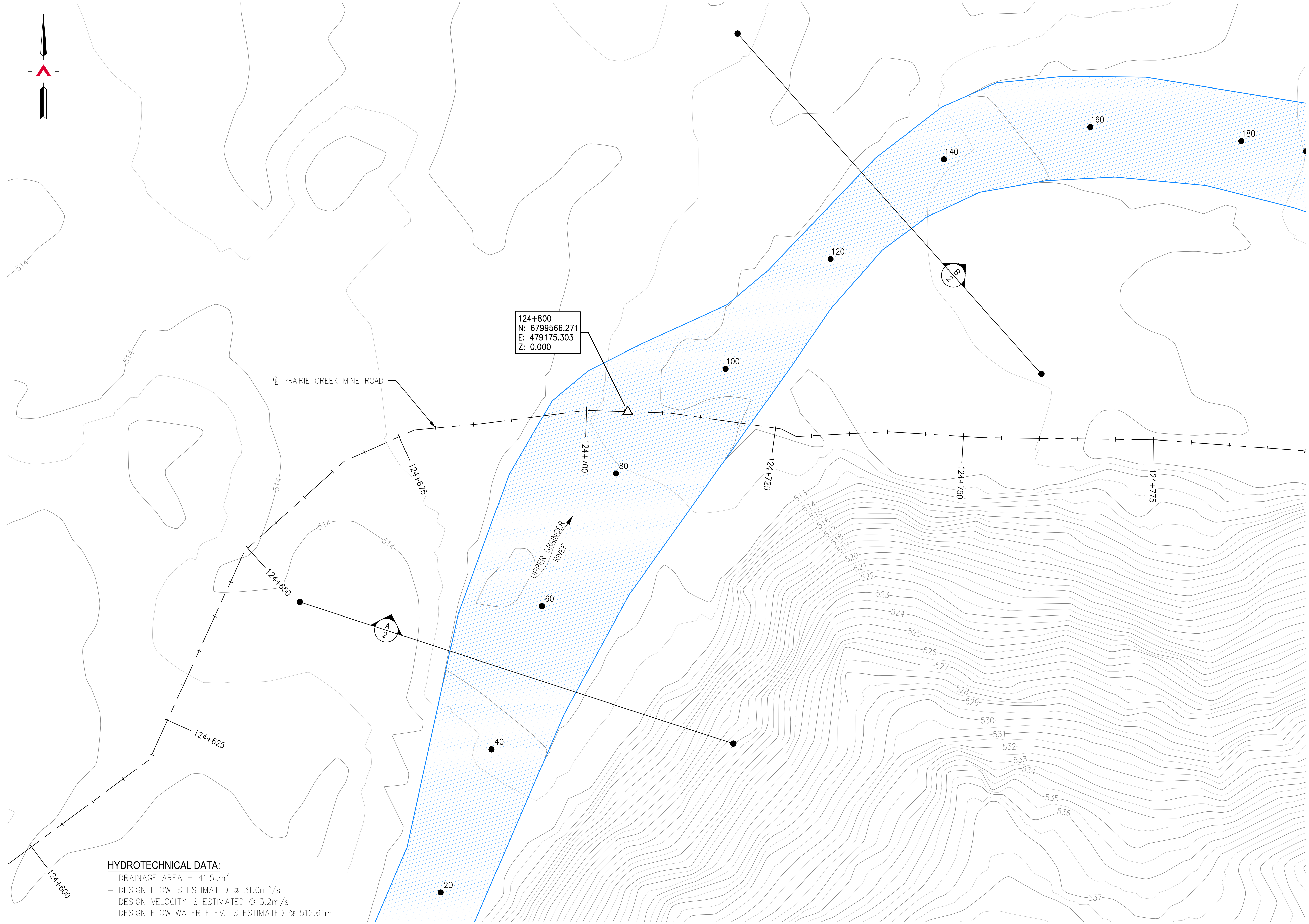
CLIENT NO: -	DRWN: TJB	DATE: 15/07/30
PROJECT NO: 15GP0091	DSGN: WBM	DATE: 15/07/30
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -
SCALE: AS NOTED	APVD: -	DATE: -

PROJECT:
STREAM CROSSING TRIBUTARY TO GRAINGER RIVER PRAIRIE CREEK MINE ROAD AT STA. 118+100

TITLE:
CULVERT ELEVATION AND GENERAL NOTES

DWG NO: **15GP0091-118-1960-004**
REV: **0**

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15gp0091-111-1960_111+700 | Layout: 118.1_004 | Paper Size: 558.8mm x 431.8mm



HYDROTECHNICAL DATA:

- DRAINAGE AREA = 41.5km²
- DESIGN FLOW IS ESTIMATED @ 31.0m³/s
- DESIGN VELOCITY IS ESTIMATED @ 3.2m/s
- DESIGN FLOW WATER ELEV. IS ESTIMATED @ 512.61m

SITE PLAN
SCALE: 1:500

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	2015/07/23	ISSUED FOR REVIEW	IHY	WBM
0	2014/02/10	ISSUED FOR REVIEW	TJB	WBM

CLIENT:
CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:	DRWN: MDB	DATE: 14/11/28
PROJECT NO: 15-GP-0091	DSGN: WBM	DATE: 14/11/26
DRAWING SIZE: ANSI "B"	CHKD:	DATE:
SCALE: AS NOTED	APVD:	DATE:

PROJECT:

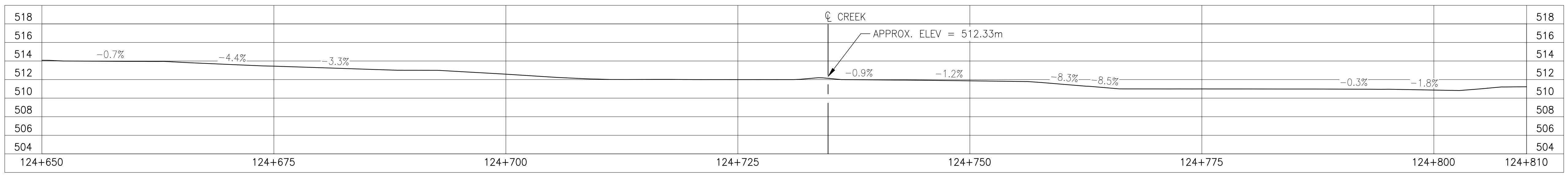
STREAM CROSSING
UPPER GRAINGER RIVER
PRAIRIE CREEK MINE ROAD
AT STA. 124+800
OPTION 'A'

TITLE:

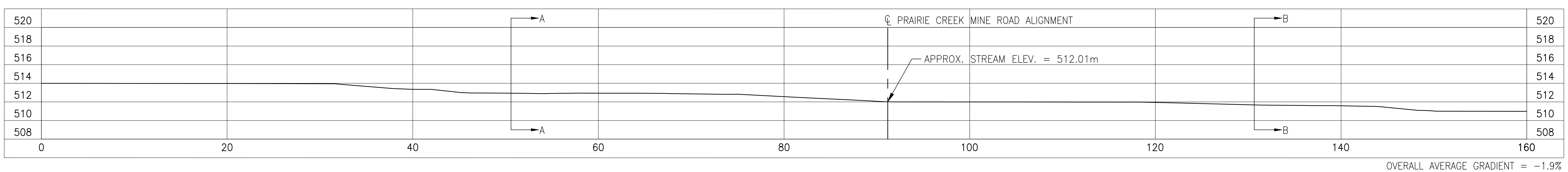
SITE PLAN

DWG NO: **15GP0091-124-1960-001**
REV: **1**

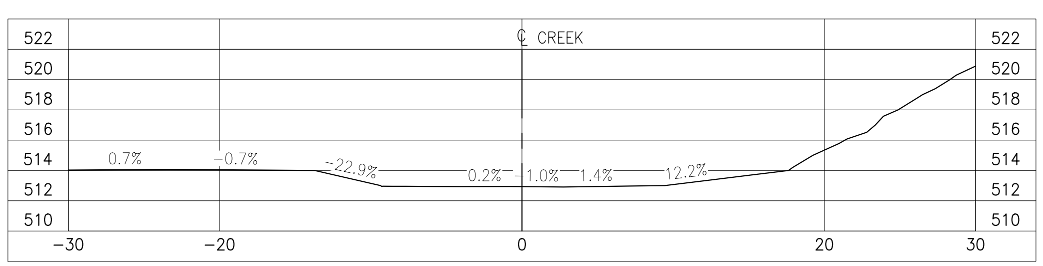
Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-124-1960_124+800_Option A | Layout: 001 | Paper Size: 558.8mm x 431.8mm



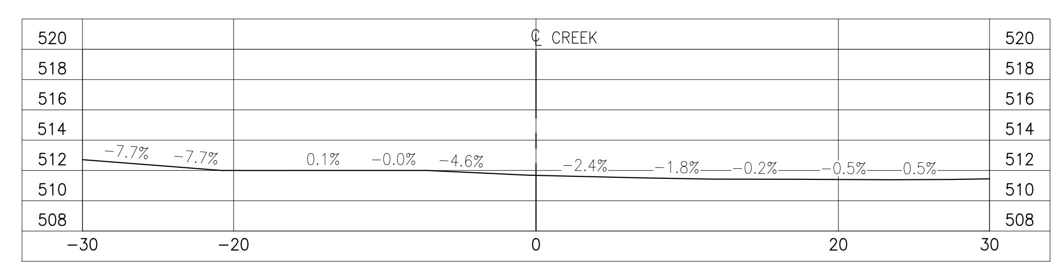
GROUND PROFILE ALONG PRAIRIE CREEK MINE ROAD CENTRELINE ALIGNMENT
SCALE: 1:500



CREEK PROFILE
SCALE: 1:500



SECTION A/1
SCALE: 1:500



SECTION B/1
SCALE: 1:500

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	2015/07/23	ISSUED FOR REVIEW	IHY	WBM
0	2014/02/10	ISSUED FOR REVIEW	TJB	WBM

CLIENT: CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:	DRWN: MDB	DATE: 14/11/28
PROJECT NO: 15-GP-0091	DSGN: WBM	DATE: 14/11/28
DRAWING SIZE: ANSI "B"	CHKD:	DATE:
SCALE: AS NOTED	APVD:	DATE:

PROJECT:

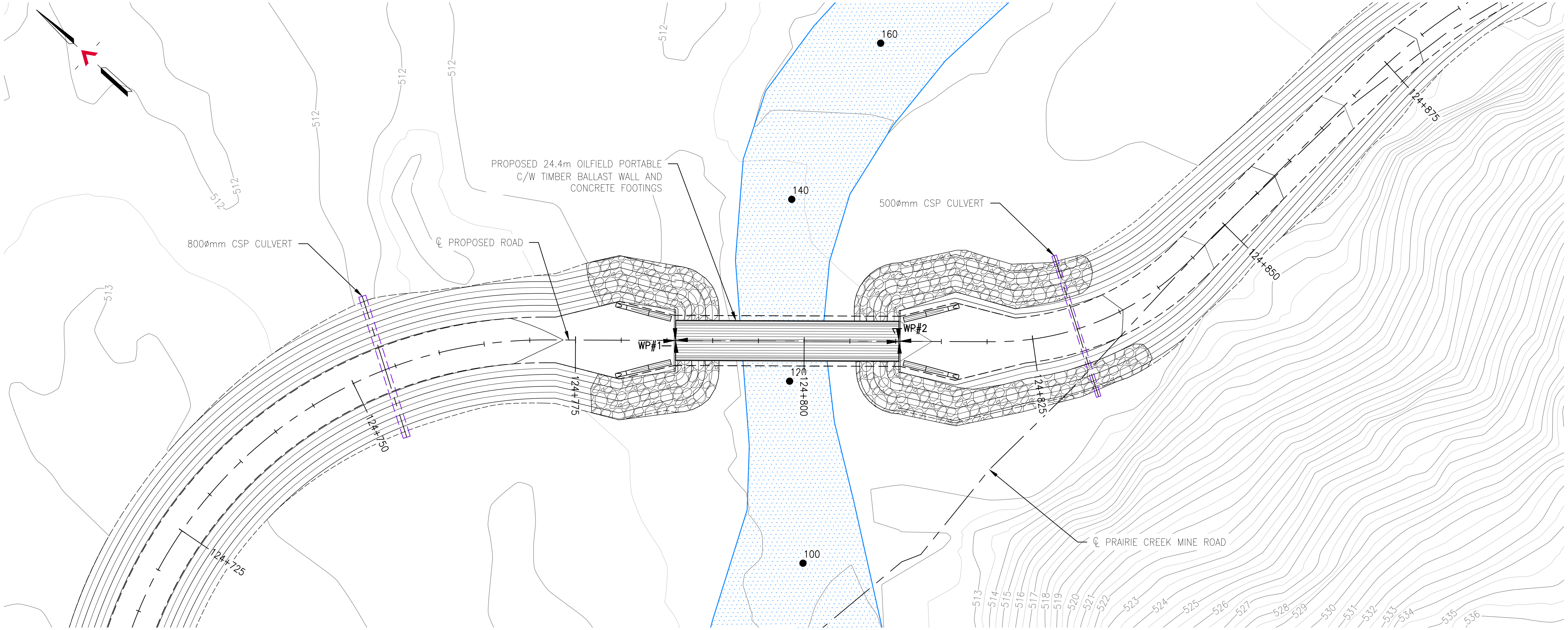
**STREAM CROSSING
UPPER GRAINGER RIVER
PRAIRIE CREEK MINE ROAD
AT STA. 124+800
OPTION 'A'**

TITLE:

**PROFILES
AND
SECTION VIEWS**

DWG NO: **15GP0091-124-1960-002** REV: **1**

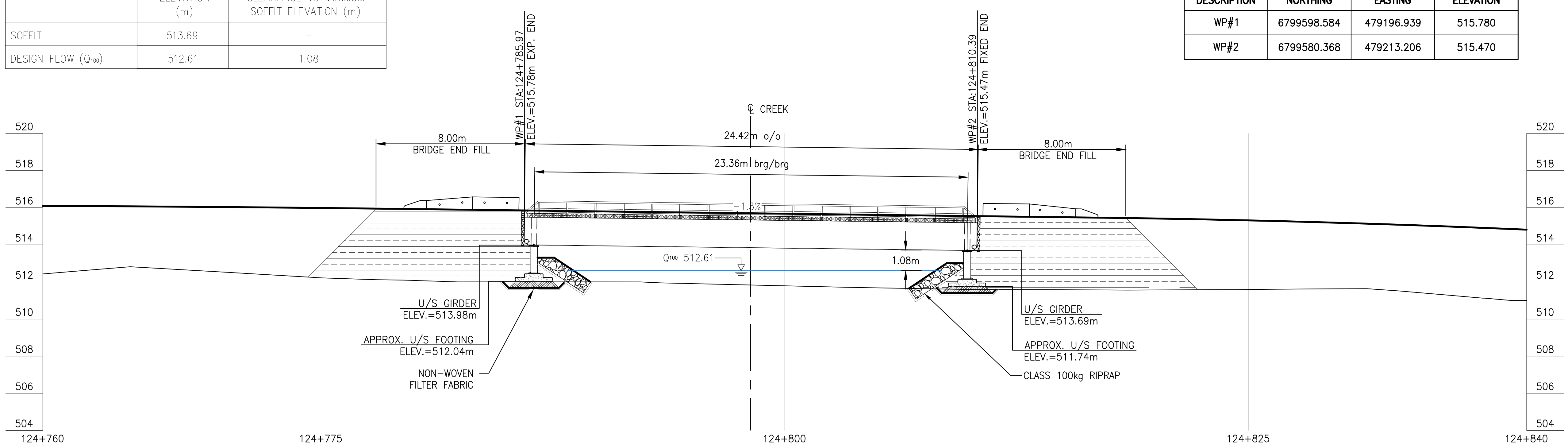
Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091\15GP0091-124-1960_124+800_Option A | Layout: 002 | Paper Size: 558.8mm x 431.8mm



GENERAL ARRANGEMENT PLAN
SCALE: 1:500

CLEARANCE INFORMATION		
	ELEVATION (m)	CLEARANCE TO MINIMUM SOFFIT ELEVATION (m)
SOFFIT	513.69	–
DESIGN FLOW (Q_{100})	512.61	1.08

SURVEY CONTROL			
DESCRIPTION	NORTHING	EASTING	ELEVATION
WP#1	6799598.584	479196.939	515.780
WP#2	6799580.368	479213.206	515.470



REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	2015/07/23	ISSUED FOR REVIEW	IHY	WBM
0	2014/02/10	ISSUED FOR REVIEW	TJB	WBM

CLIENT:
CANADIAN ZINC CORPORATION

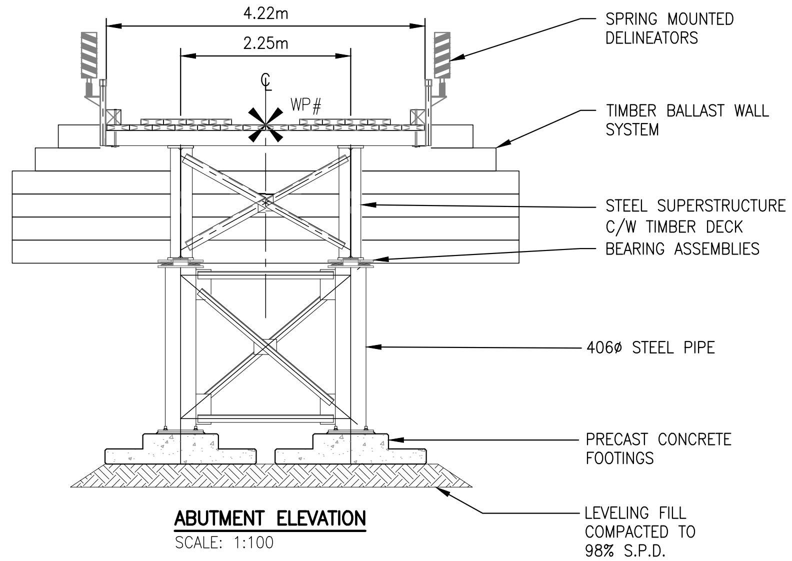
Allnorth

CLIENT NO:		DRWN: TJB	DATE: 15/02/09
PROJECT NO:	15-GP-0091	DSGN: WBM	DATE: 15/02/09
DRAWING SIZE:	ANSI "B"	CHKD:	DATE:
SCALE:	AS NOTED	APVD:	DATE:

PROJECT:
STREAM CROSSING UPPER GRAINGER RIVER PRAIRIE CREEK MINE ROAD AT STA. 124+800 OPTION 'A'

TITLE:
GENERAL ARRANGEMENT PLAN AND BRIDGE PROFILE

DWG NO: **15GP0091-124-1960-003** REV: **1**



ABUTMENT ELEVATION
SCALE: 1:100

NOTES:

1. THESE DRAWINGS ARE INTENDED FOR CONCEPTUAL PURPOSES ONLY.

2. BRIDGE STRUCTURE SHOWN ON GENERAL ARRANGEMENT PLAN AS MANUFACTURED BY RAPID-SPAN STRUCTURES LTD.

3. RIPRAP SHALL EXTEND AROUND ABUTMENTS AS SHOWN ON THE PLAN. THE RIPRAP SHALL BE CLASS 100kg. AND SHALL HAVE A MINIMUM DEPTH OF 700mm.

CLASS OF RIPRAP (kg.)	NOMINAL THICKNESS OF RIPRAP (mm)	ROCK GRADATION PERCENTAGE SMALLER THAN GIVEN ROCK MASS (kg)			APPROXIMATE AVERAGE DIMENSION (mm)		
		15%	50%	85%	15%	50%	85%
10	350	1	10	30	90	195	280
25	450	2.5	25	75	120	260	380
50	550	5	50	150	155	330	475
100	700	10	100	300	195	415	600
250	1000	25	250	750	260	565	815
500	1200	50	500	1500	330	715	1030

4. NO SITE SPECIFIC GEOTECHNICAL INVESTIGATION HAS BEEN COMPLETED AT THE SITE TO DATE. THEREFORE, THIS CONCEPTUAL DESIGN HAS BEEN PREPARED WITHOUT THE BENEFIT OF GEOTECHNICAL ADVICE. GROUND CONDITIONS MAY VARY AND THE FOUNDATION CONCEPT MAY NEED TO BE MODIFIED TO ACCOMMODATE ACTUAL SITE CONDITIONS.

5. BACK FILL OF APPROACHES SHALL GENERALLY CONFORM TO THE LINES SHOWN ON THE DRAWINGS AND SHALL BE PLACED IN LIFTS NOT EXCEEDING 305mm THICK, COMPACTED TO 95% STANDARD PROCTOR DENSITY. MATERIAL SHALL BE NON-FROZEN, CLEAN, FREE DRAINING, WELL GRADED GRANULAR FILL OF 75mm MAXIMUM SIZE. USE LIGHT MECHANICAL TAMPERS ONLY.

6. CONSTRUCTION SHALL BE CARRIED OUT IN SUCH A MANNER AS TO ENSURE WATER QUALITY IS MAINTAINED BY KEEPING SOIL EROSION AND RUN-OFF TO A MINIMUM DURING INCLEMENT WEATHER AND BY TAKING MEASURES TO PREVENT SEDIMENTATION, LEACHATE, AND CONSTRUCTION MATERIALS FROM ENTERING THE STREAM.

7. OPERATE MACHINERY IN A MANNER THAT MINIMIZES DISTURBANCE TO THE BANKS OF THE WATERCOURSE. MACHINERY IS TO ARRIVE ON SITE IN CLEAN CONDITION AND IS TO BE MAINTAINED FREE OF FLUID LEAKS. REFUEL AND SERVICE MACHINERY AT MINIMUM 100m AWAY FROM THE WATERCOURSE. ENSURE EMERGENCY SPILL KIT IS ON SITE IN CASE OF FLUID LEAKS OR SPILLS FROM MACHINERY.

8. ALL EXPOSED MINERAL SOILS MUST BE SEEDED USING AN APPROVED RECLAMATION GRASS SEED MIXTURE AND COVERED WITH AN APPROVED EROSION CONTROL BLANKET.

9. MAINTAIN EFFECTIVE SEDIMENT AND EROSION CONTROL MEASURES UNTIL COMPLETE RE-VEGETATION OF DISTURBED AREA IS ACHIEVED.

10. ENVIRONMENTAL MANAGEMENT PLAN TO BE PREPARED FOR PROJECT BY OTHERS. COMPLETION OF WORKS TO COMPLY WITH MITIGATION RECOMMENDATIONS OUTLINED IN ENVIRONMENTAL MANAGEMENT PLAN.

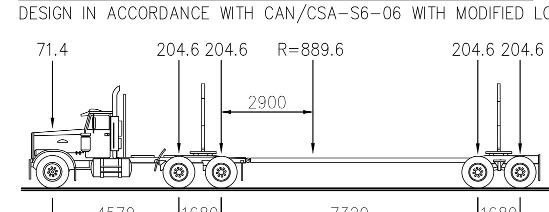
11. ALL PERMITS AND REGULATORY APPROVALS TO BE IN PLACE PRIOR TO COMMENCING WORK. INSTALLATION OF WORKS TO COMPLY WITH BEST MANAGEMENT PRACTICES.

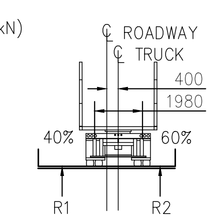
12. DESIGN SPEED OF APPROACH ROAD SHOWN IS 30 km/hr. LOCAL CHAINAGE SHOWN RELATIVE TO APPROXIMATE CENTRE OF STREAM.

13. STRUCTURE DESIGN SHALL BE COMPLETED IN ACCORDANCE WITH CAN/CSA-S6-06 CANADIAN HIGHWAY BRIDGE DESIGN CODE, WITH VARIATIONS IN THE DESIGN LOADING VEHICLE TO MEET ANTICIPATED VEHICLE LOADING.

LOADING DIAGRAM L-100 OFF HIGHWAY G.V.W. = 90 680kg:

DESIGN IN ACCORDANCE WITH CAN/CSA-S6-06 WITH MODIFIED LOADING AS FOLLOWS:





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DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
1	2015/07/23	ISSUED FOR REVIEW	IHY	WBM
0	2014/02/10	ISSUED FOR REVIEW	TJB	WBM

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:		DRWN: TJB	DATE: 15/02/09
PROJECT NO:	15-GP-0091	DSGN: WBM	DATE: 15/02/09
DRAWING SIZE:	ANSI "B"	CHKD:	DATE:
SCALE:	AS NOTED	APVD:	DATE:

PROJECT:

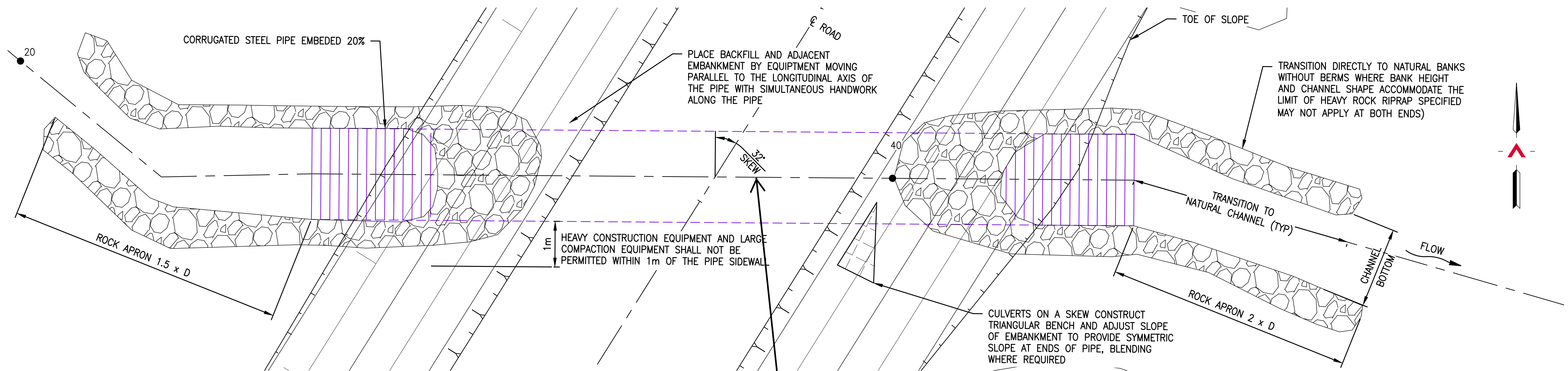
STREAM CROSSING UPPER GRAINGER RIVER PRAIRIE CREEK MINE ROAD AT STA. 124+800 OPTION 'A'

TITLE:

ABUTMENT ELEVATION AND NOTES

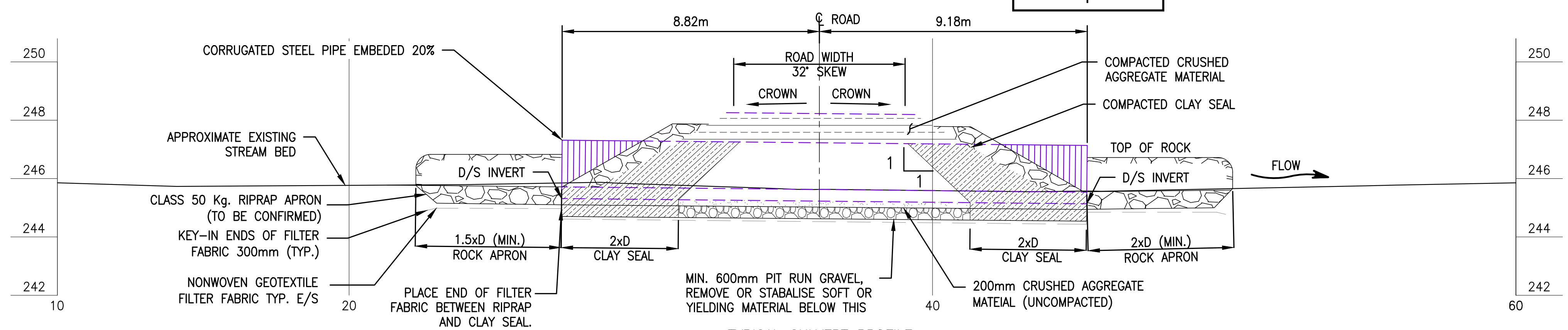
DWG NO: **15GP0091-124-1960-004** REV: **1**

Date: 2015/08/06 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production_Site Plans\15GP0091-124-1960_124+800_Option A | Layout: 004 | Paper Size: 558.8mm x 431.8mm



PLAN
SCALE: 1:100

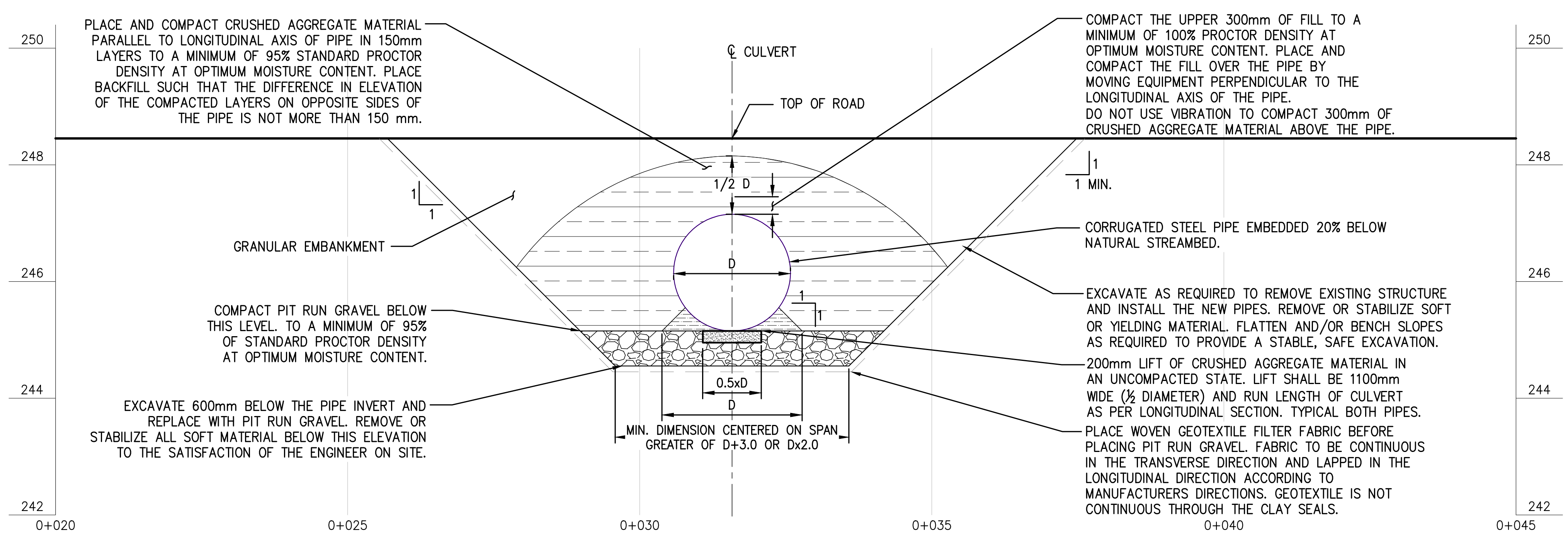
As Required



TYPICAL CULVERT PROFILE
SCALE: 1:200

NOTES:

1. THESE DRAWINGS ARE INTENDED FOR CONCEPTUAL PURPOSES ONLY.
2. CULVERT OR APPROVED EQUAL. WALL THICKNESS TO BE SPECIFIED BY CULVERT SUPPLIER.
3. RIPRAP SHALL EXTEND AROUND CULVERT INLET AND OUTLET AS SHOWN ON THE PLAN.
4. FOUNDATION, BEDDING, AND BACKFILL MATERIAL SHALL BE WELL GRADED AND FREE DRAINING AS APPROVED BY THE ENGINEER. IT SHALL NOT CONTAIN FROZEN SOIL, CHUNKS OF CLAY, OR ANY OTHER DELETERIOUS MATERIAL WITHIN 1000mm OF THE STRUCTURE.
5. MAINTAIN EFFECTIVE SEDIMENT AND EROSION CONTROL MEASURES UNTIL COMPLETE RE–VEGETATION OF DISTURBED AREA IS ACHIEVED.
6. ALL PERMITS AND REGULATORY APPROVALS TO BE IN PLACE PRIOR TO COMMENCING WORK.
7. ENVIRONMENTAL MANAGEMENT PLAN TO BE PREPARED FOR PROJECT BY OTHERS. COMPLETION OF WORKS TO COMPLY WITH MITIGATION RECOMMENDATIONS OUTLINED IN ENVIRONMENTAL MANAGEMENT PLAN.



TYPICAL CULVERT ELEVATION
SCALE: 1:100

Concept #1 D = 1400 mm CMP
Concept #2 D = 2000 mm CMP
Concept #3 D = 800 mm CMP

Concept Crossings
#1, #2, #3

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
0	2015/01/09	ISSUED FOR REVIEW	TJB	WBM

CLIENT: CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO:		DRWN: TJB	DATE: 15/01/09
PROJECT NO:	14-GP-0128	DSGN: WBM	DATE: 15/01/09
DRAWING SIZE:	ANSI "B"	CHKD: -	DATE:
SCALE:	AS NOTED	APVD:	DATE:

PROJECT:
TYPICAL CULVERT CROSSING

TITLE:
TYPICAL CULVERT PLAN, PROFILE AND ELEVATION

DWG NO: **14GP0128-TYP-1960-001** REV: **0**

Appendix C Operational Management Plans

BORROW PIT MANAGEMENT AND RECLAMATION PLAN

Prairie Creek Mine Access Road

1 BACKGROUND

Canadian Zinc Corporation (CZN) is seeking to begin operation of the Prairie Creek Mine located in the south west corner of the Northwest Territories approximately 555 kilometers west of Yellowknife, 330 kilometres north of Fort Nelson, B.C.

The “Prairie Creek Mine Access Road” is a 184 km proposed route connecting the mine site to Highway 7 near the community of Nahanni Butte. The construction of this all season access road will require borrow material from defined locations to support the construction of road subgrade, running surface, road protection and stabilization, stream protection and stabilization, operational areas such as camps, load-outs, airstrip, and bridge construction. Borrow material will also be required for long term road maintenance, such as sanding, and required minor road upgrades and repairs.

To date, the original alignment contains a total of 82 borrow locations identified with 28 locations listed as back-up locations or if the alternate alignment is selected, 86 borrow locations identified, with 30 locations listed as back-up locations. This would include all types of borrow, clay/silt/sand for subgrade, aggregate for subgrade or running surface, or rock quarry to serve as subgrade, road surfacing (crushing required), or road/stream stabilization or protection. The borrow areas have been defined with limited sample data collected. A detailed site evaluation, including improved sampling, will be conducted to select the appropriate borrow location, and quantify borrow area/volume. A “Detailed Borrow Site Plan and Design” (DBSPD) would be completed on those sites selected for borrow location.

2 SCOPE

This plan is intended to provide general management guidelines and approaches to develop, extract, and reclaim all borrow sources located “outside” the prescribed road right of way clearing. It will include all areas disturbed outside of this right of way, including access roads for borrow material. Borrow material extraction within the road right of way is addressed in a companion document titled “Road Construction and Maintenance Plan”.

A “Detailed Borrow Site Plan and Design” (DBSPD) would be completed for each selected borrow location. This site specific, detailed design would provide any unique directions in regards to development, extraction, and reclamation on a site by site basis, and would reflect the following:

- Buffer strips or zones between borrow and riparian zones of water bodies.
- Surface water runoff from the borrow site cannot directly enter a natural water body. Water will be directed away and be allowed to naturally filter through forested areas or bogs to minimize soil erosion. If surface water cannot be directed away from the water body, then appropriate

water settling structures, capable of handling the water quantity, must be installed to allow natural settling and filtering of the water.

- Re-direct all surface water away from the borrow location to prevent surface water entering, and ponding, in the borrow area.
- Slope stability, with final contouring and shaping.
- The presence, quantity, and extent of permafrost and/or ice rich soils.
- Nature and location of any required access roads.

3 RESPONSIBILITY AND AUTHORITY

CZN will have final ownership of the access road and supporting infrastructure and will have responsibility and authority to enact, and delegate, this plan. As the project progresses and contractors are established, CZN will direct and forward responsibilities, as required. CZN will ensure, either directly or via delegated authority, that all conditions of regulatory permits are met.

4 STRIPPING AND GRUBBING

Prior to initial stripping, the borrow area shall be clearly defined and field marked. The site will be inspected jointly with CZN's designated environmental monitor (EM), road construction foreman, and equipment operator(s) working on the site. The EM will clearly review with the road construction crew the DBSPD specifically for that site identifying all concerns and unique situations relating to that site. This would include all necessary precautions regarding surface water management, sedimentation, and erosion protection. Depending on the season of activity, unique seasonal precautionary measures may be required, such as a nesting bird survey during spring/early summer. However, the EM will be responsible for addressing these measures and giving the construction foreman the 'all clear' before work commences. Necessary procedures and plans will be made available to all parties; check lists will be marked and signed off. Stripping and grubbing will then proceed when all aspects of the DBSPD have been formally reviewed.

The Stripping and Grubbing process would implement the following:

- The DBSPD would identify a prescribed area designated for temporary storage of stripped material. Stripped material would include all material not useable for road construction which includes organic top soil, woody material, roots, un-useable mineral soils, and ice rich soils. If topsoil and organic material are in sufficient quantity, they will be stored separately.
- The prescribed area to store stripped material would be located to allow access for future reclamation activities.
- All prescribed precautionary measures would be taken, such as installation of silt fences and settling arrangements. These measures may not be required during winter borrow development, but must be in place if the borrow and/or stored material will remain after winter.

- Equipment operators must be familiar in identifying various types of stripping material, and actively sort and separate organic top soils, large woody debris, un-useable mineral soils, and ice rich soils.
- Following the completion of stripping, all piles will be secured properly for erosion/sedimentation protection, surface water management including water bars and ditches if required. If borrows are developed in winter, only those piles that will remain after winter need be secured. Borrow sources identified as permanent will require additional, long term stabilization and protection measures for the stripped waste piles to ensure long term future reclamation access. These measures would be defined in the DBSPD.
- All attempts will be made to only clear sufficient area to meet road construction obligations and expand the borrow size as required. This is particularly important with larger borrow locations to avoid a greater disturbed area than what was initially intended and required to meet construction requirements.

It is important to note that borrow sources located in mountainous areas may have very thin top soils with small diameter trees and shrubs, and may not produce large stripped volumes. Limited stripped volume may limit the options available for future borrow site reclamation.

5 TEMPORARY VS PERMANENT BORROW SOURCES

The borrow pits would be defined as temporary or permanent. The majority of borrow sources would be temporary, generally utilized for construction only and being active for up to 3 years. Reclamation would follow after the pit is declared inactive and when site conditions allow.

Permanent sources would include those sources primarily utilized for future road repairs and improvements, road surfacing, winter sanding operations, and rock quarries for future rip rap, stream and road armoring. In the selection process, the permanent borrow sources would preferably be located within close proximity to the main access road, however limited availability of suitable borrow, particularly in the eastern half of the road, may dictate the selected permanent borrow sources. The timing of reclamation of permanent borrow sites will be based on long term future demand and available volume. Reclamation of these sites will occur within 1 year of being considered “not needed”, or otherwise as part of the final reclamation of the main access road.

6 FROZEN SOILS / PERMAFROST / ICE RICH SOILS

Given the location of the project, either frozen soils and/or permafrost conditions may be encountered. Investigations prior to the DBSPD should detect and identify most permafrost/ice rich conditions, and would be part of the selection of borrow locations and description of appropriate measures if selected. Borrow sites with significant permafrost/ice rich would only be utilized if no other reasonable source is available. If these locations are utilized, the following would be implemented:

- Small concentrations or volumes could be removed and stored with (but separated from) the stripping and grubbing pile. The material would then be restored during the reclamation process.

- Larger concentrations or volumes with permafrost/ice rich material would be stockpiled to allow the natural thawing, water drainage, and drying process to occur over time until the material can be utilized in the road structure. Additional measures will be taken to manage the thawing process which would include using either a well drained base underneath the stockpile to aid the draining process, or provision for management of seepage, sediment and the potential for sloughing.
- Borrow sources with permafrost will have additional un-disturbed clearance defined around the perimeter to account for potential future settling and slumping.
- Water ponding in and around the permafrost will be avoided as it tends to accelerate the thawing process.
- Buffer strips between external borrow sources and the road right of way will be maintained, as necessary, to allow natural settling to occur without degrading the road structure.

7 ARD AND HIGH SULPHUR CONTENT SHALE

The potential for acid rock drainage (ARD) material or high sulphur content shale will be further assessed as part of borrow site investigation, although the potential is considered to be low given the current knowledge of local geology. Any suspect material on visual examination will be subject to testing. Depending on results, the site will be rejected or a specific material management plan developed, such as separate storage of material for later placement at the bottom of the pit during reclamation. The same approach applies if such material is not found during the initial investigation, but is subsequently suspected during pit development.

8 ACCESS ROADS

The majority of identified borrow is within close proximity to the proposed road right of way. Short access roads (<100m) may be required to access borrow volume, and the disturbed area is included in the defined area. A total of 12 borrow sites may require access roads outside the defined borrow area.

The following standards will apply to access roads connecting borrow locations to the road right of way:

- Running surface width of 3.5m and 15m wide right of way clearing.
- Ditching only as required for temporary borrow sources. Permanent access roads will be ditched as required to maintain natural drainage patterns.
- Pullouts only as required to maintain equipment productivity
- When possible, winter access roads will be constructed (snow and ice) to avoid additional stripping.
- Stripped material will be placed to one side, typically the lower side, to be available for future reclamation.

- Standard operating procedures would be followed for any stream crossing. Winter access only would utilize ice/snowfill, and permanent roads would require similar crossing approaches as applied on the main access road. Based on the pit access roads as presently defined, all but one avoids any significant stream. BP 47A & B requires a stream crossing

9 WASTE AREAS

The same practices and procedures utilized for borrow extraction will be applied to any waste areas. Following stripping and grubbing, waste material will be deposed of within the prescribed area and compacted as required to ensure future stability. The final waste pile will be contoured and shaped to fit the site location with preferably 3:1 slopes (minimum 2:1 for fine material, steeper for coarse rock material).

The road construction process may generate some natural material undesirable for construction, either woody debris, timber volume, or stripped overburden which cannot be disposed of within the existing road right of way. If this situation is encountered, this material maybe wasted in a nearby, suitable disturbed area such as a depleted borrow location. The standard reclamation approach would be followed.

10 ROCK QUARRIES

A number of rock quarry pits have been identified for the project. The characteristics of most rock quarries will not allow the normal shaping, contouring, and reclamation approach as other borrow sources. As rock quarries become depleted or decommissioned, the rock face would be left in a stable condition. Proper signage would be placed at any entry points to those quarries which have a significant risk related to rock stability or rock fall. Additional measures will be developed if the pit constitutes a hazard to humans or wildlife. Access roads will be deactivated to discourage entry.

11 RECLAMATION

The reclamation of all borrow and waste areas is required to enhance the natural re-vegetative process and help establish a stable ecosystem. The goal of reclamation is to enable the disturbed area to return to productive use in the context of the surrounding area. The reclamation process will re-vegetate and restore temporarily disturbed areas in a manner that is environmentally sound; will reduce erosion and transport of sediment-laden water; and is consistent with sustainable development. The primary areas that will require reclamation are the borrow/waste pits and their temporary access roads.

CZN will ensure that the onsite reclamation activities include but are not limited to the following:

- Temporary support facilities and camp infrastructure, including buildings, equipment, surplus construction materials and wastes from the work site(s), will be removed and subsequently re-used or disposed of in appropriately authorized facilities.
- Excavations (if any) will be backfilled i.e. excavations other than the borrow pits.

- Topsoil will be salvaged and stored where possible and warranted for later use in reclamation.
- Equipment operators will be trained on how to identify and separate surface soil from subsoil.
- Salvaged soils will be protected, as necessary, for future use in reclamation/restoration activities.
- Stockpiled soils will be located and flagged during periods of longer storage so they will not be disturbed until required for reclamation. Stability and the appropriateness of storage areas will be considered if the volume of soil is large. In any event, stockpiled soils will be stored to prevent erosion.
- Coarse woody debris, if available, may be used for erosion protection.
- During clearing and grubbing of new borrow pits, large woody debris and suitable snags will be stockpiled separately for potential later use during reclamation. Other organic material will be stripped and stockpiled within the Project area
- During reclamation, any stockpiled organic material will be utilized in the best way to achieve reclamation objectives.
- Any surplus material disposed of into new or existing borrow pits will be done as follows:
  i. Surplus material will preferably not be used as top dressing during final re-contouring.
  ii. Surplus material will not be placed so as to 'contaminate' stockpiled organic material.
  iii. If a berm is required to store surplus material in excess of what can be placed to fill extracted depressions, the berm will be installed on the road side of the borrow pit, where possible.
- Sites will be graded and re-contoured to blend with adjacent areas, as much as possible. The original drainage patterns will be re-established as much as possible, but additional water flow will not be directed into the borrow area. Water bars are to be installed as required to maintain natural drainage patterns.
- Borrow pit banks will be re-contoured to preferably no steeper than 3 horizontal to 1 vertical ratio (minimum 2:1, except rock quarry pits) to allow larger animals to safely enter and exit the pit, and to promote the establishment of emergent vegetation.
- Soils in areas that have been compacted by traffic from heavy equipment or other vehicles will be ripped or scarified to reduce surface compaction (especially on the borrow pit access roads).
- Re-vegetation will be accomplished through natural regeneration.

12 INSPECTION AND MONTIORING

An inspection and monitoring program will be established starting when the first material is stripped from the site until the site has stabilized after reclamation. Disturbed areas utilized for borrow would be considered stable when, under normal conditions:

- re-vegetation is occurring, consistent with the local area.
- surface water is being contained and managed with no significant erosion or sedimentation.
- no slope or soil stability issues exist.

The time required for stability would vary on a site by site basis. During road construction, an Environmental Monitor would be onsite monitoring all activities, including borrow pit development and operation. Periodic environmental monitoring of reclamation will also occur at a frequency dependent on reclamation progress.

On completion of access road construction, responsibility for the condition of the road and related facilities would shift from the construction foreman to the Road Operations Manager. He would be responsible to coordinate as required inspections of borrow sites not yet classified as stable.

13 REVISION HISTORY

Rev.#	Date of Issue	Reviewed By	Approved By	Description
1	2015 Aug 31	EK		Initial Guide

SEDIMENT AND EROSION CONTROL PLAN

Prairie Creek Mine Access Road

1 BACKGROUND

Canadian Zinc Corporation (CZN) is seeking to begin operation of the Prairie Creek Mine located in the south west corner of the Northwest Territories approximately 555 kilometers west of Yellowknife, 330 kilometres north of Fort Nelson, B.C. The “Prairie Creek Mine Access Road” is a 184 km proposed route connecting the mine site to Highway 7 near the community of Nahanni Butte.

The Sediment and Erosion Control Plan (SECP) is an integral component of environmental management for the Prairie Creek Mine Access Road. The primary goal of the SECP during road construction activities is to minimize downstream impacts to water quality, fish, and fish habitat from sedimentation. Installation of new culverts and construction in the vicinity of watercourses has the potential to result in sediment releases if the work is not completed using effective prevention and control measures. Increased surface runoff as a result of development due to lack of vegetation, filtration, and ponding, and the loose condition of disturbed soils can lead to increased downslope transport of soils by the runoff. Even after the replacement and compaction of slopes and surfaces, soil erosion and gulley formation can occur (DFO 1993).

Over the longer term, erosion associated with grubbing, stripping, culvert and bridge installation, road improvements, reclamation activities, construction work near water and/or erosion from excavations at the borrow sites could potentially impact sediment and drainage. Increased sedimentation can displace fish from prime habitat into less suitable areas. In addition, the potential exists for chronic erosion and sediment generation if there is poor drainage management and unsuccessful re-vegetation and/or stabilization of the disturbed areas that are near watercourses, including the temporary access roads to borrow areas.

The seasons associated with the highest potential for erosion and sediment are spring and summer after the surface has thawed and with the onset of intense rain events on the disturbed areas. Poor winter construction methods, with respect to soil or sediment management, will likely result in erosion and sediment control issues during spring and summer. Hence, it is very important to implement the erosion and sediment control mitigation methods prior to, and during, construction activities.

2 SCOPE

This plan is intended to provide general management guidelines and approach to manage sediment and erosion control measures to be applied to ensure water quality protection related to road infrastructure and slope stability. This plan will be applied to all activities related to the construction and operation of the Prairie Creek Mine Access Road.

Many of the approaches within this guide are also contained in the companion documents Borrow Management and Reclamation Plan, Road Operations Plan, and Road Closure and Reclamation Plan. Approximately 85 kilometres of the road system is located within the recently expanded Nahanni National Park Reserve (NNPR).

3 RESPONSIBILITY AND AUTHORITY

CZN will have responsibility and authority to enact this plan. CZN will designate an Environmental Monitor (EM) to monitor and support the SECP from initial clearing to the final completion of access road construction. As the project progresses and contractors are established, CZN will delegate responsibilities as required.

4 EROSION AND SEDIMENT CONTROL METHODS

Soil disturbance is inevitable for most road construction activities. A variety of techniques are available to control erosion and sediment and each one is specifically tailored to the existing environmental conditions.

As the Prairie Creek Mine Access Road will be constructed over a number of years, segments will be built in stages. The post construction measures would be applied concurrently as road construction progresses.

4.1 Special Erosion Protection Areas

Special Erosion Protection Areas (SEPA) is characterized by poor soil types, unstable areas, poor drainage, standing water, and/or drainage flowing directly into fish-bearing streams. Special Erosion Protection Areas (SEPA) could also include wetland complex's, and bridge and culvert crossings of fish bearing channels. Prior to commencement of construction activities within these identified areas, CZN, the EM and the construction contractor will formulate an action plan which would:

1. Identify all critical areas or concerns and apply practical approaches to mitigate or minimize the potential risk(s).
2. Ensure the equipment and operators are suitable for the task, and operators are briefed on the action plan.

The final road location and design would specifically identify the SEPA.

4.2 Clearing and Grubbing

Clearing, grubbing, and site preparations leading to the storage and disposal of construction wastes, overburden, soil, or other substances will be managed to minimize the potential for entry into any streams or watercourses, using the following approaches:

a. No materials will be stockpiled within 15 metres of the top of bank of any defined watercourse or wetland.

b. Soil stockpiles will be sloped to minimize erosion, wherever possible. In difficult locations where an unstable stockpiles is close to a watercourse, a berm around the perimeter to prevent unwanted displacement of material may be considered.

4.3 Riparian Areas

To date, 102 major and minor stream crossings have been identified along the 184 km access road. Developmental processes including grubbing and stripping, road subgrade construction, bridge/culvert installation, road surfacing, and borrow pit development/extraction will follow these recommendations to minimize erosion and sediment releases:

- Construction activities will be assessed during periods of heavy rain and runoff. If appropriate measures cannot be implemented to minimize sediment production, construction will be temporarily suspended.
- Runoff will be diverted away from cleared areas.
- Silt or filter fences will be installed on the lower perimeter of slopes (i.e. lower 1/3 to 1/2 of the site) and areas where the erosion and sediment production potential is high and/or it is desirable to contain waterborne movement of eroded soils unless local vegetation is an ineffective filter. Such areas include the bottom of cut or fill slopes, material stockpiles and disturbed natural areas.
- To control sediment close to its source of production, there are a number of installations that can be considered to stop the migration of eroded soils. These installations include gravel berms, small silt fences, check dams, turf reinforced mats, and local organic based berm structures. The number and spacing of these installations will depend on the nature of the construction operations.
- Fill brought to the Project site will be managed properly to prevent soil erosion and/or sediment in runoff. Mitigation methods to be considered for fill stockpiles include silt fences, gravel berms, check dams, local organic based berm structures and/or geotextile fabric covering, as necessary.
- Equipment used for site preparation, construction, installation of culverts will operate outside the wetted channel from the top of the bank or in a dry stream channel.
- The disturbance to existing vegetation in the riparian zones will be minimized.
- All areas with steep slopes will be reviewed closely prior to stripping to ensure that accurate work limits are established.
- Clearing and grubbing activity and road subgrade construction will work concurrently. Clearing and grubbing activity will preferably not significantly outpace the road subgrade construction so to avoid the unnecessary exposure of large, disturbed areas for significant periods of time.
- Erosion control devices will be inspected regularly, as needed (see Section 7 Monitoring).
- Culvert inlets and outlets will incorporate measures to protect the structure and the stream channel against erosion and scour.
- If debris cannot safely pass, provision will be made to prevent the entrance of debris into the culvert.

- The installation, maintenance, or removal of a culvert will not destabilize the stream channel.
- The culvert and its approach roads will not produce a backwater effect or increase the head of the stream, unless this is provided for in the road profile for flood events.
- The culvert will be installed in a way that will permit the removal of obstacles and debris within the culvert and at the culvert ends.
- Where possible, the stream channel, located outside the cleared width will not be altered.
- Embankment fill materials will not encroach on culvert inlets and outlets.
- Where possible and if necessary, construction within riparian areas (i.e., 15 m from the top of a bank) of any existing watercourse or wetland will be conducted in favorable weather and low-water conditions, and according to project regulatory approvals.
- Machinery on land will be operated above the high-water mark in a manner that minimizes disturbance to the banks of watercourses, unless work in braided alluvial floodplains is required, in which case machinery will avoid normally active channels.
- For stream crossings which contain local fine grain soils (fine sands, silts, clay), cut and fill slopes influencing the riparian zone will suitably stabilized to manage sedimentation using erosion control techniques.

4.4 Borrow Areas

Significant release of sediments to drainage systems and receiving waters can be caused by development of borrow areas and the temporary roads leading to them. To minimize the potential impacts, the construction activities at or near the borrow areas will incorporate the following mitigations:

- Construction site access roads will be restricted in number and to locations that will serve as permanent access after development (if required).
- Borrow pit access roads will be constructed prior to site area development, and in a manner that will prevent the loosening of native subsoil.
- Non winter borrow pit access roads will be constructed or topped with a suitable coarse granular material with a minimum of fines and clays. Wood wastes, such as hog fuel, sawdust, and wood chips, are not acceptable for the construction of borrow pit access roads because of the potential release of leachate.
- Before materials are removed from the borrow areas, surface water will be suitably diverted around the operating area. Drainage will be controlled throughout the borrow operations to prevent natural drainage and surface runoff from carrying sediment into the surrounding watercourses.
- Runoff from borrow pit access roads will be collected via interceptor ditches or swales, as necessary. If necessary, these flows will be routed to settling areas, or ponds, to allow the settling of sediments before release to the wider environment.

- Transport of excavated materials from the borrow areas will limit spillage on adjacent road surfaces and dropping of loose soils in the form of dust or mud from wheels, tracks and undercarriages of equipment.

4.5 Stream Crossings

Potentially, a total of 14 bridges will be constructed, including some larger clear-spans and multi-spans. Also, numerous large diameter culverts will be installed on the 184 km access road. The following is the erosion and sediment control mitigation methods to be applied:

- The bridge and its approach roads will not produce a back-water effect or increase the head in the stream.
- Where possible, schedule sensitive construction activities during optimum weather seasons, excluding the spring thaw period. While freshets can be small and brief, there is also the possibility of intense summer storms. Fish spawning windows must also be accounted for, which is spring for most of the road, but early fall for Prairie and Funeral.
- Pre-work meetings with all individuals involved with the construction will be held on-site prior to the construction phase of the project. These meetings include two components. The first is to review all environmental requirements, what erosion, sediment and runoff control measures are to be used, and during which phase of construction, where and in what form such measures are to be employed. The second component is to review any mitigation measures outlined by the regulatory agencies
- Equipment crossing open surface water will be avoided. If a crossing is unavoidable, it will be limited to a one time crossing (over and back)to gain equipment access to oppose side and can only be considered if the stream depth and bottom material is acceptable to support such a crossing not to create significant stream bed damage. Otherwise, an alternative must be applied.
- Equipment used for construction, including site preparation and maintenance of bridges, will be situated either in a dry stream channel or on top of the bank.
- Isolation of the stream area is required for keying in riprap or other in-stream works if the area is not frozen. In-stream isolation is to prevent disturbed, turbid water from being released. Water pumps can be used to draw turbid water from the work area and discharge to a well vegetated area or a settling basin away from the stream. Alternatively, the turbid water can be allowed to clear after the work is complete before removing the isolation. An inspection for fish inside the isolated area and possible salvage may need to be completed prior to commencement of work.
- Wherever possible, damage to vegetation on the banks of the creek and the approaches to the worksite should be avoided. Unconsolidated material resulting from clearing or brought in as fill must be stockpiled in areas where surface runoff from such material cannot lead to sedimentation of the watercourse. Silt fences or filtration aids must be deployed as necessary, before starting work, in areas of the work site where there is potential for surface run-off to entrain and transport sediments to the channel (e.g. road fill slopes).

- Any damage to the banks must be re-contoured. The crossings must be inspected to ensure any exposed mineral soils are stable and beginning to re-vegetate.

4.6 Schedule work to Minimize Risk of Potential Erosion

Construction activities will generally not be scheduled during spring. Winter, summer and fall are preferred. Work will be temporarily suspended during periods of heavy or persistent rainfall if they could result in sediment delivery to a stream. However, work may still be possible in spring since freshets can sometimes be brief and weather conditions favourable for construction, as was the case in 2015.

4.6.1 Seasonal / Adverse Weather Shutdowns

As the construction is scheduled over a period of several years, the operations will likely experience seasonal shut downs and/or unavoidable adverse weather shutdowns. It is important to apply additional protection procedures and measures during these periods when generally the disturbed areas are at greatest risk of exposure and the majority, if not all, of the road construction personnel are not on site and therefore cannot readily respond to a problem or situation. The following will be implemented:

- Plan seasonal shutdowns accordingly. Only clear sufficient right of way, including stripping and grubbing, to fulfill the scheduled subgrade construction.
- Plan and schedule known challenging construction sections, particularly wet sites and significant stream crossings during suitable weather conditions.
- Ensure completion is attainable within the available operating window.
- Plan all erosion and sedimentation measures that require placement/installation when crews/equipment are available prior to a shut down and implement accordingly.
- Ensure all natural drainages and streams are fully functioning.
- Anticipate problem areas and ensure sufficient supplies of material and resources within proximity to respond. (Example silt fencing, erosion mats, etc.)
- Restrict access to road structures vulnerable to vehicle damage during these periods.
- Ensure equipment is properly stored at acceptable locations, so as to not adversely damage road structure or create avoidable disturbance when operations return.
- When unavoidable adverse weather impacts the project, construction crews are to make necessary corrective action to stabilize the site and to avoid additional sedimentation or erosion impacts prior to the evacuation of the site.
- Ongoing EM and/or Contractor inspections will continue during periods of inactivity to enable corrective planning and/or action to be implemented, if required.

5 RUNOFF CONTROL

Construction-phase erosion and sediment control will focus on managing surface drainage patterns and minimizing the potential to adversely affect water quality in streams and drainages. Runoff control reduces the erosive energy of runoff and/or conveys it using non-erodible surfaces.

Where spawning areas are situated in the receiving waters, the runoff water will not, at any time, increase the level of suspended solids significantly above the background level in the receiving waters. Background suspended solids levels are the natural in-stream suspended solids. Sediment-bearing water will be conveyed away from streams and drainages during construction.

Runoff control can be achieved by establishing a number of temporary or permanent structures such as slope breaks, check dams, and various kinds of swales and bars. Generally, runoff control will incorporate the following measures:

- To minimize erosion and sediment deposition, catchment area will be controlled by planning construction activities according to the topography surrounding the drainage.
- A clean water diversion swale to keep clean water out of a disturbed area may be employed, together with a perimeter ditch/dike system to channel dirty water to an on-site sediment control area.
- For a large disturbed area, the site may be divided internally into smaller catchment areas (<2 Ha) to avoid concentrating large volumes of runoff water.
- Water in each catchment area will be isolated from another.
- Each catchment area will be graded to encourage rainfall to remain dispersed and prevent gullying.
- Water bars or cross ditches will be installed to direct road surface runoff away from the access road in a safe manner and, where required, appropriately sized culverts, to reduce road failure through erosion, will be installed. Runoff would be directed to areas for settling.

Slope breaks may be used to reduce the effective length of slopes. Slope breaks are terraces with diversion swales or dykes, which collect sheet runoff from a catchment area and direct it to a slope drainpipe or other drop structure. Diversion swales will be gently sloping, and may include check dams, rock lining, or grass linking depending on the soil types and slope.

Check dams are small barriers placed across a swale or ditch. They reduce the effective slope of the channel decreasing water velocity and allowing for sediment to settle. Some general recommendations for check dams include the following:

- Steeper swales (>5% in stable soils) require check dams to slow velocity and reduce channel erosion (sediment capture is a secondary function).
- Check dams made from drain rock with a finer material core and coarse drain rock surfacing. Silt fence structures will be used for low energy flows, not in channels.

- A flat pool of water between dams will be created. The base elevation of a check dam should preferably be the same level as the top of the check dam below.

Rock channel lining is an armouring technique to prevent channel bed erosion. When implementing a rock channel lining system, the following recommendations will be followed:

- Channels with runoff velocities >2 m per second will be considered for rock-lining.
- The channel base will be armored with rock graded from small to large sizes that is free of silt, overburden, or other substances deleterious to fish.
- Where riprap is not available, fabric linings/geotextile can be used.
- A mix of sizes of rock pieces will be determined according to the volume and design velocity of the channel.
- The toe of rock riprap at channel drops will be trenched (keyed) in.

Groundwater control will prevent water ponding and flooding. The following recommendations are made for groundwater control:

- Areas of sand or silt soils with groundwater seepage are highly susceptible to erosion and shallow sloughing. Perforated drains can be installed to intercept the groundwater before it surfaces.
- Alternatively, a surface applied drainage blanket of riprap can stabilize the slope. Seek engineering advice for proper design.

Energy dissipaters are precast concrete structures or riprap/geotextile solutions (rock aprons). Energy dissipaters can be installed at the outfall of pipes or high-velocity channels. Energy dissipaters will reduce runoff velocities to less than 2 m per second, and will disperse the runoff.

6 EROSION CONTROL

6.1 Pre-Construction/ Construction Phase

Source erosion control stops erosion before it starts, by keeping soil from being displaced at the outset. Source erosion control is less expensive than other types of controls. A key to success is minimizing the exposure of uncovered soil to rainfall, running water or wind. During construction, temporary erosion control practices will include (but not be limited to):

- Existing trees, shrubs, and grasses or other vegetation will be retained wherever possible, as they are the best and lowest cost erosion protection.
- If clearing must be performed, hold back grubbing of tree roots if possible until grading is to proceed. The root masses and ground cover can provide substantial erosion control.
- Clean water diversion will ensure that water from undisturbed areas does not pick up deleterious particles from construction areas. Following are some general recommendations for clean water diversions:

- A diversion swale can be installed above graded areas to direct clean water from undisturbed areas away from the grading activity.
- Gentle swale grades (1%) are preferred in erodible material, or erosion control lining can be installed in the swale.
- A rock apron can be placed to disperse swale runoff into vegetated areas of the property, or a slope drainpipe can be used, if necessary, to transport clean water to below the construction site.

Minimizing areas of disturbance will consequently minimize the amount of disturbed material to be transported by runoff. Clear only those areas of the site that must be graded in the current phase of development. Leave vegetated areas in place as long as possible to reduce erosion. On larger sites, complete grading and erosion control in one area before opening another.

Proper slope design will prevent gullying by adjusting the slope grade and the velocity at which runoff will travel. Some general recommendations for proper slope design are included below:

- Soil, runoff, and groundwater conditions will be recognized when designing slopes. Saturated sand and silt soils are highly erodible.
- Erodible soil types with slopes greater than 2:1 are to be avoided.
- Slope lengths over 30 m between slope breaks are to be avoided.
- “Sheet” drainage will be encouraged for avoiding concentrated water flow down unarmoured slopes.

Surface roughening slows runoff and encourages infiltration, which then promotes germination and plant survival. Some general recommendations include:

- The surface of graded areas will be left rough across the slope.
- Roughening can be created by machine tracking.
- A surface layer of topsoil or coarse organics can reduce the erodibility of high-risk soils like sand and silts.
- For stability, placed material should be compact prior to surface roughening.

6.2 Post Construction

Following the construction of road subgrade or installation of stream crossing structures, it is important to stabilize exposed soils for long term erosion protection and implement sediment control (i.e. silt fencing) until re-vegetation has occurred. This is particularly important in riparian areas, sites containing fine soil types, and/or wet/saturated unstable soils. Some general recommendations include:

- Immediately following construction activities, disperse/spread available stockpiled organics and top soil over exposed cut/fill slopes. The use of large woody debris or mulched woody debris could also be placed on slope. This would assist to stabilize the slope and promote the re-establishment of vegetation.
- Cover larger cut/fill slopes with gravel base material with non-erodible properties.

7 MONITORING

7.1 Pre-Construction/Construction Phase

The pre-construction/construction phase will extend from initial mobilization of equipment and crew to the site until all road construction activities have completed and the road is operational.

All stream crossings and sediment control structures require inspection and maintenance. The Environmental Monitor (EM), under the direction of CZN, is responsible to inspect, record, and report on findings. CZN will notify and direct the contractor regarding items to maintain compliance of the SECP. The EM will complete a Daily Environmental Monitoring Report to ensure that the erosion and sediment control recommendations are being followed. The following are recommendations for the monitoring and maintenance activities associated with the SECP:

- The frequency of inspections will be commensurate with the risk of damage to structures from major storm or runoff events
- Ongoing inspection and maintenance of stream crossings and control structures will be conducted on a regular basis to ensure that they:
  a. protect fish and fish habitat;
  b. maintain safe fish passage; and
  c. reduce the risk of releasing sediment or other deleterious substances.
- At a minimum the erosion and sediment control installations will be inspected every 7 days and following a rain storm or snow melt event. Within riparian areas, these structures will be inspected on a daily basis while adjacent to active construction zone. These facilities will be maintained until construction is completed and the affected areas are sufficiently stabilized and re-vegetated so there is minimal risk of erosion or sedimentation at the site as a result of construction activities.
- Turbidity measurements should be taken during inspections. Additional erosion and sediment control features will be installed at any crossing where monitoring identifies a significant increase in turbidity above natural background levels. CCME numerical guidelines for turbidity will be used to identify reasonable management triggers (CCME 2002). A suitable trigger will also be specified for the collection of a water sample for total suspended sediments (TSS) analysis.
- Erosion and sediment control measures, such as plastic sheeting and silt fencing, when it is no longer required, will be removed, as determined by the EM.
- Sediment and debris accumulating in the erosion and sediment control structures will be removed by the contractor and disposed of in an environmentally acceptable manner. The silt fences will be cleaned when the sediment accumulates to a depth of greater than 30 cm along any portion of the structure.
- All fish-bearing stream crossings will be marked on a map or electronic database and provided to the contractor who should have it available in the field.

- If inspection reveals ongoing maintenance problems, then consideration will be given to modifications of the structure to meet objectives.
- A surplus of erosion and sediment control materials, spill kits, pumps and other related materials (e.g., silt fences and accessories) will be kept on site throughout the duration of the Project.
- Contingency supplies of erosion and sediment control materials will be maintained in a central location to active work sites, and workers will be sufficiently trained in their appropriate installation and maintenance. To be able to more effectively respond to emergency situations, CZN' contractor will maintain a list of erosion and sediment control equipment and their storage location(s).
- CZN's contractor and its subcontractors will take immediate action to correct any deficiency in the operation of the erosion and sediment control measures, and will have sufficient materials readily available (e.g., clean rock, granular material, and filter fabric) to apply the corrective actions. The Contractor's response will be initiated within two hours of observing the deficiency or being informed of the deficiency. The judgment of the need for, and timing of, corrective action, will be at the discretion of the EM and the Inspector.

7.2 Post Construction

Following the completion of the access road, the Road Operations Manager will assume responsibility for the monitoring of the SECP. CZN will be responsible to provide adequate resources of materials and manpower to apply the corrective actions necessary to correct deficiencies related to sedimentation and erosion protection.

8 REVISION HISTORY

Rev.#	Date of Issue	Reviewed By	Approved By	Description
0	2015-08-24	WBM	WBM	Initial Release

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Allnorth

ROAD CONSTRUCTION AND MAINTENANCE PLAN

Prairie Creek Mine Access Road

1 BACKGROUND

Canadian Zinc Corporation (CZN) is seeking to begin operation of the Prairie Creek Mine located in the south west corner of the Northwest Territories approximately 555 kilometers west of Yellowknife, 330 kilometres north of Fort Nelson, B.C.

The "Prairie Creek Mine Access Road" is a 184 km proposed route connecting the mine site to Highway 7 near the community of Nahanni Butte. The majority of the road, 174 kilometres, will be newly constructed road and the remaining 10 kilometres utilizes the Nahanni Butte Access Road. This plan will apply to the construction of the 174 kilometre access road and the maintenance required supporting the operations of the road over the expected 20 year life.

The access road traverses through rolling terrain in the east to major mountain valleys and passes in the west. The road will cross major streams, wetlands, rock exposures, talus slopes, and probable discontinuous permafrost. It is expected that the first 5 years of the newly constructed road will present the period of greatest ongoing road maintenance.

The access road will permit bulk transportation of lead/zinc/silver concentrate utilizing 8 or 9 axle tractor/trailers from the mine site to Fort Nelson, B.C. The road will also provide operational support to bring supplies and manpower to the Mine. Road operations and maintenance would revolve around the seasonal limitations of the Liard River crossing with a barge in summer and ice bridge during winter.

2 PROJECT SCOPE

The purpose of this Road Construction and Maintenance Plan (RCMP) is to provide general management guidelines and approaches with respect to the construction of roads and the required long term maintenance. The RCMP will be in effect from the mobilization of construction equipment to the site until final closure of the Prairie Creek Mine and subsequent road closure, as described in the Road Closure and Reclamation Plan (RCRP).

The RCMP provides guidelines related to all road activities, including:

Road Construction

- Road Construction Operations (summer and winter)
- Right of way clearing
- Wildfire protection – operational flow chart, hot works procedures
- Subgrade construction
- Surfacing

- Operations within Riparian areas
- Minor culvert installation
- Major culvert installation
- Bridge Installation
- Erosion and Sedimentation Control
- Equipment fueling and storage - Spill Prevention and Containment

Road Maintenance

- Road surface conditioning, grading, and updating
- Road ditch and drainage maintenance
- Minor stream crossing (culvert) and approach maintenance
- Major stream crossing (bridge) and approach maintenance
- Road signage and maintenance
- Liard River crossing, ice bridge winter or barge in summer
- Winter road maintenance
- Right of way brushing and line of sight
- Rock fall assessment and maintenance
- Avalanche assessment and maintenance
- Road operational closures, environmental regulations, general rules and regulations

All operations must comply with local laws, rules, and regulations and in compliance with the NWT "NORTHERN LAND USE GUIDELINES" and B.C. MOT..

3 LIMITATIONS OF THE RCMP

It is understood that this RCMP may be influenced by new Government direction, policies, and legislation in the future. This plan is considered a living document, evolving, and is subject to change with input from the road construction contractor and from government agencies.

4 RESPONSIBILITY AND AUTHORITY

CZN will have ownership of the access road and supporting infrastructure, therefore CZN will have responsibility and authority to enact this plan. A team of qualified personnel will be retained on CZN behalf to supervise, direct, and ensure compliance of the road construction and future maintenance activities completed by the contractor and/or its' subcontractors. For construction activities, this team would consist of a Road Construction Manager (RCM), Environmental Monitor (EM), and support staff including additional environmental monitors. Following construction of the road, the Road Operations Manager (ROM), supported by an Environmental Monitor (EM) and maintenance staff, will be responsible for managing and directing road maintenance activities.

5 ROAD CONSTRUCTION OPERATIONS

The designated RCM has acting authority and responsibility to ensure:

- Prime Contractor, sub-contractor(s), and those employed are working in full compliance of the project especially related to safe work practices.
- All environmental safeguards and procedures are followed
- Manage budget and schedule of project
- Road construction practices are consistent with accepted good practices and in full compliance of prescribed road designs, bridge and culvert designs, permits, and the RCMP.

5.1 Pre-Works Checklist

Prior to the commencement of operational works, the checklist will be jointly reviewed and checked between the contractor(s), the RCM, the acting EM, and if and when necessary, local government agencies (or acting agent). The pre-works checklist will be completed as necessary at both a macro level (example, initial start-up of construction) and micro level (example, specific bridge installation). The checklist would identify and communicate such things as:

- Safety actions or concerns
- Specific construction approaches, concerns, and procedures
- Erosion and sediment control measures
- Scheduling
- Environmental protection approaches, concerns, and procedures

5.2 Right of Way Clearing

The following will be applied to right of way clearing operations:

- Prior to commencing right of way clearing, all operators must confirm all permits are obtained, right of way area is defined and understood, any erosion/sedimentation measures are applied, and special precautions/procedures are understood.
- During summer operations, ensure any bird nesting procedures are followed.
- Right of way clearing not to extend beyond the reasonable required length to maintain efficient subgrade construction progress. Generally, this would be considered 1 week advancement and the clearing activity/schedule would reflect known shutdown periods.
- Provisions for special defined areas or circumstances where it is known to be beneficial to the construction schedule, without causing significant additional environmental risk. An example would be clearing and drainage of an identified wet area in advance of construction activities to improve the future constructability of the site.
- Clearing of riparian areas only to occur during optimum weather conditions. Stripped material and overburden to be placed in defined locations for timely future reclamation within the riparian zone.

- Right of way stripped material and overburden to be placed in accordance with the road design plan. Typically, these piles would be located on the lower side of the right of way. These piles must be placed to allow future accessibility for required reclamation of the road.
- Any temporary storage of stripped material and overburden, such as at borrow locations, will be consistent with the specific site plan.
- Right of way stripped material and overburden piles must not be stockpiled within 15 m of the top of bank of any watercourse, wetland, or riparian area, unless otherwise reviewed by the Environmental Monitor (EM) and deemed to pose a low risk of sediment entry into any water body.
- Equipment crossing of open surface water will be avoided. If a crossing is unavoidable, it will be limited to a one time and back crossing, and can only be considered if the stream depth and bottom material is acceptable to support such a crossing and will not create significant stream bed damage. Otherwise, an alternative must be applied. The EM must be notified and consulted prior to crossing if not previously addressed.

5.3 Subgrade construction

The following will be applied to the construction of road subgrade:

- Subgrade will be constructed in accordance with the road design
- Prior to commencement of activities, all operators must confirm all permits are obtained, specific tasks are defined and understood, any erosion/sedimentation measures are applied, and special precautions/procedures are understood.
- Construction will be stopped during periods of heavy rain and runoff to minimize soil disturbance.
- Runoff will be diverted away from water bodies.
- Silt or filter fences will be installed on the lower perimeter of slopes (i.e. lower 1/3 to 1/2 of the site) and areas where the erosion potential is high and/or it is desirable to contain waterborne movement of eroded soils. Such areas include the bottom of cut or fill slopes, material stockpiles and disturbed natural areas.
- Immediately following the completion of a road segment, erosion and sediment control measures will be applied to minimize erosion and the migration of eroded soils. These installations include gravel berms, small silt fences, check dams, and local organic based berm structures. The number and spacing of these installations will depend on the nature of the construction operations. Large cuts/fills may be capped with gravels/rock as required within a reasonable time.
- Fill brought to the Project site will be managed properly to prevent soil erosion and/or sediment-bearing runoff. The mitigation methods to be applied to the fill stockpiles include silt fences, gravel berms, check dams, local organic based berm structures and/or geotextile fabric covering.
- Equipment operator competence and adequate supervision to prevent unwanted/undesirable material placed into the road subgrade. This is particularly important during winter operations avoiding added ice and snow.

- Equipment used for site preparation, construction, installation of culverts will operate outside the wetted channel from the top of bank or in a dry stream channel.
- All areas with steep slopes will be reviewed closely prior to stripping to ensure that accurate work limits are established.
- Maintain all natural water drainage patterns unless erosion and sedimentation control is compromised.
- All open water stream crossings must use a temporary crossing structure such as temporary culvert, bridge, or crane mats. The use of log bundles is not permitted as the primary structure providing free water flow, however approach can be used to support the temporary structure.
- When crossing wet sections vulnerable to erosion or significant environmental impacts, the contractor will utilize rig mats or other capable alternative crossing methods.

5.4 Aggregate Production and Placement

The placement of an acceptable surfacing aggregate over the subgrade may be applied up to a year following the construction of road subgrade to allow proper drainage, drying, and settling of the subgrade. Aggregate for surfacing the road subgrade may utilize natural pit run, potentially screened material or, if required, crushed material in accordance with the detailed design perameters. The following approach will be taken:

- All borrow sites will be operated in accordance with the “Borrow Pit Management and Reclamation Plan” (BPMRP).
- Material will be applied as defined in the detailed road design as required.
- Water application may be required to improve compaction and the quality of the application, and possibly for dust management.

5.5 Operations within Riparian Areas

All riparian areas will be clearly marked, identified, and communicated to equipment operators. All works within riparian areas will follow the EM’s direction and guidelines to prevent or minimize adverse impacts to the riparian zone. Works conducted within riparian areas will be completed in a continuous manner until completion, unless site conditions do not permit.

Work will be conducted within riparian areas, including crossing installations, during optimum seasonal conditions, either winter or dry summer/fall periods during low water flows and outside fish windows. Peak water flow periods will be avoided. Temporary crossings may be utilized to maintain the construction schedule and allow the installation to occur at a later date when conditions improve. It is preferred to install culverts concurrently with subgrade construction.

5.5.1 Minor Culvert Installation

Minor culvert installations would include those 800 mm and smaller diameter. This would include non-classified drainages, non-fish bearing streams, and cross drainage culverts. The installation of these culverts would be generally considered simple. The following approach will be applied:

- Install required erosion and sediment control measures.
- Complete works in a timely manner and minimize disturbance to the natural channel.
- Establish a solid base to place the culvert and apply adequate compaction during installation process.
- If there is significant surface water flow, a diversion of the water flow is required by either the use of pumps or short term diversion channel.
- Add additional erosion and sediment control measures as required.
- Install/place required rip rap at outlets.

5.5.2 Major culvert installation

- Major culvert installations would include those greater than 800 mm in diameter, and some sites may require multiple culverts. This would include crossing larger wetlands and larger streams classified as both non-fish and fish bearing. Typically, the installation of these culverts would be considered a more complex process regarding proper site preparation and installation approaches. The following approach will be applied:
- Install required erosion and sediment control measures.
- Complete works in a timely manner and minimize disturbance to the natural channel.
- Establish a solid base to place the culvert, apply 30 to 50 cm lifts of suitable granular material and apply adequate compaction (may require compaction testing) until the installation is complete. Typically, the fill thickness on top of the culvert must be a minimum of ½ the diameter of the pipe.
- If there is significant surface water flow, a diversion of the water flow is required by either the use of pumps or a short term diversion channel. When isolation of the main channel is required, water pumps shall be used to draw sediment-bearing water from the work area to be discharged to a well vegetated area or a settling basin away from the stream. If fish could be present, a fish salvage will be completed prior to commencement of pumping from the isolated channel area.
- Add additional erosion and sediment control measures as required.
- Install/place required rip rap at outlets.
- Complete riparian reclamation measures immediately following the completion of subgrade construction within the riparian area, unless conditions do not allow.
- Avoid installing major culverts when extreme cold temperatures prevail and/or with frozen fill material.
- Equipment crossing of open surface water will be avoided. If a crossing is unavoidable, it will be limited to a one time and back crossing, and can only be considered if the stream depth and bottom material is acceptable to support such a crossing and will not create significant stream bed damage. Otherwise, an alternative must be applied.

5.5.3 Bridge Installation

A total of 14 bridges will be constructed, including some large multi-spans, on the 174 kilometres of access road. The following approach will be applied to bridge installation operations:

- Bridge installations to be scheduled during preferred seasonal windows.
- Install required erosion and sediment control measures.
- Complete works in a timely manner and minimize disturbance to the natural channel
- The bridge and its approach roads will not produce a back-water effect or increase the head in the stream.
- The equipment used for construction, including site preparation, maintenance of the bridge, will be situated in a dry stream channel or will be operated from the top of bank.
- Add additional erosion and sediment control measures as required.
- Complete riparian reclamation measures immediately following the completion of subgrade construction within the riparian area, unless conditions do not allow.
- Avoid installing foundations with frozen fill material or installing spread footings over frozen ground.
- Bridge installations will be under the direct supervision of a suitably qualified professional.
- Equipment crossing of open surface water will be avoided. If a crossing is unavoidable, it will be limited to a one time over and back crossing, and can only be considered if the stream depth and bottom material is acceptable to support such a crossing and will not create significant stream bed damage. Otherwise, an alternative must be applied.

5.6 Wildlife Management

All operations will respect the following wildlife management policies:

- Wildlife have the right-of-way if crossing or attempting to cross the Project footprint, which obligates drivers to stop (when safe to do so) for all wildlife seen on or immediately adjacent to the road, giving wildlife the opportunity to move off. Headlights are to be turned off.
- If caribou, Moose, Dall's Sheep, and Wolverine are reported beyond 500 m of the Project footprint, traffic speeds are to be reduced to half the posted speed limit within 1 km of the sighting, or as soon as the animal is sighted.
- If caribou, Moose, Dall's Sheep, and Wolverine are reported on the road or within 500 m of the Project footprint, traffic or activity will cease at least 500 m from (or at first observation of) the animal(s) and all headlights turned off until the animal moves off at least 100 m, or 5 minutes after last visual. Once traffic resumes, speed reduced to half the posted speed limit within 1 km of the sighting.
- Reporting the presence/absence of Collared Pikas (ranked as "maybe at risk" in the NWT) in summer at borrow sources BP 14 and 16 prior to Project-related disturbances. Consider additional mitigation should Pikas be present. No winter work permitted without prior summer survey.

- Food and food wastes and other putrescible matter will be collected and stored in a manner inaccessible to furbearers and incinerated in an enclosed structure or otherwise disposed of off-site to reduce the risk of attraction and habituation to the access road and its facilities.
- Petroleum products and other attractants will be stored in a manner inaccessible to wildlife.
- Littering is strictly prohibited.
- Train employees and contractors on bear awareness (and other dangerous species) on Project entry for the first time and on a regular basis to be informed of the risks.
- All employees and contractors will report human-dangerous wildlife encounters and resulting incidents to Mine management. A Renewable Resource Officer (ENR) or Parks Canada (depending on incident location) will be informed within 24 hours.
- Train CZN Environmental Monitor and Mine management (in communication with ENR and Parks Canada, where necessary) to ensure worker safety and efficient and speedy resolution of human-dangerous wildlife incidents.
- No significant changes in water levels permitted and adhere to the DFO Water Withdrawal Protocol if pumping water from a known Beaver pond. Use only pre-authorized water sources, adhere to daily and total extraction limits for the source, record extraction volume.
- Utilize designated fuelling locations. Complete refuelling of trucks and equipment away from any stream, lake, wetland or other water body, per industry standards.
- Diligent application of the GNWT (2013) dust suppression guidelines at the TTF and along portions of the road as appropriate.
- Undertake wildlife reconnaissance (to be completed by the CZN Environmental Monitor) by scanning adjacent slopes, ponds, and surrounding areas with binoculars prior to blasting, if blasting should be necessary. Blasting is prohibited if caribou, Dall's Sheep, and Wolverine observed within 1 km of the blast site until the animal moves out of the area.
- If blasting is required within Boreal Caribou range, prohibit blasting from May 1 to July 15 to avoid disturbance to potential Boreal Caribou calving and post-calving (also mitigation for potential Dall's Sheep lambing on Nahanni Range) (based on recommendations in AANDC 2011).

6 SEDIMENT AND EROSION CONTROL

The SEDIMENT AND EROSION CONTROL PLAN (SECP) is an integral part of this plan and shall be followed.

7 ROAD MAINTENANCE CRITERIA

The designated ROM has acting authority and responsibility to ensure:

- The contractor and/or maintenance staff are working in full compliance of the project especially related to safe work practices.
- All environmental safeguards and procedures are followed, including the SECP.

- Maintenance requirements are compliant and consistent with the Road Operations Plan (ROP).
- Road structures are maintained as required to provide safe and efficient transport of personnel, goods, and concentrate to and from the mine site.

7.1 Road Surface Conditioning, Grading, and Updating

It is expected that graders will be located along the route to maintain the road surface to ensure efficient, safe transport of materials to and from the mine site. The frequency of routine grading and conditioning of the running surface of the road varies based on:

- Quality of surfacing material
- Volume and type of traffic utilizing the road
- Weather including, temperature, precipitation, and season

When maintaining a newly constructed road, it can take several years or more for the fresh subgrade/surface to stabilize. It is expected that at some locations or segments, the road subgrade and surface will break down, and therefore updating road subgrade and/or surfacing may be required to maintain a safe and efficient road system.

7.1.1 Summer/Fall Operations

This season will operate primarily when the Liard River barge service starts in mid-July (following the removal of weight restrictions on Highway 7) until October when either low water levels or ice accumulation restricts barge operation. Since equipment will be captive on the road and not reliant on the barge, maintenance may also be completed in shoulder periods when hauling is not occurring, depending on circumstances. The summer/fall maintenance program would include:

- As required grading of road running surface.
- As required, on a spot basis, apply water to road surface as dust suppression for safety and/or grading purposes.
- Monitor all minor and major stream (culvert) crossings to ensure full capacity.
- Monitor ditches and established drainage systems to ensure full operation and capability. This may include, from time to time, ditch restoration and cleanout.
- Maintain all major bridge crossings and approaches. Inspect bridge decks, rails, and safety berms for deflects. Repair as required.
- Ensure all proper signage is maintained and fully functioning. This may include identifying culvert locations for future reference.
- Maintain proper line of sight which may include right of way brushing
- Routine inspections of Liard River Barge crossing approaches. Safety and operational inspections of barge operation.
- Monitor all erosion and sedimentation infrastructure established during the road construction process.

- Monitoring and minor repair of deflective road subgrade/surfacing segments and culverts as required.
- Monitoring of potential rock fall sections. Refer to Section 8 below

7.1.2 Winter Operations

This season will operate when the Liard River ice bridge is successfully established, in December until up to mid-April, after which a safe ice bridge can no longer be maintained. Since equipment will be captive on the road and not reliant on the ice bridge, maintenance may also be completed in shoulder periods, depending on circumstances. The winter maintenance program would include:

- As required snow removal, grading, and sanding of the running surface.
- Snow clearing practices along access road to manage high snow banks, allowing wildlife to readily move off and escape the running surface of the roadway.
- Monitor all minor and major stream (culvert) crossings to ensure full capacity, especially prior to break-up.
- Monitor ditches and established drainage systems to ensure full operation and capability. This may include de-icing and clean out of culverts to ensure future capacity.
- Maintain all major bridge crossings and approaches.
- Ensure all proper signage is maintained and fully functioning.
- During questionable weather systems which may impact road conditions, assess road conditions prior to the transport of goods or personnel.
- Monitor and maintain Liard River ice bridge in accordance with “Winter Roads Handbook” from Saskatchewan Ministry of Highways and Infrastructure and/or “Best Practice for Building and Working Safely on Ice Covers in Alberta” from the Government of Alberta.
- Monitoring of potential avalanche zones. Refer to Section 8 below.

8 ROCK FALL/AVALANCHE ZONES

With regards to road construction activities, the access road traverses through some steep mountainous terrain with a risk of avalanche and/or rock fall. Rock fall/avalanche monitoring and mitigation procedures will be developed prior to road operations commencing. These would include:

- Classify and identify sections from low to high risk.
- Establish a monitoring program to assess the ongoing risks.
- Establish procedures for road operations during periods of high risk, which may include temporary road closure.
- Mitigation procedures or methods to reduce risks.

Following the construction of the road, road maintenance will be conducted in accordance with the operational rules within the Road Operations Plan (ROP).

9 OPERATIONAL RULES AND REGULATIONS

All rules and operations of the road will comply with the ROP.

9.1 Spill Prevention and Containment

All personnel on site are responsible to ensure proper handling, storage, clean up procedures, and reporting related to fuels and chemicals utilized in the construction operation. The following approach will apply:

- All equipment will be equipped with operational spill kits.
- All personnel will be familiar with spill prevention, containment, clean up rules and policies.
- All chemical spills shall be reported to the EM. The EM will direct any additional action and report and record the incident.
- All petroleum spills and antifreeze spills must be reported to the EM and appropriate government agency for the appropriate regulated amounts.
- Equipment operators must routinely, minimum daily, inspect equipment for leaks. Appropriate action must be taken to clean up any known spills and complete repairs to equipment to rectify the problem. Drip trays will be carried, and used if a vehicle is stationary for more than one hour.
- Should the operator notice a sudden fuel or oil leak (namely hydraulic), the machine shall be immediately shut down if it is safe to do so, and suitable collection and containment provided. Equipment can be removed from the location to an acceptable repair site only if the operation will not add additional environmental impact. The EM should be contacted for direction.
- All spills shall be cleaned up promptly.
- Cleaning of equipment shall be done in designated locations.

9.2 Equipment Fueling and Storage

The fuelling of equipment and storage of diesel fuel will comply with regulations and permit conditions. The following approach will apply:

- All fuel will be stored in compliance with DOT approved fuel storage containers.
- No fuelling of equipment, including power saws, within riparian areas.
- Large equipment must be fuelled in designated fuelling locations.
- Graders may be fuelled utilizing a portable type “slip tank” in compliance with the statement below.
- All portable fuel tanks such as slip tanks or tidy tanks fixed on portable vehicles shall be secured properly, cannot exceed 400 l, and must be DOT approved, including double lined.
- The base of designated fuelling locations will be lined with poly or other suitable material, bermed to contain large spills, to prevent fuel seeping into native ground.

- Designated fuelling locations will be placed a minimum 100 m from any riparian area, on ground types which will resist fuel penetration, and on ground that does not slope towards a waterbody.
- All onsite larger fuel storage locations will be approved by the EM and the base must be poly lined or other suitable material, and bermed to contain spills equivalent to 110% of the capacity of the tank. Designated fuel storage locations will be placed a minimum 100 m from any riparian area, on ground types which will resist fuel penetration, and on ground that does not slope towards a waterbody.
- All fuel storage containers, fixed and mobile, are to be inspected regularly for deflects and leaks. Leaking fuel containers must be immediately removed from service.
- Any used oil, chemical containers, grease tubes, batteries, etc. must be removed from site on a regular basis and disposed of appropriately.

9.3 Wildfire Regulations, Prevention, and Procedures

Wildfires, and the prevention thereof, are of great concern. With scheduled summer construction and maintenance operations, the following approach will be taken to prevent wildfires and contain a wildfire if necessary.

- All personnel on site are responsible to prevent wildfires and report immediately any unintended fire.
- All personnel will be properly informed and familiar with fire prevention policies and reporting procedures. They must also be trained appropriately to apply basic firefighting techniques.
- Smoking is permitted only in designated areas. All butts will be disposed of in contained locations.
- No camp fires are permitted from May 1 to September 30, the official NWT fire season.
- The proper “timely” disposal and storage of right of way brush, woody material, and log decks to reduce risks. Attempt to maintain a 3 m mineral soil buffer between an actively used road and storage piles.
- All equipment must be in good working condition, clean, and maintained. Working spark arrestors must be on all power equipment.
- Any hot works conducted on site shall at a minimum maintain a 15 m radius of exposed mineral soil around the site. A watchperson must be on site during the hot works, and for 1 hour following any hot works activity. Appropriate fire extinguishers and tools must be located on site.
- During periods classified as high risk, a watchperson will remain on site for 1 hour after all heavy equipment construction operations have ceased for the day.
- Should an individual(s) spot a wildfire, they must report it immediately and act accordingly, if safe to do, to extinguish and contain the fire.
- All work sites must have established communications on site.

9.3.1 NWT Wildfire Regulations

All industrial operations must conform to FOREST PROTECTION ACT (FPA), the FOREST MANAGEMENT ACT (FMA), and the MACKENZIE VALLEY RESOURCE MANAGEMENT ACT (MVRMA). The approach taken within this plan will be consistent with NWT "Forest Fire Prevention and Suppression Guidelines for Industrial Activities" and can be found at:

http://www.nwtfire.com/sites/default/files/Guidelines%20for%20Forest%20Fire%20Prevention%20and%20Suppression.pdocated

The guidelines state"

"The intent of these Guidelines is threefold. Firstly, industrial operations must be conducted so that they do not contribute to the seasonal forest fire load. Secondly, industrial operations must be able to control and extinguish any fires that occur as a result of their operations. Finally, industrial operations must be able to respond to wildfires that may affect human life and the property of their operations."

10 MONTIORING

Monitoring of the road construction process will be the responsibility of the Road Construction Manager (RCM) and his designated Environmental Monitor(s) (EM).

The Road Operations Manager will be responsible to ensure the monitoring of all road operations including road upgrading and maintenance, bridge and stream crossing inspections, minor road repairs and upgrading, compliance of rules and regulations.

11 REVISION HISTORY

Rev.#	Date of Issue	Reviewed By	Approved By	Description
0	YYYY-MM-DD			Initial Guide

12 REFERENCES

NWT FOREST FIRE PREVENTION AND SUPPRESSION GUIDELINES FOR INDUSTRIAL ACTIVITIES

BCFLNRO ENGINEERIN MANUAL

ROAD OPERATIONS PLAN

Prairie Creek Mine Access Road

1 BACKGROUND

Canadian Zinc Corporation (CZN) is seeking to begin operation of the Prairie Creek Mine located in the south west corner of the Northwest Territories approximately 555 kilometers west of Yellowknife, 330 kilometres north of Fort Nelson, B.C.

The “Prairie Creek Mine Access Road” is a 184 km proposed route connecting the mine site to Highway 7 near the community of Nahanni Butte. The majority of the road, 174 kilometres, will be newly constructed road and the remaining 10 kilometres utilizes the existing Nahanni Butte Access Road which is maintained publically by MOT. It is assumed that a maintenance agreement would be established between MOT and CZN. This plan will apply to the new 174 kilometres of access road.

The proposed 174 kilometres of access road traverses through rolling terrain in the east to major mountain valleys and passes in the west. The road will cross major streams, wetlands, rock faces, talus slopes, and probable permafrost. It is expected the first 5 years of the newly constructed road will present the greatest challenge to the ongoing road maintenance.

The access road will permit bulk transportation of lead/zinc/silver concentrate utilizing 8 or 9 axle tractor/trailers from the mine site to Fort Nelson, B.C. The road will also provide operational support of supplies and manpower to the mine. Road operations and maintenance would revolve around the seasonal limitations of the Liard River crossing with a barge in summer and ice bridge during winter.

The “Prairie Creek Mine Access Road” report defined a 20 year road life expectancy.

2 PROJECT SCOPE

The purpose of this Road Operations Plan (ROP) is to provide general management guidelines and approach with respect to road use and maintenance activities for the Prairie Creek Mine Access Road. The ROP will be in effect following the completion of road construction activities until mine operations have shut down indefinitely. The Road Closure and Reclamation Plan would then follow.

The ROP plan will provide guidelines related to all road maintenance requirements and will include:

- Road surface conditioning, grading, and updating
- Road ditch and drainage maintenance
- Minor stream crossing (culvert) and approach maintenance
- Major stream crossing (bridge) and approach maintenance
- Road signage and maintenance
- Liard River crossing, ice bridge winter or barge in summer
- Winter road maintenance
- Right of way brushing and line of sight

- Rock fall assessment and maintenance
- Avalanche assessment and maintenance
- Road operational closures, rules and regulations

3 LIMITATIONS OF THIS ROAD MANAGEMENT PLAN

It is understood that this ROP may be influenced by new Government direction, policies, and legislation in the future. The Special Use Permit for the access road may be assigned all, or in part, to other road users in the future, and some or all of the responsibilities described in this ROP may be assigned to that road user. No other known limitations exist for the road.

4 RESPONSIBILITY AND AUTHORITY

CZN will have final ownership of the access road and supporting infrastructure therefore CZN will have responsibility and authority to enact this plan. CZN will designate a Road Operations Manager who will monitor and manage all of the road operations related to safety, route maintenance, and minor road repairs. As the project progresses and prime contractors are established, CZN Road Operations Manager will direct and forward responsibilities as required.

5 ROAD MAINTENANCE CRITERIA

5.1 Road Surface Conditioning, Grading, and Updating

It is expected that a sufficient fleet of graders will be located at strategic locations along the route to maintain the road surface to ensure efficient, safe transport of materials to and from the mine site. The frequency of routine grading and conditioning of the running surface of the road varies based on:

- Quality of surfacing material
- Volume and type of traffic utilizing the road
- Weather including, temperature, precipitation, season

When maintaining a newly constructed road it can take several years or more for the fresh subgrade/surface to stabilize. It is expected at scattered locations or segments, the road subgrade and surface will break down and therefore updating road subgrade and/or surfacing may be required to maintain a safe and efficient road system.

5.1.1 Summer/Fall Operations

This season will operate when the Liard River barge service starts in mid-July (following the removal of road bans on Highway 7) until October when either low water levels or ice accumulation restricts barge operation. The summer/fall maintenance program would include:

- As required grading of road running surface.
- As required, on a spot basis, apply water to road surface as dust suppression for safety and/or grading purposes.

- Schedule the transport of personnel during periods which offer least risk or conflict with bulk carriers.
- Monitor all minor and major stream (culvert) crossings to ensure full capacity.
- Monitor ditches and established drainage systems to ensure full operation and capability. This may include from time to time ditch restoration and cleanout.
- Maintain all major bridge crossings and approaches. Inspect bridge decks, rails, and safety berms for deflects. Repair as required.
- Ensure all proper signage is maintained and fully functioning. This may include identifying culvert locations for future reference.
- Maintain proper line of sight which may include right of way brushing
- Routine inspections of Liard River Barge crossing approaches. Safety and operational inspections of barge operation.
- Monitor all erosion and sedimentation infrastructure established during the road construction process.
- Monitoring and minor repair of deflective road subgrade/surfacing segments and culverts as required.
- Monitoring of potential rock fall sections. Refer to Section 6 below.

5.1.2 Winter Operations

This season will operate when the Liard River ice bridge is successfully established in early January until mid-April when a safe ice bridge can no longer be maintained. The winter maintenance program would include:

- As required snow removal, grading, and sanding of the running surface.
- Schedule the transport of personnel during periods which offer least risk or conflict with bulk carriers.
- Monitor all minor and major stream (culvert) crossings to ensure full capacity.
- Monitor ditches and established drainage systems to ensure full operation and capability. This may include de-icing and clean out of culverts to ensure future capacity.
- Maintain all major bridge crossings and approaches.
- Ensure all proper signage is maintained and fully functioning.
- During questionable weather systems which may impact road conditions, assess road conditions prior to the transport of goods or personnel.
- Monitor and maintain Liard River ice bridge in accordance to “Winter Roads Handbook” from Saskatchewan Ministry of Highways and Infrastructure and/or “Best Practice for Building and Working Safely on Ice Covers in Alberta” from the Government of Alberta.
- Monitoring of potential avalanche zones. Refer to Section 6 below.

6 ROCK FALL/AVALANCHE ZONES

The access road traverses through some steep valley mountainous terrain with significant risk of avalanche or rock fall. A detailed rock fall/avalanche plan will be completed prior to road operations commencing. This plan would include:

- Classify sections from low to high risk.
- Establish a monitoring program to assess the ongoing risks.
- Establish procedures for road operations during periods of significant risk which may include temporary road closure.
- Mitigation procedures or methods to reduce the risk including rock scaling and controlled explosive detonation.

7 ROAD OPERATIONAL CLOSURES, RULES AND REGULATIONS

The following rules and regulations will apply to the operation of the access road to support safe and long term protection of the road structure. These include:

- All road users must obey all posted speed limits and signage.
- Road distance signs will be posted every kilometre. This road will be operated as a radio controlled road for added. safety and efficiency. However, all traffic must drive according to conditions and line of sight rules.
- During extreme weather conditions such as significant avalanche, rock fall, heavy snow, or rain, temporary closure may apply to all or part of the road to minimize risk to safety and/or road structure.
- Wildlife will be given right of way and when encountering wildlife along the road right of way, road users must provide sufficient time for wildlife to disperse safety outside the right of way.
- Winter operations, all vehicles must carry chains. Mandatory chain up of all vehicles >5000 kg from 0 to 29 KP during winter operations.
- All vehicles must be equipped with spill kits, fire extinguishers, shovel, and first aid. In addition, during fire season, a backpack water pump and Pulaski.

7.1 Access Control

No other user groups have been identified to utilize the road. It is expected that should other user groups be interested in the future, a road use agreement would be established between the interested party, CZN, and the representative government agency.

The access road will provide access to an area of the territory which is presently considered remote and largely inaccessible to the majority of the public. As the road is located on public land, CZN has no legal authority to restrict other road users such as the public. However, the Liard River crossing, in the summer season, will provide a natural barrier to other users. In addition, CZN will install a check point at a preferred location near KP 140 which will be manned and will discourage other users by recording and documenting road users.

8 MONITORING

CZN designated Road Operations Manager will be responsible to ensure the monitoring of all road operations including road upgrading and maintenance, bridge and stream crossing inspections, minor road repairs and upgrading, compliance of rules and regulations.

9 REVISION HISTORY

Rev.#	Date of Issue	Reviewed By	Approved By	Description
0	2015-08-24	WBM	WBM	Initial Release

ROAD CLOSURE AND RECLAMATION PLAN

Prairie Creek Mine Access Road

1 BACKGROUND

Canadian Zinc Corporation (CZN) is seeking to begin operation of the Prairie Creek Mine located in the south west corner of the Northwest Territories approximately 555 kilometers west of Yellowknife, 330 kilometres north of Fort Nelson, B.C.

The "Prairie Creek Mine Access Road" is a 184 km proposed route connecting the mine site to Highway 7 near the community of Nahanni Butte with a defined the road life expectancy of 20 years. Following the resource depletion and mine closure, the road and related infrastructure will require full reclamation.

2 SCOPE

This guide is intended to provide general management guidelines and approach to reclaim and restore the access road and related infrastructure to create stability and return the land to productive use. This guide includes all related road infrastructure including road right of way; cleared areas for camps, load outs, and borrow; Liard River barge/crossing; stream crossings (both bridge and culverts), Tetcela Transfer Facility (TTF) and the Liard Transfer Facility (LTF).

Many of the approaches within this guide are also contained in the companion documents Borrow Management and Reclamation Plan and Sediment and Erosion Control Plan. Approximately 85 kilometres of the road system is located within the recently expanded Nahanni National Park Reserve (NNPR). It is envisaged that a more detailed, site-specific reclamation plan would be developed at a later date.

3 RESPONSIBILITY AND AUTHORITY

CZN will have the responsibility and authority to enact this plan, and comply with all conditions of regulatory permits. As the project progresses and contractors are established, CZN will delegate responsibilities as required.

4 RECLAMATION

The reclamation of the main access road and supporting infrastructure is required to enhance the natural re-vegetative process and assist in stabilizing the disturbed area. This process will be conducted in a manner that is environmentally sound, and will reduce erosion and transport of sediment-bearing water,. The approach must also consider that following a 20 year road life, much of the road right of way and disturbed area outside the main running surface may have undergone some previous reclamation process, or has naturally re-vegetated to a reasonable stable state. Generally, it is not recommended to disturb this balance, rather to enhance those areas requiring beneficial intervention.

4.1 Main Access Road

The reclamation process would be applied to 174 kilometres of the 184 km route. The remaining 10 kilometres utilizes the Nahanni Butte access road and will remain active for continued access to the Nahanni Butte community. The reclamation process may include:

- Establish or install structure that will prevent the ongoing access to the area (Gates , Berms, bridge removal).
- Removal of all culverts and the re-establishment/re-contouring of all natural drainage patterns within the right of way.
- Re-contouring of larger, significant cut/fill slopes to ensure long term stability.
- Outsloping or insloping the road surface as appropriate.
- Partial or full road fill pullback may be applied to road sections experiencing on-going slope stability, saturated and weeping cut slopes, slumping ditches, and road settling problems. The partial or full road fill pullback would place the "fill" portion of the road base against the cutslope to stabilize the slope and return it closer to its natural state. Any stripped or overburden material available locally would then be placed overtop the mineral soil. This process would be considered the reverse order from the original road construction.
- Stabilizing wet, weeping, saturated, unstable cut slopes and stabilizing erosion prone stream banks.
- Scarification and placement of overburden/stripped material on the road bed where deemed beneficial to enhance the re-vegetation process along the running surface.
- Install cross drainage ditches on remaining road running surfaces to minimize future erosion/sedimentation potential at a frequency of :
    - (i) < 6 % road grade – as needed
    - (ii) 6 to 10% road grade – as needed, minimum every 100m
    - (iii) 10 to 15% road grade – as needed, minimum every 50m
- The removal of "overland" construction sections which cross larger wetland complexes. The woody log debris and excess subgrade material will be pulled back and disposed of along appropriate sections of the remaining road subgrade.
- Signage to be placed at any critical sections with safety concerns.

Chapter 6 of the BC Forest Road Engineering Guidebook covers road deactivation. The objectives of deactivation are listed as the avoidance of landslides, uncontrolled soil erosion and sediment transport. This will be achieved if the following occurs:

- the road prism and cleared width is stabilized;

- surface drainage patterns are restored or maintained, and subsurface drainage is consistent with natural drainage patterns; and,
- silt and sediment transport is minimized

Following the initial construction of the Access Road, a more detailed, site-specific deactivation plan might be developed. At this time, prior to construction, general road deactivation concepts can be discussed that should achieve the objectives listed above.

4.1.1 Deactivation without Pullback

For most sections of the road, side slopes will be absent and no significant pullback of cut material will be required. Road grades of less than approximately 6% may not require runoff control. However, grades in excess of 6% may need runoff management structures on a site-specific basis. These are discussed below.

A cross-ditch is a simple way of passing channeled runoff from the upslope side of the road bed to the downslope side. A diagram of such a structure is provided below. For larger ditches, it may be necessary to dissipate flows at the ditch outlet to avoid erosion. This can be done by placing boulders in the outlet area.

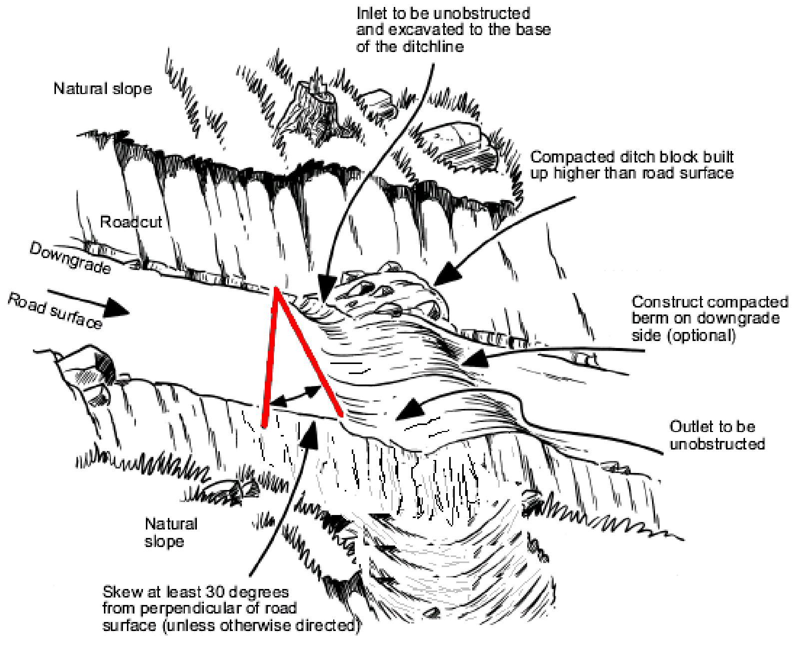


Diagram of a Cross-Ditch

Another runoff passage structure is a waterbar, which may or may not be combined with a cross-ditch. Waterbars are intended to reduce the impact of water running down the road surface on grade, causing erosion and sedimentation.

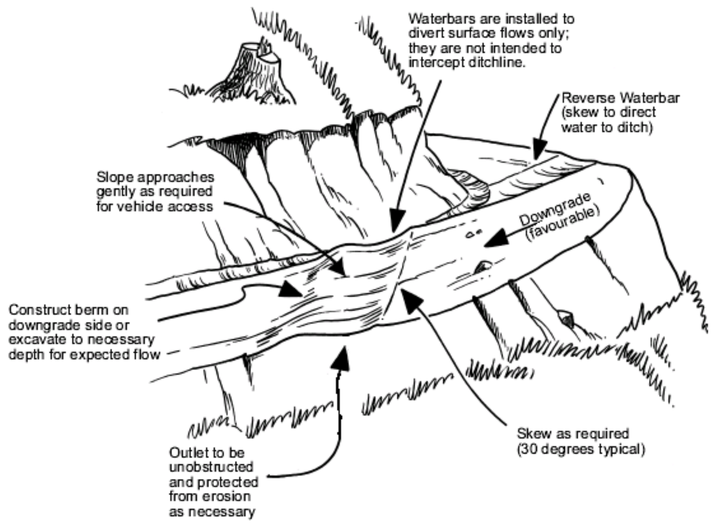


Diagram of a Waterbar

Soon after initial construction, and throughout the operating period prior to deactivation, it is assumed that the road development will be stable in terms of slope stability, runoff management and sediment control. Measures to achieve this may include those noted above. To stabilize cut and fill slopes, it may be necessary to place large woody debris or boulders on the slopes, with silt fence used as necessary until vegetation has been established. The latter may take some time as a seed mix will not be used because of the danger of introducing an exotic species, because of the thin or absent soil cover in upland areas, and because of the short northern growing season. However, it is assumed that road deactivation and closure begins with a well-constructed, and inherently stable, road development.

4.1.2 Deactivation with Pullback

Road sections with significant cuts are likely to be deactivated by pulling back cut material from downslope, re-contouring and stabilizing the material. . Runoff may need to be passed across the filled sections using structures. This might involve a cross-ditch, as shown below. To avoid erosion of the ditch, it might be filled with coarse rock to act as a french drain.

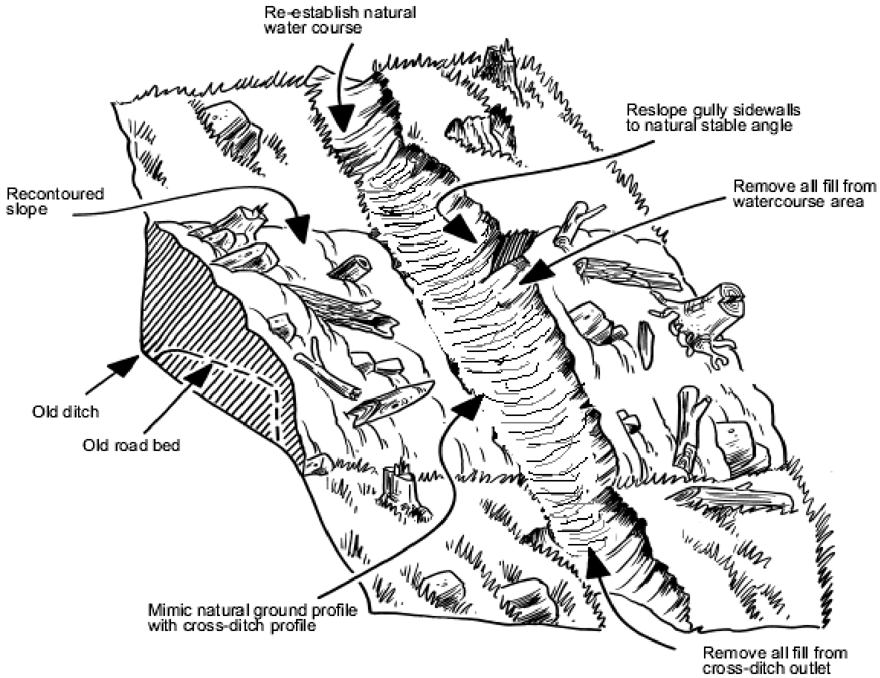


Diagram of Cross-Ditch in Fill Pullback

As for cut slopes prior to deactivation, pullback areas may require the placement of large woody debris or boulders on the slopes, with silt fence used as necessary, until vegetation has been established. Some cut areas may have internal drainage ditches to carry upslope runoff or seepage during road operations. If flows are likely to continue after pullback, water conveyance can be continued by filling the ditch with rock prior to pullback to create a trench drain. For localized areas of excessive seepage, more rock can be placed to create a blanket drain.

4.2 Stream Crossings

The intent of the reclamation process at all stream crossings is to return the disturbed area to a natural state which will require no long term maintenance. Generally, riparian area's re-vegetate within a few years of disturbance. Therefore, consideration must be given to whether additional site disturbance to restore the streamside has a net benefit. The reclamation process at all stream crossings may include:

- Pullback of all fill material within the riparian zone and re-contouring slopes to the natural setting and grades, de-compacting soils as necessary to promote revegetation.
- Complete removal of stream crossing structures, either bridge(s) or culvert.
- All bridge structure material constructed with unnatural materials (concrete, steel, plastics) will be hauled away for salvage. Natural materials such as wood decks will be removed from site and disposed of at a designated location if not suitable for salvage and reuse.

- All culverts (metal or plastic) will be removed from site and disposed of at a designated location.
- Stripped/overburden/woody debris material originally removed and stored within proximity of the crossing will be placed over the disturbed area to enhance the natural re-vegetation process..
- Apply any additional erosion and sedimentation measures as required to ensure short and long term erosion and sedimentation protection.

For the restoration of natural drainage, some general approaches can be described which will likely be used. Culverts will be removed, and if upslope flow will continue at the removal location, a passage structure will need to be built, which might be an armoured swale or re-creation of an original creek bed, or a cross-ditch or cross-drain. Culverts will preferably be removed in winter or during dry summer periods. However, a method for removing culverts while flow is occurring is shown below. However, this approach would only be used for non-fish bearing streams. Also, for any work not conducted in winter, consideration will need to be given to spawning windows for fish-bearing streams.

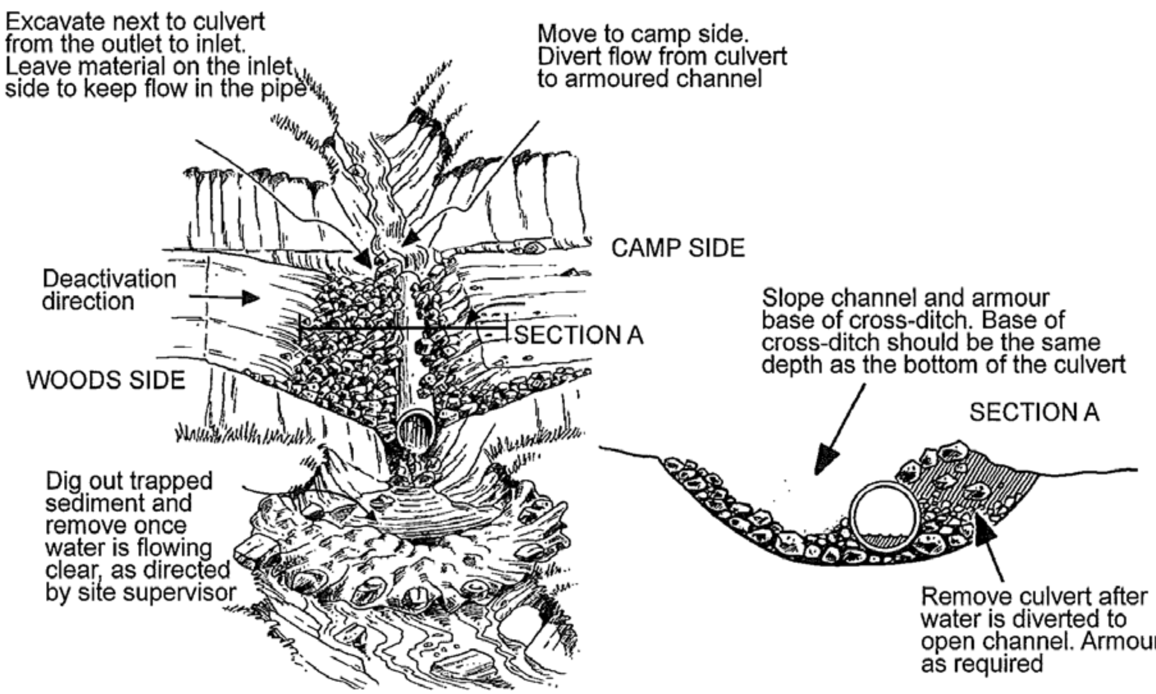


Diagram of Culvert Removal with flow occurring

Other drainage structures could include one or more of those discussed above

- Any damage to stream banks will need to be repaired, with stabilization as necessary, preferably using woody debris or boulders. If significant compaction of soils has occurred, some scarification may be needed to promote revegetation via invasion. Abutments will need to be removed or pushed back a suitable distance from the creek. Scarification of the newly exposed areas may then be needed.

4.3 Camps, Laydowns, TTF, LTF

The reclamation process at all camp, laydown, and TTF/LTF locations may include:

- Removal of all structures and components for recycling.
- Removal and disposal of all unnatural materials to a designated and approved location. Natural materials such as lumber to be disposed of in accordance with NWT and local regulations and laws.
- Re-contouring of cut/fill slopes to ensure long term stability.
- Soils in areas that have been compacted by traffic from heavy equipment or other vehicles will be ripped or scarified to reduce surface compaction and aid in the re-vegetation of the disturbed area.
- Stripped/overburden/woody debris material original removed and stored within proximity of the disturbed area will be placed over the disturbed area to enhance the natural re-vegetation process.
- Apply any additional erosion and sedimentation measures as required to ensure short and long term erosion and sedimentation protection.

4.4 Liard River Barge Crossing

The reclamation process at the Liard River Barge Crossing may include:

- Removal of all structures and components for recycling.
- Removal and disposal of all unnatural materials to a designated and approved location. Natural materials such as lumber to be disposed of in accordance with NWT and local regulations and laws.
- Re-contouring of cut/fill slopes to ensure long term stability
- Soils in areas that have been compacted by traffic from heavy equipment or other vehicles will be ripped or scarified to reduce surface compaction and aid in the re-vegetation of the disturbed area.
- Stripped/overburden/woody debris material original removed and stored within proximity of the disturbed area will be placed over the disturbed area to enhance the natural re-vegetation process.
- Apply any additional erosion and sedimentation measures as required to ensure short and long term erosion and sedimentation protection.

5 MONITORING

An inspection and monitoring program will be established starting when reclamation commences. Disturbed areas would be considered stable when, under normal conditions:

- Re-vegetation is occurring, consistent with the local area.
- Surface water is being contained and managed with no significant erosion or sedimentation.

- No slope or soil stability issues exist.

The time required for stability would vary on a site by site basis. An Environmental Monitor would be onsite monitoring all activities during reclamation. Periodic environmental monitoring to assess the progress of reclamation, and determine any need for follow-up works, will occur at a frequency dependent on reclamation progress, frequently initially and a reduced frequency thereafter.

6 REVISION HISTORY

Rev.#	Date of Issue	Reviewed By	Approved By	Description
0	YYYY-MM-DD			Initial Guide

Appendix D Evaluation of Potential Borrow Pits

1 EVALUATION OF POTENTIAL BORROW PITS

(Alternative Alignment plus additional borrow from KP 130 to 155)

1.1 Km 106.8 – BP 107/BP 107 Alter.– Carbonate Rock

Large elevated knob with potential clay till type material overlying a carbonate layer underneath. The clay could be utilized for subgrade overland base material, the rock could be blasted/crushed and utilized for road surfacing.

Figure 65: One of many large, elevated rock knob "humps" in a south to north linear line which the proposed road parallels. Exposed rock outcrops are common along a number of these knob features. We expect this particular one to offer the same material.

1.2 Km 107.8 – BP 108 Alter. – Clay till Overburden/Carbonate Rock

A combination of exposed talus carbonate base rock on the upper slopes and clay till type material on the lower slopes. The clay could be utilized for subgrade overland base material, the rock could be blasted/crushed and utilized for road surfacing. Requires 450m access road. Future test pits will determine the precise shape and size.

Figure 66: A view of the exposed talus slopes below the carbonate based rock cliffs.

1.3 Km 108.8- BP 109 Alter. – Clay till Overburden/Carbonate Rock

Similar land feature to BP XYZ, a combination of exposed talus carbonate base rock on the upper slopes and clay till type material on the lower slopes. The clay could be utilized for subgrade overland base material, the rock could be blasted/crushed and utilized for road surfacing. Requires 650m access road. Future test pits will determine the precise shape and size.

Figure 67. Similar feature found along the section KP 104 to 109, exposed carbonate based cliffs with talus accumulations at the base and expected silt/clay till on the lower slopes suitable for subgrade borrow.

1.4 Km 112.0– BP 112 Alter. – Clay/Silt Till

Noticeable, large elevated ridge expected to be clay/silt/ gravel glacial till mix suitable for overland subgrade material. May encounter carbonate bedrock suitable for rock quarry and crushing underlying the till mix.

Figure 68. The noticeable elevated knob/ridge should provide suitable subgrade borrow. The proposed alternative alignment is located at the lower base of the

1.5 Km 112.3 – BP 112.3 Alter. – Alluvial Cobble and Gravels - Carbonates

A large outwash alluvial fan originating from the nearby Franklin Mountains of the Nahanni Range located east of the defined source. As with much of the other alluvial cobble noted along the route, this source appears to originate from competent carbonate bedrock, making them an environmentally friendly and preferred construction material. Seasonal stream flows during spring thaw. Detailed design would maintain natural drainage channels.

Sufficient volume and area for setting up a crushing plant and for holding stockpiled materials. This area could support aggregate material for long term road maintenance.

Figure 69. Large source of quality limestone gravels and cobbles available along the proposed alternative route near KP 112. Ideal for crusher operation and a stockpile for future maintenance requirements.

1.6 Km 118.3 – BP 118 Alter. – Alluvial Cobble and Gravels - Carbonates

Part of an old, large floodplain now vegetated and outside the active stream channel. Similar material type at BP 112.3, a large alluvial deposit originating from the nearby Franklin Mountains of the Nahanni Mountain Range. As with much of the other alluvial cobble noted along the route, this source appears to originate from competent carbonate bedrock, making them an environmentally friendly and preferred construction material. Seasonal stream flows during spring thaw. Detailed design would maintain natural drainage channels.

Sufficient volume and area for setting up a crushing plant and for holding stockpiled materials. This area could support aggregate material for long term road maintenance.

Figure 70: View of BP 118 with similar material as found at BP 112.3.

1.7 Km 119.2 – BP 119 Alter. – Alluvial Cobble and Gravels - Carbonates

The material deposited at BP 112.3, 118, 119 all originate from the nearby Franklin Mountains of the Nahanni Range in the east. As with much of the other alluvial cobble noted along the route, this source appears to originate from competent carbonate bedrock, making them an environmentally friendly and preferred construction material. Seasonal stream flows during spring thaw. Detailed design would maintain natural drainage channels.

Sufficient volume and area for setting up a crushing plant and for holding stockpiled materials. This area could support aggregate material for long term road maintenance.

Figure 71: An aerial view of BP 119, downstream from BP 118.

1.8 Km 124.4 – BP124 – Alluvial Cobble and Gravels - Carbonates

Similar material type as BP 123, BP 118, BP 119, part of the old floodplain of the Grainger River. Preferred location vs. BP 123A because closer proximity to surfacing requirements between KP 125 to 132.

Sufficient volume and area for setting up a crushing plant and for holding stockpiled materials. This area could support aggregate material for long term road maintenance.

Figure 77: Another aerial view of the large deposit of gravels and cobbles, this one at KP 124.

1.9 Km 132.2 – BP 132 – Clay/Silt Till

Back-up clay/silt/sand till borrow material for subgrade overland construction.

Figure 84. View of the vegetation cover at BP 132.

1.10 Km 136.2 – BP 136 – Clay/Silt Till

Back-up clay/silt/sand till borrow material for subgrade overland construction. Some limited potential for alluvial cobble and gravels within the gully and limestone bedrock quarry on the upper portions.

Figure 85. View looking west from the proposed road location. Limited alluvial gravels located in bottom of draw and exposed outcrops of limestone bedrock upper portions. Side slopes (on the lower right) could provide suitable clay/silt/sand till borrow material for subgrade construction.

1.11 Km 138.2 – BP 138 – Exposed Limestone / Carbonate Bedrock

BP 138 contains exposed limestone rock outcrops which could be blasted and crushed for surfacing material. Requires a 1.2 km access road.

Figure 86. A view of the exposed limestone rock outcrops.

1.12 Km 139.6 – BP 139 - Alluvial Cobble and Gravels - Carbonates

A large alluvial fan deposit originating from the nearby Nahanni Range in the west. As with much of the other alluvial cobble noted along the route, this source appears to originate from competent carbonate bedrock, making them an environmentally friendly and preferred construction material. Seasonal stream flows during spring thaw. Detailed design would maintain natural drainage channels.

Sufficient volume and area for setting up a crushing plant and for holding stockpiled materials. This area could support aggregate material for long term road maintenance. Requires 2.0 km access road.

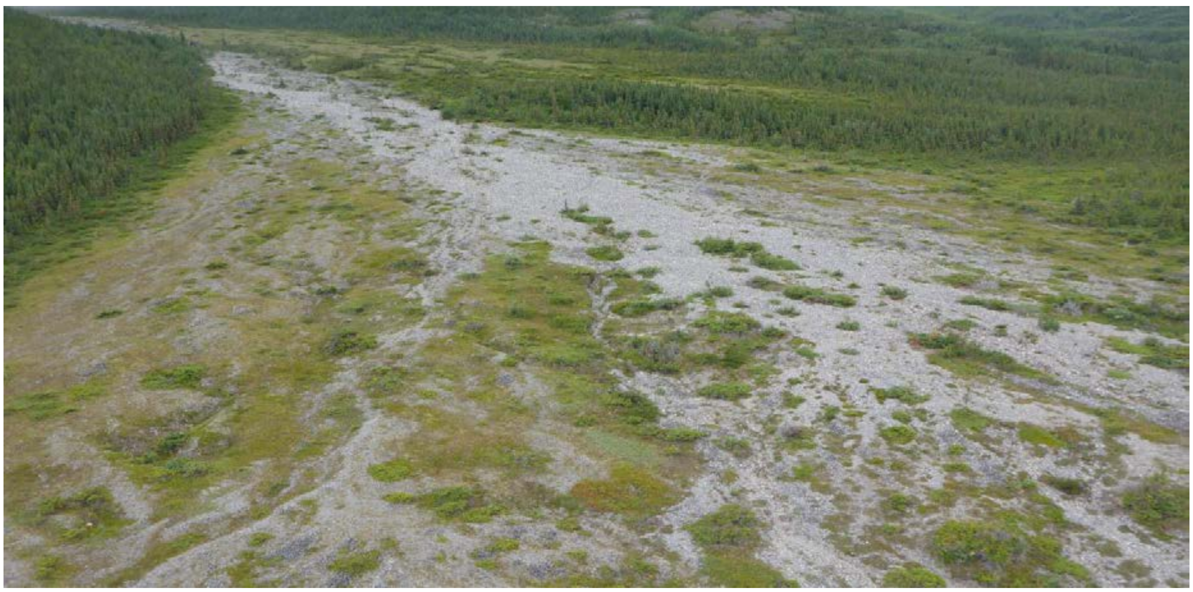


Figure 87. An aerial view of the vast alluvial fan deposit at BP 139.

1.13 Km 140.2 – BP 140 – Clay/Silt Till

Back-up clay/silt/sand till borrow material for subgrade overland construction.

Figure 88. A raised knob vegetated with mature aspen/cottonwood could provide suitable backup borrow material for subgrade construction.

1.14 Km 143.8 – BP 143 – Clay/Silt Till

Back-up clay/silt/sand till borrow material for subgrade overland construction.

Figure 89. Mature aspen covers the proposed backup borrow material at BP 143

1.15 Km 146.5 – BP 146 – Clay/Silt Till

Back-up clay/silt/sand till borrow material for subgrade overland construction.

Figure90. A view of BP 146.

1.16 Km 154.0 – BP 154 – Clay/Silt Till

Back-up clay/silt/sand till borrow material for subgrade overland construction.

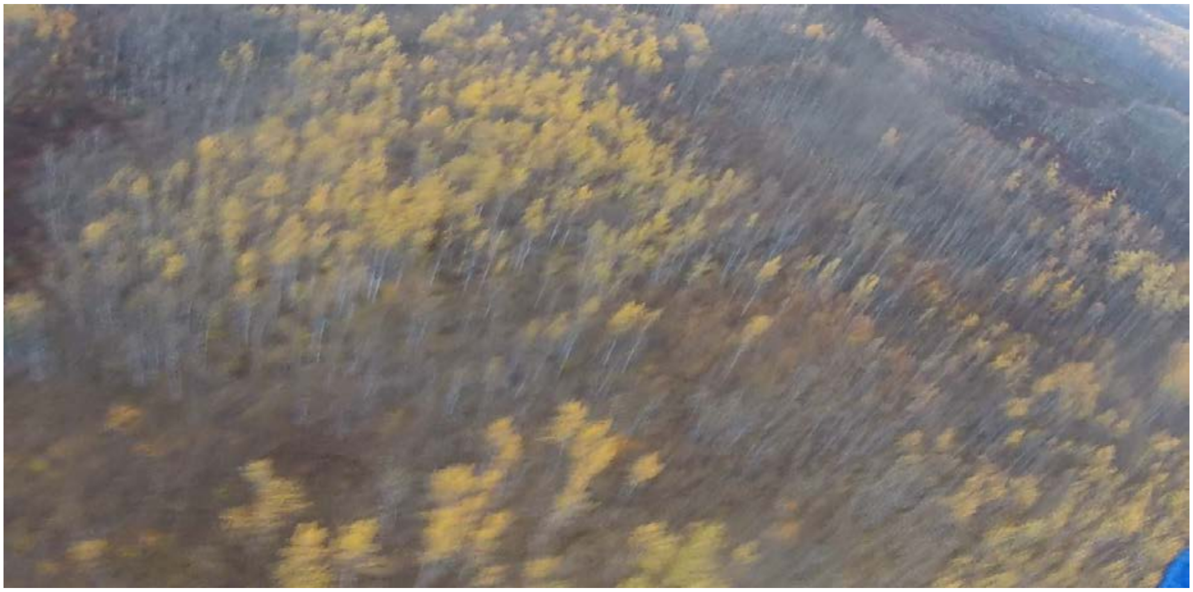


Figure 93: Back-up borrow source option at BP 154.

Appendix E Revised Tables (2, 5, 6, 7, 8, 11 and 16)

Table 2: Summary of Right of Way Clearing Widths and Areas – Alternate Alignment

SECTION	Section Length (kms)	Right of Way Clearing Width (m)	Clearing Area (ha)	Justification
KP 0 to 33.2	33.2	20 m average, variable 15 to 40m	66.4	Road location follows mainly the original road location utilizing the existing right of way. Expect additional clearing to allow for safe line of sight and steep slide slopes creating back-slope cuts and/or stabilization.
KP 33.2 to 40.1	6.9	15 m average, variable 10 to 20m	10.4	Location directly adjacent to Sundog Creek may only require 10m width. The balance of the road is located on old floodplain of Sundog Creek with little or no overburden or vegetation clearing.
KP 40.1 to 95.0	54.9	22 m average, variable 15 to 30m	120.8	60% of the section will utilize the original road right of way. Incorporates overland and conventional construction approaches. Mostly vegetated with small diameter lodgepole pine, spruce, aspen, and scrub birch. Some added right of way required to extract borrow material for overland construction and line of sight.
KP 95.0 to 101.7	6.7	25 m average, variable 15 to 30m	16.8	Fish trap Creek to Wolverine Gap. Road passes through mature, dense aspen with mixed lodgepole pine. Wider right way expected to provide adequate line of sight and safety around the proposed 4 switchbacks.
KP 101.7 to 120.9 (=123.8)	19.2	22 m average, variable 15 to 30 m	41.6	Mostly vegetated with small diameter lodgepole pine, spruce, aspen, and scrub birch. Some added right of way required to extract borrow material for overland construction and line of sight.
KP 123.8 to 126.8	3.0	15 m average, variable 10 to 20 m	4.5	Located along the old floodplain of Grainger River with minimal stripping and clearing. Includes portion of 100% overland.
KP 126.8 to 143.6	16.8	22 m average, variable 15 to 30 m	37.0	Mostly vegetated with small diameter lodgepole pine, spruce, aspen, and scrub birch. Some added right of way required to extract borrow material for overland construction and line of sight.
KP 143.6 to 159.4	15.8	25 m average, variable 15 to 30 m	39.5	Road located through more dense, mature aspen, lodgepole pine, and spruce. Greater right of way clearing required to accommodate safe line of sight, added stripping and clearing volumes and waste.
KP 159.4 to 160.0	0.6	N/A	0.0	Liard River
KP 160.0 to 174.1	14.1	25 m average, variable 15 to 30 m	35.2	Road located through more dense, mature aspen, cottonwood, and spruce. Greater right of way clearing required to accommodate safe line of sight, added stripping and clearing volumes and waste.
KP 174.1 to 184.1	10.0	Not required	0.0	Utilizes existing Nahanni Bute Access Road. No clearing required.
TOTALS	**170.6 (181.2)**	**21.8 m AVERAGE**	**372.2**	**EXCLUDES THE EXISTING NAHANNI BUTE ACCESS ROAD AND LIARD RIVER.**

Table 5: Road Construction Types – Alternate Alignment

Type	Length (km)	Description
TYPE I	**6.5**	UTILIZE EXISTING ROAD GRADE, RE-CONSTRUCTION/WIDENING OF RIGHT OF WAY AND SUBGRADE ON 50% LENGTH, IMPROVE PULLOUTS, DITCH RE-BUILDING AND ESTABLISHMENT, ADDITIONAL CROSS DRAINAGE CULVERTS 3/KM OR AS REQUIRED, MOUNTAIN CONSTRUCTION WITH EXISTING GRANULAR BASE MATERIAL.
TYPE II	**16.8**	UTILIZE EXISTING ROAD , RE-CONSTRUCTION/WIDENING OF SUBGRADE AND SUBGRADE REQUIRED ON 100% LENGTH, IMPROVED PULLOUTS (AS [ER DESIGN SPECS), DITCH IMPROVE-MENT AND RE-BUILDING ADDITIONAL CROSS DRAINAGE CULVERTS 3/KM OR AS REQUIRED, MOUNTAIN CONSTRUCTION WITH EXISTING GRANULAR BASE MATERIAL
TYPE III	**3.8**	NEW CONSTRUCTION WITH EXISTING GRANULAR BASE MATERIAL. 15 TO 50 % SIDE SLOPES, EXPECT RIPPABLE ROCK AND SOME MINOR BLASTING
TYPE IV	**6.5**	EASY UPGRADING EXISTING ROAD ALONG FLOODPLAIN 0 TO 10% SIDE SLOPES, EXSISTING GRAVEL/GRANULAR ROCK BASE MATERIALS.
TYPE V	**5.4**	NEW CONSTRUCTION WITHIN EXISTING R/W, SAND MINOR SILT SOILS, 0 TO 30% SIDE SLOPES, 50% SECTION LENGTH OVERLAND CONSTRUCTION, BORROW MATERIAL WITHIN 300M OR IDENTIFIED OTHERWISE
TYPE VI	**28.7**	NEW CONSTRUCTION WITHIN EXISTING R/W, SAND MINOR SILT SOILS, 0 TO 30% SIDE SLOPES, 25% SECTION LENGTH OVERLAND CONSTRUCTION, BORROW MATERIAL WITHIN 300M
TYPE VII	**53.3**	NEW CONSTRUCTION, SAND MINOR SILT SOILS, 0 TO 30% SIDE SLOPES, 25% SECTION LENGTH OVERLAND CONSTRUCTION, BORROW MATERIAL WITHIN 300M
TYPE VIII	**6.0**	NEW TYPICAL OVERLAND CONSTRUCTION REQUIRED ON 100% OF THE SECTION. BORROW MATERIAL PROVIDED BY DEFINED BORROW PITS OUTSIDE THE NORMAL RIGHT OF WAY CLEARING WIDTH.
TYPE IX	**29.9**	NEW CONSTRUCTION, SAND MINOR SILT SOILS, 0 TO 30% SIDE SLOPES, 25% SECTION LENGTH OVERLAND CONSTRUCTION, BORROW MATERIAL WITHIN 300M, SIMILAR TO TYPE VII BUT LARGER RIGHT OF WAY CLEARING THROUGH MATURE TIMBER.
TYPE X	**6.2**	NEW TYPICAL OVERLAND CONSTRUCTION REQUIRED ON 75% OF THE SECTION. BORROW MATERIAL PROVIDED BY DEFINED BORROW PITS OUTSIDE THE NORMAL RIGHT OF WAY CLEARING WIDTH.
N/A	**7.5**	SEVEN SECTIONS WHERE TERRAIN OR CONSTRUCTION TECHNIQUES ARE DIVERSE AND UNIQUE. FULL CONCEPT DESIGNS HAVE BEEN CREATED FOR EACH OF THESE SECTIONS.
N/A	**10.0**	NAHANNI BUTTE ACCESS ROAD. AN EXISTING ALL SEASON SINGLE LANE PUBLIC ACCESS ROAD WHICH WOULD REQUIRE GRAVELLING TO ACCOMODATE ADDITIONAL INDUSTRIAL TRAFFIC. AS THIS ROAD IS CONSIDERED A PUBLIC ROAD, THE PARTY RESPONSIBLE FOR THIS UPGRADE HAS NOT BEEN DETERMINED AND THEREFORE IS EXCLUDED FROM THIS REPORT.
LIARD R.	**0.6**	
TOTALS	**181.2**	

Table 6: Road Construction Season – Alternate Alignment

Section	Length (km)	Optimal Construction Season	Optional Construction Season	Constraining Factor(s)
KP 0 to 33.2	33.2	Summer	Winter, dry fall	The granular, gravel based well drained soils allow flexibility of construction. The constraining factor includes the two significant stream crossings at KP 28.4 and 29 which may have construction season restrictions related to fish.
KP 33.2 to 38.9	5.7	Summer/Fall	N/A	Construction adjacent to Sundog Creek subject to active channel relocation related to fisheries window.
KP 38.9 to 40.0	1.1	Summer	Winter, dry fall	The granular, gravel based well drained soils allow flexibility of construction. The constraining factor includes a significant stream crossing which may have a restricted construction season related to fish.
KP 40.0 to 60.0	20.0	Dry Summer	Winter with limited snow pack	Road passes through a number of wetter areas which require a good visibility of microsites to manage and apply appropriate construction practices.
KP 60.0 to 90.0	30.0	Dry Summer	Winter, dry fall	Includes significant crossings of Tetcela River which may have a restricted construction season related to fish.
KP 90 to 96.5	6.5	Winter	Dry summer	Construction of subgrade during winter season. Allow a full dry summer season to settle and dry prior to surfacing.
KP 96.5 to 101 101.3 to 103.3	6.5	Dry Summer or early fall	Winter with limited snow pack	Under the guidelines set by Geotechnical Engineer, construction of subgrade under the driest conditions with full visibility of ground conditions to ensure quality control and allows construction adaptation to microsite conditions.
KP 103.3 to 112.0	8.7	Winter	Dry Summer or early fall	The major stream crossing/wetland crossing at KP 111.7 would be considered as winter only. The remaining portion maybe considered for dry late summer/early fall or later fall after some initial freezing temperatures.
112.0 to 120.9/ 123.8 to 124.8)	9.9	Summer	Winter, dry fall	One significant stream crossing at 118.1 must be crossed in mid to late summer, fall, or winter preferably during periods with no surface water flow. The remaining road section consists of dry, well drained soils which should offer suitable conditions for mid/late summer construction.
KP 124.8 to 127.2	2.2	Winter	Early dry fall	Crosses an historic old floodplain of Grainger River with high water in mid-summer. If fall construction is considered, must confirm acceptable site conditions prior to scheduled construction.

Section	Length (km)	Optimal Construction Season	Optional Construction Season	Constraining Factor(s)
KP 127.2 to 150	23	Dry Summer or early fall	Winter with limited snow pack	Several smaller stream crossings which may have restricted construction season related to fisheries.
KP 150 to 174.1	24.2	Winter	Dry summer	Includes the Liard River crossing.
KP 174.1 to 184.1	10.0	Summer	Dry fall	Gravelling of the existing Nahanni Butte Access Road. AS THIS ROAD IS CONSIDERED A PUBLIC ROAD, THE PARTY RESPONSIBLE FOR THIS UPGRADE HAS NOT BEEN DETERMINED AND THEREFORE IS EXCLUDED FROM THIS REPORT.

Table 7: Road Summary – Alternate Alignment

Section	Length (km)	Construct Type	Site Details	Field Photo
0 to KP 6.5	6.5	I	Proposed road follows existing road tightly along the base of steep mountain slopes on the east side and Prairie Creek on the west side. Existing road was constructed with well drained, gravel/rock base 3 to 5 m wide running surface. Several narrow road sections contain steep talus rock side slopes and rock faces which will require rock fall and avalanche management plan. The most severe sections may require rock fences/barriers to ensure the reliability and safety of transportation. Several sections require additional armouring of fill slope susceptible to Prairie Creek.	

Section	Length (km)	Construct Type	Site Details	Field Photo
KP 6.5 to KP 13.0	6.5	II	Similar to the earlier section, the proposed road follows the existing road tightly along the base of steep mountain slopes on the south side and along Funeral Creek on the north side. Existing road was constructed with well drained, gravel/rock base with mostly a 3 m wide running surface, some sections 4 meters wide. Several narrow road sections contain steep talus rock side slopes and faces which will require some type of rock stabilization and avalanche management plan. The most severe sections may require rock fences/barriers to ensure the reliability and safety of transportation. The toe fill of the road subgrade is located tightly to the active channel of Funeral Creek and will require additional armoring.	
KP 13.0 to KP 13.8	0.8	N/A	Re-construction of a switchback referred to as the "hairpin corner". Combination of utilizing the existing road alignment and new alignment to improve a tight and challenging section. Existing road was constructed with well drained, gravel/rock base with mostly a 3 m wide running surface, some sections slightly wider. Includes a crossing over a significant tributary of Funeral Creek. The switchback will require a large cut-through on the west side which will produce 20,000m3 excess waste volume to be end hauled to KP 12.5.	

Section	Length (km)	Construct Type	Site Details	Field Photo
KP 13.8 to KP 23.0	9.2	II	Proposed road follows existing road grade with several short new re-alignment sections. Existing road is 3 m wide with many sections with 10% grade, some short sections may exceed 10% grade. Mountain pass and construction with gravel/loose rock base. Several narrow road sections contain steep talus rock side slopes and rock faces which will require some type of rock stabilization and avalanche management plan.	
KP 23 to 23.8	0.8	N/A	Challenging new construction section includes a major crossing of upper Sundog Creek. Will include an unavoidable 500 m section of sustained 11 % grade. Expect blasting to meet maximum grade and alignment design specs. Well drained gravel/loose rock base.	

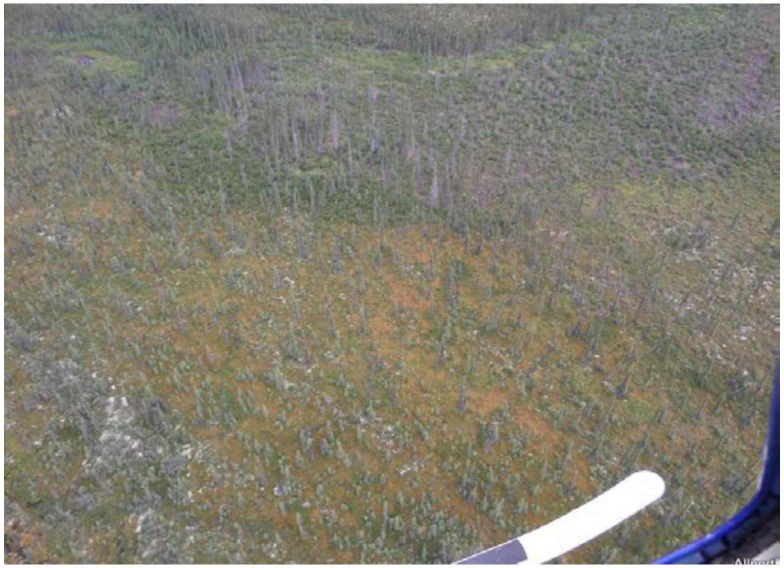
Section	Length (km)	Construct Type	Site Details	Field Photo
KP 23.8 to KP 25.2 KP 25.6 to KP 28.0	3.8	III	New construction section through typical mountain conditions contouring along the slope with minimal cuts. Gravel/loose rock base material, 20 to 40% side slopes, mostly covered in short, scrub type black spruce cover. May encounter some permafrost sections but should be manageable with drier, granular soil types.	
KP 25.2 to KP 25.6	0.4	N/A	Challenging new construction section includes a crossing of major tributary of upper Sundog Creek. Expect blasting to meet maximum grade and alignment design specs. Well drained gravel/loose rock base. Reduced road design with 4 meter road design to minimize costs and environmental footprint. This proposed section along the south side of Sundog Creek is re-alignment from the original (north side) road location. Although this crossing is difficult, overall it is considered a better alternative to avoid multiple crossings over the upper Sundog Creek, crossing major talus rock side-slopes, and high risk avalanche zones.	

Section	Length (km)	Construct Type	Site Details	Field Photo
KP 28.0 to KP 28.4	0.4	N/A	Challenging new construction section with 50 to 60% side slopes with talus rock and some bedrock. Expect blasting to meet maximum grade and alignment design specs. Reduced road width of 4 m to minimize costs and environmental footprint. Well drained gravel/loose rock base. This proposed section along the south side of Sundog Creek is part of re-alignment from the original (north side) road location. Although this crossing is difficult, overall it is considered a better all season alternative to avoid multiple crossings over upper Sundog Creek, crossing major talus rock side slopes, and high risk avalanche zones.	
KP 28.4 to KP 29.5	1.1	II	Proposed road utilizes existing road along the base of talus rock slope. Steep talus rock side hill may require a rock stabilization and avalanche management plan. The most severe sections may require rock fences/barriers to ensure the reliability and safety of transportation. Existing road base 3 meters wide constructed with well drained gravel/loose rock base. Includes two major crossings over the Sundog Creek.	

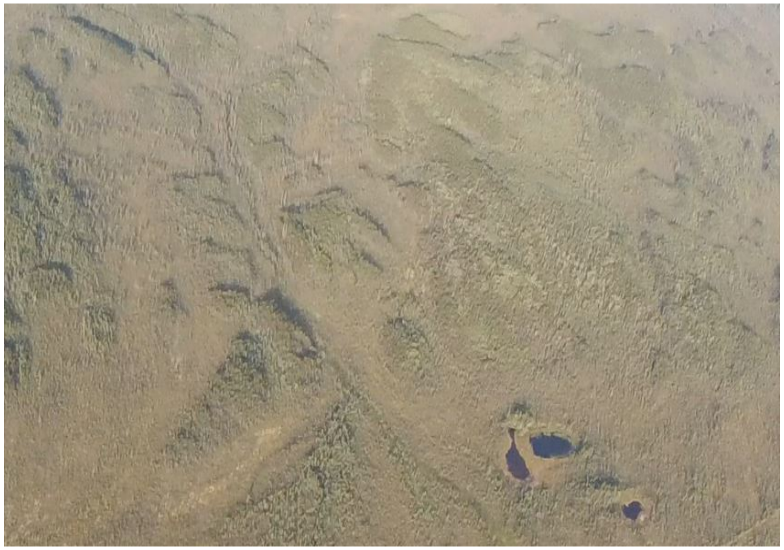
Section	Length (km)	Construct Type	Site Details	Field Photo
KP 29.5 to KP 33.2 KP 34.2 to K P34.8	4.3	IV	Part of the old flood plain of Sundog Creek, a relatively easy section combining existing road grade and some new alignment allowing greater buffer from Sundog Creek. Final route selection will balance the pros/cons associated utilizing existing road subgrade in close proximity to Sundog Creek compared to a greater buffer allowance without increasing avalanche hazard. Well drained gravel/loose rock base with 10% side slopes. The old subgrade is identifiable within most of the section.	
KP 33.2 to KP 34.2 KP 34.8 to KP 38.9	5.1	N/A	Potentially challenging new construction section defined as "non-typical" overland. The subgrade will be constructed tightly at the base of the steep loose talus rock slopes and rock faces along the south side of the lower Sundog floodplain. Road will be built up mainly with imported (locally available) larger talus rock base which in places will be placed in a seasonally active stream channel. CZN proposes channel re-alignment to maintain habitat and provide separation from the road. Any sections with significant rock fall hazard will require rock fences/barriers to ensure the reliability and safety of transportation.	

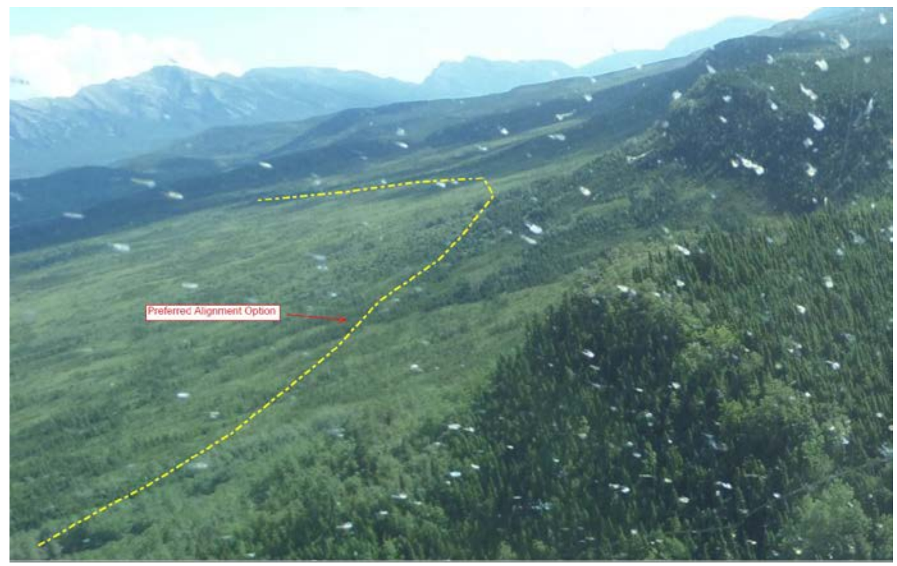
Section	Length (km)	Construct Type	Site Details	Field Photo
KP 38.9 to KP 40.1	1.2	IV	Relatively easy upgrade section on existing road grade on old floodplain of Sundog. Well drained gravel/loose rock base with 10% side-slopes. One major stream crossing over a significant tributary of Sundog Creek.	
KP 40.1 to KP 41.5	1.4	V	Utilizing the existing road, expect 50% length will require typical overland construction over wet sections. Borrow material for subgrade should be available within 300 m, extracted mainly from a wider right of way. Sand base material with 10 to 20% side slopes.	

Section	Length (km)	Construct Type	Site Details	Field Photo
KP 41.5 to KP 49.0	7.5	VI	Utilizing the existing road, expect 25% length will require typical overland construction over wet sections. Borrow material for subgrade should be available within 300 m, extracted mainly from a wider right of way. Sand base material with 10 to 20% side-slopes. Forested with open smaller diameter mature spruce and jack pine.	
KP 49.0 to KP 51.5 KP 54.5 to KP 58.8	6.8	VII	New construction section expecting 25% length requiring typical overland construction approach over wet areas. Silty sand soils with 20 to 30 % side-slopes, some sections with 40 to 50% side-slopes. Borrow material to be extracted primarily from right of way with some defined borrow areas defined outside the standard right of way.	

Section	Length (km)	Construct Type	Site Details	Field Photo
KP 51.5 to KP 54.5	3.0	VIII	New construction which will require typical overland construction over the full length. Borrow material for subgrade should be available from defined borrow areas outside road right of way. Includes one major crossing over Poljie Creek. Sand base material with 0 to 20% side slopes. Near KP 54, a recent (past 10 years) significant slope failure has occurred believed to be the result of thawing permafrost (refer to Geotech report). The proposed road maintains 100 m buffer skirting above the slump. We propose an overland construction approach which will not disturb the natural rooted vegetation and soils.	
KP 58.8 to KP 80.0	21.2	VI	Utilizing the existing road, expect 25% length requiring typical overland construction over wet sections. Borrow material for subgrade should be available within 300 m extracted primarily from a wider right of way, with some defined borrow areas outside road right of way. Sand base material with 20 to 30% side slopes.	

Section	Length (km)	Construct Type	Site Details	Field Photo
KP 80.0 to KP 86.5	6.5	VII	New construction with 25% length requiring typical overland construction over wet sections. Borrow material for subgrade should be available within 300 m extracted mainly from a wider right of way. Sand base material with 10 to 20% side slopes. Forested with dense forest of mature aspen, spruce and jack pine	
KP 86.5 to KP 90.5	4.0	V	Utilizing mainly the existing road location, construction 50% length requiring typical overland construction over wet sections. Borrow material for subgrade should be available within 300 m extracted mainly from a wider right of way. Potential large source of gravel near KP 87 may provide quality borrow material. Sand base material with 0 to 20% side slopes.	

Section	Length (km)	Construct Type	Site Details	Field Photo
KP 90.5 to KP 94.5	4.0	VII	Interesting landscape with large "island like" dry humps covered with dense layer of mature, small diameter aspen, spruce, and jack pine; surrounded by a network of wet to very wet black spruce, and tamarack. The road will jump across these wet sections "island to island" utilizing the mixture of silt / fine sand material as borrow source for typical overland construction.	
KP 94.5 to KP 95.5	1.0	VIII	Utilizing the existing road, a very wet overland section crossing Fishtrap Creek. Borrow material for subgrade will be extracted at either end of the crossing up to 1 km away.	

Section	Length (km)	Construct Type	Site Details	Field Photo
KP 95.5 to KP 101.7	6.2	X	The location utilizes the winter route with some modifications to avoid stability concerns identified by the Geotechnical Engineer. The road climbs up from Fishtrap Creek valley bottom gaining over 300 m in elevation up to "Wolverine Gap". In general, the hillside is considered a geotechnical concern regarding slope / ground stability however the proposed location offers reasonably safe passage. The final construction approach taken will be under Geotechnical Engineer guidelines with of construction operations. Borrow material for subgrade extracted mainly from defined borrow sites near KP 96, 102, and 103 (up to 3 km away). This southwest aspect hillside is covered in mature aspen and spruce.	
KP 101.7 to KP 112.0	10.3	VII	Referred to as the "Silent Hills", new construction with 25% of the section requiring typical overland construction over wet sections. Borrow material for subgrade should be available within 300 m extracted mainly from a wider right of way. The proposed road passes within close proximity to a series of elevated carbonate based rock humps and ridges which may offer potentially favorable borrow material for overland sections and blast rock crush supply. A mix of open scrub birch/aspen and small diameter aspen, spruce, and jack pine cover the proposed route. This alternative option passes along the eastern or lower portions of the series of ridges. Fewer numbers of small streams and drainages will be crossed but greater in size. May have greater probability of permafrost along the north-easterly	

Section	Length (km)	Construct Type	Site Details	Field Photo
			aspect slopes but vegetation cover suggests otherwise.	
KP 112.0 to KP 120.9 (= 123.8)	8.9	VII	New construction with 25% of the section requiring typical overland construction over wet sections. Borrow material for subgrade should be available within 300 m extracted mainly from a wider right of way. This section of road follows along the western slopes of the Franklin Mountains of the Nahanni Range. The vegetation cover consists of immature pine and spruce. Exposed bedrock was viewed periodically along the route. These indicators suggest dry, well drained soils likely gravel based.	
KP 123.8 to KP 124.8	1.0	IV	Grainger Gap. Relatively easy upgrade section utilizing existing road grade on old floodplain of Grainger River. Well drained gravel/loose rock base with 10% side-slopes	

Section	Length (km)	Construct Type	Site Details	Field Photo
KP 124.8 to KP 126.8	2.0	VIII	Under the suggestion of the Geotech Engineer, the road utilizes primarily the original winter route through this section which crosses a historical flood plain of Grainger River. Proposed as a full overland section utilizing coarse granular base material to allow the natural surface drainage.	
KP 126.8 to KP 143.6	16.8	VII	The proposed road meanders along the east slopes of the Nahanni Range. It tracts along dry ridges and slope breaks crossing wet black spruce/tamarack lowlands in which typical overland construction will be applied. These north/north-east slopes are gently rolling, with 10 to 30% side slopes. Permafrost is likely to be encountered on a spotty basis. The landscape is covered with a mix of mature aspen/cottonwood patches scattered within open 1 to 2 m tall scrub willow and birch. The road crosses a number of mostly small streams and drainages. The base soils consist of a mix of silt/clay, with some sand.	

Section	Length (km)	Construct Type	Site Details	Field Photo
KP 143.6 to KP 159.4	15.8	IX	As the proposed road moves farther east and south, away from the influence of the Nahanni Range, the vegetation becomes denser with mature aspen, spruce, cottonwood, and some lodgepole pine. The road contours along the slopes and drier ridges linking the patches and strips of mature timber while crossing short wet sections in between. Rolling terrain with 10 to 30% side-slopes. Permafrost is likely to be encountered on a spotty basis.	
KP 160.0 to KP 174.1	14.1	IX	The proposed road connects the Liard River crossing to the Nahanni Butte access road via an old logging road. Located along the old floodplain of the Liard River. Mostly covered with mature aspen, cottonwood, and spruce. Near flat terrain with 0 to 10% side slopes and silty sand/sandy silt fine soils. It will be difficult sourcing suitable aggregate surfacing material. Options include the north side of Liard River (best and preferred option, if available) or existing operational pits located near and along the Liard Highway.	

Section	Length (km)	Construct Type	Site Details	Field Photo
KP 174.1 to KP 184.1	10.0	N/A	Utilizing the existing Nahanni Butte access road connecting to the Liard Highway, #7. Existing road looks in good shape. Expect additional gravelling. This is a public road and is publicly maintained, as such will exclude upgrades required to this road.	

Table 8: Earthworks Summary – Alternate Alignment

Section	Type	Stripping (m^3)	Cut Volume (m^3) (blast rock)	Fill Volume (m^3)	Armouring / Rip Rap (m^3)	Surfacing (M^3)	Borrow (Waste) Volume (M^3)	Utilized Borrow Pit (BP)	Comments:
0 to KP 6.5	I	0	13,000	43,180	2,000	2,925	30,180	2	Borrow fill material required for subgrade will extracted from combination within right of way and borrow pit.
KP 6.5 to KP 13.0	II	0	8,840	6,755	2,000	3,950	2,000	2, 14, 16	Excess waste to be utilized from KP 0 to 6.5.
KP 13.0 to KP 13.8	N/A	893	23,556	3,022	150	901	(20,534)	14, 16	Excess waste to be end hauled to KP 12.6.
KP 13.8 to KP 23.0	II	0	13,800	13,652	350	6,150	350	14, 16	
KP 23 to KP 23.7	N/A	0	10,581 (6,077)	2,238	100	304	(8,343)	16	Excess waste (primarily blast rock) will be utilized as rip rap or armouring as required nearby. Excess waste can be placed at the proposed Camp 23.2.
KP 23.7 to KP 25.2	III	1,554	2,097	2,077.8	0	1,400	0	16, 25	
KP 25.2 to KP 25.6	N/A	484	7,735 (6,972)	2,106	0	156	(5,629)	16, 25	Excess volume will be utilized into subgrade from KP 24.5 to 25.2 and KP 25.6 to 26.0
KP 25.6 to KP	III	5,592	3,595	3,562	100	2,400	0	25	

Section	Type	Stripping (m^3)	Cut Volume (m^3) (blast rock)	Fill Volume (m^3)	Armouring / Rip Rap (m^3)	Surfacing (M^3)	Borrow (Waste) Volume (M^3)	Utilized Borrow Pit (BP)	Comments:
28.0									
KP 28.0 to KP 28.4	N/A	0	4,747 (3,913)	4,778	0	300	0	25	
KP 28.4 to KP 29.5	II	0	1,348	1,336	250	650	0	25	Rip Rap and armouring required at two streams and should be available from local talus rock deposits within existing right of way.
KP 29.5 to KP 33.2	IV	4,558	7,881	6,812	600	2,039	(1,000)	25,	
KP 33.2 to KP 34.2	N/A	0	3,798	7,116	2,372	550	3,318	33, 34, 39	
KP 34.2 to KP 34.8	IV	739	1,278	1,105	0	350	350	39	
KP 34.8 to KP 38.9	N/A	0	5,456	36,079	10,000	2,249	30,623	34, 35, 38, 39	
KP 38.9 to KP 40.1	IV	1,478	2,556	2,209	200	660	(347)	38, 39	

Section	Type	Stripping (m^3)	Cut Volume (m^3) (blast rock)	Fill Volume (m^3)	Armouring / Rip Rap (m^3)	Surfacing (M^3)	Borrow (Waste) Volume (M^3)	Utilized Borrow Pit (BP)	Comments:
KP 40.1 to KP 41.5	V	743	1,400	6,087	0	2,496	4,687	40	
KP 41.5 to KP 49.0	VI	6,923	6,623	26,295	300	13,103	19,972	40, 43A, 43B, 47B, 47C	Borrow material for overland subgrade extracted primarily from within the right of way.
KP 49.0 to KP 51.5	VII	3,765	13,523	13,669	150	4,649	296	47B, 47C, 50B	Borrow material for overland subgrade extracted primarily from within the right of way.
KP 51.5 to KP 54.5	VIII	0	0	25,428	150	5,385	25,428	47B, 50, 51, 53	Overland section.
KP 54.5 to KP 58.8	VII	9,816	35,256	35,637	100	12,121	381	59, 61, 64, 65	
KP 58.8 to KP 80.0	VI	19,568	18,698	74,327	250	37,036	55,629	59, 61, 64, 65, 67, 70, 72, 76, 78	Borrow fill material required for subgrade will extracted from combination within right of way and borrow pit.
KP 80.0 to KP 86.5	VII	8,740	31,393	31,732	0	10,792	339	87	Borrow material for overland subgrade extracted primarily from within the right of way.
KP 86.5 to KP 90.5	V	2,124	19,976	17,392	300	7,132	(2,584)	86A, 86B, 87	Includes sand borrow for long term winter maintenance.

Section	Type	Stripping (m^3)	Cut Volume (m^3) (blast rock)	Fill Volume (m^3)	Armouring / Rip Rap (m^3)	Surfacing (M^3)	Borrow (Waste) Volume (M^3)	Utilized Borrow Pit (BP)	Comments:
KP 90.5 to KP 94.5	VII	5,379	19,318	19,527	200	6,641	209	87, 90, 92, 93A, 93B	Borrow material for overland subgrade extracted primarily from within the right of way. Some additional volume identified to reflect the terrain.
KP 94.5 to 95.5	VIII	0	0	8,476	50	1,795	8,476	87, 94, 96	Overland section.
KP 95.5 to KP 101.7	X	22,748	43,007	72,838	100	11,265	32,011	87, 96, 97, 102, 103, 112.3	Use coarse blast rock generated at BP 103 to stabilize toe fills on steeper side slope sections and reduce required borrow volume.
KP 101.7 to KP 120.9 (=123.8)	VII	26,170	94,963	95,995	250	33,100	404	102, 103, 112.3, 118	Some additional volume identified to reflect the terrain.
KP 123.5 to KP 124.8	IV	2,130	2,130	1,842	200	550	(374)	124	
KP 124.8 to KP 126.8	VIII	0	0	16,952	0	3,590	20,342	118, 123B, 124,	Overland section requires coarse, granular borrow material.
KP 126.8 to KP 143.6	VII	22,590	81,138	82,014	450	27,894	876	124, 139,	Borrow material for overland subgrade extracted primarily from within the right of way.
KP 143.6 to KP	IX	18,052	30,311	87,333	400	27,665	56,874	139,151 A, B	Borrow material for overland subgrade extracted primarily from

Section	Type	Stripping (m^3)	Cut Volume (m^3) (blast rock)	Fill Volume (m^3)	Armouring / Rip Rap (m^3)	Surfacing (M^3)	Borrow (Waste) Volume (M^3)	Utilized Borrow Pit (BP)	Comments:
158.3								158	within the right of way.
KP 158.3 to KP 159.4	N/A	4,390	8,359	12,743	4,384	6,046	4,384 (1,700)	151A, B 158	North Access Ramp on Liard River. Some cut volume not suitable material for ramp and must be wasted and imported rip rap material required for ramp.
KP 159.4 to KP 160.	Liard R.	0	0	0	0	0	0		
KP 160.0 to KP 160.7		619	537	30,382	4,000	9,177	30,070	151A, B 158	South Access Ramp on Liard River. Rip rap material required for ramp
KP 161.7 to KP 174.1.	IX	16,578	27,837	80,204	100	25,407	52,231	151A, B 158	Borrow material for overland subgrade extracted primarily from within the right of way.
KP 174.1 to KP 184.1	N/A	0	0	0	0	Not Included	0.0	151A, B 158	Existing Nahanni Butte Access Road.
TOTALS		**185,633**	**544,737 (16,962)**	**874,901**	**29,506**	**270,828**	**379,430 (40,511)**		

Table 11: Minor Stream Crossing Summary – Alternate Alignment

Location	Concept Design	Watershed	Fish	Approach for Design Selection
KP 2.9	No.2	Prairie Creek	no	Ground confirmed. Existing culvert.
KP 3.3	No. 1	Prairie Creek	no	Ground confirmed. Existing culvert.
KP 4.4	No.2	Prairie Creek	no	Ground confirmed. Existing culvert.
KP 6.1	No. 2	Prairie Creek	no	Ground confirmed. Existing culvert.
KP 6.6	No. 2	Prairie Creek	no	Ground confirmed. Existing culvert.
KP 9.3	No. 1	Funeral Creek	no	Ground confirmed. Existing culvert.
KP 9.7	No. 1	Funeral Creek	no	Ground confirmed. Existing culvert
KP 9.8	No. 1	Funeral Creek	no	Ground confirmed. Existing culvert.
KP 10.7	No.2	Funeral Creek	no	Ground confirmed. Seasonal flow. 3.2m w x 0.5m d @25% gradient
KP 10.9	No.2	Funeral Creek	no	Ground confirmed. Seasonal flow. 3.0 m d x 0.3m d @25% gradient
KP 11.1	No.2	Funeral Creek	no	Ground confirmed. Seasonal flow. 3.3m w x 0.3m d @12% gradient
KP 11.7	No. 1	Funeral Creek	no	Ground confirmed. Seasonal flow. 2.0m w x 0.3m d @14% gradient
KP 13.3	No. 1	Funeral Creek	no	Ground confirmed. Seasonal flow. 2.0 m w x 0.3m d @ 12% gradient
KP 14.8	No. 1	Funeral Creek	no	Ground confirmed. Seasonal flow. 1.0m w x 0.3 d @ 40% gradient
KP 15.2	No. 2	Funeral Creek	no	Ground confirmed. Seasonal flow. 2.0m w x 0.3m d @ 25% gradient
KP 15.8	No. 1	Funeral Creek	no	Ground confirmed. Seasonal flow. 1.2m w x 0.2m d @7 % gradient
KP 18.9	No. 1	Sundog Creek	no	Ground confirmed. Seasonal flow. 1.0m w x 0.3 d @ 25% gradient
KP 26.7	No. 2	Sundog Creek	no	Ground confirmed. Bedrock evident on bottom. 3.0m w x 0.3m d @25% gradient
KP 27.3	No. 2	Sundog Creek	no	Low elevation aerial view.
KP 29.9	Concept Completed	Sundog Creek	no	Low elevation aerial view. Individual concept design created utilizing 3 large diameter culverts.
KP 29.3	No. 2	Sundog Creek	no	Low elevation aerial view.
KP 30.2	No. 1	Sundog Creek	no	Low elevation aerial view.
KP 30.6	No. 2	Sundog Creek	no	Low elevation aerial view.
KP 31.0	No. 1	Sundog	no	Low elevation aerial view.

Location	Concept Design	Watershed	Fish	Approach for Design Selection
		Creek		
KP 31.4	Concept Completed	Sundog Creek	no	Low elevation aerial view. Individual concept design created utilizing 2 large diameter culverts.
KP 31.7	Concept Completed	Sundog Creek	no	Low elevation aerial view. Individual concept design created utilizing 1 large diameter culverts.
KP 32.4	Concept Completed	Sundog Creek	no	Low elevation aerial view. Individual concept design created utilizing 1 large diameter culverts.
KP 45.5	No. 3	Poljie Creek	no	Low elevation aerial view.
KP 46.2	No. 1	Poljie Creek	yes	Ground confirmed. 0.5m w x 0.3m d @5%. gradient Oversize culvert to allow for fish passage.
KP 46.3	No. 3	Poljie Creek	no	Ground confirmed. 0.5m w x 0.2m d @8% gradient
KP 47.2	No. 3	Poljie Creek	no	Ground confirmed. 1.0m w x 0.1m d @7% gradient
KP 49.7	No. 1	Poljie Creek	yes	Ground confirmed. 1.2m w x 0.4m d @5% gradient Oversize culvert to allow for fish passage.
KP 50.7	No. 3	Poljie Creek	no	Ground confirmed. 1.0m w x 0.2m d @6% gradient
KP 50.8	No. 1	Poljie Creek	no	Ground confirmed. 0.9m w x 0.4m d @ 3% gradient
KP 53.6	No. 2	Poljie Creek	yes	Low elevation aerial view.
KP 53.65	No.2	Poljie Creek	yes	Low elevation aerial view.
KP 56.4	No. 3	Poljie Creek	no	Ground confirmed. 0.4m w x 0.2m d @5% gradient
KP 56.5	No. 2	Poljie Creek	no	Ground confirmed. 2.5m w x 0.4m d @5% gradient
KP 60.4	No. 2	Poljie Creek	no	Low elevation aerial view.
KP 61.6	No. 2	Poljie Creek	no	Low elevation aerial view.
KP 63.5	No. 2	Poljie Creek	no	Low elevation aerial view.
KP 67.2	No. 3	Tetcela River	no	Low elevation aerial view
KP 71.1	No. 3	Tetcela River	no	Low elevation aerial view
KP 87.4	No. 3	Tetcela River	no	Low elevation aerial view
KP 85.5	No. 2	Tetcela River	no	Low elevation aerial view.
KP 87.2	No. 2	Tetcela River	no	Low elevation aerial view.
KP 91.3	No. 1	Fishtrap Cr.	no	Low elevation aerial view.
KP 92.5	No. 1	Fishtrap Cr	no	Low elevation aerial view.
KP 93.1	No. 1	Fishtrap Cr	no	Low elevation aerial view.
KP 93.6	No. 2	Fishtrap Cr	no	Low elevation aerial view.
KP 97.5	No. 3	Fishtrap Cr	no	Low elevation aerial view.
KP 98.6	No. 3	Fishtrap Cr	no	Low elevation aerial view.
KP 103.4	No. 3	Unnamed	no	Low elevation aerial view.
KP 104.0	No. 3	Unnamed	no	Low elevation aerial view.
KP 105.3	No. 2	Unnamed	no	Low elevation aerial view.
KP 105.4	No.1	Unnamed	no	Low elevation aerial view.
KP 105.6	No.3	Unnamed	no	Low elevation aerial view.
KP 106.4	No.1	Unnamed	no	Low elevation aerial view.
KP 106.9	No. 2	Unnamed	no	Low elevation aerial view.
KP 109.5	No. 2	Unnamed	no	Low elevation aerial view.
KP 109.8	No. 1	Unnamed	no	Low elevation aerial view.
KP 110.8	No. 1	Unnamed	no	Low elevation aerial view.

Location	Concept Design	Watershed	Fish	Approach for Design Selection
KP 112.2	No. 2	Unnamed	no	Low elevation aerial view.
KP 112.4	No. 2	Unnamed	no	Low elevation aerial view.
KP 112.7	No. 2	Unnamed	no	Low elevation aerial view.
KP 113.0	No. 1	Unnamed	no	Low elevation aerial view.
KP 114.0	No. 2	Unnamed	no	Low elevation aerial view.
KP 114.5	No. 1	Unnamed	no	Low elevation aerial view.
KP 114.9	No. 1	Unnamed	no	Low elevation aerial view.
KP 115.1	No. 3	Unnamed	no	Low elevation aerial view.
KP 115.2	No. 3	Unnamed	no	Low elevation aerial view.
KP 117.1	No. 2	Unnamed	no	Low elevation aerial view.
KP 118.4	No. 1	Unnamed	no	Low elevation aerial view.
KP 119.3	No. 1	Unnamed	no	Low elevation aerial view.
KP 119.6	No. 1	Unnamed	no	Low elevation aerial view.
KP 126.4	No. 2	Grainger	yes	Not field confirmed but assumed to be fish bearing. Low elevation aerial view. Oversize culvert to allow for fish passage.
KP 126.5	No. 2	Grainger	yes	Not field confirmed but assumed to be fish bearing. Low elevation aerial view. Oversize culvert to allow for fish passage.
KP 127.1	No. 1	Grainger	no	Ground confirmed. 1.5m w x 0.2m d@ 7% gradient
KP 131.2	No. 3	Grainger	?	Low elevation aerial view.
KP 133.2	No.1	Grainger	?	Low elevation aerial view.
KP 134.9	No. 3	Grainger	?	Low elevation aerial view
KP 136.2	No. 3	Grainger	no	Low elevation aerial view
KP 136.5	No. 3	Grainger	?	Low elevation aerial view
KP 137.2	No. 3	Grainger	no	Ground confirmed. 0.8m w x 0.1m d @15% gradient
KP 140.1	No. 3	Liard	no	Low elevation aerial view
KP 140.5	No. 1	Liard	no	Low elevation aerial view.
KP 141	No. 3	Liard	no	Low elevation aerial view
KP 144.4	No. 1	Liard	no	Ground confirmed. 1.0m w x 0.2m d @5% gradient
KP 146.9	No. 1	Liard	no	Low elevation aerial view.
KP 149.9	No. 3	Liard	no	Low elevation aerial view
KP 150.8	No. 3	Liard	no	Low elevation aerial view
KP 152.5	No. 1	Liard	no	Ground confirmed. 1.3 m w x 0.3m d @19% gradient
KP 154.9	No. 1	Liard	?	Low elevation aerial view
KP 164.2	No. 3	Liard	no	Low elevation aerial view
KP 172.4	No. 1	Liard	no	Low elevation aerial view

Note: Fish stream classification provided by CNZ.

Table 16: Land Requirements – Alternate Alignment

Feature	Disturbance Type	Area (Ha)	Duration (years)	Reclamation Approach
All Season Access Road	Road right of way and prism.	372.2	Long Term	Full de-activation upon completion of mine operations.
* Borrow Pits	Extraction of borrow material and required access roads.	40.84 Roads 7.31	90% Short Term, balance Long Term	Full de-activation as borrow source is depleted or no longer required. Re-establish water natural water drainages and contour cut slopes as required.
Waste Pit	Cleared for the deposit of excess cut material	0.69	Short Term	Full restoration of disturbed area, contour cut slopes to natural shape and allow natural regeneration.
Major Bridge Construction	Cleared staging/ landing to support construction.	4.25	Short Term	Full restoration of disturbed area, contour cut slopes to natural shape and replace any removed stripping/organics to allow natural regeneration of vegetation.
Camps and Laydowns	Cleared staging/ landing to support construction.	21.0	Short Term	Full restoration of disturbed area, contour cut slopes to natural shape and replace any removed stripping/organics to allow natural regeneration of vegetation.
Airstrip	Airstrip and access road right of way	32.5	Long Term	Full de-activation of airstrip, apron area, and access road.
TTF	Transfer facility and small camp for concentrate hauling.	3.4	Long Term	Full de-activation when no longer required.
Liard Crossing	Additional right way clearing and staging area to support construction and long term crossing.	3.0	Long Term	Full de-activation upon completion of mine operations.
TOTALS		**485.19**		

*Borrow Pit Area is not the gross area but the actual estimated disturbed area required to access and extract borrow material volume.

Appendix F Soil Lab Test Results

Sieve Analysis Report

2011 PG Pulpmill Road, PO Box 968, Prince George, BC V2L 4V1 Phone: 250-614-7291			
ASTM C-117; C-136 CAN/CGSB-8.2M			
Test Date:	July 17th 2015	Report Number:	Sample 1 -2015
File Number:	15GP0091	Inspector:	D.Main
Client:	Canadian Zinc	Sampled By:	EK / Allnorth
Project:	Praire Creek Mine Access Road	Sample Date:	July 8th 2015
Location:	KP 112.3 Preferred Alignment, BP 112.3	Copy To:	
Contractor:			

TEST RESULTS

SIEVE SIZE (mm)	75	50	37.5	25	19	16	12.5	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075
MAX % PASS SPEC															
MIN % PASS SPEC															
% PASS RESULTS	**100.0**	**88.6**	**75.3**	**62.4**	**44.8**	**40.8**	**33.6**	**28.2**	**17.6**	**12.4**	**9.8**	**8.2**	**6.7**	**5.2**	**3.3**

MATERIAL TYPE

SIEVE METHOD

Wash

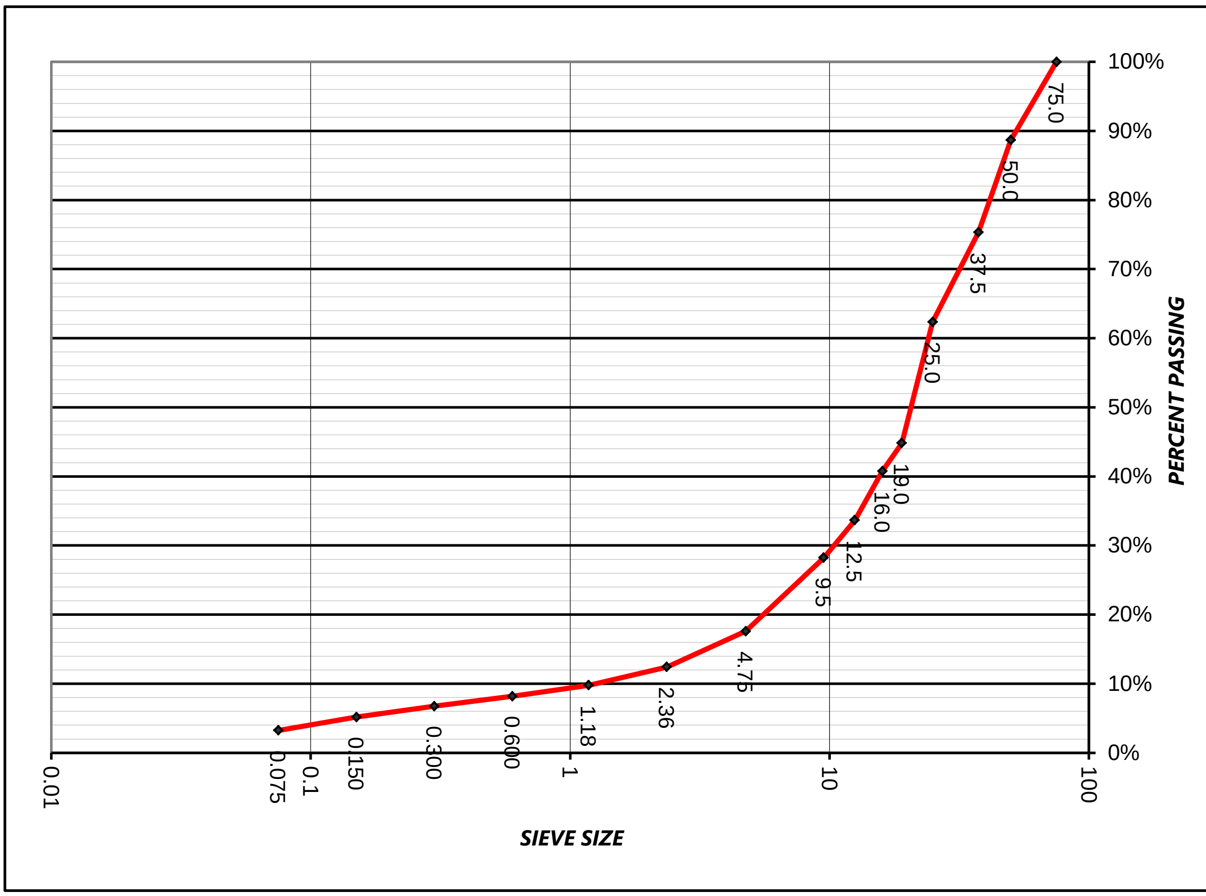
% FRACTURE

% MOISTURE

1.8%

GRADATIONS

GRAVEL	**82.4%**
SAND	**14.3%**
SILT/CLAY	**3.3%**



COMMENTS

Sample label : EK July 8 (61 22 55) (123 28 35)	**Reviewed By:**

Sieve Analysis Report

2011 PG Pulpmill Road, PO Box 968, Prince George, BC V2L 4V1 Phone: 250-614-7291

ASTM C-117; C-136 CAN/CGSB-8.2M

Test Date:	July 17th 2015	Report Number:	Sample 2 -2015
File Number:	15GP0091	Inspector:	D.Main
Client:	Canadian Zinc.	Sampled By:	EK / Allnorth
Project:	Praire Creek Access Road	Sample Date:	July 8th 2015
Location:	KP 140, BP 139	Copy To:	
Contractor:			

TEST RESULTS

SIEVE SIZE (mm)	75	50	37.5	25	19	16	12.5	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075
MAX % PASS SPEC															
MIN % PASS SPEC															
% PASS RESULTS	**100.0**	**100.0**	**78.8**	**56.1**	**45.2**	**39.1**	**33.4**	**29.9**	**24.5**	**22.4**	**20.4**	**17.2**	**11.0**	**5.5**	**2.7**

MATERIAL TYPE

SIEVE METHOD

Wash

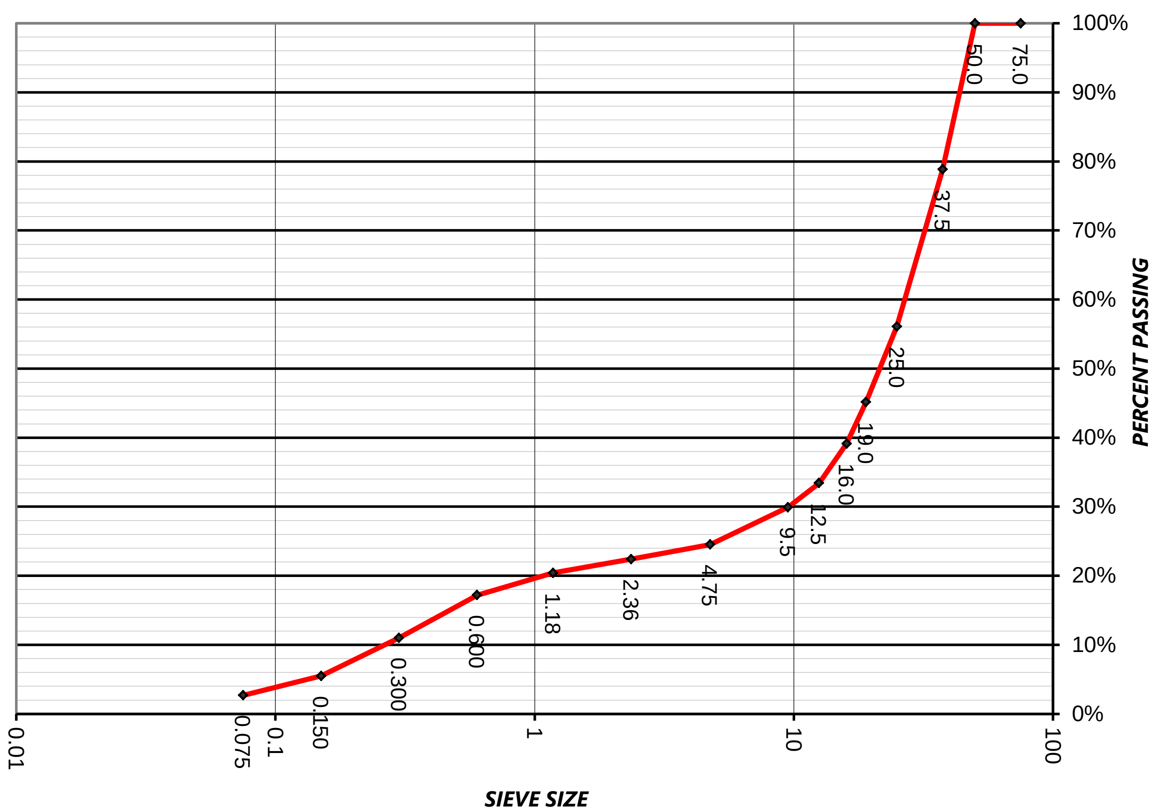
% FRACTURE

% MOISTURE

1.1%

GRADATIONS

GRAVEL	**75.5%**
SAND	**21.8%**
SILT/CLAY	**2.7%**



COMMENTS

Sample label : EK July 8 (61 13 07) (123 17 36). Sample taken from similar feature located r	**Reviewed By:**

Sieve Analysis Report

2011 PG Pulpmill Road, PO Box 968, Prince George, BC V2L 4V1 Phone: 250-614-7291

ASTM C-117; C-136 CAN/CGSB-8.2M

Test Date:	July 17th 2015	Report Number:	Sample 3 -2015
File Number:	15GP0091	Inspector:	D.Main
Client:	Canadian Zinc.	Sampled By:	EK / Allnorth
Project:	Praire creek Access Road	Sample Date:	July 8th 2015
Location:	KP 136.5, BP 136	Copy To:	
Contractor:			

TEST RESULTS

SIEVE SIZE (mm)	75	50	37.5	25	19	16	12.5	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075
MAX % PASS SPEC															
MIN % PASS SPEC															
% PASS RESULTS	**100.0**	**100.0**	**84.0**	**63.8**	**51.1**	**41.8**	**34.2**	**25.0**	**15.0**	**10.8**	**8.6**	**7.4**	**6.4**	**5.3**	**4.0**

MATERIAL TYPE

SIEVE METHOD

Wash

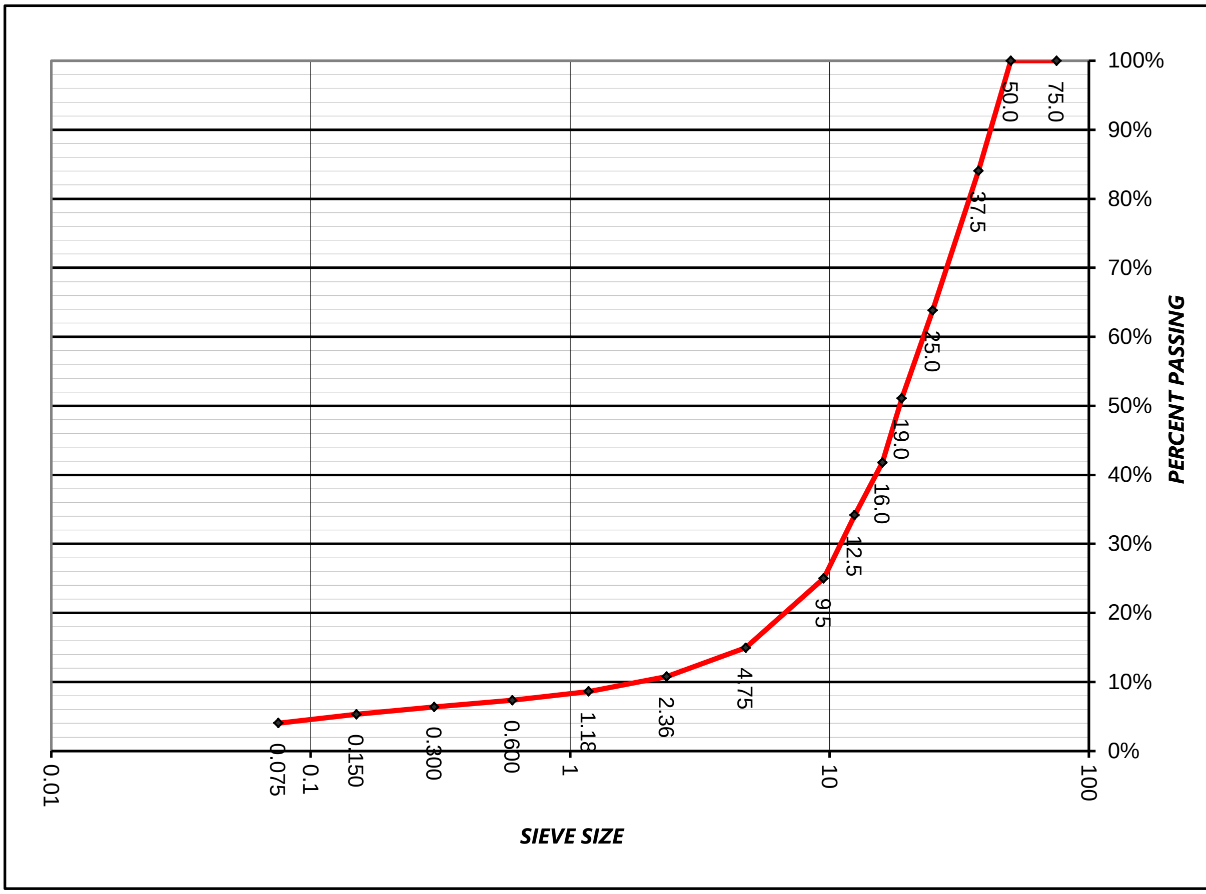
% FRACTURE

% MOISTURE

1.2%

GRADATIONS

GRAVEL	**85.0%**
SAND	**10.9%**
SILT/CLAY	**4.0%**

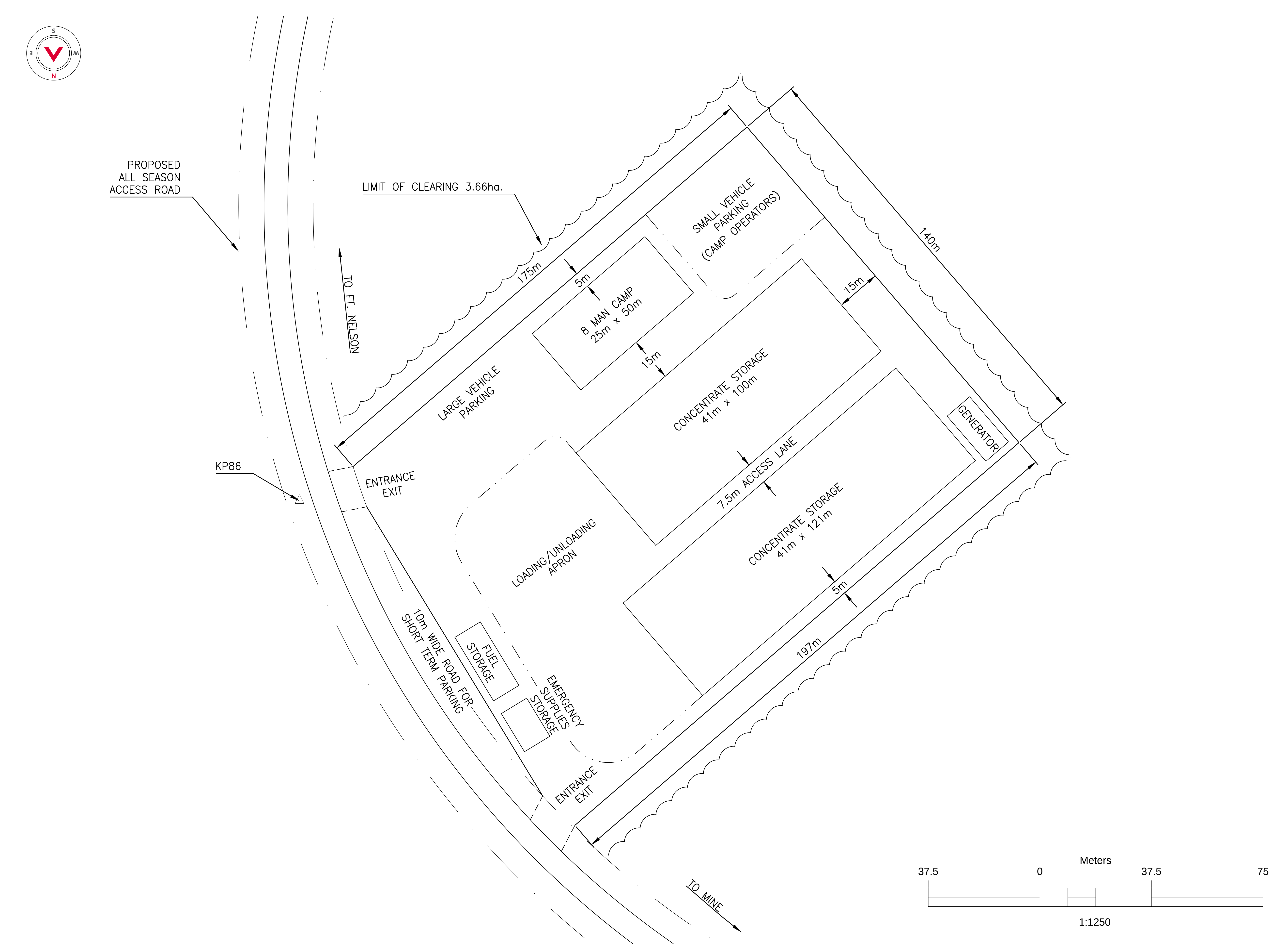


COMMENTS

Sample label : EK July 8 (61 17 16) (123 20 17)

Reviewed By:

Appendix G Tetcela Transfer Facility (TTF) Layout Plan



REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
0	15/04/01	ISSUED FOR REVIEW	AJB	EK

CLIENT:

CANADIAN ZINC CORPORATION

Allnorth

CLIENT NO: -	DRWN: AJB	DATE: 15/04/01
PROJECT NO: 14GP0128	DSGN: -	DATE: -
DRAWING SIZE: ANSI "B"	CHKD: EK	DATE: 15/04/01
SCALE: 1:1250	APVD: -	DATE: -

PROJECT:

**PRAIRIE CREEK MINE
ALL SEASON
ACCESS ROAD**

TITLE:

TETCELA TRANSFER FACILITY (TTF) PRELIMINARY LAYOUT CONCEPT

DWG NO: **14GP0128** REV: **0**

Date: 2015/09/01 | User: Tammy Beer | File: P:\GP\2014\100\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\1000-Drawings\1011-Civil\01-Production\Alex sketch\Tetcela Transfer Facility Preliminary Layout_R1 | Layout: 000 | Paper Size: 558.8mm x 431.8mm