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Memo

To:	Johan Skoglund, Nyrstar	**Client:**	CanZinco Mines Ltd
From:	Arlene Laudrum	**Project No:**	1CB002.002
Cc:		**Date:**	September 5, 2014
Subject:	Remediation Confirmatory Soil Sampling Methodology		

1 Objectives

This memo provides information pertaining to the methodology used for confirmatory soil sampling/analysis during the remediation of the petroleum hydrocarbon (PHC) contaminated soil at the former Nanisivik bulk fuel storage facility. The rationale for the types and frequency of parameters being analyzed for, in comparison to details contained in the 2010 Abandonment and Reclamation Plan, are also presented.

The information has been provided at the request of the Nunavut Water Board (NWB) to address questions raised by the Department of Fisheries and Oceans (DFO) and the Department of National Defence during the Technical Meeting held on July 18, 2014 to facilitate the renewal and amendment of Licence 1AR-NAN0914 for reclamation activities at the former Nanisivik Mine.

2 Confirmation Sampling of Soils

Confirmatory sampling is undertaken to ensure that contaminated material is properly remediated. To confirm that contaminated soil has been removed from an excavation, samples are collected *in situ* (in the ground) from the walls and floor of the excavation. To confirm that the contaminated soil removed from the excavation has been remediated to the established remediation objectives, samples are collected *ex situ* from the stockpiles or biopiles of soil being treated.

All remediation confirmatory soil samples are analyzed at a laboratory accredited by the Canadian Association for Environmental Analytical Laboratories.

2.1 In Situ Sampling Procedure

This section describes the procedure followed to confirm that the contaminated soil was removed from excavations within the former fuel tank facility. Pending the receipt of laboratory results confirming the soil quality remediation objectives (SQROs) were met in August 2014, No further excavation of contaminated soil is expected to be required at Nanisivik.

The sampling methodology to confirm the success of contaminated soil excavation is described in the *Nanisivik Mine Reclamation and Closure Monitoring Plan* (Gartner Lee Limited 2004) as stipulated under Part J Item 1.g. of Water Licence 1AR-NAN0914. Under the NWB approved confirmatory soil sampling procedure each excavation area at the former Nanisivik Mine site has been subdivided into individual composite sampling areas of approximately 25 m by 25 m (or less) as required to cover the floor of the excavation. Wall samples are composited over a length of 25 m. The combining of four or five evenly spaced aliquots of soil within the individual composite sample area created the composite sample. A single aliquot of soil from a specific point is a discrete sample. Discrete samples were analyzed by the laboratory as part of QA/QC measures.

Grouping discrete samples from homogenous areas and submitting the resulting composite sample for laboratory analysis reduced the analytical costs and delays associated with a large volume of sample containers being shipped to and from site.

On-site screening of soil samples for PHC vapours was conducted to provide an indication of remedial progress prior to the collection of remediation confirmatory samples. This approach prevented delays and increased costs that would be encountered by the exclusive use of an off-site laboratory for on-site control. Soil samples were screened on site for PHC vapours using a bag-headspace method and a portable gas detector and/or a photo-ionization detector. The soil vapour measurements provided an indication of the presence or absence of PHC contamination.

During the excavation of PHC contaminated soil at the former fuel tank farm discrete field screening samples were collected across the base of the excavation in a 10 m by 10 m grid pattern. To establish the depth of the contamination the walls of the excavation were profiled at 0.5 m vertical intervals. Discrete wall samples were collected at 5 m horizontal intervals within 0.25 m of the base of the horizon determined to be contaminated. Where elevated vapour concentrations were detected additional infill samples were tested to delineate the limits of the suspected PHC contamination to be excavated.

Confirmatory soil samples were collected and analysed at an off-site laboratory once the field screening results indicated that the SQROs had been met.

2.2 Ex Situ Sampling Procedure

The soil sampling plan to confirm soil remediation of ex situ soil was described in the 2012 Progress Report (SRK and WESA 2013) and the 2013 Progress Report (SRK 2014). Remediation confirmatory soil samples were collected based on the volume of soil in a given stockpile or biopile and the homogeneity of the soil in the pile. In accordance with the *Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils* (SAIC 2006, updated 2013) the sampling plan includes the methods (grid, composite) and frequency (number of samples per surface area). The samples were analyzed for contaminates of interest and compared with the remediation guidelines presented in the Canadian Council of Ministers of the Environment (CCME) in *Canadian Environmental Quality Guidelines* (CCME 1999) and *Canada-Wide Standards for Petroleum Hydrocarbons in Soil* (CCME 2008).

A composite sample to characterize a stockpile or biopile of soil was created by combining five discrete samples. Discrete remediation confirmatory samples were collected following the turning (aeration) of soil or during the placement of soil into a stockpile. The volume of soil represented by each composite sample typically ranged from 50 m^3 to 150 m^3, with no discrete sample representing more than 50 m^3. For example, the biopiles in the cells in the Upper Treatment Area (UTA) and Lower Treatment Area (LTA) contain approximately 220 m^3 of soil for remediation but when remediation was completed between 70 m^3 and 100 m^3 of the soil in each cell is not removed from the cell to protect the underlying liner. Therefore a single composite sample from the UTA and LTA functionally represents between 150 m^3 and 120 m^3 of the remediated soil that was removed. Discrete samples were analyzed by the laboratory as part of QA/QC measures.

The site-specific ex situ remediation confirmation procedure took into consideration the homogeneous nature of the soil now stockpiled. Ninety-five percent of the contaminated soil remaining at Nanisivik that requires ongoing treatment to reduce the PHC concentrations has been homogenized by passing it through a vibrating screener in 2012 and 2013. QA/QC analysis of select discrete samples used to generate composite samples for the biopiles in the treatment facilities demonstrated PHC F2 concentrations in the biopiles were homogenous (Table 4: Remediation Progress Soil Samples, *Nanisivik Mine Contaminated Soil Remediation 2013 Progress Report* (SRK 2014)).

2.3 Quality Assurance and Control

Quality assurance and control (QA/QC) measures associated with the collection and analysis of the soil samples included the comparison of field screening results with laboratory data and laboratory analysis of blind duplicates and discrete QA/QC samples. Blind field duplicate samples monitor a combination of the precision of the laboratory analyses, sample preparation errors, sample collection errors and genuine short scale variations in soil geochemistry. Discrete samples monitor the homogeneity of composite sample areas.

The QA/QC sampling plan described in the *Nanisivik Mine Reclamation and Closure Monitoring Plan* (Gartner Lee Limited 2004) requires one discrete sample be submitted for laboratory analysis for every five composite samples submitted. In 2007, the QA/QC plan was revised to require one duplicate and three discrete samples from one of the composite sample area for every ten composite samples submitted for laboratory analysis. The continued implementation of the revised QA/QC plan was recommended in both the 2012 and 2013 contaminated soil remediation progress reports (SRK Consulting (Canada) Inc. and WESA, a division of BlueMetric Environmental Inc. 2013, SRK 2014) submitted to the NWB as part of CanZinco's annual report.

3 Parameters Analyzed

Soil samples were analyzed for the parameters of concern as identified by the source of contamination and by a series of samples collected to characterize and verify the suspected contaminants. Four areas of contamination were identified based on the type of contamination present as reported in Section 4.3.1 of the *Nanisivik Mine Contaminated Soil 2012 Progress Report* (SRK Consulting (Canada) Inc. and WESA, a division of BlueMetric Environmental Inc. 2013). The types of parameters analyzed for are based on the origin of the soil being treated.

PHC F1 and benzene, ethylbenzene, toluene, xylenes (BETX) impacts were not detected in areas where only diesel fuels or waste diesel was stored within the former bulk fuel storage facility; as such no PHC F1 or BETX impacts were present in soil originating from Area 1 or Area 4. Given that PHC F1 and BETX are not parameters of concern in Areas 1 and 4, these parameters were not included in the remediation confirmation and remediation performance monitoring testing conducted on soils originating from these areas.

During the removal of the tanks in 2011, soil samples were collected and analyzed from a series of test pits to characterize and delineate the contaminated soil. In accordance with the *Abandonment and Reclamation Plan, Fuel Tank Farm, Former Nanisivik Mine Site* (Stantec 2010) select samples were tested for the presence of polycyclic aromatic hydrocarbons (PAHs). PAH impacts were not detected and therefore PAH analyses were not reported in the remediation confirmation and remediation performance monitoring progress reports. In 2012 and 2014 additional samples were tested for PAH impacts and the results indicated that no PAHs were present at concentrations greater than the *Canadian Environmental Quality Guidelines* (CCME, 1999). The analytical test results for PAH analyses were provided to DFO directly in 2011, 2012 and 2014, but they were not summarized in the annual contaminated soil remediation progress reports submitted to the NWB. All PAH results obtained between 2011 and 2014 will be summarized in the 2014 progress report.

During the excavation of soil beneath the former horizontal flushing agents tanks at the north end of Area 3 in 2014 the presences of volatile organic compounds (VOC) impacts were suspected and a suite of samples were analyzed to characterize the parameters of concern and to permit remediation confirmation and performance monitoring. The analytical test results for VOC parameters received to date have been provided to DFO directly and will be included in the 2014 progress report to the NWB. VOC-contaminated soil located underneath and adjacent to the former flushing agent tanks was excavated during the 2014 field season. Pending the receipt of laboratory results confirming the soil quality remediation objectives (SQROs) were met in August 2014, no further excavation of VOC-contaminated soil is expected to be required.

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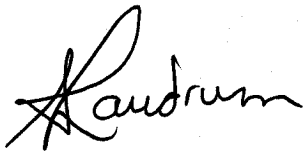

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4 References

Canadian Council of Ministers of the Environment (CCME), 1999 – Updated to September 2014. Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment, Winnipeg.

Canadian Council of Ministers of the Environment (CCME), 2001, Revised 2008. Canada-Wide Standards for Petroleum Hydrocarbons in Soil: Technical Supplement. January 2008.

Gartner Lee Limited. 2004. Nanisivik Mine Reclamation and Closure Monitoring Plan. Prepared for CanZinco Ltd. and included as Appendix F, Nanisivik Mine 2004 Reclamation Plan and Closure Plan. February 2004.

SAIC Canada, 2006. Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils. Prepared for Environment Canada. March, 2006

SRK Consulting (Canada) Inc. and WESA, a division of BlueMetric Environmental Inc. 2013. Nanisivik Mine Contaminated Soil Remediation 2012 Progress Report. Prepared for CanZinco Ltd. March 2013.

SRK Consulting (Canada) Inc. 2014. Nanisivik Mine Contaminated Soil Remediation 2013 Progress Report. Prepared for CanZinco Ltd. March 2014.

Stantec Consulting Ltd., 2010. Abandonment and Reclamation Plan, Fuel Tank Farm, Former Nanisivik Mine Site. January 2010.