Contingency Plan for Water Quality Exceedances, Former Nanisivik Mine Site

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Executive Summary

A contingency plan for surface water quality monitoring is developed for the former Nanisivik Mine site, located near Arctic Bay, Nunavut. Sampling stations identified in the Water Licence issued by the Nunavut Water Board include 159-4 (for which there are specific maximum authorized concentrations for arsenic, cadmium, copper, lead, nickel, zinc, total suspended sediment and pH), as well as 159-6, 159-14, NML-23, NML-29 and NML-30. Site-specific action levels are required for all stations except 159-4.

The contingency plan recommends the use of the 95th percentile value as the basis for specifying action levels for monitoring water quality in relation to concentrations of total cadmium, total lead, total zinc, sulfate, and TSS. For pH, an acceptable range of 6.0 to 9.5 is recommended. Since the 95th percentile value is likely to be exceeded for one in every twenty observations by chance alone, it is recommended that a follow-up investigation should be initiated into the potential cause of water quality impairment if an action level is exceeded in two consecutive observations at any single location.

Action levels were first established for water quality monitoring stations in 2009. The action levels are recalculated in this updated contingency plan to include data between 2009 and 2014. The proposed site-specific action levels for 2015 and beyond (as per Water Licence No. 1AR-NAN1419) represent the lower of the 95th percentile values calculated in 2009, and the recalculated 95th percentile values taking subsequent data into consideration.

The follow-up investigations should 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; 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 originates.

An annual report on 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 2 of the Water Licence). The format and content of the report will be similar to those of the 2014 Annual Water Quality Monitoring Report. The annual report will 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 water quality exceedances at the former Nanisivik Mine, near Arctic Bay, Nunavut. The Contingency Plan is a requirement of the Water Licence (No. 1AR-NAN1419, Part I, Item 12) issued for the site on December 23, 2014, by the Nunavut Water Board and approved by Bernard Valcourt, Minister of Aboriginal Affairs and Northern Development Canada on January 29, 2015. As per the Water Licence:

12. *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. *Post Closure Geotechnical Monitoring Contingency plan, dated September 28, 2009;*

    b. *Contingency Plan for Water Quality Exceedances, former Nanisivik Mine site, September 9, 2007; and*

    c. *Instrument Installation and Contingency Plan, dated November 17, 2004.*

This report addresses item "b". Items "a" and "c" will be addressed under separate covers.

2.0 SURFACE WATER QUALITY MONITORING

The Water Licence (Schedule I, Tables 1 and 2) defines the required surface water quality monitoring program (analytical parameters and sampling frequency) at the former Nanisivik mine site. In addition, for monitoring station 159-4 (the outlet from the West Twin Disposal Area), the Water Licence (Part F, Items 1 and 2) establishes maximum allowable concentrations of total arsenic, cadmium, copper, lead, nickel, zinc, total suspended solids and total petroleum hydrocarbons, and defines the permissible range of pH values.

For the remaining surface water monitoring stations (159-6, 159-14, NML-23, NML-29 and NML-30), maximum allowable concentrations of substances in water are not defined within the Water Licence. Concentrations of water quality monitoring parameters for these stations are compared to action levels, previously developed within the Contingency Plan. Updates to the Contingency Plan will also include updates to these action levels.

At any time when hydrocarbon sheens are observed at a water quality monitoring station, additional water samples must be collected to be analysed for hydrocarbons in compliance with the Water Licence, Part F, Item 2.

2.1 ESTABLISHING ACTION LEVELS FOR SURFACE WATER QUALITY PARAMETERS

Action levels for monitoring station 159-4 are defined in the Water Licence (Part F, Items 1 and 2), and are presented here in Table 1. For the remaining monitoring stations, action levels that would trigger further investigation and possible abatement or mitigation actions must be defined.

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

Parameter	Maximum Authorized Concentration (mg/L)
Total Arsenic	0.25
Total Cadmium	0.005
Total Copper	0.1
Total Lead	0.1
Total Nickel	0.5
Total Zinc	0.25
Total Suspended Sediment	15
pH	6.0 – 9.5
Hydrocarbons	Where a visible sheen of oil and grease has been observed under Part I, Item 2, the maximum authorized concentration in a grab sample shall not exceed 15 mg/L.

The streams draining the Nanisivik area flow through terrain that is naturally mineralized with the metals that were mined, as well as a variety of other minerals. Although some areas such as East Twin Lake (represented by monitoring station NML-23) reliably provide water that meets most Canadian water quality guidelines, other areas (such as monitoring station 159-6) are periodically influenced by natural mineral outcrops such that some of the Canadian water quality guidelines may not apply. In order to be meaningful, therefore, action levels must be developed in a site-specific manner for each relevant water quality parameter, at each monitoring station.

The statistical basis for developing action levels must depend on the statistical characteristics of the underlying water quality data. Experience shows that the underlying statistical distributions of many key water quality parameters (such as lead and zinc concentrations) are not reflective of a normal distribution. Therefore, parametric statistics (including measures such as the mean and standard deviation) are not meaningful and non-parametric statistics must be considered.

The simplest and most transparent non-parametric statistic to apply is the percentile. The 50th percentile or median divides the data into two groups (those that are lower or higher than the median). In a similar way, the 95th percentile is defined as the point where 95% of the data are lower, and 5% of the data are higher, and the 99th percentile is defined as the point where 99% of the observations are lower, and only 1% of the observations are higher.

The 95th percentile value is recommended here as the basis for establishing action levels since it represents a reasonable balance between responding to too many "false positive" signals (if the value is set too low), or failing to respond to a significant event (if the value is set too high). In a randomly varying dataset, one observation in every twenty would be expected to exceed the 95th percentile value, regardless of the underlying statistical distribution, without indicating that anything unusual is occurring. However, unless there was a fundamental change in the underlying data, it would be unlikely (one in four hundred) for two consecutive observations to exceed the 95th percentile value.

Taking into consideration that in addition to monitoring station 159-4, there are five (5) other monitoring stations for which action levels must be defined. There are on average six "key" monitoring parameters (*e.g.*, total cadmium, total lead, total zinc, sulphate, TSS and pH), as well as 15 to 20 additional supporting parameters that are measured. On any given sampling date, therefore, there will be roughly thirty (30) "tests" to determine whether any single value exceeds an action level. Based on chance alone, it would be typical for several parameters to exceed the 95th percentile values at one or more monitoring stations, without indicating any abnormal condition. It would be unusual, however, for the 95th percentile value to be exceeded, for the same parameter and monitoring station in two consecutive (monthly) samples, by chance alone.

Therefore it is recommended that action levels be defined based upon the 95th percentile values (calculated from historical data) for each key parameter at each monitoring station. When the 95th percentile value is exceeded for any key parameter at the same monitoring station on two consecutive occasions, an investigation will be triggered to determine the cause of the exceedance. Action levels are not identified for the supporting parameters because they are of less 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 95th percentile value. For pH, the action limits at all stations 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).

The previous and re-calculated 95th percentile values are presented in Table 2, the previous values being based on data collected between 1996 and 2008, and the re-calculated values being based on data collected between 1996 and 2014. The proposed action levels for each station are selected as the lower of the two values, and are presented in Table 3. Table 3, therefore, represents a continuation of the values previously in effect, except where monitoring between 2009 and 2014 has shown a reduction in typical concentrations, in which case the action level has been revised downward based on the results of the continued monitoring.

Table 2 Previous (Prev.) and Re-calculated (Re-C.) 95th Percentile Values for Water Quality Parameters at Nanisivik Monitoring Stations

Station ID	Total Cadmium (mg/L)		Total Lead (mg/L)		Total Zinc (mg/L)		Sulfate (mg/L)		TSS (mg/L)	
	Prev.	Re-C.	Prev.	Re-C.	Prev.	Re-C.	Prev.	Re-C.	Prev.	Re-C.
159-6	0.018	0.014	0.063	0.044	6.3	4.6	509	463	63	53
159-14	0.0005	0.0005	0.0022	0.0023	0.13	0.34	408	662	33	32
NML-23	0.0058	0.0044	0.046	0.016	0.14	0.12	25	39	11	10
NML-29	0.00025	0.00025	0.0055	0.0050	0.03	0.03	240	306	22	22
NML-30	0.00025	0.00025	0.0055	0.0050	0.03	0.03	240	306	22	22

Notes:
Prev. – Historical action levels implemented under Water Licence NWB1AR–NAN0914, based on water quality data collected prior to 2009.
Re-C – Re-calculated 95'th percentile value, incorporating additional water quality data collected between 2009 and 2014.
Flow at NML-29 is intermittent and rare; due to their proximity, action levels in case of flow at NML-29 are set to action levels determined for NML-30.
Zinc values for NML-29 and NML-30 are set equal to the CCME Guideline.

Table 3 Proposed Water Quality Action Levels for the Former Nanisivik Mine Site

Station ID	Total Cadmium (mg/L)	Total Lead (mg/L)	Total Zinc (mg/L)	Sulfate (mg/L)	TSS (mg/L)
159-6	0.014	0.044	4.6	463	53
159-14	0.0005	0.0022	0.13	408	32
NML-23	0.0044	0.016	0.12	25	10
NML-29	0.00025	0.0050	0.03	240	22
NML-30	0.00025	0.0050	0.03	240	22

Notes:
Zinc values for NML-29 and NML-30 are set equal to the CCME Guideline.

2.2 CONTINGENCY PLAN FOR RESPONSE WHEN ACTION LEVELS ARE EXCEEDED

If an action level is exceeded for a key parameter in two consecutive water samples, a follow-up investigation will be triggered. The follow-up investigations will 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; 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 originates.

In the event that the cause of a water quality exceedance is identified, and is found to originate from mine infrastructure, a need for remedial action may be identified. It is beyond the scope of this contingency plan to identify what such remedial actions may be. Contingency plans for former mine infrastructure are provided under separate cover.

3.0 REPORTING

An annual report on 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 2 of the Water Licence). The format and content of the report will be similar to those of previous years' Annual Water Quality Monitoring Report submissions. A proposed 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 was reviewed by Malcolm Stephenson, Ph.D., 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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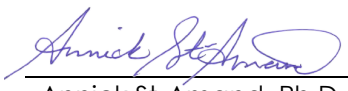

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