Abandonment and Reclamation Plan for Treatment of Contaminated Soil at the Former Nanisivik Mine

Prepared for

CanZinco Mines Ltd.

Prepared by

SRK Consulting (Canada) Inc.
1CB002.002
September 2014

Abandonment and Reclamation Plan for Treatment of Contaminated Soil at the Former Nanisivik Mine

September 2014

Prepared for

CanZinco Mines Ltd.
c/o Nyrstar
Tessinerplatz 7, CH-8002
Zurich, Switzerzerland

Tel: +41 44 145 8210
Web: www.nyrstar.com

Prepared by

SRK Consulting (Canada) Inc.
202–5204 50th Avenue
Yellowknife, NT X1A 1E2
Canada

Tel: +1 867 873 8670
Web: www.srk.com

Project No: 1CB002.002

File Name: ARP_1CB002 002_20140915.docx

Executive Summary

This abandonment and reclamation plan serves as an update to the 2010 abandonment and reclamation plan for the former fuel tank farm. The activities described are specific to the treatment of petroleum hydrocarbon contaminated soil at the Nanisivik dock area. This abandonment and reclamation plan does not serve as an update to the ongoing post closure monitoring and maintenance of other facilities reclaimed previously by CanZinco Mines Ltd.

The goal of the abandonment and reclamation plan for the treatment of contaminated soil is to remediate the petroleum hydrocarbon contaminated soil and affected areas so:

(a) it does not represent a risk to wildlife, aquatic life, or future human users and

(b) the land can continue to be used for commercial and industrial use.

At the Nanisivik dock area, piles of petroleum hydrocarbon contaminated soil are treated through two principal mechanisms: volatilization and bioremediation. Volatilization occurs when the soil is aerated. In the bioremediation process, microorganisms are responsible for the degradation of the petroleum hydrocarbon in the soil. To enhance the microbial performance, nutrients are added and moisture content managed.

The soil is being treated in two constructed treatment facilities, the upper treatment area and lower treatment area at the site. A concrete pad is used for the temporary storage of contaminated soil.

Following successful remediation to the applicable environmental quality standards, the treated soil is to be reused or disposed of appropriately. When the soil treatment facility is no longer in use it will be decommissioned and the land surface contoured to inhibit the ponding of water. The final reclamation and closure of the treatment facilities is scheduled to be completed by September 2016.

ᓇᐃᓪᓕᒋᐊᕐᓗᒍ ᐅᓂᒃᑳᖅ

ᐊᑭᑦᑎᓐᓄᑦ ᓴᓇᔨᓄᑦ ᕿᒪᒃᑕᐅᓂᑯᓂᒃ ᐱᖁᓯᑐᕐᑲᖏᓐᓄᑦ ᐅᑎᖅᑎᑕᐅᒋᐊᓕᖕᓄᑦ ᐸᕐᓇᐃᔪᑕᐅᓯᒪᔪᓄᑦ ᖃᓄᐃᓕᐅᖅᓯᒪᓂᑦᑎᓐᓂᒃ ᐅᓂᒃᑲᐅᓯᕐᑲᕐᓂᐊᓕᖅᐳᒍᑦ ᐅᑭᐅᖅ 2010-ᒧᑦ ᑎᑭᓯᒍ ᐱᐊᓂᒃᑕᐅᓯᒪᓕᖅᑐᓂᒃ ᑕᐃᑲᓂ ᐅᕐᓯᐊᓗᕐᑲᐅᑎᒃᑯᕙᕚᓃᑦ ᐱᖁᓯᑐᕐᑲᖕᒐᓄᑦ ᒪᓂᕋᖕᒐ ᐅᑎᖅᑎᑕᐅᕐᑯᔭᐅᓯᒪᖕᒪᑦ. ᐱᓕᕆᐊᕆᔭᐅᓯᒪᔪᑦ ᐅᓂᒃᑲᐅᓯᕆᔭᕗᑦ ᑕᕝᕙᖕᒐᑐᐊᖅ ᐱᖓᑕ ᓴᓗᒻᒪᖅᓴᐃᔪᑕᐅᔪᑦ ᐅᕐᓯᐊᓗᕈᔪᖕᓂᒃ ᒪᓂᕋᖕᒐᓂ ᓄᓇᒥ ᓇᓂᓯᕕᒃ ᑐᓚᒃᑕᕐᕕᐊᓂ. ᑖᓯᒥᖕᒐᑐᐊᖅ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᓯᒪᔪᒥᒃ ᐸᕐᓇᐃᔪᑕᐅᓯᒪᔪᓂᒃ ᐅᓂᒃᑲᐅᓯᕐᑲᖅᑐᒍᑦ ᐊᓯᖏᑦ ᒪᑐᔭᐅᓚᐅᖅᑐᑦ ᓄᖅᑲᖅᑎᓪᓗᒋᑦ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᒋᐊᓖᑦ ᐅᕐᑲᐅᓯᕆᖕᒋᑕᕗᑦ ᒫᓇᒧᑦ ᑎᑭᓪᓗᒍ ᐅᔮᖅᓱᖅᑕᐅᒋᐊᕐᑲᖅᑐᑦ ᐋᕿᒃᓱᖅᑕᐅᔪᕙᓃᑦ ᐅᑎᖅᑎᑕᐅᔪᕙᓃᑦ CanZinco Mines Ltd.-ᑯᓐᓄᑦ.

ᑐᕋᕐᑲᕐᒪᑕ ᐸᕐᓇᐃᔪᑕᐅᓯᒪᔪᑦ ᓴᓗᒻᒪᖅᓴᐃᔨᑏᑦ ᕿᒪᒃᑕᐅᓂᑯᓂᒃ ᐱᖁᓯᑐᕐᑲᖏᓐᓄᑦ ᐅᑎᖅᑎᑕᐅᕐᑯᔭᐅᓯᒪᔪᑦ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᕐᑯᔭᐅᓚᐅᖅᑐᑦ ᓱᕈᔫᓯᒪᔪᑦ ᒪᓂᕋᐃᑦ ᓄᓇᐃᓪᓗ ᐅᕐᓯᐊᓗᕈᔪᖕᓂᒃ ᐃᑦᓯᓯᒪᔪᑦ ᐅᓂᒃᑲᐅᓯᕆᔭᕗᑦ ᑲᒪᒋᔭᐅᓚᐅᕈᓯᖕᒋᑦ ᐃᒫᒃ:

ᐃ. ᐊᑦᑕᕐᓇᕈᓐᓃᖅᑎᑕᐅᕐᑯᓪᓗᒋᑦ ᑕᒫᓂ ᐆᒪᔪᓄᑦ, ᐃᒪᕐᒥᐅᑕᓄᑦ, ᓄᓇᒥᐅᑕᓄᓪᓗ ᐊᒻᒪᓗ ᐃᒻᒪᕐᑳ ᖃᖕᒐᑐᐃᓐᓇᖅ ᑕᒫᓂᕐᒥᐅᓄᑦ ᐊᑐᖅᑕᐅᔫᒪᕐᒥᖕᒪᑕ ᐊᒻᒪᓗ

ᐱ. ᓄᓇᖕᒐ ᑕᒪᓐᓇ ᑭᖑᓂᑦᑎᓐᓂ ᐊᑐᖅᑕᐅᒃᑲᓐᓂᕈᓐᓇᕐᓂᐊᕐᒪᑦ ᓂᐅᕙᐊᒃᓴᕐᑲᕈᒪᔪᓄᒃ ᐊᒻᒪᓗ ᓴᓇᖅᑯᑎᕐᑲᕈᒪᔪᓄᑦ.

ᓇᓂᓯᕕᐅᑉ ᑐᓚᒃᑕᕐᕕᐊᓂ, ᑲᑎᖅᓱᖅᑕᐅᓯᒪᖕᒪᑕ ᓱᕈᔫᓯᒪᔪᑦ ᐃᑦᑎᓯᒪᔪᑦ ᐅᕐᓯᐊᓗᕈᔪᖕᒥᒃ ᒪᓂᕋᐃᑦ ᓄᓇᐃᓪᓗ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᓂᐊᖅᑐᑦ ᐊᑐᕐᓗᑎᒃ ᒪᕿᐃᓕᖕᒐᔪᓂᒃ: ᐃᑭᑎᑕᐅᓗᑎᒃ ᐃᓚᖏᑦ ᓄᓇᖕᒐᑕ ᐱᖁᓯᑐᕐᑲᖕᒐᓄᑦ ᐅᑎᖅᑎᑕᐅᔪᓐᓇᕐᒪᑕ ᓯᓚᒧᑦ ᐊᓯᐸᖅᑕᐅᓗᑎᒃ. ᓄᓇᖕᒐᓂ ᓯᓚᒧᑦ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᔪᓂ ᐊᑐᕐᑲᑦᑕᕐᒪᑕ ᐅᕐᓯᐊᓗᕈᔪᖕᓂ ᕐᑯᐱᕈᑯᓗᖕᓄᑦ ᓂᕆᔭᐅᑎᓯᒍ ᓴᓗᒻᒪᖅᓴᐃᔪᑎᕐᑲᖅᓱᑎᒃ ᑕᐃᒪᖕᒐᓂᑦ ᓱᕋᒃᑎᖅᑕᐅᕙᓪᓕᐊᕐᑲᑦᑕᕐᒪᑕ ᐅᕐᓯᐊᓗᕈᔪᐃᑦ ᓄᓇᒥ. ᓄᓇᖕᒐᓂ ᕐᑯᐱᕈᑯᓗᐃᑦ ᓴᓗᒻᒪᖅᓴᐃᔪᑦ ᐊᔪᖏᓐᓂᖅᓴᐅᕐᑯᓪᓗᒋᑦ, ᓂᕿᖏᓐᓂᒃ ᐅᐊᕈᑎᕐᑲᑦᑕᖅᑕᕗᑦ ᖃᐅᓯᓕᖅᓱᖅᑕᐅᓪᓗᑎᓗ ᖃᐅᓯᖅᑐᒥᒋᐊᖅ ᕐᑯᕙᐊᒻᒪᑕ ᐊᐅᓚᑕᐅᖏᓐᓇᖅᑐᑦ.

ᒪᓂᕋᖕᒐᓂ ᓄᓇ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᔪᖅ ᒪᕿᖖᓂ ᓴᓗᒻᒪᖅᓴᐃᕙᕐᑲᖅᓯᑎᒃ, ᕐᑯᑦᑎᖕᓂᖅᓴᒥ ᐊᒻᒪᓗ ᐊᑦᑎᖕᓂᖅᓴᒥ ᓄᓇᒥ. ᕿᑯᓕᖅᓯᐃᓚᐅᖅᑐᑦ ᒪᓂᕋᖕᒐᓂ ᓴᓗᒻᒪᖅᓴᐃᕙᐅᓂᐊᖅᑐᒥ ᓱᕈᔫᓯᒪᔪᓂᒃ.

ᐅᑯᐊ ᐱᖁᓯᑐᕐᑲᖏᓐᓄᑦ ᐅᑎᖅᑎᑕᐅᓇᓯᐊᖅᑐᑦ ᐊᑭᑎᖕᒐᓂ ᐱᐅᓂᖅᐹᒥᒃ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᓂᐊᖅᑐᑦ, ᐊᑐᖅᑕᐅᒃᑲᓐᓂᕈᓐᓇᖅᓯᓂᐊᕐᒪᑕ ᐅᕝᕙᓘᓐᓃᑦ ᐊᒃᑕᖅᑕᐅᓗᑎᒃ ᓄᓇᒧᑦ ᓴᐅᔭᐅᓗᑎᒃ. ᒪᓂᕋᖕᒐᓂᒃ ᓄᓇᖕᒐᓂᓗ ᓴᓗᒻᒪᖅᓴᐃᔨᑏᑦ ᐊᑐᓇᐊᕐᑲᕈᓐᓃᖅᐸᑕ ᐋᔭᖅᑕᐅᓂᐊᖅᑐᑦ ᐊᒻᒪᓗ ᒪᓂᕋᖕᒐ ᓴᐅᔭᐅᓗᓂ ᓄᓇᖕᒐᑕ ᓴᓇᒪᓂᖕᒐᓂᒃ ᐃᔾᔪᐊᖅᓯᓗᑎᒃ ᓇᖅᓴᑯᔫᓕᕐᓗᓂ ᑕᓯᕐᓗᕐᑲᓖᖕᒋᒪᑦ ᑕᒫᓂ. ᑭᖑᓪᓕᖅᐹᒥ ᐱᖁᓯᑐᕐᑲᖏᓐᓄᑦ ᐅᑎᖅᑕᐅᓯᒪᓕᖅᐸᑕ ᒪᑐᔭᐅᓗᑎᒃᓗ ᓴᓗᒻᒪᖅᓴᐃᔪᑕᐅᓚᐅᖅᑐᑦ ᐱᐊᓂᒃᑕᐅᓯᒪᓇᓱᐊᕐᓂᐊᖅᑐᑦ ᓯᑎᐱᕆ 2016-ᒥ.

Table of Contents

List of Figures

List of Tables

Appendices

1 Introduction

1.1 Purpose and Scope of the Abandonment and Reclamation Plan

This abandonment and reclamation plan serves as an update to the 2010 *Abandonment and Reclamation Plan, Fuel Tank Farm, Former Nanisivik Mine Site, Nunavut* prepared by Jacques Whitford Stantec Limited (Stantec 2010). The activities described are specific to the treatment of petroleum hydrocarbon (PHC) contaminated soil at the Nanisivik dock area. This plan does not serve as an update to the ongoing post closure monitoring and maintenance of other facilities reclaimed previously by CanZinco Mines Ltd.

1.2 Goal of the Abandonment and Reclamation Plan

The goal of the plan for the treatment of contaminated soil is to remediate the PHC contaminated soil and affected areas so:

(a) it does not represent a risk to wildlife, aquatic life, or future human users and

(b) the land can continue to be used for commercial and industrial use.

1.3 Regulatory Instruments for Abandonment and Reclamation

Operations at the former Nanisivik Mine are regulated by a water licence. The original water licence was granted by the Northwest Territories Water Board under the Northwest Territories Waters Act. The Nunavut Water Board (NWB) assumed the responsibility for current water licences in 1996 under the mandate of the Nunavut Land Claims Agreement Act. The Nunavut Waters Act received Royal Assent in May 2002.

The current Nanisivik water licence (No. 1AR-NAN0914) came into effect April 1, 2009 and expired on March 31, 2014. The licence was issued for the purpose of reclamation and closure activities and post closure monitoring and contains the conditions under which reclamation and closure and post closure monitoring of the site must proceed. An application to renew the licence for the purpose of reclamation and closure activities and post closure monitoring was submitted to the NWB on November 13, 2013, by CanZinco Ltd.

During the term of the previous licence CanZinco Ltd. was acquired by Nyrstar Sales & Marketing AG (August 2011). The incorporation of CanZinco Ltd. continued into British Columbia from the jurisdiction of Canada on December 27, 2013. As part of this change, the legal name changed to CanZinco Mines Ltd.

The surface lease at the dock area, where contaminated soil is being treated is administered by the Department of Fisheries and Oceans (DFO) (Lease No. L-9195300). CanZinco holds no sub-surface mineral rights in the area.

2 Project Environment

The former Nanisivik dock area is located in the Canadian Arctic on northern Baffin Island, on the south shore of Strathcona Sound, on the Borden Peninsula, at latitude 73°04'N and longitude 84°33'W (Figure 1). The environment around the site is typical of the High Arctic region, characterized by extremely cold temperatures, low precipitation, continuous permafrost, and largely barren surface soils that results in the mine area having minimal vegetation coverage and wildlife usage (BCRI 1975).

The former mine site is located approximately 35 kilometres by road from the Hamlet of Arctic Bay, which is located on the shore of Arctic Bay on the Adams Sound. This community has a population of about 825 people, composed of a majority of Inuit.

Climatic data was collected at the Nanisivik Airport by Environment Canada from 1976 to 2010. The Nanisivik Airport is located approximately 20 km south of the Nanisivik dock area at an elevation of 642 metres (m) and elevations at the dock area range from sea level to 30 m. The recorded climate data were analyzed in Golder (1998). The following list is a summary of the main climatic parameters based on the data available in 1998:

- Mean annual air temperature was estimated to be −15.2 degrees Celsius (°C).
- Mean annual precipitation total was estimated to be 240 millimetres (mm).
- Twenty-four hour probable maximum flood value was estimated to range from 140 to 210 mm.
- The mean annual lake evaporation value, as measured was approximately 200 mm.

Climate monitoring was discontinued at the Nanisivik Airport in January 2011. The nearest available climate monitoring station is located at Arctic Bay. The Arctic Bay weather station is located approximately 14.5 kilometres west of the Nanisivik dock area and at an elevation of 31 m. A statistical assessment of the comparable data sets collected at the Nanisivik Airport and Arctic Bay between 2008 and 2010 was undertaken by BGC Engineering Inc. and it was found that the average difference in air temperature was approximately 1.6°C, with a standard deviation of approximately 4°C. Arctic Bay generally experienced warmer air temperatures than the Nanisivik Airport, as expected. This difference was more pronounced in the months between May and September where it was found that the average difference increased to in excess of 3°C (BGC 2012).

Because the Arctic Bay weather station is close to the ocean and at a similar elevation to the soil treatment facilities, the climate data recorded at Arctic Bay is expected to be accurate for the Nanisivik dock area.

3 Project Description

3.1 Access

Access to mine site is via scheduled air service from Iqaluit and Resolute Bay to Arctic Bay. The road from Arctic Bay to Nanisivik is open during snow free periods from mid-June to mid-September. Freight is delivered to Nanisivik via ship during the 14-week open water season. The site includes a deep water dock located on the south shore of Strathcona Sound approximately 30 kilometres from Admiralty Inlet.

3.2 Site History

The early site history is summarized in the 2004 Nanisivik Mine reclamation and closure plan (CanZinco 2004).

Pyrite mineralization in the area was known to the Inuit people and the area was called Nanisivik, “The Place Where People Find Things”. Formal mineral exploration was first documented in 1910 by the Canadian Government. Claims were first staked in 1937. The Geological Survey of Canada conducted surface mapping in 1954 that documented the presence of galena and sphalerite with the pyrite. Advanced mineral exploration in the area began around 1957 by Texas Gulf Inc., which involved prospecting, diamond drilling, and underground exploration. This exploration work outlined the future Nanisivik orebody.

The property was optioned by Mineral Resources International Limited in 1972 who subsequently hired Strathcona Mineral Services Limited to manage the property. Development of the mine facilities took place from 1974 to 1976 under a master agreement signed June 18, 1974, between Nanisivik Mines Ltd. (as assignee of Mineral Resources International Limited) and the Department of Indian Affairs and Northern Development. Under the master agreement, the federal government agreed to the construction and maintenance of an airport, roads, and a public cargo shipping wharf at Strathcona Sound. Mining and milling commenced in 1976. The property was sold to CanZinco in July of 1996, and they operated the mine to September 2002 when the mine was closed permanently. On February 12, 2002 CanZinco submitted its final reclamation and closure plan. The plan was subsequently updated and on July 6, 2004, the NWB approved the *Nanisivik Mine 2004 Reclamation and Closure Plan* (CanZinco 2004) and closure and demolition activities commenced.

Soil reclamation activities began in April 2005. By October 1, 2008 reclamation activities specified in the *Nanisivik Mine 2004 Reclamation and Closure Plan* (CanZinco 2004) had been completed (GLL 2008a, GLL 2008b, SRK 2009, BGC 2009). No activities were undertaken within the fuel tank farm during this period because, following mine closure, the fuel tank farm was operated by a third party, and it was anticipated that ownership would be transferred to a third party. In August 2007, the prime minister of Canada announced that Nanisivik would be the future site of a military deep-water docking and refueling facility, and the fate of the existing facility became unknown. In June 2008, the Department of National Defence (DND) inspected the tank facility to determine if they could be used for their purposes. However, in February 2009, the DND requested that the fuel tank farm be decommissioned.

On April 26, 2010 the *Abandonment and Reclamation Plan, Fuel Tank Farm, Former Nanisivik Mine Site, Nunavut* (Stantec 2010) was approved by the NWB. Decommissioning of the fuel storage tanks was undertaken in May and June 2011. Treatment facilities for PHC contaminated soil remediation were constructed in 2011 and 2012. Excavation PHC contaminated soil was undertaken between 2011 and 2014. Treatment measures commenced in 2011 and are to continue under a renewed water licence until the soil remediation objectives are met.

3.3 Project Summary

3.3.1 Soil Treatment Operating Plan

Biopiles of PHC contaminated soil are treated through two principal mechanisms: volatilization and bioremediation. Volatilization occurs when the soil is aerated. In the bioremediation process, microorganisms are responsible for the degradation of the PHC in the soil. To enhance the microbial performance nutrients are added and moisture content managed. The treatment of contaminated soil is restricted to a 90 day field season.

Biopiles are located in two constructed treatment facilities, the upper treatment area (UTA) and lower treatment area (LTA). A concrete pad is used for the temporary storage of soil that does not exceed the management limits for commercial land use established by the Canadian Council of Ministers of the Environment (CCME) Canada-Wide Standards (CWS) for PHC for coarse-grained soil (CCME 2008). The location of the treatment facilities are shown on Figure 2.

Aeration

Gas transfer in the contaminated soil is important for two reasons: (a) the bioremediation process requires oxygen to occur and (b) gas transfer promotes volatilization of the PHC from the soil. To achieve the gas transfer, the contaminated soil is turned and aerated once every four days during the field season, as equipment availability and weather conditions allow. Under the same climatic conditions a wet soil will volatilize less mass of hydrocarbons than will a dryer soil and therefore soil aeration is primarily performed on fair days (days with sun) under dry conditions.

The biopiles in the UTA and LTA are formed to a height of 1.5 m and each cell contains a biopile with a volume of approximately 220 m^3. The biopiles are typically aerated to a depth of 1.0 m using an excavator or backhoe. Each full bucket is lifted to the vertical extent of the bucket arm and then let to fall from elevation to achieve an air exchange. The bottom 0.3 to 0.5 m of the biopiles is not aerated or removed during off-loading in order to reduce the risk of damaging the liner at the base of the biopiles.

Management of Moisture Content

Water is required for microbial respiration and therefore PHC remediation. Hydrocarbon-degrading microbes (hydrocarbonoclastes) need to come into contact with solubilised nutrients in order for PHC bioremediation to occur; this contact is largely governed by the soil moisture content. As recommended by WESA Inc., the soil moisture of each biopile is managed by obtaining readings from each biopile with a handheld soil moisture meter and additional water added to the biopiles to maintain an average above 5% (WESA 2013).

Nutrient Amendment

The nutrients needed for accelerating bioremediation are added to the soil based on the level of total PHC concentration for the microbial cells to replicate and survive. As advised by WESA, in cold region soils, nitrogen and phosphorus are the nutrients that typically limit microbial activity. Nitrogen and phosphorus were added to the constructed biopiles in the form of granular agricultural fertilizers Urea and diammonium phosphate. The amount of urea and diammonium phosphate applied is based on the volume of soil being treated and the total PHC concentration as recommended by WESA (2013).

Remediation Performance Monitoring

Monitored bioremediation performance indicators include PHC concentrations, moisture content, nutrient concentrations, and the number of hydrocarbon degrading bacteria in sampled soils. Performance monitoring is conducted throughout the field season. Laboratory results are obtained for PHCs at the start of each field season, mid-way through the season and then again at the end of the season. Soil samples are also analyzed for of total kjeldahl nitrogen, total phosphorus, pH, and hydrocarbonoclastes at the start of each field season.

Remediation Confirmatory Sampling

To confirm the performance of the bioremediation progress, representative soil samples are collected from the biopiles before the soil is classified as meeting the soil quality remediation objectives and removed from the area where it is being treated. The confirmatory soil sampling methodology is included as Appendix A and the remediation criteria for contaminants of concern are included as Appendix B.

3.3.2 System Monitoring and Maintenance

Remediation performance monitoring results are included in biweekly reports provided to DFO and the annual remediation progress report submitted to the NWB.

The berms and ditches are maintained to minimize the amount of surface water coming in contact with the contaminated soil. If there is excess water ponding it is transferred to the stormwater retention ponds at the treatment areas or applied to the biopiles to improve their moisture content.

Prior to demobilization for winter the condition of the ditches and berms are to be inspected and, if needed, reinforced in an effort to accommodate the spring runoff. Should the water diversion structures fail, soil samples will be collected to determine if the contamination has spread. Contaminated soil will be directed to the treatment facilities and remediation confirmation samples collected.

3.3.3 Record Keeping and Reporting

Record keeping and reporting for the treatment of contaminated soil at the Nanisivik dock area includes the following:

- Inventory of the soil undergoing treatment including its origin, volume, contaminant types and concentrations;
- Daily supervisor reports of site activities; and
- Database of results of all monitoring activates and soil analyses.

Spills are to be reported in accordance with the site spill contingency plan (Nyrstar 2014). Appropriate corrective action must be taken to contain and control any release of leachate from a soil treatment facility and measure taken to prevent occurrence of similar events in the future.

3.4 Deviations from Original Conceptual Plan

3.4.1 Soil Treatment Facility

The original plan (Stantec 2010) called for one collection pond. However, given the site topography and location of the constructed treatment cells, two water retention ponds (one at the UTA and one at the LTA) were constructed to accept any potential accumulated water from the treatment cells as a result of excessive water from rainfall or snowmelt.

The conceptual plan for the treatment of PHC contaminated soils included a series of treatment vessels to filter out PHC and metal compounds (Stantec 2010). The arid conditions resulted in little or no water accumulating in the sumps of the treatment cells. To optimize soil moisture conditions, impacted water is applied to the biopiles instead of being treated and discharged to the environment.

The location of the soil treatment facility proposed in 2010 encroached on Twin Lakes Creek. Two separate areas for treatment were required to accommodate 16 treatment cells.

3.4.2 Soil Management

At the end of the 2011 field season, the biopile treatment cells were covered in accordance with the original 2010 remediation program for the site (Stantec 2010). Insufficient supplies were available to cover all of the bioplies. Cells UTA-1 and part of UTA-2 remained uncovered during the 2011/2012 winter season. In June 2012, field observations indicated the soil within the uncovered biopiles did not show evidence of washout or erosion. Water was not observed to be pooling and the moisture content of the soil was observed to be within the ideal range for bioremediation within the uncovered cells. Surface soil samples were collected from both the uncovered and covered biopiles and submitted for laboratory analyses of PHC F1-F4. Soil samples collected from outside of the biopiles and in the path of snowmelt confirmed that contaminated soil was not displaced from the uncovered cells. As a result of these findings, WESA recommended that no cover be placed on the biopiles in subsequent winter seasons (SRK and WESA 2013).

Instead of submitting one composite sample made up of 16 subsamples from the treatment cells (Stantec 2010), one composite sample from each treatment cell was created from five subsamples collected within the same cell (Appendix A).

Exova Canada Inc. was retained instead of the National Research Council of Canada – Biotechnology Research Institute to conduct the bacterial population counts and WESA was retained to provide recommendations on nutrient amendments.

In 2011, when it became apparent that the volume of PHC contaminated soil exceeded the estimate made by Stantec (Stantec 2010) and there was insufficient level and dry ground available to accommodate the necessary number of treatment cells, authorization to utilize part of the concrete pad was sought from the DFO. In 2013, authorization to use a portion of the pad for the temporary storage of PHC contaminated soil was received. The memorandum of agreement reached between the DFO and CanZinco was subsequently updated July 24, 2014, to allow for an expansion of the area being used by CanZinco.

The final desired landscape in the original plan called for the regrading of all areas excavated. CanZinco has subsequently been advised verbally by DND representatives that the excavation within the DND construction area is to remain open.

3.4.3 Disposal of Liner

Numerous liners were encountered during the removal of the infrastructure in the former bulk fuel storage facility. Instead of disposing of the pieces of liner in a rubble pit on-site (Stantec 2010) all liner material recovered in 2011 was shipped south for disposal with other waste materials from the demolition of the fuel tanks.

Waste liner accumulated since 2011 is temporally stored within wire cages. The closure of the soil treatment facilities will create additional waste liner. Authorization to dispose of the waste liner in a small landfill near the former industrial complex from the NWB is being sought by CanZinco.

4 Abandonment and Reclamation Requirements

4.1 Constructed Soil Treatment Facilities

4.1.1 Existing Facility

The facilities constructed for PHC contaminated soil are located in two areas referred to as the lower treatment area (LTA) and upper treatment area (UTA) (Figure 2). The treatment facilities comprise a series of 16 cells in which biopiles of PHC contaminated soil are managed. Details on the treatment facility design and construction are provided in the *Construction Summary Report, Nanisivik Mine Site* (WESA 2012). The report was submitted to the NWB on November 29, 2012, in accordance with Part D Section 9 of the water licence (No. 1AR-NAN0914).

4.1.2 Final Site Condition

Following successful remediation of soil to the applicable environmental quality standards, the treated soil is to be reused or disposed of appropriately. When the soil treatment facility is no longer in use it must be decommissioned and the land surface must be contoured to inhibit the ponding of water and allow for the commercial use of the area.

Following decommissioning, closure samples must be collected from the soil beneath and surrounding the former soil treatment facility. Soil samples are to be submitted for laboratory analysis of contaminants of concern to establish whether the land has been contaminated during soil treatment. Remediation of contamination caused by the operation of the facility (if present) is required as part of the closure process.

The decommissioning of the treatment facilities will be staged such that any underlying contamination can be treated. It is anticipated that soil treatment cells UTA 9 and UTA 10 will be the last cells to be decommissioned.

4.1.3 Closure Objectives and Criteria

The objectives of the *Nanisivik Mine 2004 Reclamation and Closure Plan* (CanZinco 2004) in whole are to ensure that concentrations of potential contaminants of concern in surface soil are below levels at which no adverse human or ecological effects are expected. The closure objective for the soil treatment facility is to leave the land in a condition that is suitable for commercial use.

In situ remediation confirmation soil samples are to be collected in accordance with the NWB approved Remediation Confirmatory Sampling Methodology (included as Appendix A) across the base of the area that formerly held the soil treatment facilities and from soil immediately adjacent to the facilities.

The remediation criteria are based on soil quality remediation objectives endorsed by the CCME. Generic environmental quality criteria for commercial land use are provided under the PHC CWS Tier 1 soil quality guideline (CCME 2008) and the in *Canadian Environmental Quality Guidelines* (CCME 1999 - 2014). The CCME allow for the development of site-specific soil remedial objectives. Risk-based site-specific soil remedial objectives were developed for the majority of the contaminants of concerned (lead, zinc, arsenic, cadmium, and copper) (JWEL 2003) and studies are under way to develop a site-specific soil remedial objective for PHC fraction F2. An overview of the methodology for developing a site-specific soil remedial objectives for PHC fraction F2 was prepared by Hemmera (2014) and submitted to the NWB September 8, 2014. The current remediation criteria for PHCs are summarized in Appendix B.

4.2 Concrete Pad

4.2.1 Existing Facility

A portion of the concrete pad that formerly held the 125,000 tonne capacity concentrate storage shed is utilized for the temporary storage of PHC contaminated soil. In 2008, the concrete pad was swept and then covered with 0.5 m of shale, contoured to be similar to the natural surroundings and to provide positive drainage in accordance with the *Nanisivik Mine 2004 Reclamation and Closure Plan* (CanZinco 2004). The cover on the pad was partially removed by DFO in 2009 (BGC 2010). In 2013 and 2014 a portion of the exposed concrete pad was swept. The dust was collected and stored for future disposal off-site. The joints and holes in the pad were cleaned of accessible fill. The fill is considered to be contaminated with lead and zinc and stored with the dust for future disposal off-site. The joints in the pad were sealed to prevent the transfer of hydrocarbon contaminated contact water below the pad. Surface water diversion berms were established to reduce the amount of surface water coming into contact with the contaminated soil.

Soil with similar PHC concentrations and grain size are combined into stockpiles on the concrete pad. The nature of the soil placed is determined by its origin, laboratory results, field screening vapour concentrations and maximum grain size.

Prior to offloading soil from the pad, soil samples are collected to determine the PHC concentration of the contaminants of concern. Soil that meets the soil quality remediation objectives is relocated to the former secondary containment area or used to repair water management structures or improve heavy equipment access to other areas being worked by CanZinco. Soil that exceeds the soil quality remediation objectives either remains on the pad or reports to the UTA or LTA for further treatment.

4.2.2 Final Site Condition

Under the memorandum of agreement between CanZinco and DFO, CanZinco is required to remove the stockpiles of soil and water diversion berms by July 31, 2015.

4.2.3 Closure Objectives and Criteria

The closure objective for the concrete pad is to restore it to the condition that existed on May 31, 2013.

Prior to evacuating the pad in 2015, sampling and analysis in the immediate surroundings of the pad will be conducted applying CanZinco's NWB-approved confirmatory sampling protocol. The remediation criteria will be the same for the soil on and adjacent to the pad as it is for the soil treatment facilities as described in section 4.1.3. Soil exceeding the PHC remediation objectives will be relocated to the UTA or LTA for treatment. The final condition of the pad documented in a memo that includes a photographic record and a tabulation of soil sample results.

4.3 Footprint of Former Bulk Fuel Storage Facility

4.3.1 Existing Facility

The fuel tanks were demolished in 2011 and the excavation of PHC contaminated soil commenced. Four areas of excavation were identified based on location and contaminants of concern as shown on Figure 2. In 2014 the excavation of PHC contaminated soil was essentially complete; however remediation confirmatory laboratory results received by September 11, 2014 show a small pocket (less than 50 m^3) of PHC F2 contamination remaining in the east wall of the former facility (Area 1). At the request of DND and DFO the excavation of areas 1, 2 and 3 remain open and the areas were not capped and graded to match the existing conditions of the surrounding land.

The excavation in Area 4 has been backfilled to inhibit the ponding of water. Soil remediated between 2011 and 2014 has been placed in the Area 4 excavation and elsewhere in the former secondary containment area.

4.3.2 Final Site Condition

The residual contamination remaining in the east wall of the Area 1 excavation will be excavated. Additional remediated soil is to be placed in a southern portion of the former bulk fuel storage facility.

4.3.3 Closure Objectives and Criteria

The closure objective for the footprint of the former bulk fuel storage facility is to leave the land in a condition that is suitable for commercial use.

The soil sampling plan to confirm the success of contaminated soil excavation was described in the NWB-approved *Nanisivik Mine Reclamation and Closure Monitoring Plan* (GLL 2004b). Future remediation confirmatory sampling will follow the methodology provided in Appendix A.

The remediation criteria are based on soil quality remediation objectives endorsed by the CCME. Generic environmental quality criteria for commercial land use are provided under the PHC CWS Tier 1 soil quality guideline (CCME 2008) and the in *Canadian Environmental Quality Guidelines* (CCME 1999 - 2014). The CCME allow for the development of site-specific soil remedial objectives. The current remediation criteria for PHCs are summarized in Appendix B.

4.4 Buildings and Equipment

4.4.1 Existing Facility

There is no camp associated with the treatment of contaminated soil at the former Nanisivik Mine site. Two portable trailers, a sea container and a portable outhouse are rented from a businessman in Arctic Bay.

The heavy equipment is supplied by a local contractor from Arctic Bay, and it is mobilized and demobilized annually for the field season.

4.4.2 Final Site Condition

All trailers, containers, equipment and supplies are to be removed from the site.

4.4.3 Closure Objectives and Criteria

No garbage, equipment or supplies are to remain.

4.5 Post-Closure Monitoring, Maintenance and Reporting

Contaminated soil remediation progress is to be documented in the annual report filed with the NWB.

4.6 Contingencies

The *Post Closure Geotechnical Monitoring Contingency Plan* (BGC 2009), the *Contingency Plan for Water Exceedances, Former Nanisivik Mine Site* (Stantec 2009) and the *Former Nanisivik Mine Site Spill Contingency Plan* (Nyrstar 2014) shall apply.

Based on the volume and current concentrations of PHC contaminated soil and rate of remediation achieved in 2013 and 2014, it is anticipated space will be available for all PHC contaminated soil in the UTA and LTA at the end of July 2015. As a contingency measure, a site-specific soil remedial objective for PHC F2 is being developed that would allow for a reduction in the volume of soil requiring further treatment in 2015. If necessary some of the biopiles in the UTA and LTA could be increased in height to accommodate additional PHC contaminated soil. Aeration of soil greater than 1.0 m below surface will not be undertaken and depending on the configuration of the piles there may be no mechanical treatment of the soil until additional space becomes available in other treatment cells.

Some open space on the concrete pad was maintained at the end of the 2014 field season to accommodate soil requiring excavation at the start of the 2015 field season. In addition, there will be space in the treatment cells for contaminated soil, as laboratory results received September 11, 2014, indicate that soil in five treatment cells has been remediated and the cells can be off-loaded.

5 Schedule of Activities

The annual Nanisivik Mine Contaminated Soil Remediation Progress Report will be submitted as part of the annual report to the NWB by March 31 of the following year.

In late June, equipment will be mobilized to site to:

- Promote the thaw of the biopiles and stockpiles,
- Excavate residual contaminated soil,
- Collect soil remediation progress and remediation confirmatory samples,
- Off-load soil from the treatment areas that meets the remediation objectives, and
- Commence the routine aeration of the biopiles.

In mid-July, all biopiles that meet the remediation objectives will be off-loaded. Soil remediation progress and remediation confirmatory samples will again be collected.

In 2015, the removal of the stockpiles of soil on the concrete pad will commence prior to July 15 in order to accommodate the targeted evacuation of the pad by August 1, 2015. Prior to August 1, 2015, the stockpiles and water diversion structures will be removed and the final condition of the pad documented.

In mid-August, a third round of soil remediation progress and remediation confirmatory samples will be conducted. All biopiles that meet the remediation objectives will be off-loaded and the decommissioning of cells within the UTA and LTA will commence if they are no longer needed to treat contaminated soil.

Soil treatment and the decommissioning of the treatment cells will continue under the supervision of the project manager or their designate. The final reclamation and closure of the treatment facilities is scheduled to be completed by September 2016.

6 Financial Security

The estimated cost to operate the soil treatment facilities is in the order of $230,000 annually. Table 1 provides a summary of the costs. Depending upon the results of the site specific soil remedial objective study, between one year and two years will be required to meet the soil remediation criteria.

Table 1: Summary of Annual Operating Cost Estimate

Costs	Amount
Direct	$ 150,000
Indirect	$ 50,000
Contingency	$ 30,000
Project Total	**$ 230,000**

The estimated cost to close the soil treatment facilities is in the order of $105,000. Table 2 provides a summary of the costs, while the detailed closure cost estimate is attached as Appendix C.

Table 2: Summary of Closure Cost Estimate

Costs	Amount
Direct Costs	$ 54,735
Indirect Costs	$ 41,832
Contingency	$ 8,210
Post-Closure	$ 0
Project Total	**$104,777**

This report, Abandonment and Reclamation Plan for the Treatment of Contaminated Soil, Former Nanisivik Mine, was prepared by

Arlene Laudrum, PGeo, FGC

and reviewed by

Mark Liskowich, PGeo

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

Disclaimer—SRK Consulting (Canada) Inc. has prepared this document for CanZinco Mines Ltd.. Any use or decisions by which a third party makes of this document are the responsibility of such third parties. In no circumstance does SRK accept any consequential liability arising from commercial decisions or actions resulting from the use of this document by a third party.

The opinions expressed in this document have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. While SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

7 References

[BCRI] British Columbia Research Incorporated 1975. Terrestrial Environmental Studies at Strathcona Sound, Northwest Territories. Progress Report Nos. 1, 2 & 3. Prepared for Strathcona Mineral Services, Project 1552.

BGC Engineering Inc. 2009. Nanisivik Mine Reclamation Project Completion Report. Prepared for CanZinco Ltd. January 2009.

BGC Engineering Inc. 2010. 2009 Annual Geotechnical Inspection, Nanisivik Mine, Nunavut. Report No. 0255-019-03. Submitted to Breakwater Resources Limited, March 26, 2010.

BGC Engineering Inc. 2012. 2011 Annual Geotechnical Inspection, Nanisivik Mine, Nunavut. Report No. 0255-021-03. Submitted to Nyrstar, March 1, 2012.

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

[CCME] Canadian Council of Ministers of the Environment. 2008. Canada-Wide Standards for Petroleum Hydrocarbons in Soil: Technical Supplement. January 2008. Revised from 2001 version.

CanZinco Ltd. 2004. Nanisivik Mine 2004 Reclamation and Closure Plan. March 2004.

[GLL] Gartner Lee Limited. 2004b. 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.

[GLL] Gartner Lee Limited. 2008a. Nanisivik Mine Summary of Contaminated Soil Remediation Interim Close Out Report: Dock Area. Prepared for Breakwater Resources Ltd. April 2008.

[GLL] Gartner Lee Limited doing business as AECOM. 2008b. Nanisivik Mine Summary of Contaminated Soil Remediation Progress – December 31, 2007. Prepared for CanZinco Ltd. November 2008.

Golder Associates. 1998. 1998 Geotechnical Inspection of Waste Containment Dykes, Nanisivik Mine, Baffin Island, N.W.T. Report No. 982-2432.5100. Submitted to Nanisivik Mine, a division of CanZinco Ltd, October 1998, 27 pages plus Drawings.

Hemmera. 2014. Overview of the Methodology/Approach for Developing Site Specific Soil Remediation Objectives (SSROs) for Pre-determined Project Areas of the Nanisivik Docksite. Letter. Prepared for CanZinco and included as Attachment 3 in a letter dated September 5, 2014, from CanZinco Mines Ltd. to the NWB: CanZinco’s Response to Pre-Hearing Conference Decision List of Commitments.

[JWEL] Jacques Whitford Environmental Limited. 2003. Human Health and Ecological Risk Assessment, Nanisivik Mine, Nunavut. Prepared for CanZinco Ltd. October 2003.

Nyrstar. 2014. Former Nanisivik Mine Site Spill Contingency Plan. April 2014.

SRK Consulting (Canada) Inc. 2009. Nanisivik Mine Summary of Contaminated Soil Remediation Progress – September 10, 2008. Prepared for CanZinco Ltd. January 30, 2009.

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. 2009. Contingency Plan for Water Quality Exceedances, Former Nanisivik Mine Site. Prepared for Breakwater Resources Ltd. September 2009.

[Stantec] Jacques Whitford Stantec Limited. 2010. Abandonment and Reclamation Plan, Fuel Tank Farm, Former Nanisivik Mine Site, Nunavut. Prepared for Breakwater Resources Ltd. January 8, 2010.

WESA Inc. 2012. Construction Summary Report, Nanisivik Mine Site. Prepared for CanZinco Ltd. November 2012.

WESA Inc., a division of BlueMetric Environmental Inc. 2013. Memorandum RE: Nanisivik 2013 Bioremediation Performance Monitoring. Prepared for SRK Consulting Inc. and included as Appendix B of the Nanisivik Mine Contaminated Soil Remediation 2013 Progress Report. November 2013.

Figures

srk consulting

nyrstar

Former Nanisivik Mine

Site Location Plan

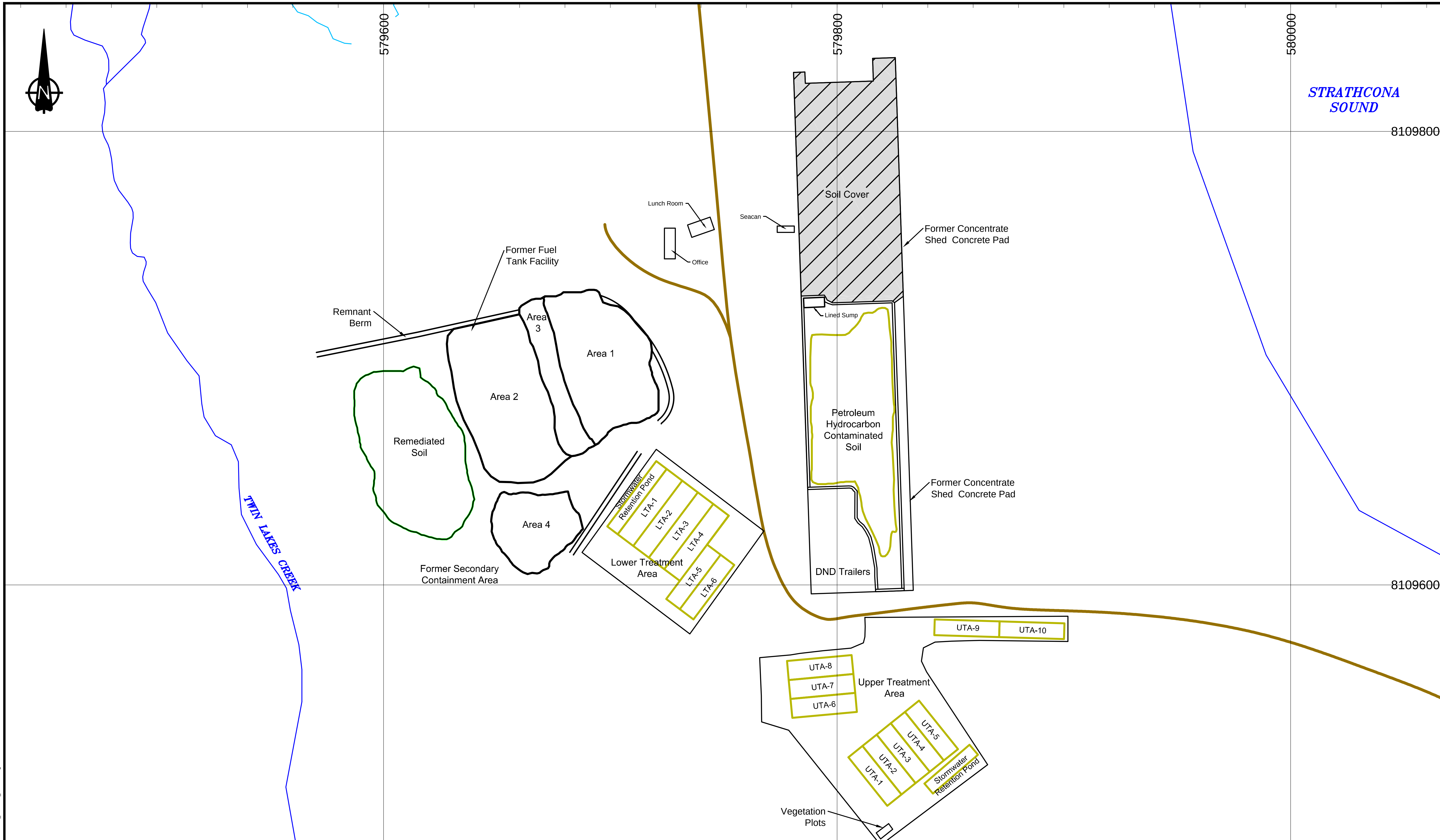
SRK JOB NO.: 1CB002.002

FILE NAME: 1CB002.002_Nanisivik_General_Loc.dwg

Abandonment and Reclamation Plan for the Treatment of Contaminated Soil

DATE:	APPROVED:	FIGURE:
September 2014	AL	1

A:\Nanisivik\010_Base_Files\040_AutoCAD\1CB002.002_Nanisivik_General_Loc.dwg



0m 10 20 30 40 50 60

LEGEND

BERM

NOTES

COORDINATE SYSTEM: UTM NAD 1983 ZONE 16.

srk consulting

nyrstar

SRK JOB NO.: 1CB02.02

FILE NAME: 1CB002.002_Nanisivik_Site GA.dwg

Abandonment and Reclamation Plan for the Treatment of Contaminated Soil

Former Nanisivik Mine

General Site Arrangement

DATE: September 2014

APPROVED: AL

FIGURE: 2

A:\Nanisivik\010_Base_Files\040_AutoCAD\1CB002.002_Nanisivik_Site GA.dwg

Appendix A: Remediation Confirmatory Soil Sampling Methodology

SRK Consulting (Canada) Inc.
202–5204 50th Avenue
Yellowknife, NT X1A 1E2

T: +1.867.873.8670

yellowknife@srk.com
www.srk.com

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.

SRK Consulting (Canada) Inc.

Arlene Laudrum, PGeo, FGC
Principal Consultant

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.

Appendix B: Soil Quality Remediation Objectives

Soil Quality Remediation Objectives

Soil quality remediation objectives for the treatment of contaminated soil at Nanisivik dock area as specified in the Abandonment and Reclamation Plan (Stantec 2010) are listed in Table 1. The objectives were derived from generic commercial land use guidelines established 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).

Table 1: Soil Quality Remediation Objectives for the Nanisivik Former Bulk Fuel Storage Facility

Parameter	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)
Benzene	110	360
Toluene	250	500
Ethylbenzene	300	600
Xylenes	350	700
PHC Fraction 1 (F1)	320	700
PHC Fraction 2 (F2)	260	1,000
PHC Fraction 3 (F3)	1,700	3,500
PHC Fraction 4 (F4)	3,300	10,000
PAH Anthracene	32	32
PAH Benzo(a)pyrene	72	72
PAH Fluoranthene	180	180

Source: Stantec (2010)

References

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

[CCME] Canadian Council of Ministers of the Environment. 2008. Canada-Wide Standards for Petroleum Hydrocarbons in Soil: Technical Supplement. January 2008. Revised from 2001 version.

[Stantec] Jacques Whitford Stantec Limited. 2010. Abandonment and Reclamation Plan, Fuel Tank Farm, Former Nanisivik Mine Site, Nunavut. Prepared for Breakwater Resources Ltd. January 8, 2010.

Appendix C: Treatment Facility Closure Cost Estimate

Activity / Task	Quantity	Unit	Cost Code	Rate	Cost	Subtotals		Source / Comments
CLOSURE							**$ 54,735**	
Decommissioning Soil Treatment Facilities						$ 35,508		
Remove liners	16	ea.	LS	$ 1,661.42	$ 26,582.72			3 hours to decommission each of the 16 treatment cells
Grade area	2	day	day rate	$ 2,280.00	$ 4,560.00			10 hr days
Remediation confirmatory sampling	15	ea.	LS	$ 291.03	$ 4,365.45			
Vacating Concrete Pad						$ 6,277		
Remove stockpiles of soil	7	days	daily rate	$ 6,260.40	$ 43,822.80			10 hr days. One loader, two tandem axle trucks
Grade area	2	hours	hourly rate	$ 228.00	$ 456.00			
Remediation confirmatory sampling	20	ea.	LS	$ 291.03	$ 5,820.60			
Excavate Residual Contaminated Soil						$ 2,951		
Excavation	3	hours	hourly rate	$ 498.52	$ 1,495.56			
Remediation confirmatory sampling	5	ea.	LS	$ 291.03	$ 1,455.15			
Remove Buildings and Equipment						$ 10,000		
Demobilization of trailers	3	ea.	LS	$ -	$ -			rental rates include demobilization
Shipping materials off-site	1	ea.	LS	$ 10,000.00	$ 10,000.00			
INDIRECTS							**$ 41,832**	
Mobilization&Demobilization						$ 4,908		
Mobilization	6	hours	hourly rate	$ 280	$ 1,680			one D6 dozer and one excavator from Arctic Bay
	3	ea.	LS	$ 516	$ 1,548			one loader, two tandem axle trucks from Arctic Bay
Demobilization	6	hours	hourly rate	$ 280	$ 1,680			one D6 dozer and one excavator from Arctic Bay
	3	ea.	LS	$ 516	$ 1,548			one loader, two tandem axle trucks from Arctic Bay
Field Engineering						$ 21,450		
Engineer	7	days	day rate	$ 1,300	$ 9,100			10 hr days
Pick-up Truck	7	days	day rate	$ 250	$ 1,750			rental plus fuel costs
Meals and Accommodation	9	days	day rate	$ 400	$ 3,600			
Airfare	1	ea.	LS	$ 7,000	$ 7,000			
Other Indirect Allowances						$ 10,000		
Reporting	1	ea	LS	$ 10,000	$ 10,000			Final remediation progress report
Owner Costs						$ 5,474		
Owner Costs	10.0%	%	of Direct Costs	$ 54,735	$ 5,474			assumed CanZinco administration and coordination cost
CONTINGENCY							**$ 8,210**	
Contingency						$ 8,210		
Contingency	15.0%	%	of Direct Costs	$ 54,735	$ 8,210			
POST-CLOSURE							**$ -**	
Water Quality Monitoring	-	ea	per occurrence	$ -	$ -			including in water quality monitoring of whole of mine site
Geotechnical Inspections	-	ea	per occurrence	$ -	$ -			included in geotechnical inspection of whole of site
PROJECT TOTAL							**$ 104,777**	

Unit Rates

PERSONNEL RATES

Cost Code	Item	Rate Used in Estimate	Unit	Source/Comments
P.02	Engineer	$130.00	hr	Estimated
P.04	Foreman	$84.00	hr	2014 Rates provided by heavy equipment site supervisor
P.05	Heavy Equipment Operator 1	$71.33	hr	2012 Rates provided by 3rd party contractor on an Arctic job
P.06	Heavy Equipment Operator 2	$87.44	hr	2012 Rates provided by 3rd party contractor on an Arctic job
P.07	Heavy Equipment Mechanic	$90.00	hr	2014 Rates provided by local contractor
P.08	Laborer	$29.00	hr	2014 Rates provided by local contractor
P.12	Truck Driver	$65.81	hr	2012 Rates provided by 3rd party contractor on an Arctic job
P.13	Superintendant	$94.50	hr	2014 Rates provided by heavy equipment site supervisor
P.14	Supervisor	$84.00	hr	2014 Rates provided by heavy equipment site supervisor

EQUIPMENT RATES

Cost Code	Item	Rate Used in Estimate	Unit	Source/Comments
E.01	Excavator (CAT 329 or similar)	$223.56	hr	2014 Rates provided by local contractor
E.02	Dozer (CAT D6 or similar)	$156.67	hr	2014 Rates provided by local contractor
E.03	Loader (CAT 950H)	$156.67	hr	2014 Rates provided by local contractor
E.04	Loader (CAT 966)	$148.67	hr	2014 Rates provided by local contractor
E.05	Tandem Axle Truck	$116.19	hr	2014 Rates provided by local contractor
E.06	Lowboy Trailer	$192.56	hr	2014 Rates provided by local contractor
E.07	Pickup truck	$230.00	day	2014 Rates provided by local contractor