Nanisivik Mine
Landfill Closure
Construction Summary Report

Prepared for

CanZinco Mines Ltd.

Prepared by

SRK Consulting (Canada) Inc.
1CB002.002
October 2017

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Landfill Closure
Construction Summary Report

October 2017

Prepared for

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Executive Summary

In accordance with the Water License 1AR-NAN1419 Part D, Item 12, CanZinco is required to submit a Construction Summary Report, to the Nunavut Water Board (NWB) for review, within ninety days following completion of all new structures designed to contain, withhold, divert or retain water or wastes. This report provides a summary of construction of the soil cover to close the Non-Hazardous Waste Landfill facility in 2017.

Key activities undertaken for the construction of the cover included:

- Selection and placement of large pieces of waste liner to prevent ingress of water;
- Construction of a soil cover over the landfill;
- Shaping and compacting the completed cover, followed by as-built survey; and
- Construction monitoring for erosion and sediment release

The landfill was constructed as per the criteria in the design documents, with slopes not exceeding 3H:1V grades. No seepage is expected from this landfill. Some maintenance of the cover surface is expected, as the waste in the landfill will consolidate during the first year after construction.

Table of Contents

Appendices

1 Introduction

CanZinco Mines Ltd. (CanZinco), a wholly owned subsidiary of Nyrstar, retained SRK Consulting (Canada) Inc. to provide technical support and field supervision for the treatment of contaminated soil at the former Nanisivik Mine. A Non-Hazardous Waste Landfill facility (landfill from hereon) was designed and permitted on site, to dispose of scrap metal and inert waste accumulated during closure, reclamation and monitoring activities.

A field program was completed between July 21 and July 31, 2017 under the supervision of Iozsef Miskolczi, MASc, PEng of SRK to complete waste deposition in the landfill and the closure of the facility.

In accordance with the Water License 1AR-NAN1419 Part D, Item 12, CanZinco is required to submit a Construction Summary Report, to the Nunavut Water Board (NWB) for review, within ninety days following completion of all new structures designed to contain, withhold, divert or retain water or wastes. This report was produced in compliance with this licence condition.

1.1 Background

Water Licence 1AR-NAN1419 allows for the construction and operation of a non-hazardous waste landfill to contain wastes generated during ongoing remediation and monitoring actives. The design of the landfill was completed in 2014 and documented in a design report (SRK 2014). Issued for Construction drawings and specifications were prepared in February 2015 (SRK 2015a) to satisfy Part D, Item 10 of the water licence. As-built Pre-commissioning construction drawings and specifications for the landfill facility (SRK 2015b) were submitted to the NWB to satisfy Part F, Item 9 of the water licence.

The landfill has been operated and closed in accordance with the Landfill Operations and Maintenance Manual, submitted to the Nunavut Water Board (NWB) to satisfy Part F, Item 8 of the water licence (Nyrstar 2015). The landfill was commissioned and closed in July 2017.

The landfill is located 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 Arctic Bay to Nanisivik highway through historical roads used to access the former outdoor warehouse yard. Drawings in Appendix A show the location of the landfill and the proximity to access roads, water courses, and remediation works at the dock area.

1.2 Construction Documentation

The size, shape, and location of the closed landfill was documented on as-built drawings (Appendix A) showing the final cover surface as per the as-built survey. Each step of the landfill closure was documented in a photo log (Appendix B).

2 Design Concept

2.1 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 was to be closed by placing a dry soil cover over the landfill waste. The specific objective of the cover is to isolate the landfill material from the environment.

2.2 Cover design

The objective of the dry soil cover is to isolate the non-hazardous waste from the environment. A minimum of 0.6 m thick dry soil cover material was to be placed over the consolidated non-hazardous waste. The maximum slopes shall not exceed a grade of 3:1 (horizontal:vertical). The final landscaping of the facility was to prevent ponding of water and conform to existing topography as much as possible. Vegetation is naturally sparse in this area; thus no revegetation was to be undertaken.

To prevent significant water ingress into the underlying non-hazardous waste individual pieces of the waste impermeable liner were to be placed over the non-hazardous waste. This layer would act as the base for the closure cover.

The conceptual closure plan for the landfill was initially described in the Non-Hazardous Waste Landfill design memo (SRK 2014) submitted with to the NWB during the renewal of the former mine site's water licence. The conceptual closure plan was updated in 2015 to include the use of the waste liner as base of the cover (Nyrstar 2015).

3 Design Changes

The only design change pertains to the footprint of the landfill and the volume of the landfilled waste. Initial estimate for the volume of compacted waste to be deposited in the landfill was in the range of 50 m^3. The original plan was therefore for a landfill that occupies a footprint of about 105 m^2 with approximate dimensions of 15 m length and 7 m width. The actual volume of loose waste transported to the site by truck was about 200 m^3, which necessitated expanding the footprint to about 24 m long and 15 m wide. The height was constrained to not exceed the height of the till berm upstream of the landfill.

4 Construction Procedures

4.1 Construction Team and Equipment:

The work was completed by a crew of laborers and equipment operators of Arqvartuuq Services Ltd. from Arctic Bay under contract with Nyrstar. The work was directed and supervised by Iozsef Miskolczi, PEng of SRK Consulting (Canada) Inc. The following equipment was used:

- Loader CAT 950H
- Dump Truck – Sterling LT9000
- Dozer CAT D5G.

4.2 Pre-commissioning Conditions

The landfill location consisted of a level pad constructed between two bedrock outcrops. The outcrop downslope of the pad was previously used as coarse rock borrow area. The area upslope of the pad was largely comprised of granular fill material covering the outdoor warehouse yard. The pad had a small amount of non-hazardous metal debris in the south-east corner.

The historic access road from the lower benches of the former warehouse yard was deeply rutted as a result of recent activities by other users of the area and difficult to traffic, and therefore an access route from the upper warehouse yard was established (Appendix A). No road construction activities (cut/fill, compaction) were required, as the surface of the reclaimed upper warehouse yard chosen for the route was smooth and firm, directly trafficable by personnel transport vehicles and heavy equipment. Disturbance to the reclaimed warehouse yard due to vehicle traffic was minimal.

4.3 Construction materials

Soil cover materials were obtained from loose material on the former warehouse yard. No other borrow sources were used. The nature of the material is a well graded silt, sand, and gravel with cobbles. The soil appeared to be well drained, moist, and free of ice. No other characterization was completed in 2017.

Large pieces of waste liner were selected and used to provide a water shedding layer on top of the loose waste pile.

4.4 Construction work

The largest pieces of liner were extracted from the waste liner pile and inspected to confirm absence of hydrocarbon contamination (odor and/or sheen). These selected pieces were laid out flat on top of the pile (see Appendix B). These pieces were overlapped at least 30 cm and extended to the toe of the waste pile. The overlap was created in a shingle-like fashion, to promote water running off. At least three layers of liner were placed over the top of the waste, and the granular cover was placed on top.

The top of the waste was trafficked with a dozer over an initial minimal cover thickness of about 15 cm to compact the waste as much as possible. The cover was then built to complete thickness in successive layers and trafficked by the dozer to compact the individual layers. The entire pile was covered with granular material (soil) from two locations:

- From the edge of the landfill site, immediately to the west of the landfill, and
- From re-grading the loose material on the former warehouse yard upgradient of the landfill.

Material sourced from west of the landfill was hauled in place with the loader while the material resulting from the regrading of the upgradient area was pushed directly over the landfill with the dozer. Each layer of material was shaped and track-packed with the dozer.

The slope of the landfill cover was shaped to 3H:1V or shallower. On the upgradient (south) side, the cover was blended in with the reclaimed former warehouse yard. The surface of the landfill was then smoothed with the dozer and track-packed.

4.4.1 Mitigation measures and effectiveness

Prior to placing liner in the landfill, observations were made to confirm by visual and olfactory indicators that no residual hydrocarbon contamination is present. This ensured that no hydrocarbon impacted liner was used for the cover base layer.

To prevent the liner from being windblown during construction, large rocks and small piles of cover material were placed to weigh down the liner sections. This ongoing practice prevented liner from becoming airborne.

4.4.2 Monitoring

The site was inspected daily for signs of erosion in accordance with Part D, Item 15 of the water licence. No erosion was observed during and immediately after the closure cover construction.

4.4.3 Blast Vibration Monitoring

No blasting activities were undertaken during the construction of the closure cover on the landfill facility. As a result, no blast vibration monitoring was conducted.

4.4.4 Sediment Release Monitoring

Monitoring for sediment release was conducted daily. The landfill is located such that direct flow into a water body is not possible and thus no additional impacts are created during closure construction.

4.5 Survey

A survey of the area was completed in 2015 and was the basis for the design drawings. No other pre-construction survey for the closure cover was completed.

Once the landfill closure cover was constructed, an as-built survey was completed by a surveyor of Almiq Contracting Ltd. The toe and crest of the landfill were surveyed, together with a straight line at the approximate upstream extents of the waste in the landfill. The regraded portion of the upstream cover was also captured in the survey.

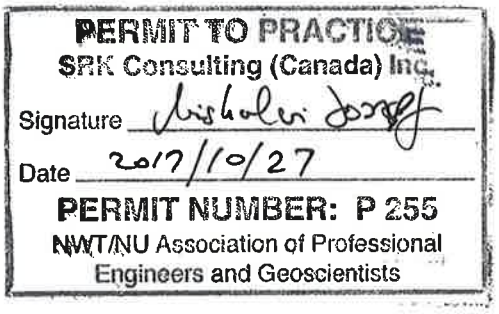
5 Post-construction Monitoring and Maintenance

Due to the likely settlement following the first season, some maintenance is to be expected, consisting of smoothing out and possibly backfilling any low spots to create the final convex shape that will not retain any standing water.

No seepage is expected from the landfill. Erosion of the landfill cover will be monitored as part of the annual geotechnical inspection and corrective action can be evaluated at that time, if and when required. Significant water erosion is not expected.

This report, *Nanisivik Mine Landfill Closure Construction Summary Report*, was prepared by

Iozsef Miskolczi, MASc, PEng
Senior Consultant



and reviewed by

Arlene Stearman, PGeo, FGC
Principal Consultant

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.

6 References

Nyrstar 2015. Former Nanisivik Mine Site, Landfill Operations and Maintenance Manual. March 2015.

SRK Consulting (Canada) Inc. 2014. Nanisivik Mine Non-Hazardous Waste Landfill. Technical memorandum prepared for CanZinco Mines Ltd., September 4, 2014.

SRK Consulting (Canada) Inc. 2015a. Engineering Drawings and Specifications, Former Nanisivik Mine, Non-Hazardous Waste Landfill Design, Issued For Construction Revision. February 27, 2015.

SRK Consulting (Canada) Inc. 2015b. Engineering Drawings and Specifications, Former Nanisivik Mine, Non-Hazardous Waste Landfill Design, As-Built Pre-commissioning Revision. August 28, 2015.

Appendix A – As-Built Drawings

Engineering Drawings and Specifications
Former Nanisivik Mine
Non-Hazardous Waste Landfill Design

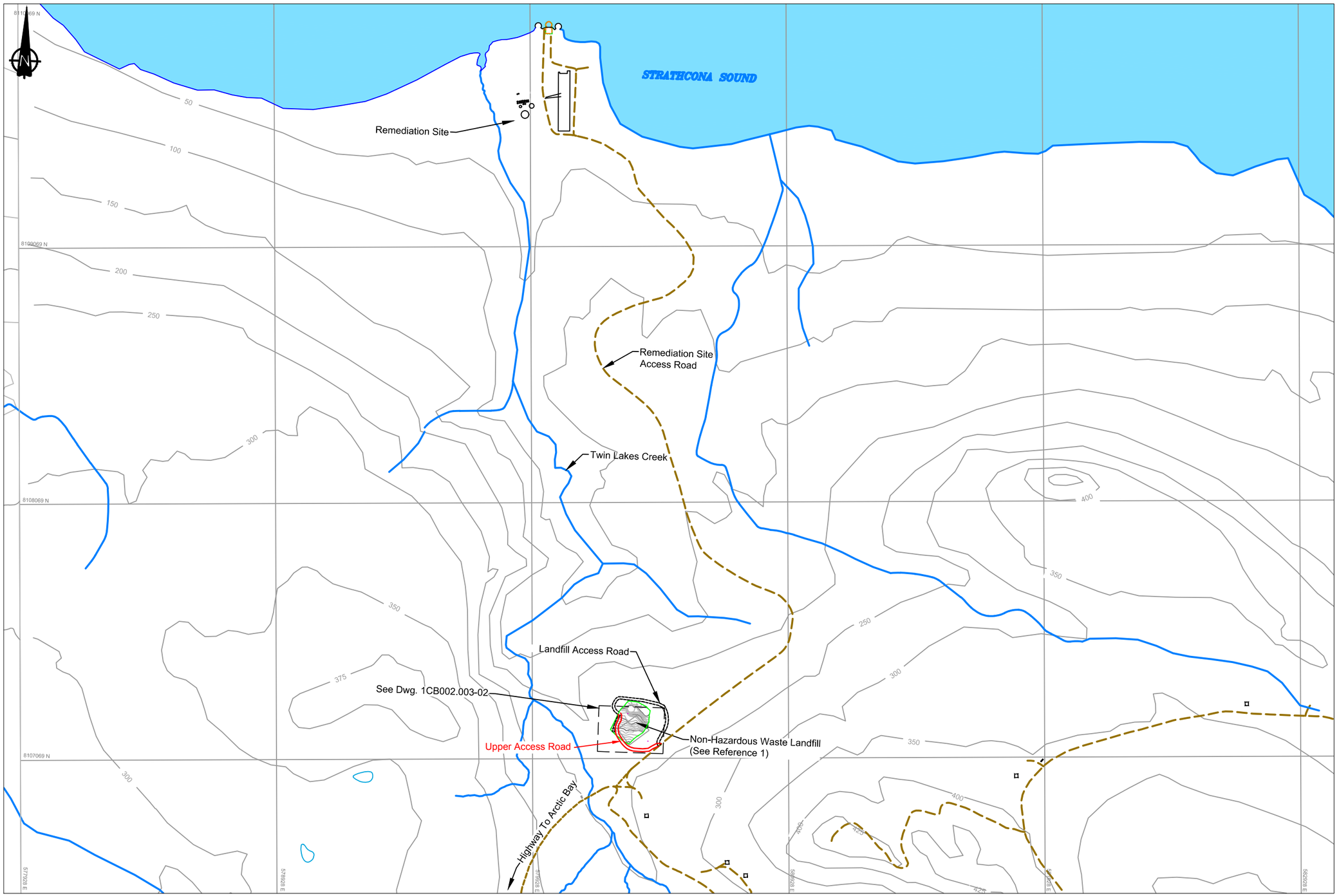
ACTIVE DRAWING STATUS

					OLD/REPLACED REVISIONS		
DWG NUMBER	**DRAWING TITLE**	**REVISION**	**DATE**	**STATUS**		**Issued for Construction**	**Issued for Review**
1CB002.002-00	Engineering Drawings and Specifications - Former Nanisivik Mine, Non-Hazardous Waste Landfill Design	AB1	Oct. 2, 2017	As-Built	Rev. AB Aug. 28, 2015	Rev. 0 Feb 27, 2015	Rev. A Feb. 4, 2015
1CB002.002-01	Site Location	AB1	Oct. 2, 2017	As-Built	Rev. AB Aug. 28, 2015	Rev. 0 Feb 27, 2015	Rev. A Feb. 4, 2015
1CB002.002-02	Landfill Plan	AB1	Oct. 2, 2017	As-Built	Rev. AB Aug. 28, 2015	Rev. 0 Feb 27, 2015	Rev. A Feb. 4, 2015
1CB002.002-03	Final Grading Plan	AB1	Oct. 2, 2017	As-Built	Rev. AB Aug. 28, 2015	Rev. 0 Feb 27, 2015	Rev. A Feb. 4, 2015
1CB002.002-04	Sections and Details	AB1	Oct. 2, 2017	As-Built	Rev. AB Aug. 28, 2015	Rev. 0 Feb 27, 2015	Rev. A Feb. 4, 2015

CanZinco Mines Ltd

srk consulting

Project No: 1CB002.002
As-Built
Revision AB1, October 2, 2017
Drawing No.: 1CB002.002-00



LEGEND

- Access Road
- Water Course

NOTES

1. All drawings are scaled appropriately for 11x17 construction drawings. Scales may not be correct if these drawings are reproduced in any other size format.
2. Details regarding landfill wastes and management are presented in the waste management plan (Nyrstar 2014) approved by the Nunavut Water Board on January 29th, 2015.
3. Regional topographic contour data for the terrain surface and shapefiles were provided by Former Nanisivk Mine in mine grid. Data compiled from investigations and surveys conducted by Gartner Lee Limited.
4. Contour intervals are 25m and all dimensions are in meters unless otherwise noted.
5. The coordinate system is UTM NAD83, Zone 16.
6. Notes and specifications on any drawings in this set apply equally to all drawings in this set.
7. As-built Pre-commissioning topographical survey data was generated in July of 2015 by Almiq Contracting Ltd. using GPS total station.
8. As-built landfill waste topographical survey data was generated July 30, 2017.

REFERENCES

1. Nyrstar 2014 . Former Nanisivk Mine Site Solid Waste and Sewage Waste Treatment Plan, April 2014.

0 100 200 300 400 500
Scale in Metres

REFERENCE DRAWINGS			
DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
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REVISIONS				
NO.	DESCRIPTION	CHK'D	APP'D	DATE
AB1	As-Built			20ct17
AB	As-Built Pre-commissioning	LW	AL	28Aug15
0	Issued for Construction	LW	AL	27Feb15
A	Issued for Review	LW	AL	04Feb15

Original Drawings Stamped and Signed by Engineer

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DESIGN:	DRAWN:	REVIEWED:
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CHECKED:	APPROVED:	DATE:
LW	AL	October 2, 2017

FILE NAME: 1CB002.003 – landfill.dwg

CanZinco Mines Ltd.

Former Nanisivik Mine

SRK JOB NO.: 1CB002.002

Non-Hazardous Waste Landfill Design

DRAWING TITLE:

Site Location

DRAWING NO.	SHEET	REVISION NO.
1CB002.002-01	2 OF 5	AB1

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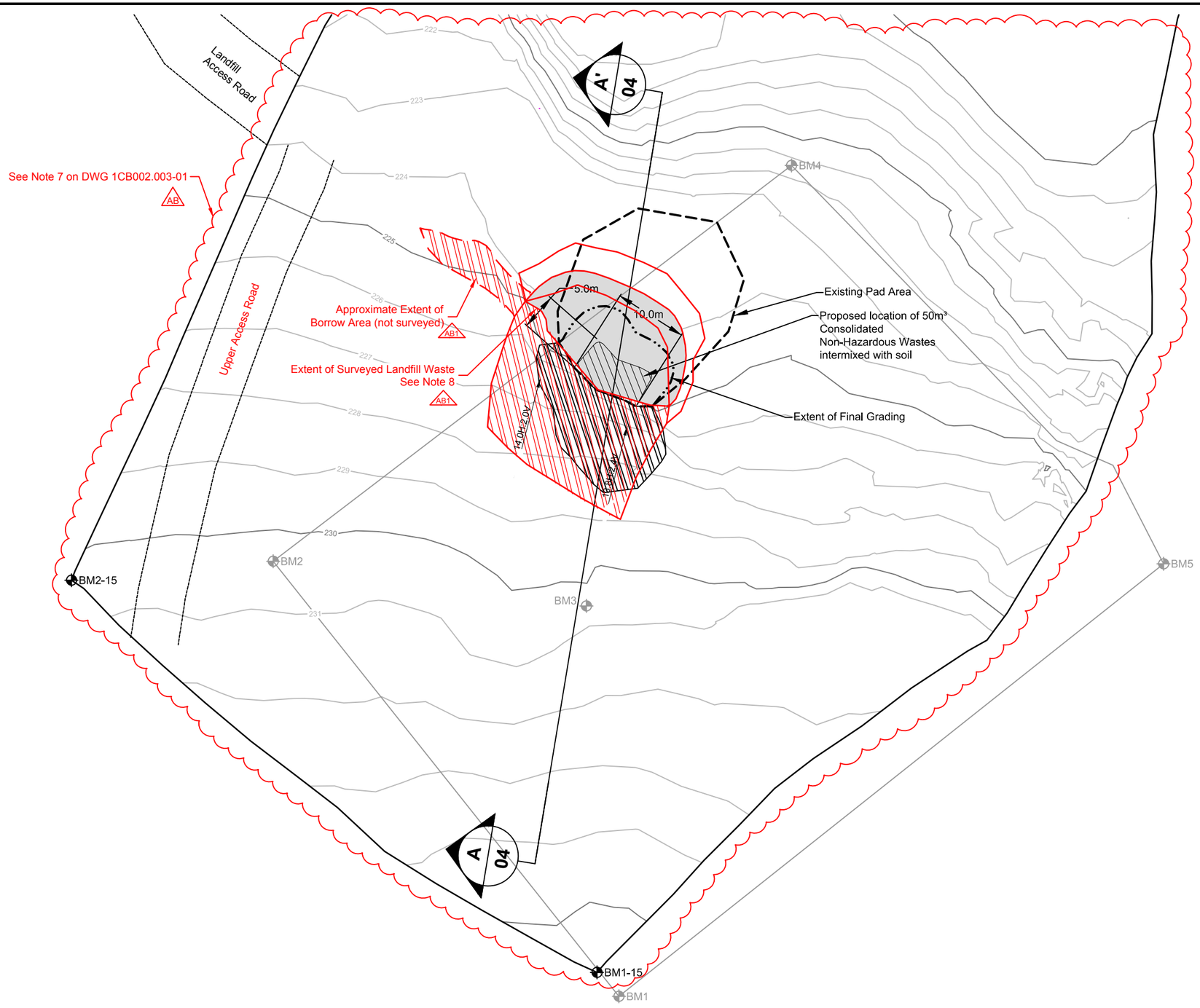

LEGEND

- Benchmark (2015)
- Benchmark (2014)
- As-built Survey Perimeter
- 2014 Site Survey Perimeter
- Existing Prepared Surface for Non-Hazardous Waste
- Extent of Final Grading
- Cover Material Borrow Area
- Consolidated Non-hazardous Waste
- Extent of Landfill Waste

NOTES

AB

1. Surface topography outside of the landfill area has not been surveyed.
2. Acceptable non-hazardous wastes to be consolidated in the landfill are listed in the Nunavut Water Board's approved waste management plan and include: Steel reinforcement bar, non-reusable geomembrane liners.
3. Total volume of non-hazardous wastes is estimated to be 50 m3. Final waste containment volume will be estimated during construction.
4. All work is to be set out by the Engineer prior to the start of any construction or waste storage. Should there be any differences between the co-ordinates provided and the field location, the Engineer is to be informed immediately.
5. The Engineer must approve all surfaces prior to the initial placement of waste or construction material. All construction surfaces must be free of ice and snow.
6. Notes and specifications on any drawings in this set apply equally to all drawings in this set.
7. New stakeout table and benchmarks were established in 2015 replacing 2014 benchmarks (See Reference 1 on Drawing 1).

AB1 8. As-built landfill waste topographical survey data was generated July 30, 2017.

AB

2015 Benchmark Location Table (See Note 7)

Point #	Northing	Easting	Elevation (m)
BM1-15	8107213.13	580146.14	235.80
BM2-15	8107267.27	580073.61	230.26

2014 Benchmark Location Table

Point #	Northing	Easting	Elevation (m)
BM1	8107209.83	580149.18	101.10
BM2	8107269.90	580101.46	104.67
BM3	8107263.72	580144.68	100.00
BM4	8107324.54	580173.00	90.71
BM5	8107269.54	580224.35	90.22

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Scale in Metres

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
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REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
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AB	As-Built Pre-commissioning	LW	AL	28Aug15
0	Issued for Construction	LW	AL	27Feb15
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REVISIONS

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FILE NAME: 1CB002.003 – landfill.dwg

CanZinco Mines Ltd.

Former Nanisivik Mine

SRK JOB NO.: 1CB002.002

Non-Hazardous Waste Landfill Design

DRAWING TITLE: Landfill Plan

DRAWING NO.: 1CB002.002-02 | SHEET: 3 OF 5 | REVISION NO.: AB1

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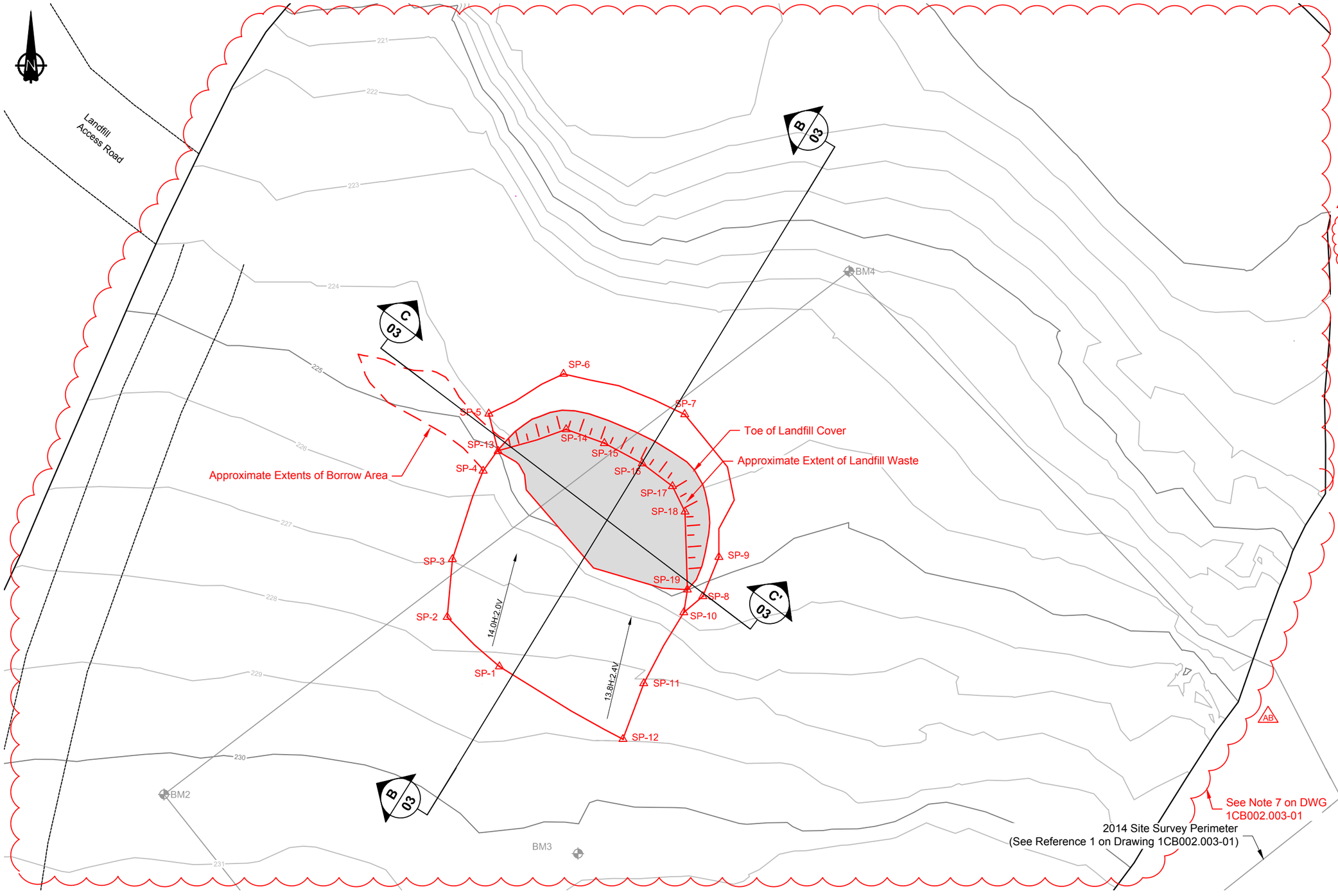

LEGEND

- Benchmark (2015)
- Benchmark (2014)
- Stakeout Point
- Grading Direction
- Extent of Landfill Waste

NOTES

1. Extent of the graded surface will be field fit into the existing topography.
2. Notes and specifications on any drawings in this set apply equally to all drawings in this set.

AB

Stakeout Point Table			
Point #	Northing	Easting	Elevation
SP-1	8107283.25	580136.49	228.7
SP-2	8107288.42	580131.04	228.3
SP-3	8107294.47	580131.58	227.6
SP-4	8107303.69	580134.78	226.4
SP-5	8107309.66	580135.38	224.5
SP-6	8107313.82	580143.18	223.7
SP-7	8107309.59	580155.83	223.4
SP-8	8107290.59	580157.73	225.5
SP-9	8107294.68	580159.41	224.7
SP-10	8107288.91	580155.74	226.6
SP-11	8107281.49	580151.56	228.0
SP-12	8107275.67	580149.38	229.3
SP-13	8107305.75	580136.35	226.0
SP-14	8107308.02	580143.46	225.2
SP-15	8107306.58	580147.44	225.1
SP-16	8107304.46	580151.40	225.2
SP-17	8107302.08	580154.55	225.3
SP-18	8107299.42	580155.87	225.3
SP-19	8107291.28	580156.11	226.1

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
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REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
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AB	As-Built Pre-commissioning	LW	AL	28Aug15
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A	Issued for Review	LW	AL	04Feb15

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LW	AL	October 2, 2017

FILE NAME: 1CB002.003 – landfill.dwg

CanZinco Mines Ltd.

Former Nanisivik Mine

SRK JOB NO.: 1CB002.002

Non-Hazardous Waste Landfill Design

DRAWING TITLE:

Final Grading Plan

DRAWING NO.	SHEET	REVISION NO.
1CB002.002-03	4 OF 5	AB1

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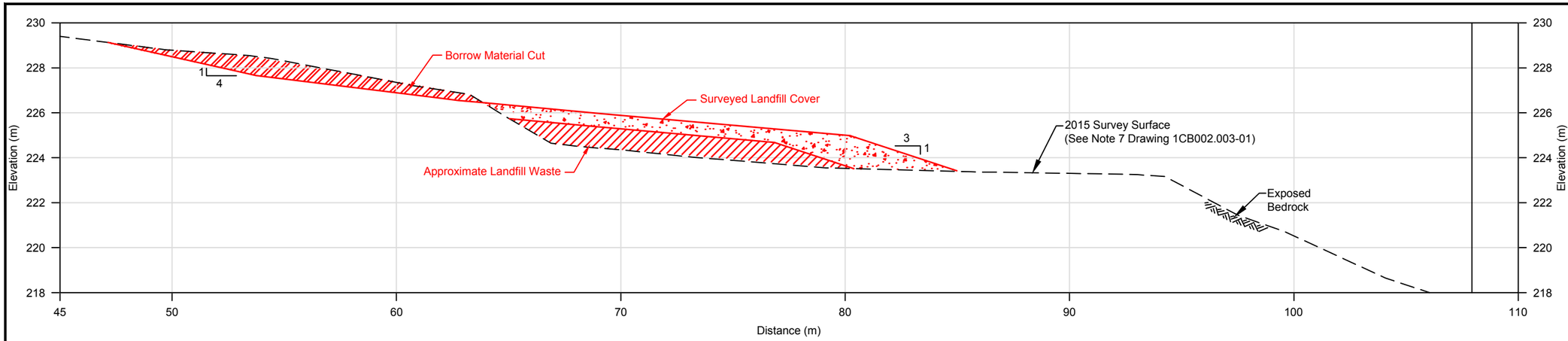
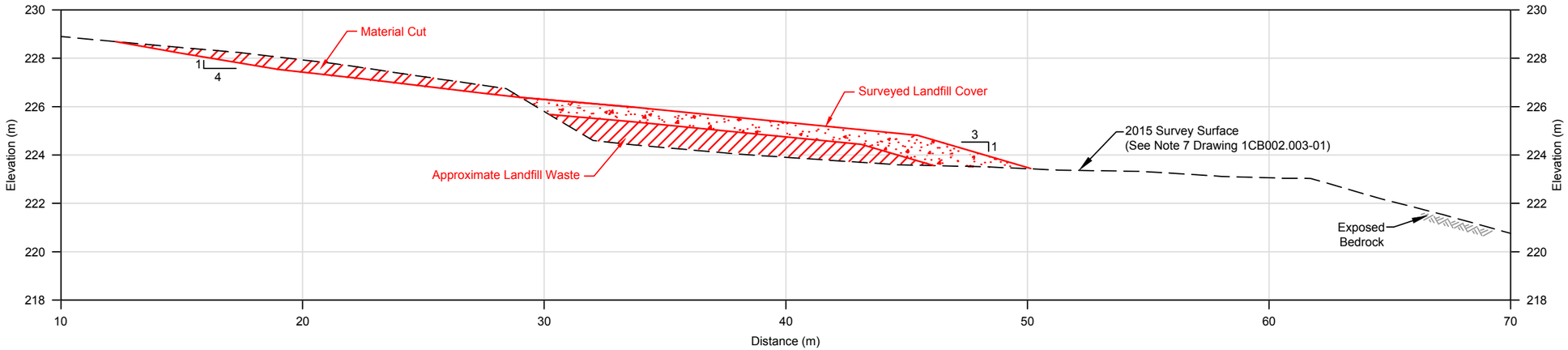


CROSS SECTION A-A'

A / 02



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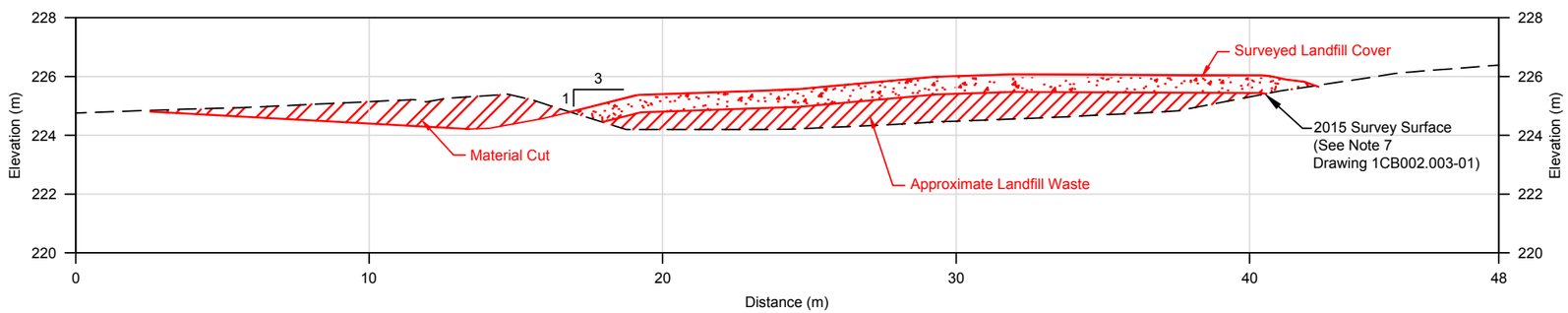
B / 03



CROSS SECTION C-C'

C / 03

LEGEND

- Shingled Waste Geomembrane
- Non-hazardous Waste
- Borrow Material Cut
- As-Built Cover Material
- As-Built Non-hazardous Waste
- As-Built Borrow Material Cut

NOTES

1. Non-hazadous wastes shall be consolidated on the existing pad by stacking alternating layers of waste and clean granular fill to minimize voids.
2. Waste geomembrane, which exhibit no petroleum hydrocarbon contamination, shall be placed over the consolidated non-hazardous wastes in a “shingled” configuration, with adequate overlap to redirect water that percolates through the cover away from the underlying wastes.
3. During construction the Engineer may require that the geomembranes be pinned with waste rebar to prevent the dry cover from sliding.
4. The maximum single loose lift thickness of cover material is 300mm.
5. The minimum compacted cover thickness is 600mm.
6. A method of compaction for cover materials will be developed on site by the engineer.
7. The onsite construction supervisor or engineer will maintain elevation control of the landfill construction.
8. Final grading of the consolidated landfill cover will prevent water ponding. The landfill will be graded to 3:1 (horizontal to vertical) and the upslope cover borrow area graded to 4:1.
9. Notes and specifications on any drawings in this set apply equally to all drawings in this set.

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Scale in Metres

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REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
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AB	As–Built Pre–commissioning	LW	AL	28Aug15
0	Issued for Construction	LW	AL	27Feb15
A	Issued for Review	LW	AL	04Feb15

REVISIONS

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LW	AL	October 2, 2017

FILE NAME: 1CB002.003 – landfill.dwg

CanZinco Mines Ltd.

Former Nanisivik Mine

SRK JOB NO.: 1CB002.002

Non-Hazardous Waste Landfill Design

DRAWING TITLE: Sections And Details

DRAWING NO.	SHEET	REVISION NO.
1CB002.002–04	5 OF 5	AB1

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Appendix B - Construction Photo Log

Photo 1: **Large pieces of liner were stretched out over the waste in the landfill and the edges were backfilled with cover material to weigh them down. Photo looking north-west.**

Photo 2: **The outer slope of the landfill was covered with cover material relocated using the loader from the west edge of the landfill. Photo looking east.**

Photo 3: **Landfill cover construction progressing from the middle toward the east. Photo looking north-west.**

Photo 4: **The upstream side of the landfill was covered by pushing the unconsolidated cover material with a dozer. Photo looking south-east.**

Photo 5: The covered landfill was surveyed immediately following completion. Photo looking north-west. The completed landfill cover shown in the right hand side of the photo.