2020 Contingency Plan for Surface Water Quality Exceedances
Former Nanisivik Mine, Nanisivik, Nunavut, Canada
Final Report

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Executive Summary

An updated (2020) contingency plan for surface water quality monitoring is developed for the former Nanisivik Mine, located near Arctic Bay, Nunavut. Sampling stations identified in Water Licence1AR-NAN2030 issued by the Nunavut Water Board include station 159-4 (the outflow from West Twin Disposal Area), as well as stations NML-23 and 159-6 (in the Twin Lakes Creek watershed), 159-14 (in the Chris Creek watershed), and NML-29 and NML-30 (in the Landfill watershed). Maximum authorized concentrations for total arsenic, total cadmium, total copper, total lead, total nickel, total zinc, total suspended solids (TSS); and a specific range for pH are specified in the Water Licence for station 159-4. Elsewhere, site-specific action levels that may act as triggers for investigation and/or remedial action are used.

The new Water Licence (1AR-NAN2030) requires no more than a single sampling event per year at the prescribed sampling stations, making the previous practice of triggering investigations on the basis of exceeding the site-specific action levels on two consecutive sampling events impractical. Therefore, an alternative set of site-specific action levels is derived and presented in this contingency plan. For pH, an acceptable range of 6.0 to 9.5 is recommended, consistent with previous programs. The updated (2020) contingency plan recommends the use of the 99'th percentile value as the basis for specifying site-specific action levels, for monitoring surface water quality in relation to concentrations of total cadmium, total lead, total zinc, sulphate, and TSS. The proposed site-specific action levels, to be used for the duration of the new Water Licence (2020 to 2029, inclusive), represent the 99'th percentile values based on data collected at each sampling station between 2009 and 2019. While the proposed 99'th percentile values are numerically higher than the previous 95'th percentile values, it is also proposed to initiate an investigation when any single site-specific action value is exceeded. The 99'th percentile value is likely to be exceeded for one in every 100 observations by chance alone. Therefore, this criterion is more stringent than the previous practice (one in every 400 observations by chance alone) and represents a balance between the requirement to detect change in environmental quality that may be related to the former Nanisivik Mine, and the risk of too frequently incurring false positive signals.

It is anticipated that starting in 2020, the surface water monitoring program will become fully integrated with the geotechnical monitoring program, so that water sampling occurs in conjunction with the physical inspection of facilities, and collection of geotechnical monitoring data. In this context, cues from field instruments or visual observation (e.g., abnormal pH, high specific conductance, or the visual observation of high turbidity or petroleum hydrocarbon sheen) should immediately trigger an enhanced evaluation of site conditions to determine whether the observation is linked to facilities or infrastructure related to the former mine, or to natural processes not directly related to the mine. This is an enhancement of field practices relative to previous monitoring programs and may eliminate the need for a follow-up site visit to investigate identified issues.

Alternatively, if values for laboratory-measured parameters exceed the maximum authorized limits or site-specific action levels, follow-up investigation should be undertaken the following year. This is the case because freezing conditions typically set in at the site before laboratory results are received and processed, and before arrangements could be made for a follow-up site visit or potential mitigation

during the same calendar year. Follow-up investigations for exceedances identified for laboratory-measured parameters may include the following:

- Visual reconnaissance of the watercourse upstream from the location where the exceedance was noted, looking for evidence of conditions that might account for the exceedance (*e.g.*, fresh erosion of mineralized outcrops; sources of turbidity; seepage areas with abnormal low/high pH or elevated specific conductivity values as determined using field instruments; or evidence of erosion or damage to any of the covers applied to waste disposal areas).

- Sampling of the watercourse at intervals upstream from the location where the exceedance was noted, using field instruments (pH, conductivity, temperature) and taking water samples for chemical analysis, to identify where the exceedance originated.

An annual report on surface water quality monitoring results will be submitted to the Nunavut Water Board no later than March 31 in the year following the calendar year being reported (as required by Part B, Item 1 of the Water Licence). The format and content of the report will be similar to previous reports and will be based on a recommended Table of Contents provided herein. The annual report will also include the results and findings of any follow-up investigations that may have been undertaken in the reporting year.

1.0 INTRODUCTION

This report outlines a Contingency Plan detailing actions to take in the event of surface water quality exceedances at the former Nanisivik Mine, near Arctic Bay, Nunavut. The Contingency Plan is a requirement of Water Licence No. 1AR-NAN2030, specifically Part H, Item 10.b. As per the Water Licence:

10. *The Licensee shall submit to the Board for review, within sixty (60) days following the approval of the Licence, updates to the following Plans to reflect changes to the monitoring requirements in the Licence:*

    a. *Updated Post Closure Geotechnical Monitoring Contingency Plan, dated March 19, 2015;*

    b. *Contingency Plan for Water Quality Exceedances, former Nanisivik Mine site, dated March 26, 2015; and*

    c. *Geotechnical Monitoring Instrument Installation Record and Contingency Plan, dated March 17, 2015.*

This report addresses item "b", while items "a" and "c" will be addressed under separate cover.

2.0 SURFACE WATER QUALITY MONITORING

The Water Licence (Schedule H, Tables 1, 2 and 3) defines the required surface water quality monitoring program (sampling frequency, analytical parameters, and sampling stations) at the former Nanisivik mine. In addition, the Water Licence (Part D, Item 2) establishes maximum allowable concentrations of total arsenic, total cadmium, total copper, total lead, total nickel, total zinc, and total suspended solids (TSS), and the permissible range of pH values for monitoring station 159-4 (the outlet from the West Twin Disposal Area). Part D, Item 3 also establishes the maximum concentration of Oil and Grease in water, at any station where a petroleum hydrocarbon sheen may be observed.

For the remaining surface water monitoring stations (i.e., NML-23, 159-6, 159-14, NML-29 and NML-30), maximum allowable concentrations of substances in water are not defined within the Water Licence (except as noted above for Oil and Grease in water where a petroleum hydrocarbon sheen is visually observed). Concentrations of water quality monitoring parameters for these stations have in the past been compared to site-specific action levels. This Contingency Plan includes updates to the site-specific action levels.

When a hydrocarbon sheen is observed at a surface water quality monitoring station, additional water samples must be collected to be analysed for petroleum hydrocarbon fractions F2 to F4. The Nunavut Water Board has previously accepted this procedure as a superior analytical methodology to the Oil and Grease method referenced in the Water Licence.

2.1 MAXIMUM AUTHORIZED CONCENTRATIONS FOR SUBSTANCES IN SURFACE WATER AT MONITORING STATION 159-4

Maximum authorized concentrations of specific water quality parameters defined in the Water Licence (Part D, Items 2 and 3) for station 159-4, the outflow from the West Twin Disposal Area, are presented in Table 1.

Table 1 Maximum Authorized Concentrations for Substances in Water at Monitoring Station 159-4

Parameter	Maximum Authorized Concentration
Total Arsenic (mg/L)	0.25
Total Cadmium (mg/L)	0.005
Total Copper (mg/L)	0.1
Total Lead (mg/L)	0.1
Total Nickel (mg/L)	0.5
Total Zinc (mg/L)	0.25
Total Suspended Sediment (mg/L)	15
pH (pH units)	6.0 – 9.5
Oil and Grease (mg/L)	15

2.2 ESTABLISHING ACTION LEVELS FOR SURFACE WATER QUALITY PARAMETERS

For monitoring stations NML 23, 159 6, 159 14, NML-29 and NML-30, site-specific action levels that would trigger further investigation and possible abatement or mitigation actions must be defined.

The streams draining the former Nanisivik mine area flow through terrain that is naturally mineralized. Natural weathering of sulphide minerals, and other natural processes, can lead to the release of acidity or the biological uptake of bicarbonate ions such that pH values may episodically fall below or rise above the preferred range. Although some areas such as East Twin Lake (represented by monitoring station NML-23) provide water that meets Canadian water quality guidelines most of the time, other areas (such as monitoring station 159-6 located near the mouth of Twin Lakes Creek) are periodically influenced by natural mineral outcrops such that some of the guidelines may not be applicable. Site-specific action levels developed specifically for each monitoring station, for each relevant water quality parameter, are considered more meaningful.

The statistical basis for developing action levels should depend on the statistical characteristics of the underlying water quality data. Underlying statistical distributions of many key surface water quality parameters at Nanisivik (such as lead and zinc concentrations) are generally not reflective of a normal distribution. In such cases, parametric statistics, including measures such as the mean, standard deviation, and statistical confidence intervals are not meaningful, and non-parametric statistics should be considered.

A simple and transparent non-parametric statistic to consider is the percentile. The 50th percentile (also known as the median) divides the data into two groups (i.e., equal numbers of data points that are lower or higher than the median). In the same way, the 95'th percentile is defined as the point where 95% of the data are lower and 5% of the data (1 in 20) are higher, and the 99'th percentile is defined as the point where 99% of the observations are lower and only 1% (1 in 100) are higher.

During the previous Licence period (i.e., 2015 to 2019), sampling of surface water quality monitoring stations was required three times per year (in late July, mid-August and early September). In other months of the year, the Arctic climate at Nanisivik is such that watercourses are likely to be frozen, and sampling was not required. For parameters of concern, the measured values were compared to site-specific action levels that were calculated as the 95'th percentile values of data collected between 1996 and 2014. Recognizing that there is a 1 in 20 chance of the 95'th percentile value being exceeded by chance alone, the accepted practice was to trigger an investigation only when the 95'th percentile value was exceeded at a monitoring station during two consecutive sampling events within the same sampling season (effectively representing a 1 in 400 event by chance alone). This was done in order to find a balance between the need to detect and respond to potentially adverse changes in environmental quality at the site, and the possibility of encountering false positive signals that would trigger an investigation without due cause.

Under the new Water Licence, there will be only one surface water sampling event each year, during August. This month was chosen to avoid the potentially confounding effects of the spring freshet (in July), as well as the risk of being unable to collect water samples in the event of an early freeze-up (usually in

early September). In addition to monitoring station 159-4 (where maximum authorized concentrations are defined), there are five monitoring stations (i.e., NML 23, 159-6, 159-14, NML-29 and NML-30) for which action levels must be defined. At each of those stations there are six key monitoring parameters (*i.e.*, total cadmium, total lead, total zinc, sulphate, TSS, and pH), as well as 15 to 20 additional supporting parameters that are measured (site-specific action levels are not required for the supporting parameters).

Therefore, on any given sampling date there will be thirty tests (*i.e.*, six key monitoring parameters for five monitoring stations) to determine whether any single value exceeds a site-specific action level. By chance alone, it would be typical for one or two parameters to exceed the 95'th percentile values at one or more monitoring stations, without indicating any abnormal condition (*i.e.*, false positive signals). The existing set of 95'th percentile values is thus potentially too likely to result in false positive determinations. Therefore, the 99'th percentile value, which would be exceeded by chance alone less than one time per year, is recommended for screening data collected on a "one sample per sampling station per year" basis, as required by the current Water Licence.

Conducting a follow-up investigation based on a single exceedance of the 99'th percentile value represents a more stringent approach than the previous practice of follow-up investigation based on two consecutive exceedances of the 95'th percentile value. Table 2 provides the 99'th percentile values (based on data collected between 1996 and 2019) proposed as site-specific action levels for surface water quality monitoring stations, and compares them to the previous set of 95'th percentile values (based on data collected between 1996 and 2014). The 99'th percentile value is recommended here as the basis for establishing site-specific action levels since it represents a balance between responding to a higher number of false positive signals (if the site-specific action level is set too low), and failing to respond to a significant event (if the action level is set too high).

Table 2 Proposed Site-Specific Action Levels for the Former Nanisivik Mine (proposed values are 99'th percentiles; the previous 95'th percentile site-specific action levels are provided in parentheses for reference)

Station ID	Total Cadmium (mg/L)	Total Lead (mg/L)	Total Zinc (mg/L)	Sulfate (mg/L)	TSS (mg/L)
159-6	0.0297 (0.014)	0.0893 (0.044)	8.9 (4.6)	614 (463)	140 (53)
159-14	0.0010 (0.0005)	0.0015 (0.0022)	0.68 (0.13)	960 (408)	158 (32)
NML-23	0.0135 (0.0044)	0.0553 (0.016)	0.23 (0.12)	118 (25)	20 (10)
NML-29	0.0017 (0.00025)	0.0062 (0.0050)	0.09 (0.03)	340 (240)	113 (22)
NML-30	0.0017 (0.00025)	0.0062 (0.0050)	0.09 (0.03)	340 (240)	113 (22)

Action levels are not identified for supporting parameters because they are of low concern from a toxicological perspective (*e.g.*, major ion concentrations such as calcium and chloride), or because there is not sufficient data to develop an estimate of the 99'th percentile value. For pH, the site-specific action levels are proposed to be the same as the Water Licence limits for station 159-4 (*i.e.*, the acceptable pH range shall be 6.0 to 9.5).

2.3 CONTINGENCY PLAN FOR RESPONSE WHEN ACTION LEVELS ARE EXCEEDED

If a site-specific action level is exceeded for a key parameter in any water sample, a follow-up investigation will be triggered. The following information is intended to provide context and guidance as to the nature and scope of follow-up investigations that may be appropriate.

For the term of the present Water Licence (i.e., 2020 to2029, inclusive), there is expected to be a single surface water sampling event per year in the years 2020, 2021, 2022, 2024, 2026 and 2029, with no planned monitoring event in the years 2023, 2025, 2027, and 2028. This schedule and frequency of monitoring also applies to monitoring of geotechnical conditions. For the term of the present Water Licence, it is expected that both surface water quality monitoring and geotechnical monitoring will be conducted simultaneously. Visual observations (*e.g.*, high turbidity in water or the presence of visible hydrocarbon sheen) and measurements with field instruments (for temperature, pH and specific conductance) will provide immediate real-time data to field personnel, alerting them to potentially abnormal conditions. Visual assessment of the condition of site infrastructure and reading of thermistors and frost gauges will be conducted at the same time as surface water sampling. Therefore, the origin and/or cause of an abnormal surface water quality condition that results from an abnormal condition associated with site infrastructure may be investigated and identified within the same time period as the surface water monitoring event.

In the event that visual cues or field instrument readings alert field personnel to an abnormal water quality condition at the time of sampling, a visual reconnaissance of the watercourse upstream from the location where low/elevated pH or elevated conductance (*e.g.*, in excess of 1,000 µS/cm) values were measured should be conducted concurrently with the surface water sampling, looking for evidence of conditions that might account for these values (*e.g.*, fresh erosion of mineralized outcrops; sources of turbidity; evidence of erosion or damage to infrastructure). Sampling of the watercourse at intervals upstream from the location where these values were noted, using field instruments (*e.g.*, pH, conductivity, and temperature), may also help to localize the source of an exceedance, particularly if these values are of natural origin. In addition, water samples should be collected and submitted for chemical analysis at these upstream locations.

When an abnormal surface water quality condition is identified during a field visit, the following procedure should be followed within 30 days of demobilization from the field:

1. Document the data evaluation and assessment process, and present a recommendation as to whether an on-site follow-up investigation is (i) not required, as it was resolved as being not related to the former Nanisivik mine infrastructure at the time of the field visit; or was not resolved so that follow-up investigation may (ii) be required during the present calendar year; (iii) during the following calendar year; or (iv) during the next scheduled sampling period.

2. Submit the above documentation and recommendation to the Nunavut Water Board for their review.

In the event that subsequent laboratory analysis of water samples for key parameters identifies an exceedance of a 99'th percentile action level, the following procedure will be followed (within 30 days of receiving water chemistry data from the analytical laboratory).

1. Confirm the parameter(s) and sampling station(s) where site-specific action levels have been exceeded based on laboratory measurements.

2. Reconcile the observation(s) against site conditions documented at the time of sampling (e.g., prevailing temperatures, seasonal precipitation, and associated natural processes such as erosion within the natural channel of Twin Lakes Creek), as well as the condition of site infrastructure and natural areas of the site, to determine whether the exceedance is likely due to a natural process, or may be indicative of changes in the functioning or integrity of site infrastructure.

3. Document the data evaluation and assessment process and present a recommendation as to whether an on-site follow-up investigation is required (i) during the present calendar year; (ii) during the following calendar year; or (iii) during the next scheduled sampling period.

4. Submit the above documentation and recommendation to the Nunavut Water Board for their review.

It is anticipated that the above information, as well as any confirmation or resolution process based on engagement with the Nunavut Water Board, will be documented in the subsequent Annual Water Quality Monitoring Report, to be submitted no later than March 31 in the calendar year following sampling.

3.0 REPORTING

An annual report on surface water quality monitoring results will be submitted to the Nunavut Water Board no later than March 31 in the year following the calendar year being reported (as required by Part B, Item 1 of the Water Licence). The format and content of the report will be similar to those of previous Annual Water Quality Monitoring Report submissions.

A suggested Table of Contents for the Annual Water Quality Monitoring Report is shown below.

Annual Water Quality Monitoring Report, Nanisivik Mine, Nunavut

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4.0 CLOSING

This report has been prepared by Annick St-Amand Ph.D. and Malcolm Stephenson, Ph.D., and was reviewed by Clayton Barclay, Ph.D. and Shereen Ismail, B.Sc. Eng., for the sole benefit of Canzinco Mines Ltd., and may not be relied upon by any other person or entity without the express written consent of Stantec Consulting Ltd. and Canzinco Mines Ltd. Stantec Consulting Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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