SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC V6E 3X2

T: +1.604.681.4196
F: +1.604.687.5532

vancouver@srk.com
www.srk.com

Memo

To:	Johan Skoglund	**Client:**	CanZinco Mines Ltd.
From:	Iozsef Miskolczi, Lowell Wade	**Project No:**	1CB002.002
Cc:	Arlene Laudrum, Stuart McPhee,	**Date:**	September 4, 2014
Subject:	Nanisivik Mine Non-Hazardous Waste Landfill		

1 Introduction

1.1 Project Description

Located on the northern region of Baffin Island, Canada, in Strathcona Sound, the former Nanisivik lead-zinc mine is currently undergoing the remediation of contaminated soil from the former fuel storage tank farm at the dock area. Post-closure monitoring of previously rehabilitated mining areas is also ongoing.

In support for renewal and amendment of the site water licence applied for by CanZinco Mines Ltd., SRK Consulting (Canada) Inc. (SRK) presents the design and closure plan for a small non-hazardous waste landfill facility (landfill). The landfill is intended to contain non-hazardous wastes generated during ongoing remediation and monitoring activities. These wastes include:

- Metal reinforcement bar,
- Non-reusable sheet metal and scrap steel, and
- Geomembrane liners.

1.2 Site Description

During the July 2014 remediation works, SRK reviewed potential locations for the landfill. The preferred location, for the landfill, was chosen because of its proximity to containment cover material and accessibility to existing temporary non-hazardous waste storage areas.

The preferred landfill location is situated on the former outdoor warehouse yard, 3 km south of the dock area, and 3 km north of the reclaimed West Twin Disposal Area. It is accessed from the highway between Arctic Bay and Nanisivik by a historical road used to access the lower benches of the outdoor warehouse yard. The existing road will be sufficient to provide access for the construction, operation and closure of the landfill. Figure 1 shows the location of the proposed landfill and the proximity to access roads, water courses, and remediation works at the dock area.

Currently, the proposed landfill location consists of a constructed pad occupied by non-hazardous metal debris below a bedrock outcrop. The area upslope of the pad and outcrop is largely comprised of the fill material composed of rock, sand, and gravel that was used to cover the outdoor warehouse yard. Downslope of the pad is a bedrock outcrop that was previously used as coarse rock borrow area.

1.3 Climate

The proposed landfill, for the former Nanisivik Mine, is located in the High Arctic region characterised by extreme cold temperatures, low precipitation, and underlying permafrost. The site has minimal vegetation growth and wildlife use (BCRI 1975).

Climate data was collected at the Nanisivik Airport by Environment Canada between 1976 and 2010. The airport is located approximately 13 km south of the proposed landfill at an elevation of 642 m, about 450 m higher than the proposed landfill. The recorded climate data were analyzed by Golder (1998). The following list is a summary of the main climatic parameters based on the data available in 1998:

- The mean annual air temperature was estimated to be −15.2°C;
- The mean annual precipitation total was estimated to be 240 mm;
- The 24 hour Probable Maximum Precipitation (PMP) value was estimated to range from 140 to 210 mm; and
- The mean annual lake evaporation 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 km west of the proposed landfill 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 (2012) and it was found that the average difference in air temperature was approximately 1.6°C, with a standard deviation of approximately 4°C. As expected, Arctic Bay generally experiences warmer air temperatures than the Nanisivik Airport due to the elevation change. This difference was more pronounced in the months between May and September when the average difference increased to over 3°C (BGC 2012).

2 Landfill Design and Construction

2.1 General

Waste material requiring containment was recovered through closure and ongoing post-closure remediation activities. The non-hazardous waste material includes steel reinforcement bar, non-reusable sheet metal, steel reinforced wiring, and geomembrane liners. Details are provided in the waste management plan (Nyrstar 2014) submitted to the Nunavut Water Board for approval on April 13, 2014.

2.2 Topographical Survey

A topographic survey was conducted over the proposed landfill area to capture the elevation of slope transitions and the general site profile. The survey consisted of establishing two benchmarks with local elevations using a Nikon AS-2 automatic construction level and rod. The local survey elevation was referenced to benchmark BM3 which was established with an arbitrary elevation of 100 m. For the purposes of the landfill design and siting, the control elevation is not relative to sea level elevation.

Survey benchmarks used during the site survey were captured with a handheld GPS at an accuracy of +/-3 m horizontal and vertical. Coordinates to the benchmarks are presented on Figure 2 and in Table 1.

Table 1: Survey benchmark locations

Benchmark ID	UTM Coordinates (Zone 16)		GPS Elevation [masl]	Survey Elevation [m]
	Easting	Northing		
BM 1	580149	8107210	234	101.10
BM 2	580102	8107270	238	104.67
BM 3	580147	8107272	234	100.00*

*The elevation was arbitrarily set at 100 m. All other elevations are relative to this arbitrary point.

2.3 Landfill Design and Operation

The small non-hazardous waste landfill facility will contain about 50 m^3 of non-hazardous waste material. Utilizing the existing pad, the non-hazardous waste will be consolidated by stacking alternating layers of waste and clean granular fill on the pad to minimize voids. Where necessary an excavator will place the material in a compact manner.

The sheets of waste geomembrane, that exhibit no petroleum hydrocarbon contamination, removed from the tank farm area remediation will be placed over the consolidated non-hazardous waste and covered with 0.6 m of dry soil cover material as discussed in Section 3.2.2. These sheets will be placed in a “shingled” configuration, with adequate overlap to direct most of the water percolating through the cover around the underlying waste. The sections of liner may require pinning with short sections of waste rebar to prevent sliding on the sloped sides.

Figure 2 presents the site layout and the approximate area of the former outdoor warehouse yard where the non-hazardous waste will be consolidated.

2.4 As-built Survey

After construction of the landfill, an as-built survey will be performed to confirm its size and location. An as-built report will be presented that contains photo documentation of the construction process and the as-built survey.

2.5 Schedule

It is anticipated the non-hazardous waste will be collected from around the site and placed into the proposed landfill during two summer work seasons and that final closure will commence during the third year of operation.

3 Conceptual Closure Plan

3.1 Reclamation Objectives

As with all reclamation activities, completed at the Nanisivik Mine by CanZinco, the objective is to return the site to a condition of similar environmental productivity and land use that existed prior to the development of mine facilities and to eliminate requirements for long-term monitoring and maintenance. The landfill will be closed by placing a dry soil cover over the geomembrane liner described in Section 2.3. The specific objectives of the landfill closure plan are to provide:

- Closure cover design that satisfies the overall objective of isolating landfill material from the environment;
- Performance monitoring plan that allows the ability to assess the effectiveness of the landfill cover; and
- Contingency plan in the event that the landfill cover does not perform in an acceptable manner.

3.2 Closure Cover

3.2.1 Cover Material Geology

The bedrock geology of the area was mapped in detail by Patterson and Powis (2002) and summarized in the 2004 Quarry Development and Reclamation Plan (BGC 2004). The Nanisivik region is underlain by carbonate and terrigenous clastic strata of the Mesoproterozoic Bylot Supergroup. The Bylot Supergroup is comprised of two terrigenous formations (Society Cliffs and Victor Bay) and a mixed carbonated and terrigenous clastic formation (Strathcona Sound). Quartz arenite of the Gallery Formation unconformity overlies the Proterozoic strata.

The landfill area is within the Society Cliffs Formation, which is over 500 m thick and exposed in the Nanisivik area. The formation is subdivided into three units:

- Microbial dolostone (lower),
- Interclastic dolostone (middle), and
- Laminated dolomitic mudstone (upper).

All components of this formation exhibit dolomite mineralization. Known sulphide deposits in the Nanisivik area are hosted within the middle and upper subdivisions of this formation.

The landfill is located on unmineralized dolomitic intraclast wackestone of the middle unit from which the cover material will be obtained. This material is non-acid generating and metal leaching is not a concern.

3.2.2 Cover design

The objective of the dry soil cover is to isolate the waste from wildlife contact. A minimum of 0.6 m thick dry soil cover material will be placed over the consolidated non-hazardous waste which has been covered by the geomembrane as discussed in Section 2.3. The maximum slopes shall not exceed a grade of 3:1 (horizontal:vertical). The final landscaping of the facility will prevent ponding of water and as much as possible will conform to existing topography. Vegetation is naturally sparse in this area, thus no revegetation will be undertaken.

The landfill will be constructed on the former outdoor warehouse yard and is unlikely to cause any permafrost degradation. As the materials are non-hazardous, permafrost aggradation into the landfill is not necessary, thus a 0.6 m thick cover is sufficient per Nunavut municipal landfill guidelines (FSC 2003).

3.2.3 Cover Construction

The dry soil cover material consists of a rock, gravel, sand, and silt material sourced immediately upslope of the landfill. It is anticipated that the dry soil cover will be constructed by pushing the material over the landfill with a bulldozer. The upslope area will be regraded to a maximum grade of 4H:1V. Figure 3 presents the proposed cover construction cut and fill details.

After the landfill is covered with a minimum of 0.6 m of dry soil cover material, the surface will be graded to prevent ponding water. The landfill cover edges will be graded to blend into the adjacent surface slope features. Figure 4 presents the proposed landfill cover grading.

3.3 Performance Monitoring

It is expected that there will be minimal monitoring needs for the landfill because the wastes contained are non-hazardous. Proper QA/QC during construction and waste consolidation will minimize cover subsidence over time. Inspection of the landfill during the annual mine closure geotechnical inspections should be sufficient to monitor the site's long-term performance.

3.4 Contingency Plan

The Post-Closure Geotechnical Monitoring Contingency Plan (BGC, 2009) is to be followed. The plan describes potential issues that could arise following the closure of the non-hazardous waste landfill facility. For each potential issue the contingency plan provides:

- A description of what each issue involves,
- How each issue can be recognized,
- The significance of each issue,

- How prevalent each issue has been during the monitoring undertaken to-date, and
- A description of potential contingency measure to be considered should each occurrence be observed.

3.5 Schedule

Construction of closure cap will be carried out during the final year of operation.

3.6 Cost Estimate

The estimated cost of the cover construction is in the order of $ 30,000. Table 2 provides a summary of the costs, while the detailed cost estimate is attached as Appendix C

Table 2: Summary of Closure Cost Estimate

Direct Costs	**$ 2,280**
Indirect Costs	$ 15,774
Contingency	$ 2,200
Post-Closure	$ 10,000
PROJECT TOTAL	**$ 30,254**

4 Construction QA/QC

Construction quality assurance and quality control (QA/QC) will consist of the following:

- **Waste Consolidation:** During waste placement on the existing pad at the former outdoor warehouse yard, the contractor will consolidate the wastes with fill cover material so fill material will occupy voids within the wastes. The contractor may place and compact alternating layers of waste and fill to minimize voids, which may lead to post-closure subsidence.
- **Elevation Control:** During construction the onsite supervisor will maintain elevation control of the landfill construction to ensure sufficient elevation remains for placement of the final containment cover over the consolidated wastes.
- **Lift Compaction:** The onsite construction supervisor will compact the landfill cover in maximum of 0.3 m lifts. Compaction will be performed either by tamping with the excavator bucket or by “track packing” using tracked equipment.

SRK Consulting (Canada) Inc.

Iozsef Miskolczi, PEng (BC)
Senior Consultant

REGISTERED PROFESSIONAL ENGINEER
L. WADE
LICENSEE
NWT/NU
04, 2014

Lowell Wade, PEng (BC, NWT/NU)
Senior Consultant

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Nyrstar 2014. Former Nanisivik Mine Site Solid Waste and Sewage Waste Treatment Plan. April 2014.

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Appendix A: Landfill Design Figures

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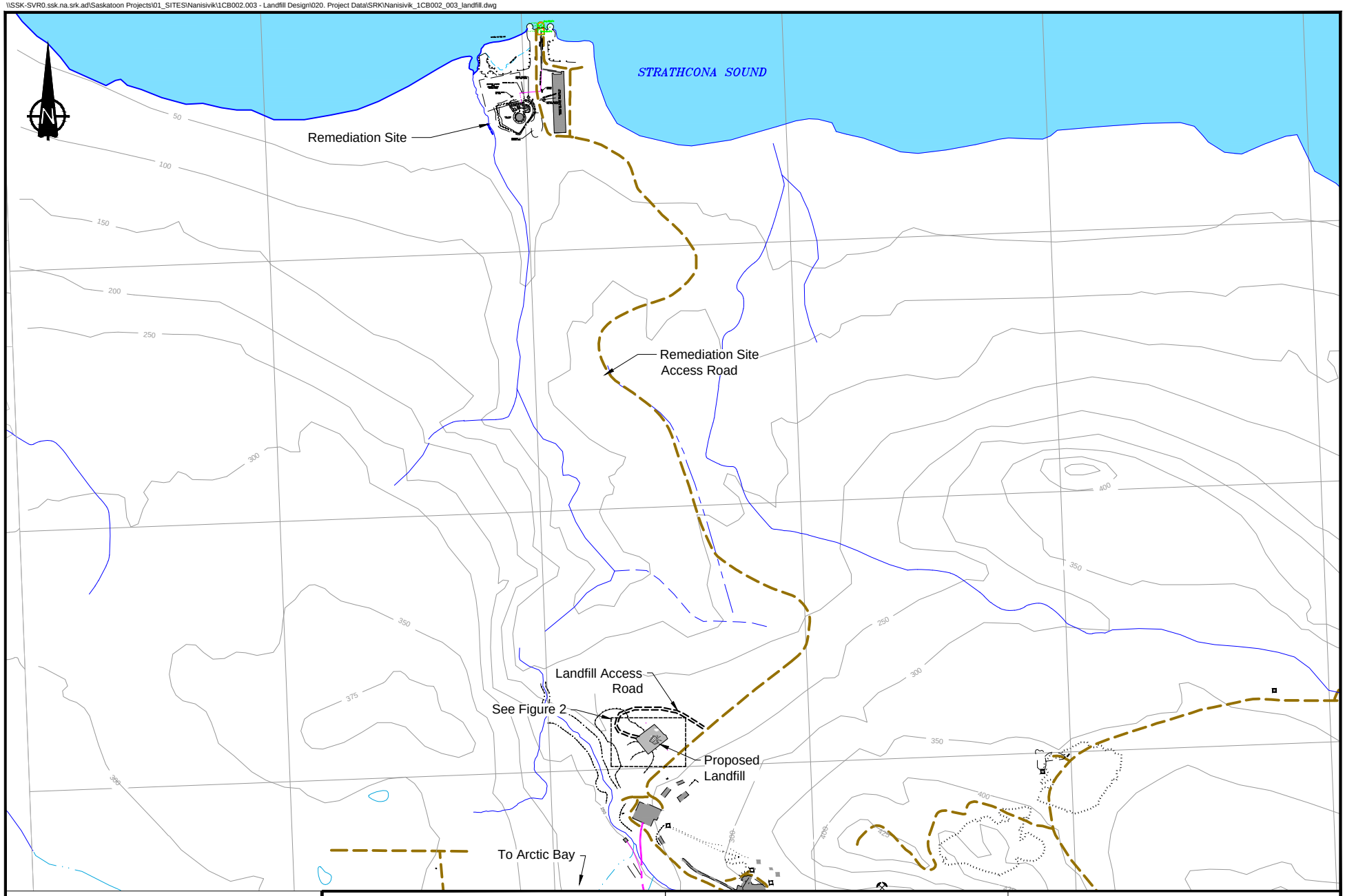

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Scale in Kilometres

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SRK JOB NO.: 1CB002.003

FILE NAME: Nanisivik_1CB002_003_landfill.dwg

CanZinco Mines Ltd.

Nanisivik Mine

Non-hazardous Waste Landfill Design

Site Location

DATE:	APPROVED:	FIGURE:
Sept. 2014	IM	1

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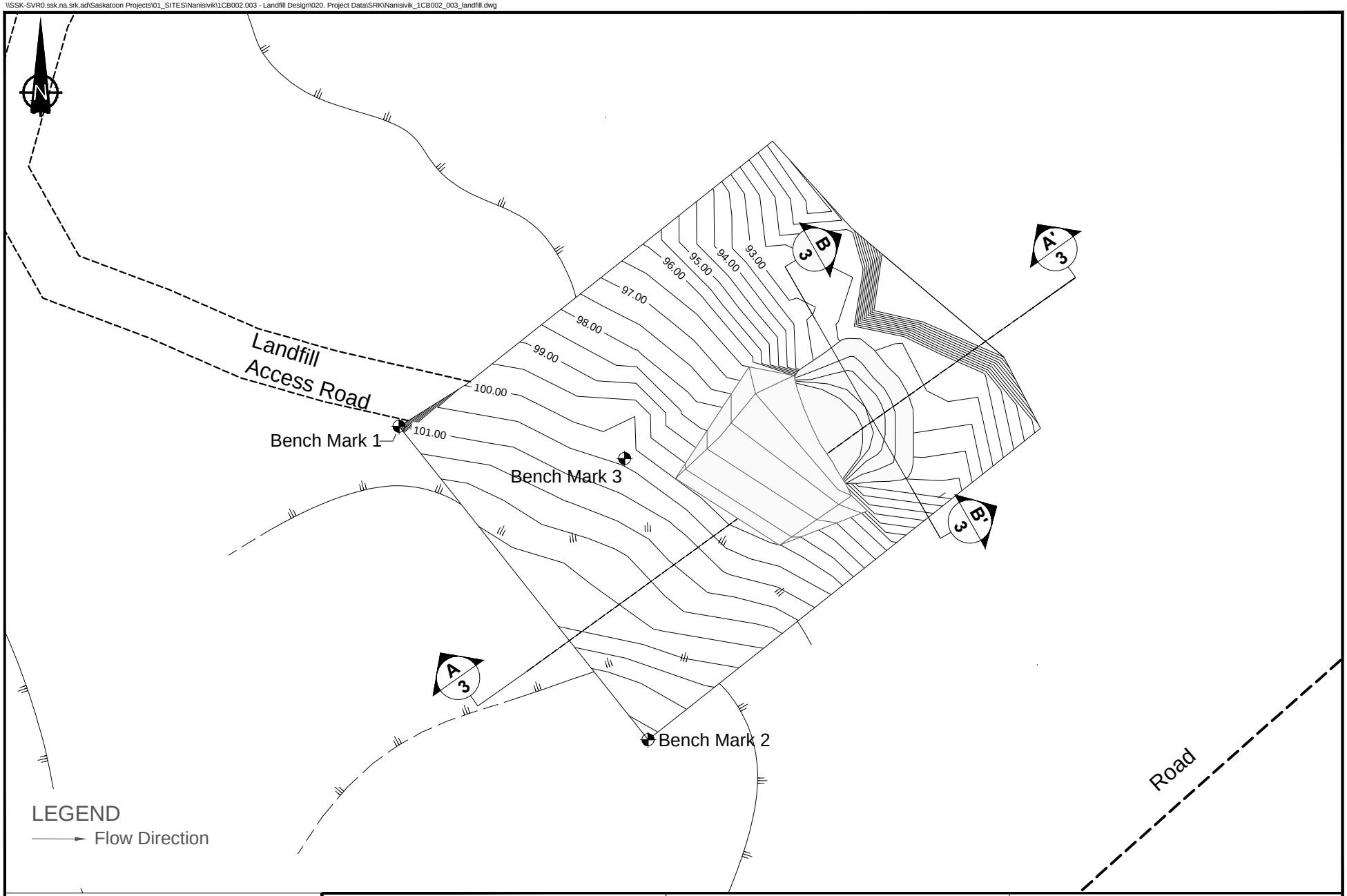

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Scale in Metres

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SRK JOB NO.: 1CB002.003

FILE NAME: Nanisivik_1CB002_003_landfill.dwg

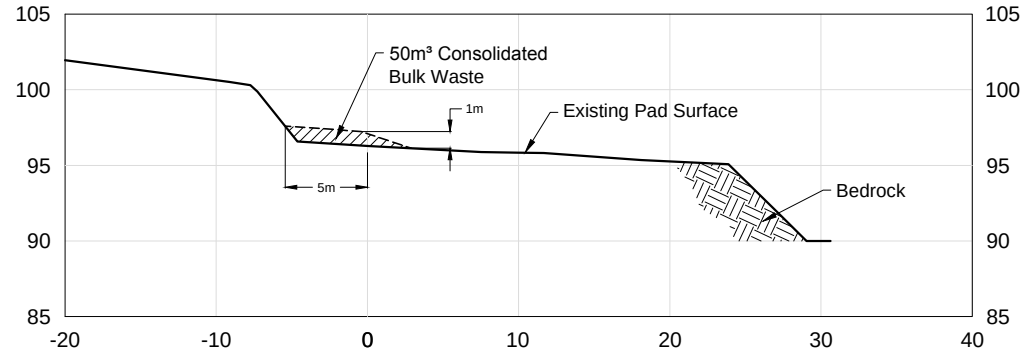
CanZinco Mines Ltd.

Nanisivik Mine

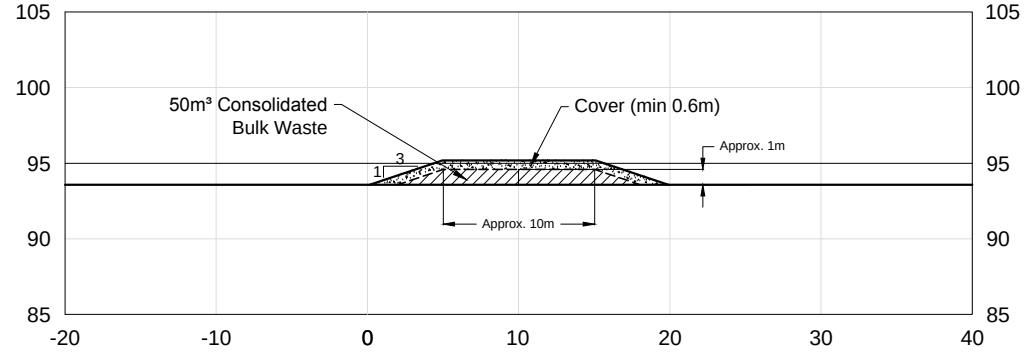
Non-hazardous Waste Landfill Design

Landfill Plan

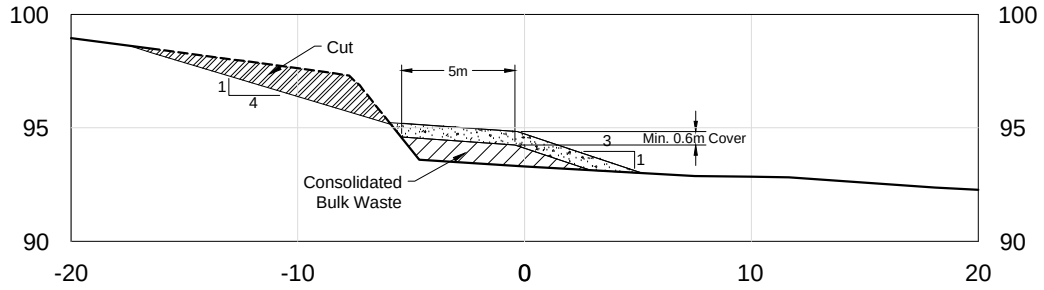
DATE:	APPROVED:	FIGURE:
Sept. 2014	IM	2



Horizontal Section
Section A-A'



Horizontal Section
Section B-B'



Horizontal Cover Construction

Note:
Elevations are relative to BM3, established with an arbitrary elevation of 100m

srk consulting	**CanZinco Mines Ltd.**	Non-hazardous Waste Landfill Design
		Sections and Details
SRK JOB NO.: 1CB002.003	Nanisivik Mine	DATE: Sept. 2014 / APPROVED: IM / FIGURE: 3
FILE NAME: Nanisivik_1CB002_003_landfill.dwg		

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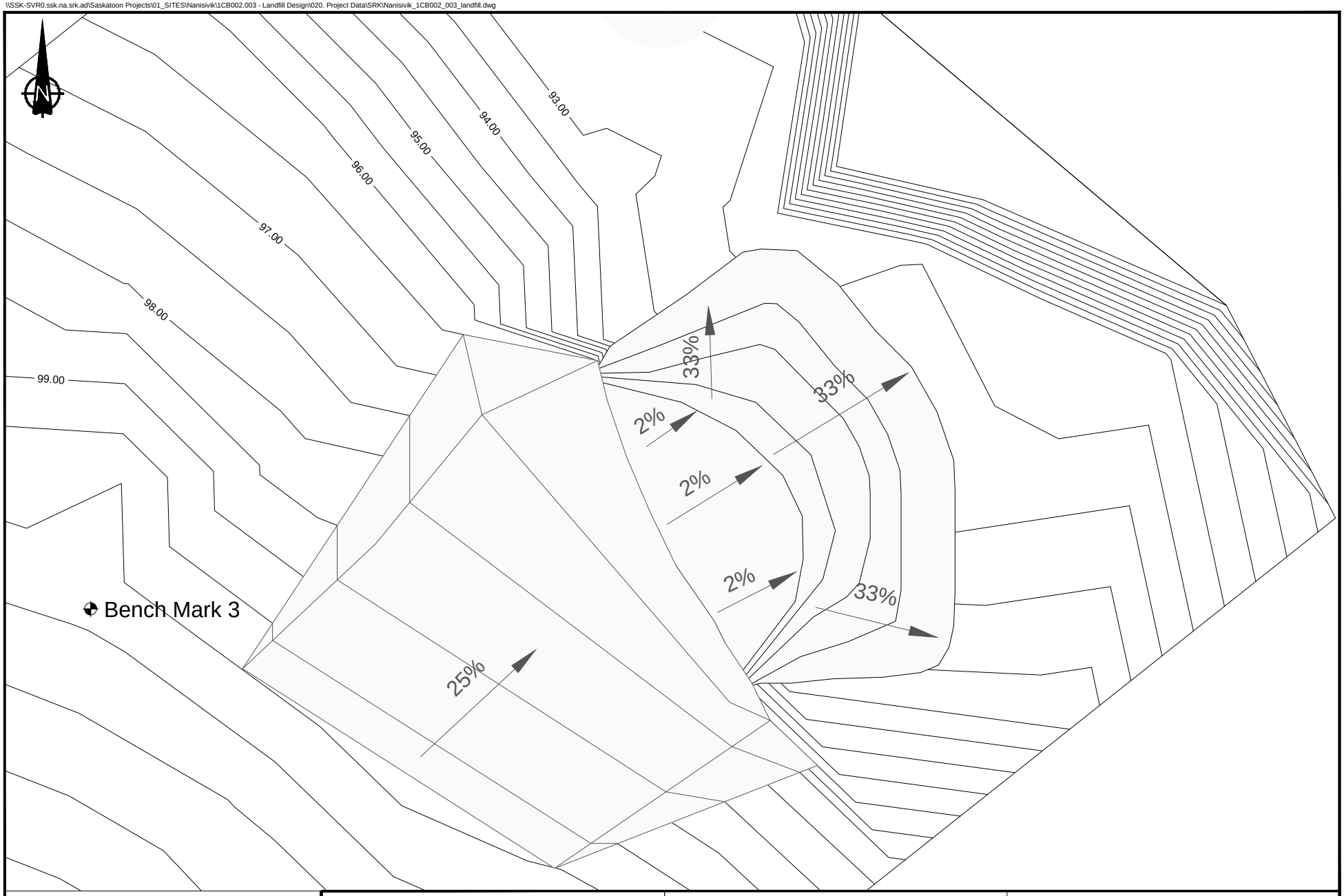

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SRK JOB NO.: 1CB002.003

FILE NAME: Nanisivik_1CB002_003_landfill.dwg

CanZinco Mines Ltd.

Nanisivik Mine

Non-hazardous Waste Landfill Design

Final Grading Plan

DATE:	APPROVED:	FIGURE:
Sept. 2014	IM	4

Appendix B: Site Photos

Photo 1: Electrical cables that will be placed in the landfill.

Photo 2: Bulky sheet metal waste that will be placed in the landfill.

Photo 3: Former outdoor warehouse yard that will be used to construct proposed landfill.

Photo 4: Bedrock outcrop downslope of the proposed landfill.

Photo 5: Proposed cover material upslope of the proposed landfill.

Photo 6: Close-up of the rock, gravel, and sandy cover material from upslope landfill location

Appendix C: Closure Cost Estimate

Activity	Task	Quantity	Unit	Cost Code	Rate	Cost	Subtotals		Source / Comments
DIRECT COSTS								**$ 2,280**	
Cover construction							$ 2,280		
	Push loose fill over landfill; shaping	1	day	day rate	$ 2,280	$ 2,280			day rate (10 hr) for dozer and operator
INDIRECT COSTS								**$ 15,774**	
Mobilization&Demobilizatio							$ 3,796		
	Mobilization	1	ea.	LS	$ 1,898	$ 1,898			one D6 dozer from Arctic Bay
	Demobilization	1	ea.	LS	$ 1,898	$ 1,898			one D6 dozer to Arctic Bay
Construction Field Support/Control							$ 10,230		
	Surveyor	1	days	LS	$ 10,000	$ 10,000			10 hr days; includes professional hours, travel&accomodation, local transportation
	Pick-up Truck	1	days	day rate	$ 230	$ 230			
Field Engineering							$ 1,520		
	Engineer	1	days	day rate	$ 1,300	$ 1,300			10 hr days
	Pick-up Truck	1	days	day rate	$ 220	$ 220			mobilization of engineer to Arctic Bay included in soil remediation project
Owner Costs							$ 228		
	Owner Costs	10.0%	%	of Direct Costs	$ 2,280	$ 228			assumed CanZinco administration and coordination cost
CONTINGENCY								**$ 2,200**	
Contingency							$ 2,200		
	Contingency	1	ea	LS	$ 2,200	$ 2,200			
POST-CLOSURE								**$ 10,000**	
Repairs							$ 10,000		
	repairs of erosion on cover	1	ea	per occurrence	$ 10,000	$ 10,000			once during first 5 years after cover construction
Geotechnical Inspections		-	ea	per occurrence	$ -	$ -			included in geotechnical inspection of other site covers
PROJECT TOTAL								**$ 30,254**	

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 jot
P.06	Heavy Equipment Operator 2	$87.44	hr	2012 Rates provided by 3rd party contractor on an Arctic jot
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.10	Surveyor	$87.19	hr	2012 Rates provided by 3rd party contractor on an Arctic jot
P.11	Surveyor Helper	$72.59	hr	2012 Rates provided by 3rd party contractor on an Arctic jot
P.12	Truck Driver	$65.81	hr	2012 Rates provided by 3rd party contractor on an Arctic jot
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.07	Pickup truck	$230.00	day	2014 Rates provided by local contractor