and there is a loose correlation between elevated field screening results and elevated levels of extractable hydrocarbons.

Metals

Metal concentrations for samples collected at and adjacent to the apron on the STOL airstrip are listed in Table 5, illustrated on Figure 7 and shown in Photograph 4.

Cadmium concentrations ranged from less than the method detection limit (0.3 μ g/g) to 18.8 μ g/g in the nine samples submitted for analysis (including two field duplicates). All of the analytical results were less than the SQRO for cadmium, 50 μ g/g.

Copper concentrations in two samples were 17.9 $\mu g/g$ and 22.4 $\mu g/g$, which were both less than the SQRO for copper, 5,900 $\mu g/g$.

Lead concentrations ranged from 13.2 μ g/g to 1,070 μ g/g for ten samples (including two field duplicates and one lab duplicate). One sample, TP03-378-1 collected between surface and 0.15 m depth, exceeded the SQRO for lead, 1,050 μ g/g. Sample TP03-378-2, collected in the same test pit from 0.5 to 0.6 m, met the SQRO for lead. Also the field duplicate of TP03-378-1, sample TP03-390-1 met the SQRO for lead.

Silver concentrations for two samples were both less than the method detection limit of 0.7 μ g/g, which is less than the SQRO for silver, 18,000 μ g/g.

Zinc concentrations ranged from 35.2 μ g/g to 5,540 μ g/g for ten samples (including two field duplicates and one lab duplicate). All of the samples analyzed were less than the SQRO for zinc, 23,400 μ g/g.

4.4.4 Carpenter Shop

Hydrocarbons

Five samples were collected from the Carpenter Shop in Town Area for analysis of petroleum hydrocarbons in soil, including one field duplicate (Photograph 5). All of the results were below detection limits (Table 3). Each of the five soil samples were field screened based on the 'dry headspace' method using a combustible gas meter calibrated to a hexane standard. The results ranged from 20 ppm to 80 ppm.

Two surface water samples were collected from the intermittent stream flowing adjacent to the Carpenter Shop and analyzed for Total Petroleum Hydrocarbon concentrations. One sample, C Shop US, was collected upstream of the area disturbed by the carpenter shop and the other sample, C Shop DS, was

collected downstream of the shop and the test pit locations. Hydrocarbon contamination was not present in either water sample (Table 7).

4.4.5 Road from Town to Industrial Complex

Metals

Five soil samples (including two field duplicates) from two test pits on the road between the Industrial Complex and the town site were analysed for metals (Table 5). Four of the samples were analyzed for arsenic and cadmium, lead and zinc by ICP-AES and one sample, TP03-392-3 was also analyzed for arsenic and thallium by graphite FAA and lead by ICP-AES.

Cadmium concentrations for these three samples ranged from 18.5 µg/g to 44.0 µg/g, which were all less than the SQRO for cadmium, 50 µg/g.

Lead concentrations ranged from 1.53 µg/g to 1,630 µg/g. Two duplicate samples, TP03-392-2 and TP03-393-2, collected from 0.2 to 0.25 m below surface in test pit TP03-392, were greater than the SQRO for lead (1,050 µg/g) at 1,260 µg/g and 1,630 µg/g, respectively. Lead concentrations is sample TP03-392-3 (123 µg/g), collected from 0.4 to 0.5 m below surface in test pit TP03-392, met the SQRO (Photograph 6).

Zinc concentrations ranged from 6,150 µg/g to 15,900 µg/g, which were all less than the SQRO for zinc, 23,400 µg/g.

4.4.6 Industrial Complex and Warehouse Yard

Нудгосагьопя

A total of fifteen soil samples, including field duplicates, from eight test pits in the industrial complex and warehouse yard area were analyzed for petroleum hydrocarbons (Table 2). The hydrocarbon contamination in this area was observed to be visibly heterogeneous (i.e., "patchy") on surface.

Five samples, collected from three test pits exceeded at least one of the generic PHC CWS criteria for Residential/Parkland (RL) land use. Three samples, TP03-329-2 (500 µg/g), TP03-331-1 (450 µg/g) and TP03-331-2 (710 µg/g), exceeded the Fraction 2 (C₁₀-C₁₆) surface guideline of 450 µg/g. Four samples, including the field duplicates, exceeded the Fraction 3 (C₁₆-C₃₄) surface guideline concentration of 400 µg/g, as follows: TP03-328-3 (2,400 µg/g); TP03-329-1 (1,300 µg/g); TP03-329-2 (4,100 µg/g); and TP03-331-1 (1,800 µg/g). Analytical results for sample TP03-331-3 met the PHC CWS criteria

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indicating that the elevated hydrocarbon contamination did not extend to 0.95 m below surface at this test pit location (Photographs 7, 8 and 9).

Each of the 15 samples was field screened based on the 'dry headspace' method using a combustible gas meter calibrated to a hexane standard. The results ranged from below detection to 110 ppm. A loose correlation is evident between the field screening results and Fraction 2 concentration. However, there does not appear to be any correlation between elevated field screening results and elevated levels of Fraction 3 results.

Two seepage water samples were collected from wells installed in test pits TP02-81 and TP02-82 during 2002. These samples were analyzed for Total Petroleum Hydrocarbons as part of the Phase 3 ESA. Results for both water samples were below the method detection limit, $0.2 \mu g/L$ (Table 7).

Metals

Fifteen soil samples (including two duplicates) from nine test pits were analysed for metals (Table 5, Figure 7). All the samples were analyzed for cadmium, lead and zinc by ICP-AES. Six of the samples were analyzed for 33 elements by ICP-AES and three of the samples were analyzed for arsenic and thallium by graphite FAA.

The samples analyzed from test pit TP03-392 excavated in the warehouse yard met the SQROs for cadmium, lead and zinc. Samples TP03-329-1 and its field duplicate TP03-329-2, collected from surface to 0.15 m, returned cadmium concentrations of 4.6 μ g/g and 19.3 μ g/g, which were both less than the SQRO for cadmium of 50 μ g/g. The lead concentrations for these samples were 161 μ g/g and 473 μ g/g, which were both less than the SQRO for lead of 1,050 μ g/g. The zinc concentrations for these samples were 1,670 μ g/g and 6,760 μ g/g, which were less than the SQRO for zinc of 23,400 μ g/g.

Cadmium concentrations ranged from 1.4 μ g/g to 91.7 μ g/g in the twelve samples and one field duplicate collected from other areas surrounding the industrial complex (Photographs 10, 11 and 12). Three samples, TP03-326-1 (2,230 μ g/g), TP03-330-1 (61.2 μ g/g) and TP03-333-1 (91.7 μ g/g), exceeded the SQRO for cadmium of 50 μ g/g. Lead concentrations ranged from 97.9 μ g/g to 2,330 μ g/g. Four samples, TP03-326-1 (2,230 μ g/g), TP03-330-1 (1,810 μ g/g), TP03-331-1 (1,350 μ g/g) and TP03-333-1 (2,330 μ g/g), exceeded the SQRO for lead of 1,050 μ g/g. Zinc concentrations ranged from 683 μ g/g to 32,500 μ g/g. One sample, TP03-333-1, exceeded the SQRO for zinc (23,400 μ g/g) at 32,500 μ g/g.

Samples TP03-330-3 (0.4 to 0.5 m below surface) and TP03-333-2 (0.3 to 0.4 m below surface) were collected at depths below samples TP03-330-1 (surface to 0.15 m below surface) and TP03-333-1 (surface to 0.1 m below surface) and the analytical results for cadmium, lead and zinc met the SQROs.

Three of the samples from the industrial complex were also analysed for copper and silver. All of the concentrations for copper and silver were less than their SQROs of 5,900 μ g/g and 18,000 μ g/g,

respectively. Two samples were analyzed for arsenic and thallium by graphite FAA and both results were less than the CEQG RL criteria.

Two seepage water samples were collected from wells installed in test pits in 2002. These samples were analysed for total and dissolved metal concentrations. As illustrated on Table 6, the concentrations of dissolved cadmium and zinc are greater than ten times the CEQG FWAL guideline for surface water quality in the sample obtained from the well in test pit TP02-82. Dissolved zinc concentrations were greater than ten times the CEQG FWAL guideline for surface water quality in the sample obtained from the well in test pit TP02-81.

4.4.7 Road from Industrial Complex to Dock

Metals

Four samples collected on the road between the Dock and the Industrial Complex were analysed for cadmium, lead, and zinc by ICP-AES and one sample was also analyzed by graphite FAA for arsenic and thallium concentrations. This is in addition to the samples collected and analyzed during the Phase 2 ESA.

Cadmium concentrations ranged from 2.7 µg/g to 59.8 µg/g. Lead concentrations ranged from 201 µg/g to 1,210 µg/g and zinc concentrations ranged from 1,250 µg/g to 21,220 µg/g. Analytical results for sample, TP03-323-1 (59.8 µg/g cadmium, 1210 µg/g lead), collected from surface to 0.15 m below surface in test pit TP03-323, exceeded the SQRO for cadmium of 50 µg/ and the SQRO for lead of 1,050 µg/g. Sample TP03-323-2 was collected from 0.4 to 0.5 m below surface in test pit TP03-323 (Photograph 13) and cadmium and lead concentrations met the SQROs. All soil samples analyzed returned zinc concentrations less than the SQRO for zinc of 23,400 µg/g.

4.4.8 Landfill Area

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Five soil samples from the toe of the landfill facility were analyzed for petroleum hydrocarbons (Photographs 14 and 15). Analytical results for all of the samples were less than the detection limit for extractable petroleum hydrocarbons (Table 2) and were all less than the generic PHC CWS RL criteria.

Five samples from the Landfarm Cell located in the east portion of the landfill facility were analyzed for petroleum hydrocarbons (Table 2). The Landfarm Cell contains hydrocarbon contaminated soil that is undergoing remediation. Three of the five samples exceeded the generic PHC CWS RL standards for

Fraction 2 (C_{10} - C_{16}), 450 µg/g for surface samples. The analytical results for Fraction 2 are as follows: TP03-380-1 (5,400 µg/g); TP03-383-1 (510 µg/g); and TP03-384-1 (550 µg/g).

All of the ten samples submitted for analysis from the landfarm and the landfarm cell were field screened based on the 'dry headspace' method using a combustible gas (PID) meter calibrated to a hexane standard. The results ranged from non-detect to 9,000 ppm, and there is a loose correlation between elevated field screening results and elevated levels of Fraction 2.

Five seepage water samples, including one duplicate, were collected and analyzed from wells installed in test pits TP02-95, TP02-97, TP02-101 and TP02-102 installed in 2002. One seepage water sample was collected from water ponding in the open test pit TP03-387 and one from the same toe seep as was sampled in 2002 ("LF-WSEEP"). These water samples were analyzed for Total Petroleum Hydrocarbons. All analytical results were below the detection limit of $0.2~\mu g/L$.

Metals

One sample from the landfill facility was analysed for metal concentrations (Table 5). The concentrations of cadmium, lead and zinc were 2 $\mu g/g$, 201 $\mu g/g$ and 924 $\mu g/g$, respectively, which were all less than their respective SQROs of 50 $\mu g/g$, 1,050 $\mu g/g$ and 23,400 $\mu g/g$.

4.4.9 WTDA

Metals

Three samples from the area south of the WTDA were analysed for cadmium, lead and zinc concentrations by ICP-AES (Table 5, Figure 7, Photographs 16 and 17). One of the samples was analyzed for the 33 elements by ICP-AES.

All analytical results obtained met the SQROs. Cadmium concentrations in three samples ranged from below the method detection limit (0.3 μ g/g) to 0.4 μ g/g, which were all less than the SQRO for cadmium of 50 μ g/g. Lead concentrations in three samples ranged from 29.5 μ g/g to 76.7 μ g/g, which were all less than the SQRO for lead of 1,050 μ g/g. Zinc concentrations for three samples ranged from 201 μ g/g to 482 μ g/g, which were all less than the SQRO for zinc of 23,400 μ g/g.

The copper and silver concentrations in sample TP03-365-1 were 22.9 μ g/g and <0.7 μ g/g, respectively, which were both less than their respective SQROs of 5,900 μ g/g and 18,000 μ g/g.

Two groundwater samples were collected from monitoring wells that had been previously installed by BGC Engineering into the Surface Cell of the WTDA. These two samples were analyzed for various physical parameters, including total and dissolved metals (Table 6). The concentrations for dissolved

metals were less than ten times the generic CEQG FWAL guidelines for surface water quality (see section 4.2.2. regarding of application of surface water guidelines to groundwater samples). The pH of one sample was 10.2, which is higher than the CEQG criterion upper limit of 9.0.

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Metals

Two surface soil samples collected on the road from the 09 Portal area to the WTDA were analysed for metal concentrations (Table 5).

The cadmium concentrations were 0.7 µg/g and 3.9 µg/g, which are both less than the SQRO for cadmium of 50 µg/g. The lead concentrations were 61.5 µg/g and 71.4 µg/g, which are both less than the SQRO for lead of 1,050 µg/g. The zinc concentrations were 192 µg/g and 1,480 µg/g, which are both less than the SQRO for zinc of 23,400 µg/g.

One of the samples, TP03-362-1, was analysed for 33 elements. The copper and silver concentrations were 52.8 µg/g and <0.7 µg/g, respectively, which were both less than their respective SQROs of 5,900 µg/g and 18,000 µg/g.

4.4.11 Road from 09 Portal to Areal4

Metals

Seven surface soil samples were collected from test pits on the road from the 09 Portal area to Area14 and analysed for cadmium, lead, and zinc concentrations (Table 5, Photographs 18 and 19). Three of the samples were analyzed for 33 elements by ICP-AES, plus arsenic and thallium by graphite FAA.

All analytical results met the SQROs. Cadmium concentrations ranged from below the method detection limit (0.3 µg/g) to 14.8 µg/g, which are all less than the SQRO for cadmium of 50 µg/g. Lead concentrations ranged from 35.4 µg/g and 689 µg/g, which are all less that the SQRO for lead of 1,050 µg/g. Zinc concentrations ranged from 158 µg/g and 5,050 µg/g, which are all less than the SQRO for zinc of 23,400 µg/g.



4.4.12 K-Baseline

Hydrocarbons

Twelve soil samples, including two field duplicates, from the K-Baseline area were analysed for petroleum hydrocarbons (Photographs 20 and 21). Two of the twelve samples, TP03-340-3 (910 μ g/g) and TP03-341-3 (1,100 μ g/g), exceeded the generic PHC CWS RL criterion for Fraction 2 (C₁₀-C₁₆) of 450 μ g/g for surface soil.

Each of the twelve samples was field screened based on the 'dry headspace' method using a combustible gas (PID) meter calibrated to a hexane standard. The results ranged from non-detect to 330 ppm, and there is a loose correlation between elevated field screening results and elevated levels of extractable hydrocarbons.

Metals

One sample collected at K-Baseline was analysed for cadmium, lead and zinc concentrations. The concentrations of cadmium, lead and zinc were 4.1 μ g/g, 178 μ g/g and 1,400 μ g/g, respectively, which are all less than the respective SQROs of 50 μ g/g, 1,050 μ g/g and 23,400 μ g/g.

4.4.13 Road from 09 Portal to Oceanview

Metals

Eight samples collected on the road from the 09 Portal area to Oceanview and adjacent the Oceanview mine workings were analysed for cadmium, lead and zinc concentrations by ICP-AES (Photographs 22, 23, 24, 25 and 26). One sample was analyzed also by graphite FAA for arsenic and thallium.

Cadmium concentrations ranged from 0.7 μ g/g to 124 μ g/g. Lead concentrations ranged from 56.6 μ g/g to 9,690 μ g/g. Zinc concentrations ranged from 236 μ g/g to 40,400 μ g/g.

Samples TP03-336-1 and TP03-336-2 collected adjacent the former portal to the underground workings at Oceanview, exceeded the SQRO for cadmium, lead and zinc by more than two times. Thallium concentrations in TP03-336-2 also exceeded the generic CEQG RL criterion.

Lead concentrations in sample TP03-335-1, collected adjacent the former open pit, returned lead concentrations greater than the SQRO.

4.5 Quality Assurance/Quality Control

4.5.1 Hydrocarbons

A quality assurance/quality control (QA/QC) assessment was conducted for four duplicate samples from three different areas that underwent analysis for extractable petroleum hydrocarbons.

The QA/QC method chosen was Relative Percent Difference, which is the difference between the sample result and duplicate result, divided by the average of the sample result and duplicate result. This number is then multiplied by 100 (to make the number a percentage) and the outcome is the relative percent difference (the "RpD"). The RpD is not allowed where one or both of the results being compared are less than the practical quantitation limit (PQL). The PQL is 5 times the Method Detection Limit (MDL). An RpD of <50% is considered to be acceptable and an RpD of greater than 50% warrants further comment or consideration.

The results of the hydrocarbon QA/QC assessment are listed in Table 8. Eight of the twelve possible RpD results are not applicable because one or both of the values were less than the PQL. The remaining four RpD's range from 89.55 to 117.46, which are all greater than 50% and warrant further comment.

Three of these duplicate samples were collected from the Warehouse Yard in the Industrial Complex area in an area where the hydrocarbon contamination was noted as being heterogeneous (i.e., "patchy") and, therefore, the RpD results are acrasidered to be verification of this observation. The fourth Rpd >50% (89.55% from test pit TP03-340) is considered to be due to the very low concentrations being compared (37 mg/kg and 97 mg/kg), which cause relatively small numerical variations to result in disproportionately larger RpD percentages. No further investigation of these variances is considered warranted.

4.5.2 Metals

A quality assurance/quality control (QA/QC) assessment was conducted for seven duplicate samples from three different areas that underwent analysis for metal concentrations. The QA/QC method chosen was Relative Percent Difference (RpD).

The results of the metals QA/QC assessment are listed in Table 9. Three of the 21 RpD results are not applicable because one or both of the values were less than the PQL. The remaining RpD's range from zero to 145%.

The ten RpD values greater than 50% are from the apron at the STOL Airstrip and the Industrial Complex/Warehouse Yard. These RpD variances are considered to be representative of the highly variable nature of metal contamination in these areas caused by intermittent and inconsistent distributions of concentrate dust or other contaminant sources. No further investigation of these variances is considered warranted.

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5. Conclusions of the Phase 3 Investigations

The following conclusions have been drawn from the data presented in this report in the context of providing information necessary for development of a soil remediation plan:

5.1 Dock Area

- The downgradient extent of hydrocarbon contaminated soil at the fuel tank farm has been delineated.
 Testing has shown that it does not extend beyond 40 m from the berm of the tank farm.
- Concentrations of hydrocarbons in the soil within the dock cell containing the ship loader facility
 exceed the generic PHC CWS IL for the protection of aquatic life, the site soil quality remediation
 objective.
- Surficial hydrocarbon contamination is present at the AST adjacent to the refuge station. The
 contamination appears to be isolated to the immediate area surrounding the AST.
- Hydrocarbon contamination was detected in a test pit which exposed the fuel line from the dock to the tank farm. Results indicate that contamination is localized and has migrated less than 40 cm from the line.
- Zinc concentration of greater than the SQRO for the dock area have been identified on surface, adjacout to the door to the concentrate shed on the west side, at the load out dock and adjacent to the refuge station. One isolated incidence is documented on the east side of the concentrate shed. Lead concentrations also exceed the SQRO adjacent to the door of the concentrate shed on the west side. No lead or zinc contamination greater than the SQROs is indicated in the reagent storage area. Analytical results indicate that the metal contaminated soil does not extend to 0.4 m below surface.
- Silver exceeds the generic CEQG IL, the site soil quality remediation objective. Elevated silver
 results were returned in samples with zinc concentrations that were indicative of zinc concentrate and
 several times greater than the SQRO and, therefore, silver contamination would be remediated during
 the remediation of the zinc contaminated soils.

5.2 STOL Airstrip

Hydrocarbon contaminated soil detected during the Phase 2 ESA at the east end of the airstrip has been delineated. The contaminated soil does not extend 45 m from the point of origin as indicated by surface staining. Hydrocarbon contaminated seepage water was encountered in test pit TP03-373, however, soil quality results from this test pit met the PHC CWS RL criteria. Test pit TP03-373 was excavated approximately 45 m from the point of origin.

Lead concentrations greater than the SQRO detected during the Phase 2 ESA on the apron on the south side of the airstrip were investigated. The lead contamination has been delineated vertically and laterally and it is confined to the soils on surface at the apron.

5.3 Town, Carpenter Shop

The downgradient extent of hydrocarbon contaminated soil at the Carpenter Shop has been delineated. It does not extend 50 m downgradient of the building. No impact of hydrocarbon contamination on the surface water was detected in the water flowing in a ditch adjacent to the Carpenter Shop.

5.4 Industrial Complex/Warehouse Yard

5.4.1 Industrial complex

- Soils beneath the surface water runoff pathway, downgradient of the fuel day tanks, are contaminated with hydrocarbons. Contamination did not extend to 0.95 m beneath surface at test pit TP03-331, but was present at 1.5 m below surface at the upgradient test pit TP02-88.
- Hydrocaron contaminated soil has been delineated at the waste oil tank, located between i win Lakes
 Creek and the industrial complex. Results indicate that it is isolated to the downhill side of the tank
- and does not extend to the creek.

 Hydrocarbon contaminated soil is present at the oil water separator. Analytical results obtained from test pit TP03-330 indicated that the contaminated soil does not extend 50 m downgradient of the oil
- water separator.

 Metal contaminated soil is present in the soil surrounding the industrial complex. Analytical results to date indicate that concentrations of cadmium, lead and zinc greater than the SQROs do not

5.4.2 Warehouse Yard

generally extend to 0.4 m below surface.

Hydrocarbon contamination is present in **surf**icial soils with patchy, visible staining. Hydrocarbon contamination at an area of heavy staining (initially identified and sampled during the Phase 2 ESA) extends into the fractured bedrock to at least 0.8 m depth. It does not extend into the weathered, fractured bedrock, encountered 0.4 m, beneath lightly stained surface soils.

5.5 Landfarm Cell

 Based on analytical results obtained to date, it is estimated that approximately 25% of the hydrocarbon contaminated soil being remediated in the landfarm cell at the landfill currently meets the generic PHC CWS RL criteria.

5.6 Landfill

- No hydrocarbon contamination was detected in soil or water samples down gradient or cross gradient
 of the landfill and all analyses were less than the method detection limits.
- No elevated metals were encountered in the soils.

5.7 K-Baseline

- Hydrocarbon contamination of soil has been detected at the former AST and maintenance shop at K-Baseline. Analytical results from test pits excavated northwest of the former AST and maintenance shop indicated that the contaminated soil does not extend to the intermittent tributary of Chris Creek.
- ^_alytical results from the Phase 3 ESA illustrate that the hydrocarbon contaminated soil is isolated to the top of the active layer.

5.8 Roads

- Surficial hydrocarbon contamination is present at the ASTs adjacent to the refuge stations at the side
 of the roadways. The contamination appears to be isolated to the immediate area surrounding the
 ASTs.
- Metal contamination of soil is present adjacent to the former Oceanview mine workings.
- Iron contaminated soil is present on the surface of the roadway between the townsite and the
 industrial complex at the west side of bridge near the sewage treatment plant. The contamination did
 not extend to 0.4 m below surface.
- Metal contaminated soil is present on the surface of the roadway between the industrial complex and
 the screening plant, located approximately 1.5 km to the north. The contamination did not extend to
 0.4 m below surface and was not detected in soils adjacent to the roadway.

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7. Limitations and Closing

This report was prepared for the exclusive use of Canzinco Ltd. The report is intended to provide the results of the 2003 environmental site characterization and other activities as documented in the report at the Nanisivik mine, Nunavut. The report, which specifically includes all tables and figures, is based on data and information collected during the investigations conducted by Gartner Lee and is based solely on the conditions of the site at the time of the investigation, supplemented by historical information and data obtained by Gartner Lee, as described in this report.

The investigation programs described in this report were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

Any use which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibility of such third parties. Gartner Lee accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on the information contained in this report.

The assessment of environmental conditions at this site have been made using the results of chemical analysis of soil, sediment and groundwater/surface seeps from a limited number of locations. The site conditions between sampling locations have been inferred based on conditions observed at sampling locations. Subsurface conditions may vary from those encountered at the sample locations. Additional study, including further subsurface investigation, can reduce the inherent uncertainties associated with this type of study. However, it is never possible, even with exhaustive sampling and testing, to dismiss the possibility that part of a site may be contaminated and remain undetected.

2003 Phase 3 Environmental Site Assessment

Nanisivik Mine, Nunavut

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Figures





