Michelle Unger
Manager, Environmental Performance
Michelle.unger@teck.com

Teck Resources Limited
Canadian Legacy Properties
Bag 2000
Kimberley, BC V1A 3E1

+1 250 427 8422 Dir
+1 250 427 8451 Fax
+www.teck.com

Teck

January 23, 2018

Richard Dwyer,
Manager of Licensing
Nunavut Water Board
P.O. Box 119
Iqaluit, NU X0A 0H0

File No: 1AR-POL1531 – Polaris Mine Long Term Limnology, Water Quality and Effluent Monitoring Program

The Polaris Mine Type A Water Licence was issued on March 19, 2015 and authorized a monitoring program for the site. Part H of the Licence requires the Licensee to submit to the Board for approval, a Long Term Limnology, Water Quality and Effluent Monitoring Program. Attached to this letter is the aforementioned proposed monitoring program. As required by the Licence, the program takes into account the recommendations of the April 2013 Azimuth Report and addresses recommendations received during the final technical review of the Application and submissions received at the Public Hearing (documented in the March 19, 2015 "Nunavut Water Board Reasons for Decision Including Record of Proceedings").

The Licence required this plan to be submitted within 6 months of issuance of the Licence which was not done. 2019 is the first year of monitoring/sampling required under the Licence and so as part of preparing for this year's activities, the proposed monitoring program is being submitted for the Water Board's review and approval.

If you have any questions or comments, please don't hesitate to contact me.

Sincerely,

Digitally signed by Michelle Unger
DN: cn=Michelle Unger, o=Teck, ou, email=michelle.unger@teck.com, c=CA
Date: 2019.01.23 16:34:40 -07'00'

Michelle Unger,
Manager, Environmental Performance, Environment

Attachment: Long-Term Limnology, Water Quality and Effluent Monitoring Program, Garrow Lake and Garrow Creek, NT – Summary Document

Azimuth Consulting Group Partnership
218-2902 West Broadway
Vancouver, BC
Canada V6K 2G8

Phone: 604-730-1220
Fax: 604-739-8511
www.azimuthgroup.ca

Our File #: Teck-18-03

October 26, 2018

Ms. Michelle Unger
Manager, Environmental Performance, Environment,

Teck Resources Limited
Bag 2000
Kimberley, BC V1A 3E1

Dear Ms. Unger:

RE: Long-term Limnology, Water Quality and Effluent Monitoring Program, Garrow Lake and Garrow Creek, NT – Summary Document

1 Background

Garrow Lake is a small (4.2 km^2), permanently chemically and thermally stratified high Arctic meromictic lake situated on Little Cornwallis Island, Nunavut. Garrow Lake is relatively deep for its size (maximum depth of 40 m) and has unique limnological characteristics (Ouellet and Dickman 1983, Fallis et al, 1987, Azimuth 2005, 2011). The upper oxygenated surface layer is ultra-oligotrophic with very low nutrient concentrations and a depauperate biological community, including a marine relict population of fourhorn sculpin, *Myoxocephalus quadricornis* (Fallis et al. 1987). The lake discharges to Garrow Bay via Garrow Creek, 1.4 km south of the lake outlet. Discharge is ephemeral during the brief open water period when the creek channel thaws in late June or early July, until early September when the system freezes again.

Garrow Lake is very strongly thermally and chemically stratified, with an oxic, cold (<4^{o}C) slightly brackish surface layer (epilimnion) extending to 10 or 11 m below surface and a deep (>13 m) anoxic, warm (8^{o}C), sulphide-rich and hyper-saline hypolimnion. These two layers are separated by a thin (2 – 3 m) transition layer (pycnocline) where water rapidly becomes anoxic, chemical rich, saltier and slightly warmer. There is no aquatic life inhabiting the deep hypolimnion layer (Azimuth 2005).

The hypolimnion of Garrow Lake was used for tailings disposal and as such, was classified as a “Tailings Disposal Facility” under Schedule 2 of the *Metal Mining Effluent Regulations* (MMER) in place during the mine’s operations. Thus, according to the MMER, Garrow Creek, which is the only discharge of Garrow Lake, was defined as an

"effluent" source under the MMER and was monitored as such under Expired Licence No. 1AR-POL0311.

2 Regulatory Requirements for Long-term Monitoring

In accordance with requirements of the former Water Board Type "A" Water Licence No. 1 AR-POL0311, it is required that the Licensee (Teck Resources Limited or 'Teck') perform limnological and water quality monitoring following requirements that pertain to Garrow Lake and its effluent, Garrow Creek, as specified in Part H, Item 1 and Part J of **Schedule H** of the new Type A Water License No. 1 AR-POL1531 (March 19, 2015). Teck shall conduct all sampling, sample preservation and analyses in accordance with methods prescribed in the most current edition of "*Standard Methods for the Examination of Water and Wastewater*", as prescribed by the *Metal Mining Effluent Regulations*.

It should be further noted that the new Water License No. 1AR-POL1531 considers monitoring recommendations made by Azimuth Consulting Group Inc. report (Azimuth 2013) submitted with the Application. The Azimuth (2013) report outlines the parameters, methods and timing of sampling of Garrow Lake and Garrow Creek. With respect to monitoring of Garrow Lake, the Licence stipulates the following in Part H, 'Conditions Applying to the Monitoring Program' in Items 16 – 18.

16. "The licensee shall conduct monitoring related to Limnology and Water Quality at Garrow Lake by sampling the water at the Garrow Lake Center Station (262-3);
17. For the samples required in Part H, Item 16, the Licensee shall record, with respect to each sample: a) water temperature and dissolved oxygen concentration; b) field pH and conductivity; c) field hardness and alkalinity and concentration of substances set out in Part J;
18. The licensee shall implement the Quality Assurance and Quality Control Plan referred to in Part H, Item 8, to ensure accuracy and precision of monitoring data."

The monitoring requirements for Lake and Effluent Monitoring are specified in **Table 2** of Section H below. **Table 3** of the License document specifies the locations where monitoring is required and the Parameter 'Group' required at each. This plan incorporates the requirements of both.

With respect to the timing of monitoring, the Azimuth (2013) report and the 'Reasons for Decision' document (March 2015) in support of the License, stipulated that the long-term limnological and effluent monitoring shall take place in winter 2019 and again in 10 years, in 2029. Therefore, all methods and procedures laid out here for the 2019 program shall also apply for the 2029 program, to be consistent with the schedule presented under the Protocol.

Schedule H - Conditions Applying to the Monitoring Program

Table 2: Vertical Limnology, Water Quality and Effluent Monitoring Group Parameters

Group	Parameters
1	pH (field); temperature (field); conductivity (field)
2	pH (laboratory); conductivity (laboratory); salinity (laboratory); hardness and alkalinity
3	Dissolved oxygen
4	Total suspended solids (TSS); total arsenic (As); total copper (Cu); total lead (Pb); total nickel (Ni); total zinc (Zn); total mercury (Hg), total cadmium (Cd); oil and grease.
5	Total metals (full suite) as determined by a standard ICP Scan
6	Dissolved metals (full suite) as determined by a standard ICP Scan

With respect to monitoring of Garrow Lake, the License stipulates that monitoring take place at a single location near the deepest part of the lake. As per **Table 3** of the License for a) vertical limnological parameters including temperature, oxygen, pH, conductivity, hardness and salinity (i.e., Group 1 – 3 parameters) as well as total and dissolved metals (Group 5 and 6 parameters). There is no requirement for Group 4 parameters, although the metals listed are captured within Group 5 and 6; thus, no monitoring for total suspended solids (TSS), or oil and grease will be made. As per Table 2 and Azimuth (2013), total mercury concentration will also not be measured. The specific depth of sampling within the lake is provided in the Standard Operating Procedures (SOP) section below.

With respect to **effluent monitoring** in Garrow Creek, surface water quality shall take place at the outlet of Garrow Lake at the former siphons discharge location and shall include Groups 1, 2 and 4 – 6 (again, as per **Table 3** of the License). Only dissolved oxygen will not be measured. Oil and grease will be measured only if there is a visible sheen present.

3 Standard Operating Procedures

3.1 Garrow Lake Limnology and Water Chemistry

3.1.1 Limnology

Vertical limnological profiling and water chemistry will be monitored from the center station (262-3) of Garrow Lake during late winter or early spring (April) near maximum

ice-depth (~ 2 m). This station is located at UTM coordinates 562125 N and 8369628 E at an approximate water depth of 38 – 40 m.

Two holes will be drilled adjacent to each other using an 8-inch diameter ice auger to prevent against freeze-up of the hole while collecting limnology and water samples.

A Hydrolab or similar multi-meter capable of measuring each of the required parameters will be deployed through the drilled hole to gather, at a minimum, temperature (°C), oxygen (mg/L; i.e., Group 3 parameter), conductivity (µ/cm) and salinity (ppt) from 2 m below ice surface at 1 m intervals until bottom, at approximately 38 m. This information will be used to identify the depth-strata where the pycnocline lies in order to target water samples above, below and within this transition zone.

3.1.2 Water Chemistry

Water samples will be collected at discrete 1 m intervals from the following depths according to the protocol by Azimuth (2013):

- Ice bottom-water interface at 2 -3 m
- 5 m
- 9 m
- 10 m
- 11 m
- 12 m
- 13 m
- 15 m
- 20 m
- 30 m
- 38 m near bottom

Water samples will be collecting using a diaphragm pump and tubing system, consistent with what was used in the most recent program in 2009. The pump is attached to a 12-v battery and water is actively pumped from depth through a depth-marked food-grade quality silicon tubing that is weighted with a plastic-coated weight. The tube is lowered through the water column and water pumped to surface. The tubing is flushed for at least 3 minutes prior to sampling. To collect a water sample from any discrete depth the tubing is lowered through the water column, to the depth displayed on the marked tubing (e.g., 10 m). Water is pumped to surface, allowing to flush for one minute prior to collecting a sample. Water is pumped directly into the pre-labeled laboratory supplied sampling vessels for Group 2 (conductivity, hardness, alkalinity, salinity, pH), Group 5 (total metals) and Group 6 parameters (dissolved metals). In addition, a sample for sulphide will also be collected from each of the above depths. The sulphide sample will be preserved with sodium hydroxide and zinc acetate immediately upon being brought to surface.

To collect dissolved metals, an in-line, high capacity 0.45 µm filter is added to the excurrent hose. The filter is flushed with site water for 3 minutes prior to sample collection and for 30 seconds between depth intervals to fully flush the filter. Thus, filtered water is added directly to pre-cleaned laboratory supplied sampling vessels.

Shortly after sample collection nitric acid will be added to the total and dissolved metals containers as a preservative.

A total of 4 sampling vessels are required for each depth; one vessel for conventional parameters (pH, hardness, alkalinity, conductivity, salinity), one for sulphide and one each for total and dissolved metals.

3.1.3 Quality Assurance / Quality Control (QA/QC)

Under terms of the license, Teck will implement the QA/QC plan referenced in Part H, Item 8 in all states of monitoring to ensure accuracy and precision of all monitoring data. In addition to using qualified and experienced staff, clean equipment, a calibrated Hydrolab or similar multi-meter and laboratory supplied bottles and distilled water, the following five QA samples will be collected.

1. A single **field duplicate** sample will be collected from at least one sampling depth for all parameters as a 'blind' sample to test precision of the laboratory;
2. A **field** blank will be carried into the field and analysed for all but dissolved parameters. These are sealed bottles, filled with laboratory supplied DI water that are opened in the field and then sealed again. This is a test to ensure that there is no site-related contamination.
3. An **equipment blank** sample. This tests the sampling pump and tubing to determine if there is any risk of cross-contamination from the equipment. Laboratory supplied distilled water is used to flush the pump and tubing and once flushed, bottles are filled for analysis of Group 2 and 5 parameters.
4. A **travel blank** sample will be taken. This is a sample similar to the field blank except that bottles for non-filtered parameters taken into and out of the field and treated in the same fashion as a routine sample, except that the container is unopened. This is a test to ensure that contamination did not occur during transport, either before or after sample collection, while enroute.
5. Finally, the laboratory supplied distilled water will be used to fill 2 bottles and analysed for Group 2 and 5 parameters to ensure that the distilled water is 'clean'.

All water sampling vessels will be sealed, packed to prevent breakage and transported back to Resolute Bay. Samples will either be shipped as cargo from Resolute Bay to ALS Laboratory in Burnaby BC or will be taken as extra baggage back to Vancouver. Samples will have been field preserved so there is no concern related to holding times of water (i.e., <28 d).

3.2 Garrow Creek 'Effluent' Monitoring

Garrow Creek was the designated final discharge location of the Schedule 2 Tailings Disposal Facility of Garrow Lake at Polaris Mine during mine operations and post-closure. Water sampling shall occur at the location of the former siphons during early to mid-summer (late July), following the majority of snowmelt adjacent to the stream channel. This will ensure that the water quality is a direct reflection of surface water

chemistry of Garrow Lake and not diluted by snowmelt. Sampling will occur at the same time as the Geotechnical Inspection, also timed for lack of snow.

3.2.1 Physical / Chemical Parameters

Prior to collecting water, field parameters (pH, temperature, conductivity) will be measured using a hand-held YSI meter or equivalent (e.g., Hydrolab), that is calibrated just prior to use (Group 1 parameters).

Water samples from Garrow Creek will be collected by hand by wading into the stream and directing a laboratory supplied collecting vessel into the stream and allowed to fill.

- Bottles will be collected for Group 2 (pH, hardness, conductivity, salinity),
- Group 4 (TSS only); and
- Group 5 and 6 parameters (total and dissolved metals respectively). To collect dissolved metals, a laboratory supplied syringe-style filer apparatus will be used to filter water in the field. Filtered water will be discharged directly into a sampling vessel and field-preserved using laboratory supplied nitric acid. The unfiltered sample will also be preserved using nitric acid. The full suite of 30 metals (including Group 3 metals) will be measured including all those regulated under MMER.

3.2.2 Quality Assurance – Quality Control

Quality Assurance – Quality Control (QA/QC) is an integral part of routine water quality monitoring and consists of the following three components as described above:

- In addition to the above, **field duplicate** sample consisting of a second *complete set* of water quality parameters will be collected at least 15 minutes apart from the original (i.e., field replicate). This will ensure that at least one sample is acquired in the event of a bottle breakage and confirm results of the first sample.
- A **field blank** will be carried into the field and analysed for all but dissolved parameters.
- A **trip blank** will also be taken into the field.

4 Reporting

In accordance with Part B General Condition and with respect to reporting of limnological and water quality parameters, Teck shall file in writing with the Board, no later than March 31 in the year following the calendar year in which monitoring occurred, a report that shall contain but not be limited to the following:

i. A summary of the results of Effluent, Limnology and Water quality monitoring required under Part J, Schedule H (using tabular summaries where applicable);

ii. Sample collection date and type of sample collection (grab or composite);

iii. The geographical coordinates of water quality monitoring stations, in degrees, minutes and seconds, with a corresponding written description of

each site that is sufficiently detailed to easily identify the location of the sampling areas;

iv. Methodologies utilized to conduct effluent and water quality monitoring, including appropriate method detection limits;

v. A description of quality assurance and quality control procedures that were implemented and the data related to the implementation of those procedures;

vi. Data, pursuant to Part H Item 6 of the license, detailing calibration histories for field instruments used on-site to measure pH, temperature, conductivity and dissolved oxygen; and

vii. A detailed report of "Limnology, Water Quality and Effluent Data Monitoring" that includes analysis of the results and comparison to regulatory standards, and discussion of the chemical and physical stability of the site.

Teck shall submit one (1) paper copy and one (1) electronic copy of all reports, studies, and plans to the Board or as otherwise requested by the Board. Reports or studies submitted to the Board by the Licensee shall include an executive summary in English, Inuktitut and French.

Sincerely,

Azimuth Consulting Group

Randy Baker, M.Sc., R.P.Bio. Incorporated Partner

References

Azimuth Consulting Group. 2005. Limnology and ecology of Garrow Lake, Little Cornwallis Island, Nunavut – August 2003. A report prepared for Teck Cominco Metals, Kimberley BC by Azimuth Consulting Group, Vancouver BC. May, 2005. 48 p. + App.

Azimuth Consulting Group. 2011. Technical Memo prepared for Teck on October 17, 2011. Evaluation of limnological and chemical conditions of Garrow Lake and chemistry of Garrow Creek, Nunavut 2002 – 2011. Prepared by Azimuth Consulting Group, Vancouver BC.

Azimuth Consulting Group. 2013. Technical Memo prepared for Teck on April 4, 2013. Long-term Monitoring Program of Garrow Creek, Polaris Mine, Nunavut. Prepared by Azimuth Consulting Group, Vancouver BC.

Fallis, B.W., S. M. Harbicht and B.J. Mackenzie. 1987. A preliminary study of the limnology and biology of Garrow Lake, Northwest Territories; an Arctic meromictic lake. Department of Fisheries and Oceans, Winnipeg, MB. Unpublished data. ii + 55 p.

Ouellet, M. and M. Dickman. 1983. The meromictic Garrow Lake, Canadian Arctic Archipelago. INRS-Eau, Rep. 77. 85 p.