BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

NYRSTAR

NANISIVIK MINE, NUNAVUT

2019 ANNUAL GEOTECHNICAL INSPECTION

PROJECT NO.: 0255030 DATE: February 24, 2020

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February 24, 2020
Project No.: 0255030

Mr. Johan Skoglund
Group Environment Manager, Americas
Nyrstar
Tessinerplatz 7
8002 Zurich, Switzerland

Dear Johan,

Re: Nanisivik Mine 2019 Annual Geotechnical Inspection

Please find attached our above captioned report on the 2019 Annual Geotechnical Inspection undertaken at Nanisivik Mine. If there are any questions or comments regarding this report, please contact the undersigned at your convenience.

Yours sincerely,

BGC ENGINEERING INC.
per:

Scott Garrison, M.Eng., P.Eng.
Geological Engineer

EXECUTIVE SUMMARY

The Annual Geotechnical Inspection was undertaken at the Nanisivik Mine site in 2019. The program involved the following:

- Completion of a site inspection by a professional geotechnical engineer. The site inspection included visual observations of all reclamation measures undertaken at the Nanisivik Mine site since 2004.
- Collection of geotechnical monitoring data from various instruments located around the mine site.
- Review of the geotechnical monitoring data to assess the performance of various reclamation measures with respect to the original design intent.

The following paragraphs provide a summary of the significant observations, conclusions, and recommendations based on the results of the 2019 Geotechnical Inspection Program undertaken at the Nanisivik Mine site.

Embankments

The West Twin Dyke and Test Cell Dyke were physically stable with no signs of erosion or seepage. The breaches in the remnant dykes at the East Adit Treatment Facility continue to permit natural drainage of the area with only limited ponding in the Retention Pond.

Hydraulic Structures

The West Twin Dyke Spillway continues to effectively drain water from the Surface Cell cover into the Reservoir and is generally functioning as intended. Previous inspections recommended maintenance to address erosion at the base of the spillway channel, as well as additional erosion of the left bank, likely caused by elevated flows during freshet in combination with ice and snow blockage within the spillway channel. In response to these recommendations, some minor grading and re-sloping were undertaken during the 2018 inspection with the objective of improving the hydraulic performance of the spillway. The maintained areas were visually assessed during the 2019 inspection and appeared to have performed favourably, as no further erosion was noted in 2019. However, given the nature of the flows causing the previously observed erosion, it is possible that additional maintenance may be required in the future. The spillway should continue to be inspected for additional erosion and maintenance should be undertaken as necessary.

As observed during previous inspections, a small head pond developed on the Surface Cell cover at the spillway inlet. The presence of the head pond is not considered to negatively impact the overall cover performance; hence the elimination of the head pond is not considered necessary.

The seepage at the West Twin Outlet Wall seems to have slowed in recent years, as the water level upstream of the wall has been maintained more consistently at or above the invert of the outlet wall.

Additional deformation of the perimeter slopes of the upstream Polishing Pond was observed in 2019, though the area of instability was further removed from the outlet wall compared to previous years. Based on the water quality measurements collected since the East Twin Lake access road was breached in 2008, the seepage losses from the Polishing Pond do not appear to be affecting the overall performance of the West Twin Area reclamation measures. The seepage losses should continue to be monitored. Additional seepage control measures could be considered, if necessary.

Previous inspections made recommendations to repair left bank armouring material following observations of erosion along a section of the East Twin Creek Diversion Channel. In response to these observations, maintenance was undertaken at the diversion dyke during the 2018 inspection. The maintenance included re-sloping of the affected area and addition of locally available armour materials. The maintained areas were visually assessed during the 2019 inspection and appeared to have performed favourably. Seepage discharge observed at the toe of the left bank of the dyke during previous inspections was observed again in 2019. The seepage water is likely originating in the Polishing Pond and is also likely related to excavation of Polishing Pond sediments during site reclamation. The seepage flow rate was visually observed to have increased compared to the 2018 inspection, likely due to a greater active layer thickness in 2019. The flow seepage was observed to be clear and free of sediment. No further maintenance of the diversion dyke is recommended at this time but should continue to be monitored for additional erosion and seepage flows.

Thermal Covers

Based on monitoring data collected from various frost gauges and thermistors, the thermal covers performed adequately throughout 2019. The thermal covers maintained the active layer thaw within the cover profile through much, if not all of the summer thaw season. In general, the active layer thaw was observed to be greater than in 2018 but within the range of historical values, reflecting the warmer air temperatures experienced at site this spring and summer. Only minor erosion, cracking, and thermokarsting/settlement was observed, which were not seen to negatively impact the thermal performance nor the water quality in the surrounding areas. Many of these features have been noted previously and have been observed to be physically stable for the past several years. The water quality observed at the final discharge point for the West Twin Disposal Area was observed to remain well below the discharge criteria throughout the open water season in 2019. This is an indication of the beneficial impacts related to geothermal performance of the cover system.

No maintenance is required for the thermal covers at this time; however, visual monitoring is recommended to check for additional surface deformation and erosion.

Talik and Mine Waste Freeze-back

Freeze-back of the talik in the Surface Cell and Test Cell appears to be proceeding faster than anticipated. Since 2018, a downward migration of the freezing front and continued cooling of ground temperatures below approximately 10-15 m was observed. On the other hand, shallow ground temperature at depths above 10 m bgs generally showed slight warming since 2018, reflective of warm spring and summer air temperatures at site in 2019. All piezometers within the

Surface Cell, and three out of five piezometers within the Test Cell, have frozen back due to continued downward migration of the freezing front. The piezometers have been observed to freeze back at lower temperatures when the piezometer tip is at a lower elevation, as well as when it is further away from the edge of the original lakebed. These relationships are likely related to the increasing solute concentrations in the unfrozen pore water contained within the remnant talik.

In areas where no talik exists (e.g., landfill, open pits), freeze-back of the materials underlying the cover systems has occurred and the rate of cooling has generally slowed over recent years, suggesting ground conditions are approaching thermal equilibrium at depth.

Mine Openings, Crown Pillars and Raises

The covers constructed over the mine openings generally appear to be physically stable. Cracking at the East Open Pit crown pillar does not appear to have progressed in many years. No maintenance is recommended, but continued visual inspection is warranted.

Shale and Armour Borrow Areas

In general, the shale and armour borrow areas appear to be physically stable and are not causing any significant ponding to occur. No maintenance was recommended at any of the borrow areas.

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LIMITATIONS

BGC Engineering Inc. (BGC) prepared this document for the account of Nyrstar. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

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1.0 INTRODUCTION

Nanisivik Mine is currently owned by Nyrstar, who obtained the property through its purchase of Breakwater Resources Ltd. (Breakwater) in 2011. Nanisivik Mine is located on the Borden Peninsula on northern Baffin Island, just south of Strathcona Sound, as shown on Drawing 01.

Mining operations at Nanisivik ceased in September 2002. Site operations, including the geotechnical site inspection, in 2019 were conducted under Nunavut Water Board License 1AR-NAN1419 (the License), effective from December 23, 2014, through December 22, 2019.

The License entitles CanZinco (the Licensee, a subsidiary of Nyrstar) to use water and dispose of waste associated with the closure and reclamation activities and post-closure monitoring at the Nanisivik Mine. Part I, Item 6 of the License stated the following:

> *"The Licensee shall undertake a geotechnical inspection, to be carried out annually by a Geotechnical Engineer, during the months of July, August or September and provide a report as set out in Part I, Item 7. The inspection shall be conducted in accordance with the Canadian Dam Safety Guidelines (2007) where applicable and be consistent with the previous Annual Geotechnical Inspection reports submitted by BGC Engineering Inc. for the project, and shall taking into account all major earthworks and any changes to the project."*

Additionally, the Nunavut Water Board's Letter of Approval for the Mine Reclamation Plan (NWB, 2004) stated the following:

> *"In addition to the requirements outlined in Part H, item 6, of the previous License (NWB1NAN0208), the Licensee shall include inspection of all portals, audits, mine openings, ventilation shafts associated with the mine and an examination of the area around the Industrial Complex ice lens."*

Also, the approved Nanisivik Mine Reclamation and Closure Monitoring Plan (Gartner Lee Ltd., February 2004) stated that the annual geotechnical inspection will include "all earth structures, water diversions, rock slopes and soil covers by a professional engineer." As per the Monitoring Plan, "the engineers report will include a professional review and assessment of all thermal monitoring information and flow information relevant to a physical stability assessment."

In fulfillment of these regulatory requirements, Mr. Johan Skoglund, Group Manager Environment, for Nyrstar, requested that BGC Engineering Inc. (BGC), conduct an inspection visit. The current report provides a summary of the conditions observed and any resulting recommendations and maintenance issues. The report also provides a comprehensive review of geotechnical monitoring data collected on site in 2019. Table 1-1 provides a list of the structures that were included within the inspection.

Table 1-1. Summary of inspection items.

Facility Type	Inspection Item
Embankments and Containment Structures	West Twin Dyke
	Test Cell Dyke
	East Twin Creek Diversion Dyke
	East Adit Treatment Facility
	Day Tank Farm Area
	West Twin Outlet Channel
Thermal Covers	Surface Cell
	Test Cell
	Toe of Test Cell Dyke
	Toe of West Twin Dyke
	Landfill
	West Open Pit
	East Open Pit
	Oceanview Open Pit
	Upper Dump Pond
	Industrial Complex
Mine Openings, Crown Pillars and Raises	00/01 Portals and crown pillar
	17 N Portal
	Oceanview Portal
	K-Baseline Portal
	9S Portal
	Former Portal to Mill Foundation
	Lower Adit
	Shale Hill Raise
	Oceanview East and West Raises

Facility Type	Inspection Item
Shale and Armour Borrow Areas	Mt. Fuji Shale Borrow Area
	West Twin Shale Borrow Area
	East Twin Shale Borrow Area
	Area 14 Shale Borrow Area
	Townsite Shale Borrow Area
	Shale Hill Shale Borrow Area
	Twin Lakes Delta Armour Borrow Area
	Kuhulu Lake Road Borrow Area
	09S/17N Armour Borrow Area
	Chris Creek Armour Borrow Area

A new Nunavut Water Board License 1AR-NAN2030 TYPE “A” (the New License) was issued effective January 8, 2020 through January 8, 2030. Future geotechnical site inspections will be conducted under the terms of the New License.

2.0 MINE RECLAMATION ACTIVITIES

The Final Closure and Reclamation Plan (FCRP) was submitted to the Nunavut Water Board for review and approval in March 2004. The review process included a technical meeting in Yellowknife in May 2004 and a public hearing in Arctic Bay in June 2004. The Board conveyed its approval of the plan in a letter to Breakwater dated July 6, 2004.

The reclamation of the mine site began in August 2004, with the bulk of reclamation completed between 2004 and 2008. Since 2004, the following reclamation activities related to the geotechnical inspection have been completed:

- Permafrost aggradation or “thermal” covers were constructed over tailings in the Surface Cell, Test Cell, toe of the Test Cell Dyke, toe of the West Twin Dyke, and at the Upper Dump Pond.
- Thermal covers were constructed over waste rock in the West Open Pit, East Open Pit, Oceanview Pit, and Area 14 Waste rock pile.
- A thermal cover was constructed over the Nanisivik Landfill.
- A thermal cover was constructed over the Industrial Complex Foundation, which had been backfilled with metals contaminated soil.
- Portal plugs and thermal covers were constructed at the Lower Adit, 09 South, Oceanview, K-Baseline, 17 North, 88 North, 00 and 01 Portals.
- A fill pillar was constructed beneath the 00/01 crown/rib pillar.
- The West Twin Dyke Spillway was constructed to convey water from the Surface Cell cover system to the Reservoir.
- The West Twin Outlet Channel was constructed to control the water level in the Reservoir.
- Additional armour was applied to the face of the East Twin Creek Diversion Berm.
- The East Adit Treatment Facility was decommissioned by breaching each of the dykes.
- The Day Tank Farm was decommissioned by removing the tanks, liner, and berms.
- The Lower Dump Pond was decommissioned by removing the berms, tailings and the liner and transporting them to the underground mine workings.
- The Concentrate Storage Shed was dismantled and a surficial cover was constructed over the concrete floor slab.
- The road separating the Polishing Pond and the Reservoir was breached, and the culverts and stop log control structure were removed.
- The Main Tank Farm was demolished and hydrocarbon impacted soils from beneath the tank farm were excavated and removed.

Most of these reclamation measures are summarized in the project completion report (BGC, September 28, 2009) and documented in detail in various as-built reports referred to throughout this document. Reclamation of the Nanisivik Mine site is complete. Post closure monitoring of the site is on-going and has been conducted in many areas of the site since 2006.

3.0 CLIMATE REVIEW

Climatic data was collected at the Nanisivik Airport by Environment Canada from 1976 to 2010, which is located approximately 10 km south of the West Twin Disposal Area (WTDA) and approximately 250 m higher in elevation. The recorded climate data were previously analyzed by Golder (October 1998) to provide a basis for deriving the existing climate parameters such as precipitation, air temperatures, and lake evaporation at the project site. The following list is a summary of the main climatic parameters provided by Golder (October 1998):

- Mean annual air temperature (MAAT) was estimated to be -15.2°C
- Mean annual precipitation total was estimated to be 240 mm
- Twenty-four-hour Probable Maximum Precipitation (PMP) value was estimated to range from 140 to 210 mm
- Mean annual lake evaporation value, as measured at the Nanisivik site, was approximately 200 mm.

Climate monitoring was discontinued at the Nanisivik Airport in January 2011. Currently, the nearest available climate monitoring station is located at Arctic Bay, approximately 30 km from Nanisivik. Data collected from Arctic Bay since 2011 is provided on Drawing 02. The MAAT recorded at the Arctic Bay weather station in 2019 was approximately -12°C. This is 2.7°C warmer than 2018, and 0.6°C warmer than the Arctic Bay 2011 to 2019 MAAT. Though January through March were cooler than the 2011 to 2019 mean monthly air temperatures, May through September were warmer. October through December cooled to near average temperatures. The Air Thaw Index calculated for 2019 was approximately 598 degree Celsius days (°C•d). This value is nearly double that of 2018 (311°C•d), and higher than the 2011 to 2019 average of 476°C•d.

Due to the approximately 630 m difference in elevation and the proximity to the coast line, the climate data sets from Arctic Bay and the historical data collected from the Nanisivik airport station are not directly comparable. In order to put the climate data collected from Arctic Bay since 2011 in historical context, a correction factor is required. A correction factor of -2°C has been estimated (Nanisivik airport 2°C cooler than Arctic Bay) based on the overlap of data sets while monitoring data was collected from both sites in 2010 and 2011, the air temperature data collected sporadically on site since 2013, and the available historical mean annual air temperature at both Arctic Bay and Nanisivik. This correction factor was applied to the climate data collected from Arctic Bay between 2011 and 2019 to create a hybrid climate data set for the Nanisivik mine site of 1977 to 2019 data.

Based on the corrected hybrid climate data set since 1977, site conditions during the winter months were colder than average in 2019, and in contrast, the summer months were the hottest on record. The corrected MAAT in 2019 was approximately -14°C, 0.5°C warmer than the 1977-2019 MAAT of -14.5°C. The corrected Air Thaw Index (ATI) calculated in 2019 was approximately 378 degree Celsius days (°C•d). This value is nearly triple that of 2018 (128°C•d) and higher than the 1977 to 2019 mean of 298°C•d.

4.0 MINE DESCRIPTION

Mining was conducted at Nanisivik Mine between 1976 and 2002. During that time, mining was conducted at four small open pits (West Open Pit, East Open Pit, East Trench, and Oceanview Open Pit) and underground (Main Lens, Area 14, Oceanview, and K-Baseline). The locations of each mining area are illustrated on Drawing 01. The ore was processed at the mill and the tailings were transported to the WTDA, located at West Twin Lake.

The WTDA is comprised of an upper, solids retention pond, named the Surface Cell, and a lower, water retention pond, called the Reservoir, as shown on Drawing 03. The Surface Cell and Reservoir are separated by the West Twin Dyke, a frozen-core, rockfill dyke. Prior to construction of the West Twin Dyke, tailings were deposited throughout the original West Twin Lake. After construction of the dyke, tailings were primarily deposited into the Surface Cell. Excess water was then siphoned or pumped from the Surface Cell into the Reservoir from where it was reclaimed for use in the mill. The Reservoir was subsequently further separated by constructing the Test Cell Dyke, creating additional tailings disposal capacity in what was known as the Test Cell.

The Reservoir and a final Polishing Pond were separated by a rockfill causeway and stop log structure. Water from the Polishing Pond was then discharged to Twin Lakes Creek at the decant structure located at the outlet from the pond. The decant structure was replaced in 2005 by the West Twin Outlet Channel. In September 2008, the stop log structure was removed and the rockfill causeway was breached allowing the Reservoir and Polishing Pond to behave as a flow-through hydraulic system.

5.0 2019 SITE INSPECTION

Mr. Scott Garrison, P.Eng., conducted the geotechnical site inspection between August 6 and 9, 2019. The following site activities were conducted:

- Each of the elements from Table 1-1 was inspected on foot. Pertinent observations concerning the physical condition of each element were recorded by photograph.
- Instrument readings were collected.

Select photos are provided in Appendix I. The following sections review the results of the geotechnical inspection and geotechnical instrumentation monitoring program at the various site facilities.

5.1. Embankments and Containment Structures

Several embankments and containment structures were constructed at Nanisivik Mine throughout its history for various purposes. These include the following:

- West Twin Dyke
- Test Cell Dyke
- East Adit Treatment Pond Dyke
- East Adit Retention Pond Dyke
- Day Tank Farm Spill Containment Berm
- Main Tank Farm Spill Containment Berm.

The following sections provide a summary of the inspection conditions at each of the structures mentioned above. It should be noted that since the West Twin Dyke and Test Cell Dyke have been incorporated into the Surface Cell and Test Cell tailings covers, respectively, the inspection conditions for these structures are reviewed in Section 6.3 (Thermal Covers). Additionally, no inspection of the Day Tank Farm or Main Tank Farm areas was completed as both facilities have been fully decommissioned and berms have been removed.

5.1.1. East Adit Treatment Facility Dykes

Construction Details

The East Adit Treatment Facility was located approximately 3 km east of the mill, downslope from the East Adit area, as shown on Drawing 01. The facility was comprised of a Treatment Pond and a Retention Pond, both of which employed earthen dykes to retain surface water flow. Water that flows through this area is runoff water from the surrounding drainage basin, where the water quality is affected and/or impacted by natural mineralized soil and rock.

Both dykes are shale rockfill structures mixed with a combination of one or more of the following: regional talus, glacial till, marine clay, and/or bentonitic clay. The Treatment Pond Dyke is approximately 5 m above the surrounding ground surface. The Retention Pond Dyke is approximately 3 m above the surrounding ground surface.

Commitments were made in the 2004 Reclamation and Closure Plan (CanZinco, March 2004) to restore natural drainage by breaching/removing any man-made diversions or catchments. As such, both dykes were breached in late 2006. The breaches are approximately 5 m wide at the base and are sloped back to the remnant crest of the dykes at an angle of approximately 3(H):1(V).

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 1 & 2). The main observations made during the inspection are summarized by the following:

- Both the breach of the East Adit Retention Pond and the breach of the East Adit Treatment Pond promote drainage of the former pond areas as intended.
- As observed during previous inspections, a small remnant pond was observed in the East Adit Retention Pond area which has been present since breaching. The ponding has been reduced in areal extent over time due to continued natural backfilling of the area by sediments, mostly weathered shale, being transported and deposited in this area from natural deposits upslope.
- Some channelization of remnant sediments was observed in the bottom of the East Adit Treatment Pond.

As expected, natural sedimentation has steadily been reducing the areal extent of remnant ponding in the East Adit Retention Pond. As such, additional remedial actions at the East Adit Treatment Facility are not considered necessary.

5.2. Water Conveyance Structures

Several water conveyance structures were constructed at Nanisivik Mine, both prior to, and during the reclamation process. These include the following structures:

- West Twin Dyke Spillway
- West Twin Outlet Channel
- East Twin Creek Diversion Berm and Channel.

The following sections provide a summary of the inspection conditions at each of the structures mentioned above.

5.2.1. West Twin Dyke Spillway

Construction Details

The West Twin Dyke Spillway is located at the south end of the Surface Cell, as shown on Drawing 03. The spillway conveys water from the Surface Cell to the Reservoir. The physical details of the spillway are summarized by the following:

- The spillway is approximately 550 m long.
- The bottom of the spillway is approximately 6 m wide.
- The grade of the spillway bottom varies from 0% at the inlet to 7% near the middle of the spillway and 2% at the outlet.
- The bottom of the spillway is founded on rock from the inlet to 100 m down gradient of the access ramp. The remainder of the spillway bottom is comprised of rockfill.

- The side slopes of the spillway vary from near vertical in rock to approximately 3(H):1(V) in soil side slopes.
- Side slopes are composed of poor-quality rock or soil are armoured with riprap.

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 3 through 9). The main observations are summarized by the following:

- A small pond was observed at the spillway inlet on the Surface Cell cover (Photo 3). The maximum depth of the pond was estimated to be approximately 20 cm, similar to previous years.
- The upper portion of the spillway (upstream of the access ramp) shows signs of minor erosion of the armour material but remains in satisfactory condition (Photos 4 through 6).
- Minor maintenance activities were undertaken in 2018 to address the erosion along the left bank (Photos 7 through 9). The maintenance activities are described in detail in a separate memorandum appended to BGC's *Nanisivik Mine 2018 Annual Geotechnical Inspection Report (March 11, 2019)*. The maintenance consisted of re-shaping the eroded section with an excavator and smoothing and track-packing portions of the base of the spillway with a bulldozer. The objective was improving the hydraulic performance of the spillway but the level of effort was constrained by the available equipment/operators and available armouring materials. During the 2019 inspection, the areas maintained in 2018 appeared to be in a similar condition to 2018. Although the maintenance was effective in improving the condition of the side slopes and channel bottom, additional erosion protection may be required in the future given the focused nature of the flows observed to cause the erosion. It is recommended that the spillway continue to be inspected for stability and erosion of the side slopes.
- During 2018 maintenance activities, transported armour material that was deposited at the base of the spillway was removed or smoothed. No new deposition of armour material in the base of the spillway was observed during the 2019 inspection (Photo 9).
- As noted in previous inspections, surface flow was observed to travel down the spillway before going subsurface into the rockfill, suggesting that the subgrade is sanding-up/freezing-back. This is not considered to have an adverse impact on spillway performance at this time.

While the spillway is effective in directing and confining flow from the Surface Cell to the Reservoir, additional maintenance may be required in the future. It is recommended that the spillway continue to be visually monitored for additional erosion and maintenance be undertaken as necessary.

5.2.2. West Twin Lake Outlet Channel

Construction Details

The West Twin Lake Outlet Channel is located in the northeast corner of the WTDA, as shown on Drawing 03. The channel conveys water from the Reservoir into Twin Lakes Creek. The channel replaces the former decant station located in the same area. The main design feature of the channel is a steel-reinforced, concrete wall which provides water retention and elevation control for the water level in the Reservoir. The physical details of the channel are summarized by the following:

- The concrete wall is approximately 17 m long and 0.3 m thick.
- The central portion of the wall where the flow occurs is 7 m wide and has an invert elevation of approximately 370.2 m.
- The wall contains sloping side walls (4(H):1(V)) and the elevation of the top of the side walls is approximately 370.8 m.
- The concrete wall is founded into the underlying bedrock via a steel-reinforced, concrete footing.
- The channel is armoured to approximately 370.8 m elevation, upstream and downstream of the wall.
- A plunge pool is located downstream of the wall to provide energy dissipation during flooding events.

In 2007, a geosynthetic clay liner (GCL) was installed upstream of the concrete wall, as recommended in the 2006 inspection report. This was completed in response to observations of declining water levels upstream of the wall during periods of low inflows. The declining water levels were inferred to suggest seepage losses through the foundation of the wall. As such, the GCL approach was suggested as a way to limit the potential for these seepage losses.

In September 2008, the culverts in the East Twin access road that had previously impeded the flow from the Reservoir to the Polishing Pond were removed and the Reservoir is now considered to be a flow-through hydraulic system at the normal water level. Due to the limited depth of the breach, the former East Twin access road restricts flow into the former Polishing Pond area at lower water levels.

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 10 through 14). The main observations are summarized by the following:

- During the inspection, the water level upstream of the wall was noted to be just above (+2 cm) the elevation of the wall invert (Photos 10 and 11).
- The seepage at the West Twin Outlet Wall seems to have slowed in recent years, as the water level upstream of the wall has been maintained more consistently at or above the invert of the outlet wall.
- Slumping and settlement of the perimeter slopes of the upstream Polishing Pond have been noted in recent years and continued to degrade in 2019 (Photos 13 and 14). The area of active instability has been observed to be further and further away from the outlet wall in recent years. As such, there is limited concern with respect to the instability and its potential impact on the effectiveness of the outlet wall to function as intended, but it should continue to be visually inspected for changes.

Water level loggers were installed in the Reservoir and the remnant Polishing Pond during the 2018 inspection trip and were left in place until they were downloaded during the 2019 inspection.

Water level logger data for the Reservoir and Polishing Pond are shown with site air temperature date on Drawing 04. As observed in previous years, the data suggests that, as freezing air temperatures cause icing of the Reservoir, inflows into the remnant Polishing Pond are reduced and water levels in the remnant Polishing Pond drop. The drop in the Polishing Pond was 62 cm in during August/September, 2018. During this time, only a 13 cm drop in Reservoir water level was observed. These observations support the concept that water cover in the Reservoir is maintained despite seepage losses from the remnant Polishing Pond typically observed at the end of the monitoring season. Also of note is the 14 cm rise in Reservoir water level between June 7 and 11, 2019, that is believed to be due to freshet. Maintenance was performed on the loggers during the 2019 inspection and they were left in place and will be downloaded again during the 2020 site inspection.

The observed seepage losses and stability issues along the edge of the remnant Polishing Pond are thought to be related to the excavation of sediments from the Polishing Pond during site reclamation activities in 2005. Excavation of these sediments created a deeper pocket of water upstream of the wall, measured to be between 3 and 4 m in the deepest parts of the pond. This provides a heat source which has likely resulted in thawing of the ground beneath the pond.

Based on the water quality measurements collected since the East Twin Access Road was breached in 2008, the seepage losses through the foundation of the wall do not appear to be influencing the overall performance of the West Twin Area reclamation measures. As suggested by the water level data discussed previously, the impact of seepage losses on the main water level in the Reservoir is minimized by the various breaches creating flow restrictions between the Reservoir and the remnant Polishing Pond. Additionally, the seepage losses from the remnant Polishing Pond do not appear to be increasing with time, as demonstrated by the water level measurements collected since closure. In previous inspection reports, it has been suggested that additional mitigation measures be considered to reduce the seepage losses, pending additional monitoring data and inspection observations. Given the recent observations, additional mitigation measures are not considered to be required at this time but monitoring of the water levels in the Reservoir and remnant Polishing Pond should continue.

5.2.3. East Twin Creek Diversion Dyke and Channel

Construction Details

The East Twin Creek Diversion Dyke is located along Twin Lakes Creek between East Twin Lake and the West Twin Outlet Channel, as shown on Drawing 03. The diversion dyke and channel deflect flow from East Twin Lake away from its previous drainage course, which drained directly into West Twin Lake (the Reservoir). The flow from the diversion channel combines with the flow from the Reservoir downstream of the West Twin Outlet Channel.

The diversion dyke is approximately 2 m above the adjacent ground level and is comprised of sand, gravel, and cobbles derived from the nearby Twin Lakes sand and gravel deposit. A portion of the dyke was re-graded during reclamation construction to be less susceptible to erosion.

Additionally, the re-graded portion of the dyke was armoured with riprap to prevent future erosion from occurring.

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 15 through 17).

Previous inspections made recommendations to repair left bank armouring material following observations of erosion along a section of the East Twin Creek Diversion Channel. The previously observed erosion at this location may be the result of similar flow conditions that contributed to the erosion observed in the West Twin Dyke Spillway. It appears that the flow in East Twin Creek was elevated near the crest of the diversion dyke by snow blockage and concentrated flow resulted in erosion of the berm as it re-entered the main channel of East Twin Creek.

In response to these recommendations, maintenance was undertaken during the 2018 site inspection. The maintenance consisted of re-shaping the in-situ material and placement of additional locally available armour materials. The maintenance activities are described in detail in a separate memorandum appended to BGC's *Nanisivik Mine 2018 Annual Geotechnical Inspection Report (March 11, 2019)*. The maintenance was visually observed to have performed favourably (Photos 15 and 16). It is recommended that the diversion dyke continue to be inspected for additional erosion of the side slopes and maintenance be undertaken as necessary.

The seepage discharge observed at the toe of the left bank during previous inspections was again observed in 2019. The seepage water is likely originating in the Polishing Pond and is also likely related to excavation of Polishing Pond sediments during site reclamation. The seepage flow in 2019 was observed to be clear and free of sediment. However, the flow rate was observed to have increased compared to 2018. The increased seepage may be associated with generally increased active layer thaw compared to last year, and therefore, a larger seepage pathway between the berm and the Polishing Pond. The seepage may be exacerbating the erosion impacts at this location. No mitigation efforts to address the observed seepage are recommended at this time, but the discharge point should continue to be visually monitored, along with associated impacts.

5.3. Thermal Covers

The following sections provide information regarding each of the thermal covers constructed at site. Each section provides details regarding the construction of each cover, a summary of the observations made during the 2019 inspection, and reviews the monitoring data collected from each area in 2019. A table documenting the instrumentation monitoring undertaken in 2019 is provided in Appendix III. No additional attempts to collect data are planned prior to August 2020, in-line with the monitoring schedule defined within the New License.

An additional note on the interpretation of the geothermal monitoring data; for the purposes of interpretations made in this report, the following assumptions were made:

- In the active layer, ground conditions are considered "thawed" when ground temperatures of 0°C and warmer are observed.

- In the taliks, ground conditions are considered “thawed” when ground temperatures of warmer than -0.5°C are observed. This temperature adjustment accounts for freezing point depression effects which have been noted in the tailings talik at the site. As the freezing front progresses deeper within the taliks, a cooler freezing point depression can be expected as the solute concentrations increase in the remnant pore water.

5.3.1. Surface Cell Tailings Cover

Construction Details

A thermal cover was constructed over the tailings in the Surface Cell in 2004 and 2005. The thermal cover consists of a 1 m thick layer (minimum thickness) of granular shale overlain by a 0.25 m thick layer (minimum thickness) of armour material comprised of sand, gravel, and cobbles. It should be noted that, due to surface grade considerations, significantly increased shale thicknesses (greater than 2 m thick) were applied to approximately 30% of the Surface Cell. Additionally, due to practical construction considerations related to the grain size distribution of the armour materials, the armour layer thickness regularly exceeded 0.25 m. The shale was sourced from the Mt. Fuji and Area 14 borrow areas (Drawing 01). The armour material was sourced from the Twin Lakes Delta deposit (Drawing 01). The Surface Cell tailings cover is drained by a series of swales which convey surface water to the spillway inlet located at the south end of the Surface Cell. The spillway transfers water draining off the Surface Cell cover system into the Reservoir. It should be noted that surface flow is not regularly observed on the Surface Cell and that the majority of the water flow occurs sub-surface due to the coarse nature of the cover materials.

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 18 through 23). The main observations are summarized by the following:

- The head pond at the entrance to the spillway at the south end of the cover was observed to be similar in size compared to previous years.
- As has been observed in previous inspections, some minor thermokarst features were noted along the south shoreline, along the east edge of the main drainage swale and just north of the E/W trench (Photo 18). These localized thermokarsts are not considered to be negatively impacting the overall performance of the cover system. Additionally, the same thermokarst features have been observed in past inspections and do not appear to be changing with time, suggesting they are physically stable.
- No erosion of the cover materials was noted, but some minor settlement deformation in the bottom of the main drainage swale was observed closer to the spillway entrance, similar to observations made during previous inspections.
- The cracking noted in the northeast and southwest quadrants of the cover system in 2016 did not visually appear to change in width or extent since 2016 (Drawing 05, Photos 21 and 22). The cause of this cracking is uncertain but is likely related to thermal effects within the cover materials or continued freeze-back of the underlying tailings.

- Cracks and heaving in an oval pattern were observed near the central-southern portion of the cover (Drawing 05). The cracks are likely due to heaving of the underlying tailings material due to freeze-back. The cracks are up to approximately 30 cm wide and 20 cm deep and were not visually observed to have changed since 2018. At this time, the cracks are not considered to be negatively impacting the performance of the cover system.

No maintenance is recommended for the Surface Cell cover system, though the surface of the cover should continue to be visually inspected for additional deformation and thermal cracking.

Monitoring Data

The Surface Cell is instrumented with 10 thermistors, seven vibrating wire piezometers, six frost gauges and two monitoring wells. The location of each of these instruments is provided on Drawing 05. Select plots providing the results of the monitoring are provided, for interpretation purposes, on Drawings 06 through 10.

The instrumentation has two main purposes; monitor the depth of the active layer thaw in the cover and monitor the ground temperatures and pore pressures in the talik during freeze-back. Monitoring wells originally installed in the Surface Cell and Test Cell taliks to monitor pore water quality during freeze-back are no longer functional due to freeze-back of the tailings and are no longer monitored in accordance with the approved geotechnical and geothermal monitoring program.

Drawing 06 provides data from thermistors installed throughout the Surface Cell talik. The graphs illustrate the following:

- At depths greater than approximately 10 m, the ground thermal profile is slightly colder than 2018 but the rate of cooling has slowed in recent years.
- The ground thermal profile in the upper approximately 6 m is warmer than 2018, reflective of warmer air temperatures at site in 2019.
- The upper 20 to 25 m of the ground profile appears to be frozen, as illustrated by data recorded from Thermistors BGC03-07, BGC03-09, BGC03-10, and BGC05-05. The exception is thermistor BGC03-11 which indicates frozen ground conditions to approximately 19 m bgs.

Drawing 07 illustrates the downward progression of the freezing front over time in the Surface Cell. The depth of the -0.5°C isotherm from various thermistors is plotted against the distance from the crest of the West Twin Dyke. The data suggests the -0.5°C isotherm has migrated downwards to a depth of 20 to 25 m bgs since the cover system was completed in 2005. The data also illustrates how the thickness of frozen ground increases with proximity to the West Twin Dyke.

Drawing 07 also illustrates that the freeze-back of the Surface Cell talik continues to proceed quicker than anticipated, compared to the results of the geothermal analysis documented in BGC (February 6, 2004a). This is illustrated by comparing the observed depth of the -0.2°C isotherm with the freeze-back envelope predicted by the original geothermal modeling. The -0.2°C isotherm was used for this comparison as it was the freezing point depression assumed during the original geothermal modelling completed as part of the talik freeze-back assessment (BGC, February 6, 2004a).

Drawing 08 provides data collected from the piezometers installed in the Surface Cell talik. The graphs indicate that all of the piezometers in the Surface Cell talik have frozen back in response to continued downward migration of the freezing front in the tailings. These piezometers were installed at depths ranging from 15 to 24 m bgs. The temperature readings within piezometer BGC05-13 have not been obtainable since 2012, and thus only piezometric elevation has been plotted since this time.

Drawing 09 illustrates the relationship between piezometer tip depth and the freeze-back temperature of the piezometers in the Surface Cell cover system. The freeze-back of the piezometer tips occurred at temperatures ranging from -0.5°C to -1.3°C, and the freeze-back temperatures appear to decrease with depth. For the purposes of this assessment, freeze-back of the piezometer tip is taken to be the time at which a significant drop or increase in erratic nature of the recorded pore pressure is observed. The deeper the piezometer tip, the lower the temperature before freeze-back occurred.

The closed system nature of the Surface Cell also creates a dimension of freezing which is related to the distance from the edge of the original lakebed. The further the piezometer is at lateral distance from the edge, the lower the freeze-back temperature was recorded within the piezometer.

These relationships are likely related to the increasing solute concentration in the remnant talik as it becomes smaller and cryo-concentration occurs. The freezing point of the water becomes lower with a higher solute concentration near the centre of the talik.

Drawing 10 shows the data collected from select Surface Cell frost gauges. The data suggests that the active layer thaw in 2019 was deeper than in 2018. With the exception of Frost Gauge 3, which shows an active layer extending approximately 10 cm into tailings, the active layer thaw remained within the cover material. Since construction of the closure works in 2004, the maximum annual active layer thickness has generally decreased, indicating improved overall thermal performance. This is believed to be largely due to increased thickness of the ice-saturated layer at the base of the cover.

The results of water quality testing undertaken on samples collected at the inlet of the West Twin Dyke Spillway are provided on Drawing 11. Samples collected in July, August and September 2019 exhibited total zinc concentrations that ranged from below the laboratory detection limit of 0.01 mg/L to a high of 0.04 mg/L, all well below the maximum allowable concentration of 0.25 mg/L defined in the Water License. The water quality monitoring data suggests that the increased active layer depth compared to recent years may have resulted in slightly increased zinc concentrations compared to previous years, but given that concentrations remain well below discharge criteria, the cover system continues to perform as intended.

5.3.2. West Twin Dyke

Construction Details

The West Twin Dyke is a frozen core, upstream constructed, earth fill dyke that separates the Surface Cell and the Reservoir (Drawing 03). The dyke is constructed of frozen, compacted shale and founded on frozen, settled tailings. The dyke is approximately 14 m high and the downstream face slopes at an angle of approximately 15°. The downstream face of the dyke was surfaced with a 0.25 m thick layer (minimum thickness) of sand, gravel and cobbles sourced from the Twin Lakes Delta.

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 24 through 26). The main observations made during the inspection are summarized by the following:

- No settlement or cracking of the crest and immediate upstream area was noted.
- The downstream face of the dyke shows no indications of erosion or settlement.
- No seepage was noted on the face of the dyke or at the toe of the dyke.

In general, the dyke appeared to be in a satisfactory condition and no maintenance is recommended.

Monitoring Data

The West Twin Dyke was instrumented with five thermocouple cables installed within the dyke, as well as four thermistors and one vibrating wire piezometer installed from the crest of the dyke. The location of each of these instruments is provided on Drawings 05 (thermistors and piezometers) and Drawing 12 (thermocouple cables). Select plots providing the results of the monitoring, for interpretation purposes, are provided on Drawing 13.

Drawing 13 provides data from Thermistor BGC03-34, which provides a geothermal monitoring profile from 5 m below the crest of the dyke to approximately 14 m bgs. It also provides data from an additional thermistor installed from the crest of the dyke (BGC05-15), as well as one vibrating wire piezometer (BGC05-17). The data indicates the following:

- The profile at the crest of the dyke, within Thermistor BGC05-15, is colder than -2°C to at least 30 m bgs, approximately 14 m below base of dyke.
- The geothermal profile has cooled slightly in 2019 compared to 2018.
- The piezometer tip temperature at piezometer 05-17 (depth of 25 m bgs) has reached the freeze-back temperature for this piezometer of approximately -1°C, and is currently reading a temperature of approximately -2.9°C.

5.3.3. Test Cell Area

Construction Details

The Test Cell area consists of the Test Cell, former Test Cell Dyke, and Toe of Test Cell Dyke. A thermal cover was constructed over the Test Cell area in 2004 and 2005. The thermal cover consists of a 1 m thick layer (minimum thickness) of granular shale overlain by a 0.25 m thick layer (minimum thickness) of armour material comprised of sand, gravel and cobbles. It should be noted that, due to surface grade considerations, significantly increased shale thicknesses (greater than 2 m) were applied to approximately 20% of the Test Cell. Additionally, due to practical construction considerations related to the grain size distribution of the armour materials, the armour layer thickness regularly exceeded 0.25 m. The shale was sourced from the Mt. Fuji, East Twin, and Area 14 borrow areas (Drawing 01). The armour material was sourced from the Twin Lakes Delta deposit (Drawing 01). The Test Cell tailings cover is drained by a main swale which conveys surface water directly into the Reservoir.

The Test Cell Dyke is an earth fill dyke that separates the Test Cell and the Reservoir (Drawing 03). The dyke is constructed of frozen, compacted shale and founded on frozen, settled tailings. The dyke was approximately 4 m high. During reclamation, the top 2 m of shale material in the dyke was removed and placed in the Test Cell as cover material. The remnant dyke was surfaced with a layer of armour material, approximately 0.25 m thick. As such, the dyke is now essentially integrated into the Test Cell cover.

A thermal cover was constructed over the tailings at the toe of the Test Cell Dyke in 2005. The thermal cover consists of a 1 m thick (minimal thickness) layer of granular shale overlain by a 0.25 m thick layer (minimal thickness) of armour material comprised of sand, gravel and cobbles. It should be noted that, due to surface grade considerations, shale fill thickness in excess of the 1 m minimum thickness was applied to the tailings beach at the toe of Test Cell Dyke, especially immediately adjacent to the remnant Test Cell dyke. The shale was sourced from the Mt. Fuji and Area 14 borrow areas (Drawing 01). The armour material was sourced from the Twin Lakes Delta deposit (Drawing 01). The riprap was sourced from the dolostone outcrop at the south end of the West Twin Dyke.

Inspection Conditions

Select photos from the inspection of the Test Cell and Test Cell Dyke are provided in Appendix I (Photos 27 through 35). The main observations are summarized by the following:

- No erosion or ponding was observed.
- Similar to previous inspection observations, the north-south arm of the Test Cell Dyke and the Test Cell Cover just inside of the dyke remains undulating, suggesting some amount of thaw settlement of the cover materials has occurred (Photo 29). This undulating nature of the cover in this area has not noticeably changed in the last several years and the cover is overbuilt in this area due to grade requirements. The undulating nature is not considered to negatively impact drainage or the thermal performance of the cover and, as such, this area is not of concern.

Minor thermal cracks (<20 cm wide and <20 cm deep) were observed in some areas of the cover system but are not considered to be negatively impacting the performance of the cover (Photo 30). Photos 31 and 32 show the overall surface of the cover system.

Selected photos from the inspection of the cover along the toe of the Test Cell Dyke and through the Test Cell outlet is provided in Appendix I (Photos 33 through 35). The main observations are summarized by the following:

- No erosion of the cover was observed.
- No disturbance due to ice plucking of the riprap was observed.

In general, the tailings cover in the Test Cell area appears to be in satisfactory condition. As such, no maintenance is recommended.

Monitoring Data

The Test Cell area is instrumented with seven thermistors, five vibrating wire piezometers, and four frost gauges. As previously noted in the Surface Cell monitoring review, the monitoring wells installed in the Test Cell talik are frozen to the bottom due to talik freeze-back and are no longer monitored in accordance with the approved monitoring program. The location of each of these instruments is provided on Drawing 12. Select plots providing the results of the monitoring are provided on Drawings 14 through 17.

Drawings 14 and 15 respectively provide geothermal and piezometric monitoring data collected from the Test Cell Cover in 2018. The data indicates the following:

- The active layer thaw was confined within the cover materials throughout 2019. Frost gauges FG-7 and FG-8 indicate that the active layer was approximately 1.25 m thick (approximately 0.1 m above the base of the cover). The 2019 active layer thickness measurements are greater than recent years, reflective of warmer summer air temperatures at site in 2019.
- The subsurface profile between 1.1 and 15 m depth in the Test Cell at the base of the West Twin Dyke (BGC05-04) is colder than -0.5°C and is presumed to be frozen. At 15 m depth, temperatures of below -7°C are measured. The rate of cooling has slowed in recent years, indicating that the geothermal profile is approaching thermal equilibrium.
- The pore pressures and ground temperatures measured at Piezometer BGC05-18 (19 m depth) have decreased considerably since the 2016 inspection. This suggests the piezometer has obtained freeze-back at approximately -0.7°C, with a current temperature of approximately -4.5°C.
- Similarly, as above, the pore pressures and ground temperatures measured at Piezometer BGC05-22 (23 m depth) have also decreased considerably since the 2016 inspection. This suggests the piezometer has obtained freeze-back at approximately -0.8°C, with a current temperature of approximately -1.4°C.
- The monitoring data from Piezometer BGC05-20 shows that pore water temperature measured at the piezometer tip has remained relatively stable over the past four years at, (between -0.3˚C and -0.5˚C). Minimal cooling of the recorded pore water temperature has been observed since installation in 2005.

Select plots providing the results of the monitoring of the Test Cell Dyke are provided on Drawing 16. The monitoring data indicates the following:

- Data from thermistor BGC03-22 suggests that the dyke and foundation beneath the dyke is frozen to approximately 25 m bgs. The geothermal profile between 7 and 22 m depth appears to have cooled in 2019. The node at 27 m remains fixed near the freezing point, suggesting that unfrozen tailings remain below 27 m.
- The vibrating wire piezometer BC05-24, installed approximately 20 m bgs beneath the dyke, has frozen back as indicated by the tip temperature around -5.5°C and the corresponding variability in pore pressures. The recorded pore pressure is considered to be localized and associated with the freeze-back of the piezometer tip and is not considered to be representative of pore water pressures throughout the Test Cell talik.

Select plots providing the results of the monitoring of the tailings cover at the toe of the Test Cell Dyke are provided on Drawing 17. The graphs indicate the following:

- The subsurface profile at the toe of the Test Cell Dyke (BGC05-27) between 3 and 20 m bgs is colder than -1.8˚C and is presumed to be frozen. The geothermal profile appears to be slightly cooler than 2018. The monitoring data demonstrates that the upper 20 m of the subsurface profile is frozen, despite being along a shoreline which was periodically submerged in water during operations of the tailings disposal area. The fact that permafrost exists at this location, to the extent it does, is considered beneficial to the overall Test Cell talik freeze-back. This is because it exceeds expectations and assumptions made in the contaminant loading model (CanZinco, March 2004) which assumed a completely thawed tailings profile adjacent to the water.
- The monitoring data from Piezometer BGC05-28, installed approximately 19 m bgs, indicates a piezometric elevation of about 370 m asl. This is consistent with the elevation of the water level in the Reservoir and suggests hydraulic connectivity between the tailings at depth and the Reservoir. However, the pore water temperature at the piezometer tip has cooled to nearly -1.8 °C in 2019 and is likely to become frozen in the next couple years.

Drawing 09 illustrates the relationship between piezometer tip depth and the freeze-back temperature of the piezometers in the Surface Cell and Test Cell cover systems. In contrast to the Surface Cell, the hydraulic connectivity that is present between the Test Cell and the Reservoir creates a cooler temperature needed to obtain freeze-back closer to the reservoir. Two more piezometers (BGC05-20 and BGC05-28) have yet to freeze back in the Test Cell. The data obtained when these piezometers freeze back will provide more context for the rate of freeze-back within the Test Cell.

5.3.4. Toe of West Twin Dyke Tailings Cover

Construction Details

A thermal cover was constructed over the tailings at the toe of the West Twin Dyke in 2005. The thermal cover consists of a 1 m thick layer (minimum thickness) of granular shale overlain by a 0.25 m thick layer (minimum thickness) of armour material comprised of sand, gravel, and cobbles. The shale was sourced from the Mt. Fuji and Area 14 borrow areas (Drawing 01). The armour material was sourced from the Twin Lakes Delta deposit (Drawing 01). The riprap was sourced from the dolostone outcrop at the south end of the West Twin Dyke.

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 36 through 38). The main observations are summarized by the following:

- No erosion of the cover was observed.
- As observed during previous inspections, some minor thermokarst features were present, but was not seen to be negatively impacting the overall performance of the cover system. No visual changes in the appearance of these thermokarst features have been noted in recent years, suggesting the area is generally physically stable.
- No erosion or ice plucking of the riprap along the shoreline was observed.

No additional maintenance items were recommended.

Monitoring Data

The tailings cover at the toe of the West Twin Dyke is instrumented with two thermistors. The location of each of these instruments is provided on Drawing 12. Select plots providing the results of the monitoring are provided on Drawing 18. The graphs indicate the following:

- As illustrated by the data collected from Thermistor BGC05-26, the subsurface profile below approximately 3 m remains colder than -5˚C. It is frozen to at least 24 m bgs, the depth of the bottom of the instrument. The bottom 15 m of the instrument is measuring ground temperatures in the bedrock, demonstrating the frozen nature of the bedrock near the base of the West Twin Dyke.
- The monitoring data collected from Thermistor BGC03-19 indicates slightly warmer temperatures than 2018, reflective of warmer surface temperatures in 2019. The ground profile remains frozen from approximately 3 m depth to at least the bottom of the instrument at 11 m depth.
- The rate of cooling in both BGC05-26 and BGC03-19 indicates that the geothermal profile has nearly reached thermal equilibrium.

West Twin Disposal Area Water Quality

As required in the Water License used for site operations in 2019, water quality sampling and testing were undertaken monthly at the West Twin Outlet Channel during the open water period in 2019. This channel is considered the final discharge point for water from the WTDA before entering the environment in Twin Lakes Creek. Three samples were collected and forwarded to a laboratory. Water samples were tested for pH, conductivity, Total Suspended Solids (TSS), sulphate, total metal concentrations, and ammonia (NH_3). The total zinc, total lead, total cadmium, sulphate and TSS concentrations observed at the West Twin Outlet Channel in 2019 are illustrated on Drawing 19. The total zinc, lead, and cadmium concentrations observed in the 2019 samples met discharge criteria, as they have since the covers were completed in 2005. The maximum total zinc concentration was observed to be 0.06 mg/L, well below the discharge criteria of 0.25 mg/L (mean monthly maximum). The low metals and sulphate concentrations suggest that the thermal covers and the water cover in the Reservoir are effective in limiting metal loading to the water in the Reservoir.

Stantec (2019) should be referenced for a detailed review of the results of the water quality monitoring program undertaken in 2019.

5.3.5. Landfill Cover

Construction Details

A thermal cover was constructed over the Nanisivik Landfill in 2005. The thermal cover consists of a 2 m thick layer (minimum thickness) of granular shale overlain by a 0.25 m thick layer (minimum thickness) of armour material comprised of sand, gravel, and cobbles. The shale was sourced from the Townsite Shale borrow area. The armour material was sourced from the Twin Lakes Delta deposit. The face of the landfill is sloped at approximately 3(H):1(V).

It should be noted that the thermal cover constructed at the Landfill was built over an existing surficial shale cover that was continuously placed and maintained during operations as part of the on-going landfill operating procedures (for pest control and protection against wind transport). No attempts were made during construction of the thermal cover in 2005 to verify the existing cover thickness and thereby, reduce the fill requirements. Therefore, it can be assumed that the thermal cover is thicker than just the material placed in 2005.

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 39 through 43). The main observations are summarized by the following:

- No erosion of the cover was observed, either on the upper flatter portion of the cover or on the sloping face of the Landfill.
- No seepage was observed at the toe of cover during the time of the inspection.
- Some exposed shale has previously been observed on the lower portion of the west face, but no changes were noted during this inspection. The exposed shale is due to an insufficient amount of armour material available for covering during construction and is not related to erosion. Previous attempts undertaken to spread the armour over the exposed shale were determined to be impractical from a construction standpoint. Considering the observed stability of the area since construction, additional maintenance is not considered necessary.
- Some minor cracking and thermokarst features have been observed along the upslope water deflection berm in past inspections. This has resulted in a minor amount of surface water running along the west edge of the cover system. The deformation of the deflection berm has not advanced for several years and is not considered to be negatively impacting the performance of the adjacent landfill cover system and no maintenance is considered necessary at this time.
- No areas of settlement or thermokarst features were observed on the surface of the landfill cover system.

No maintenance items were recommended.

Monitoring Data

The Landfill cover is instrumented with one thermistor and one frost gauge. The location of each of these instruments is provided on Drawing 20. Select plots providing the results of the monitoring are provided on Drawing 21. The graphs indicate the following:

- The active layer thaw did not penetrate into the underlying waste material throughout 2019. The depth of active layer thaw recorded in 2019 was comparable to measurements collected in 2018.
- The geothermal performance of the landfill cover in 2019 was observed to be similar compared to recent years. The maximum temperature recorded at the thermistor node located at 2.3 m bgs, near the cover/landfill debris interface, was approximately -3.5°C.
- The landfill debris underlying the cover remained frozen throughout the year.
- The rate of cooling of the underlying landfill debris has slowed suggesting ground conditions are approaching thermal stability at depth.

5.3.6. West Open Pit

Construction Details

A thermal cover was constructed over the West Open Pit in 2006. The thermal cover consists of a 2 m thick layer (minimum thickness) of granular shale overlain by a 0.35 m thick layer (minimum thickness) of armour material comprised of sand, gravel and cobbles. The shale was sourced from the Townsite Shale borrow area. The armour material was sourced from the local borrow source located along the road between the 09S portal and the 17 North Portal. The face of the West Open Pit cover is sloped at a maximum angle of approximately 3(H):1(V).

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 44 through 46). The main observations are summarized by the following:

- No erosion of the armour surface was noted.
- No areas of settlement or thermokarst features were observed.
- No advancement in the crack width or length in the crown pillar has been observed in at least 10 years.
- No seepage water was observed at the toe of the cover.

Based on the observations noted above, the West Open Pit waste rock cover is considered to be physically stable. As such, no maintenance is recommended.

Monitoring Data

The West Open Pit cover is instrumented with one thermistor (BGC08-01). The purpose of the thermistor is to monitor the freeze-back of the underlying backfill materials as well as the active layer thaw within the cover materials. The location of this instrument is provided on Drawing 22. The results of the monitoring undertaken in 2019 are provided on Drawing 23. The graphs indicate the following:

- The waste rock used to backfill the open pit has frozen back.
- The active layer thaw was confined within the cover materials throughout 2019, comparable to 2018.
- In 2019, the geothermal profile within the cover and waste rock was similar to 2017 and 2018.
- The rate of cooling in the underlying waste rock has slowed in recent years suggesting ground conditions are approaching thermal stability at depth.

5.3.7. East Open Pit

Construction Details

A thermal cover was constructed over the East Open Pit in 2005. The thermal cover consists of a 2 m thick layer (minimum thickness) of granular shale overlain by a 0.35 m thick layer (minimum thickness) of armour material comprised of sand, gravel, and cobbles. The shale was sourced from the Shale Hill borrow area. The armour material was sourced from the local borrow source located along the road between the K-Baseline Portal and Kuhulu Lake. The face of the East Open Pit cover is sloped at a maximum angle of approximately 3(H):1(V). A remnant highwall exists along the south edge of the pit area. The remnant highwall ranges from 1 to 5 m high and is sloped back at an angle of approximately 60°. A bench exists between a portion of the remnant highwall and the main portion of the cover system.

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 47 through 52). The main observations are summarized by the following:

- Some surface (rill) erosion was noted on the surface of the cover in 2019, as it has been during previous inspections. No advancement of the erosion was noted compared to 2018.
- Some cracking of the cover materials was observed, similar to previous inspections. This cracking is thought to be related to thermal expansion and contraction of the cover materials and settlement of the underlying backfill materials.
- Some cracking was noted on the crown pillar of the cover. This cracking has not changed significantly over the last several annual inspections.
- No areas of settlement or thermokarst features were observed on the surface of the cover.

The minor erosion noted on the surface of the cover was anticipated. The armour material at this location contains a fine-grained fraction that was expected to wash away with time leaving behind the coarse-grained fraction, a process known as self-armouring. As such, the armour thickness at this location, and many others where alternative armour materials were used, was increased to 0.35 m. The coarse-grained fraction of the armour material is expected to limit the amount of erosion that can occur, without negatively impacting the geothermal performance of the cover.

As mentioned, the cracking in the crown pillar at the East Open Pit was not observed to have progressed. The cracking coincides with the mined-out rib pillar and the area of the 39 Portal. No opening to the underground has been observed during any inspection undertaken since reclamation of the East Pit in 2005. As such, the cracking was not seen to be of immediate concern especially given the lack of progression over the past several years. Accordingly, no maintenance is recommended, but the crown pillar should continue to be visually monitored for additional deformation.

Monitoring Data

The East Open Pit Waste Rock cover is instrumented with two thermistors and two frost gauges. The location of each of these instruments is provided on Drawing 24. Select plots providing the results of the monitoring are provided on Drawing 25, which indicate the following:

- Data from Thermistor BGC05-02, installed in the area with a thin layer of waste rock backfill (approximately 3 m thick), indicates that the waste rock remains frozen back, despite an increase in ground temperatures in 2019 compared to 2018 at depths shallower than 15 m. Below 15 m depth, the geothermal profile is comparable to what was observed in 2018.
- Data from Thermistor BGC05-03, installed in the area with a thicker layer of waste rock backfill (approximately 9 m thick), indicates the waste rock, and hydrocarbon contaminated soil buried at depth, remains frozen back. The geothermal profile is comparable to what was observed in 2018.
- The rate of cooling of ground temperatures recorded in both BGC05-02 and BGC05-03 suggest that ground conditions are approaching thermal equilibrium at depth.
- The active layer monitoring data from Thermistor BGC05-02 and BGC05-03 indicates that the active layer was confined within the cover materials throughout 2019. Thawing remained confined to the cover material, with an approximate active layer thickness of 1.5 m, approximately 0.8 m above the base of the cover system.
- Frost gauge FG-13 indicates that the active layer was approximately 1.7 m thick, which is approximately 0.7 m above the base of the cover, shown on Drawing 25. The active layer was deeper than measured in 2018 but comparable to what has been measured previously.

5.3.8. East Trench Waste Rock Cover

Construction Details

A thermal cover was constructed over the East Trench in 2005. The thermal cover consists of a 2 m thick layer (minimum thickness) of granular shale overlain by a 0.35 m thick layer (minimum thickness) of armour material comprised of sand, gravel, and cobbles. The shale was sourced from the Shale Hill shale borrow area. The armour material was sourced from the local borrow source located along the road between the K-Baseline Portal and Kuhulu Lake. The face of the East Trench cover is sloped at an angle ranging between 4(H):1(V) and 6(H):1(V).

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 53 & 54). The main observations are summarized by the following:

- As noted in previous inspections, minor surface (rill) erosion was observed near the upslope edge of the cover where seepage water periodically discharges from natural rock outcrops onto the surface of the cover. The coarse-grained fraction of the surface armour layer in this area is limiting the progression of the erosion. No advancement of this erosion was noted in 2018.
- No seepage was observed at the toe of the cover.

In general, the East Trench cover appears to be physically stable. As such, no maintenance is recommended.

5.3.9. Oceanview Open Pit Waste Rock Cover

Construction Details

A thermal cover was constructed over the Oceanview Open Pit in 2005. The thermal cover consists of a 2 m thick layer (minimum thickness) of granular shale overlain by a 0.35 m thick layer (minimum thickness) of armour material comprised of sand, gravel, and cobbles. The shale was sourced from the Shale Hill borrow area (Drawing 01). The armour material was sourced from the Chris Creek “A” borrow area (Drawing 01). The face of the Oceanview Open Pit cover is sloped at a maximum angle of approximately 3(H):1(V). The surface of the cover in the bottom of the pit slopes to the north at a grade of approximately 3%.

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 55 through 59). The main observations are summarized by the following:

- No ponded water was observed on the surface of the cover.
- The upslope water deflection berm appeared to be effective in directing surface water away from the cover. This was inferred from visual observations indicating surface water flow along the upslope edge of the berm.
- Minor surface erosion (<10 cm deep) was noted along the backslope at the south end of the cover, as has been noted during previous inspections. The erosion appears to be slowly progressing, based on visual observations, but is not expected to impact the overall performance of the cover system. Self armouring of the erosion areas is occurring as the coarser particles within the armour layer are exposed and concentrated at surface, as anticipated.
- Some seepage was observed at the toe of the cover.

- Some acid rock drainage staining was observed on the east edge of the cover, as it has been during previous inspections. The stained area appeared to originate upslope of the extent of the cover and appeared to cover a similar extent to what has been observed in previous inspections.
- A minor sinkhole was observed in the middle of the cover surface but did not appear to have grown since the 2015 inspection.

In general, the Oceanview Open Pit cover appears to be in satisfactory condition. As such, no maintenance is recommended. The surficial erosion should continue to be visually monitored for additional progression.

As discussed previously, minor erosion of the surface of the cover was anticipated. Similar to the East Open Pit cover, the armour material at this location contains a fine-grained fraction that was expected to wash away with time. As such, the armour thickness was increased to 0.35 m. The coarse-grained fraction of the armour material is expected to limit the amount of erosion that can occur, without negatively affecting the geothermal performance of the cover.

Monitoring Data

The Oceanview Pit Waste Rock cover is instrumented with one thermistor and one frost gauge. The location of each of these instruments is provided on Drawing 26. Select plots providing the results of the monitoring are provided on Drawing 27. The graphs indicate the following:

- The active layer was confined within the cover materials throughout 2019.
- The maximum active layer thaw depth indicated by Thermistor BGC05-01 was estimated to be approximately 1.5 m bgs, which is approximately 0.8 m above the base of the cover.
- The waste rock underlying the cover has frozen back and remained frozen throughout 2019.
- Thermistor BGC05-01 shows that the geothermal profile has remained relatively unchanged since 2017. The cooling of ground temperatures recorded in BGC05-01 has slowed in recent years, suggesting ground conditions are approaching thermal stability at depth.
- Frost gauge FG-16 indicates that the thaw depth was approximately 1.1 m thick in August, approximately 1.25 m above the base of the cover, which is generally shallower than recent years, shown on Drawing 27. No September reading was collected, so the maximum annual active layer thickness may be deeper than the August reading but is likely to fall within the range of recent years.

5.3.10. Area 14 Waste Rock Cover

Construction Details

Area 14 is a satellite ore body situated on a west-facing slope, approximately 1 km to the east of East Twin Lake (Drawing 01). A waste rock pile was created outside the portal during mining operations. In 1988, the waste rock pile was flattened and a thermal cover was constructed over the top of the waste rock pile, but the face was left exposed.

In 2005, the thermal cover at the Area 14 waste rock pile was completed by constructing a cover over the exposed face and armouring the entire surface of the cover. The thermal cover consists of a 2 m thick layer (minimum thickness) of granular shale overlain by a 0.35 m thick layer (minimum thickness) of armour material comprised of sand, gravel, and cobbles. All shale was sourced from the Area 14 shale borrow area (Drawing 01). All armouring material was sourced from the hill side immediately north of the Area 14 portal.

Area 14 could not be visited by BGC during the annual inspection due to logistical constraints. However, inspections in the past 15 years have demonstrated physical stability. As such, there are no concerns about Area 14, but the area should be visited during the 2020 inspection.

Monitoring Data

The Area 14 Waste Rock cover is instrumented with one thermocouple and one frost gauge; locations for each of these instruments are provided on Drawing 28. No thermocouple data was collected in 2019 as the instrument is no longer functional. A single reading of Frost gauge FG-15 was collected in early July that shows a thaw depth of 1 m, in line with previous readings at this time, shown on Drawing 29.

5.3.11. Upper Dump Pond Tailings Cover

Construction Details

The upper dump pond was an emergency tailings storage containment cell located between the water tank and the West Twin Disposal Area, as shown on Drawing 01. A thermal cover was constructed over the tailings in the Upper Dump Pond in 2005. The thermal cover consists of a 2 m thick (minimal thickness) layer of granular shale overlain by a 0.25 m thick layer (minimal thickness) of armour material comprised of sand, gravel, and cobbles. The shale was sourced from the Townsite shale borrow area (Drawing 01). The armour material was sourced from the Twin Lakes Delta deposit (Drawing 01).

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 60 through 62). The main observations from the inspection are summarized by the following:

- No erosion of the surface of the cover was observed.
- No seepage was noted at the toe of the cover.
- No areas of settlement or thermokarst features were observed on the surface of the cover.

In general, the Upper Dump Pond tailings cover appears to be in a physically stable state. As such, no maintenance is recommended.

Monitoring Data

The Upper Dump Pond tailings cover is instrumented with one frost gauge. The location of this instrument is provided on Drawing 30. Frost gauge FG-17 indicates that the active layer was approximately 1.6 m thick, which is 0.75 m above the base of the cover, shown on Drawing 31. The active layer thickness was approximately 20 cm greater than what was measured in 2018 but falls within the range observed in recent years.

5.3.12. Industrial Complex Foundation Cover

Construction Details

The Industrial Complex is located approximately 1 km north of the town site (Drawing 01). The Industrial Complex housed the concentrator, DMS circuit, power plant, maintenance shops, warehouse, administration and technical offices, and associated facilities. The facility was built on bedrock and a reinforced concrete foundation.

The Industrial Complex was dismantled between 2005 and 2006 and the remnant foundation was backfilled with metals contaminated soils. In 2008, a thermal cover was constructed over the backfilled foundation. The thermal cover consists of a 2 m thick layer (minimum thickness) of granular shale overlain by a 0.35 m thick layer (minimum thickness) of armour material. The shale was sourced from the Mill Area deposit and the armour materials were locally sourced. The sloping face of the cover is approximately 3(H):1(V).

Inspection Conditions

Select photos from the inspection are provided in Appendix I (Photos 63 through 65). The main observations made during the inspection are summarized by the following:

- No erosion of the surface of the cover was observed.
- No settlement or thermokarst features were observed on the surface of the cover.
- No seepage was observed at the toe of the cover.

In general, the Industrial Complex cover appears to be physically stable. As such, no maintenance is recommended.

Monitoring Data

The Industrial Complex Foundation cover is instrumented with one thermistor. The location of this instrument is provided on Drawing 32. Select plots providing the results of the monitoring are provided on Drawing 33. The graph indicates the following:

- The metals contaminated soils used to backfill the foundation footprint have frozen back.
- The active layer thaw (approximately 1.8 m) was confined within the cover materials throughout 2019, approximately 0.45 m above the base of the cover system.
- As expected, due to the shallow depth of the thermistor, the geothermal profile beneath the cover in 2019 was warmer than 2018 but falls within the range observed in recent years.

5.4. Mine Openings

5.4.1. 00/01 Portals and Crown Pillar

Construction Details

00 Portal

The 00 Portal is located at the edge of the West Open Pit at the western end of the mine, as illustrated on Drawing 01. The 00 Portal was the principal access at the western extremity of the mine. The portal measured approximately 5 by 5 m in cross section. The brow immediately above the portal was approximately 4 to 5 m high.

In 2005, the portal was backfilled with waste rock. The backfill was placed approximately to within 1 m of the top of the portal and into the portal approximately 5 m from the entrance. The backfill extended outside the portal face and was sloped at an angle of approximately 3(H):1(V) and graded into the overall backfill of the West Open Pit. A thermal cover was subsequently constructed over the waste rock as part of the West Open Pit thermal cover.

01 Portal

The 01 Portal was located at the western end of the mine, as shown on Drawing 01. The 01 Portal housed the main ventilation fans during mining operations which were mounted in a plate steel bulkhead. The portal opening was approximately 22 m wide and 4 m high. The brow immediately above the portal was approximately 4 to 5 m high.

In 2005, the portal was backfilled with waste rock. The backfill was placed approximately to within 1 m of the top of the portal and into the portal up to the face of the bulkhead. The backfill extended outside the portal face and was sloped at an angle of approximately 3(H):1(V) and graded into the overall backfill of the West Open Pit. A thermal cover was subsequently constructed over the waste rock as part of the West Open Pit thermal cover.

00/01 Crown Pillar

A stope connecting the 00 and 01 portals was located approximately 5 m behind the West Open Pit highwall. A portion of the rock between the 00 and 01 portals, known as the 00/01 rib pillar, was removed during later stages of mine development as part of the pillar recovery program. After the recovery of a portion of the rib pillar, a crack developed in the crown pillar above the area that had been mined. In 2005, a fill pillar was constructed beneath the cracked portion of the crown pillar to provide additional support and prevent development of an opening into the mine workings if the pillar were to collapse. The pillar was constructed out of waste rock and was constructed approximately to within 1 m of the top of the opening.

Inspection Conditions

The area of the West Open Pit cover where the portals had existed was inspected in 2019. The observations are summarized by the following:

- No indications of surface deformation were observed.
- No indications of seepage from the mine workings were observed.

No maintenance of the portal plugs or the cover over the portal plugs is recommended.

The crown pillar was also inspected from surface. The observations are summarized by the following:

- Similar to previous inspection observations, a small crack (1 - 3 cm wide) was observed in the crown pillar area (Photo 45). Based on visual observations, the size of the crack has not changed relative to previous years, and no additional cracking has occurred.
- No visually distinguishable deformation was observed in the crown pillar.
- Overall, no significant changes have been observed in the West Open Pit crown pillar since the fill pillar was constructed in 2005.

In general, the portal plugs constructed for the 00 and 01 portals and the 00/01 crown pillar appear to be in satisfactory condition. It is recommended that the crown pillar area continue to be visually monitored to check for further propagation of the cracking.

5.4.2. 17 North Portal

Construction Details

The 17 North Portal was a culverted portal giving access to the Main Ore Zone. The location of the portal is illustrated on Drawing 01. The 17 North Decline was approximately 5 m by 5 m in cross section and the culvert was half round with a diameter of 5 m and a length of 28 m. The culvert was supported by a 0.25 m thick by 2 m high concrete wall on either side and it extended 5 m inside the dolostone bedrock of the drift.

In 2005, the culvert was removed and the portal was backfilled with granular shale derived from the Shale Hill borrow area. The backfill was placed to within 1 m of the top of the portal and extended into the portal for approximately 4 m. The backfill extended outside the portal face and was sloped at an angle ranging between 4(H):1(V) and 7H:1V and graded into the surrounding topography. A 0.35 m thick layer of armour material, derived from the Kuhulu Lake borrow area, was then applied to the surface of the shale backfill.

Inspection Conditions

A select photo from the inspection is provided in Appendix I (Photo 66). The main observations are summarized by the following:

- No erosion of the surface of the cover was observed.
- No seepage was observed at the toe of the cover.
- The small amount of water flowing along the east edge of the portal cover during the 2017 inspection was not observed in 2019.

In general, the 17 North Portal cover appears to be physically stable and in satisfactory condition. As such, no maintenance is recommended.

5.4.3. Oceanview Portal

Construction Details

The Oceanview Portal was a bare rock entrance into the north side of the Oceanview underground workings. The location of the portal is illustrated on Drawing 01. The Oceanview decline had a cross section of approximately 5 by 5 m. The brow of the portal was approximately 5 m in height.

Prior to 2004, the portal had been backfilled with waste rock and covered over with locally derived overburden materials. In 2005, a thermal cover was constructed over the existing portal plug. The cover consisted of a 2 m thick layer (minimum thickness) of granular shale overlain by a 0.35 m thick layer of armour material consisting of sand, gravel, and cobbles. The shale was derived from the Shale Hill borrow area. The armour material was derived from the Chris Creek “A” deposit. The thermal cover was extended to the east and north of the portal entrance in an old ore stockpile area. Additionally, a water deflection berm was constructed upslope of the cover extension to prevent concentrated surface water from flowing over the cover area.

Inspection Conditions

A select photo from the inspection is provided in Appendix I (Photo 67). The main observations from the inspection are summarized by the following:

- A small area of surficial settlement was observed near the southwest corner of the portal cover. The settlement area appears to have stabilized as it has not changed significantly since it was first observed in 2006.
- Some minor cracking was noted along the east edge of the portal cover, as has been noticed in previous inspections. The condition of the cracking does not appear to have changed in several years.
- No seepage was observed at the toe of the cover.
- The surface water deflection berm appeared to be effective in diverting water around the cover extension.

In general, the Oceanview Portal cover appears to be physically stable. As such, no maintenance is recommended.

5.4.4. K-Baseline Portal

Construction Details

The K-Baseline portal was a culverted entry used to access the K-Baseline ore body. The location of the portal is illustrated on Drawing 01. The K-Baseline decline was approximately 5 m by 5 m in cross section and the culvert was half round with a diameter of 5 m and a length of 28 m. The culvert was supported by two concrete pony walls, 1 m wide by 2.4 m high, on both sides. The concrete pony walls extended 3 m inside the dolostone bedrock of the drift.

In 2004, the culvert was removed and the portal was backfilled with waste rock. In 2005, a thermal cover was constructed over the waste rock portal plug. The cover consisted of a 2 m thick layer (minimum thickness) of granular shale overlain by a 0.35 m thick layer of armour material consisting of sand, gravel, and cobbles. The shale was derived from the Shale Hill borrow area. The armour material was derived from the Chris Creek “A” deposit. An additional thermal cover was constructed over the area below the road immediately outside the portal where mineralized soils and additional waste rock were located. A surficial cover of shale was also constructed adjacent to the thermal cover to improve drainage conditions.

Inspection Conditions

A select photo from the inspection is provided in Appendix I (Photo 68). The main observations are summarized by the following:

- No erosion of the cover was observed.
- No seepage was noted at the toe of the cover.
- No areas of significant settlement were observed in the cover.
- Some minor cracking was noted on the surface of the cover, likely related to thermal expansion and contraction of the cover materials.

In general, the K-Baseline portal appears to be physically stable. As such, no maintenance is recommended.

5.4.5. Area 14 Portal

Construction Details

The Area 14 Portal was a bare rock portal that provided access to the Area 14 underground workings. The location of the portal is illustrated on Drawing 01. Mining ceased in this area around 1987 and the portal was backfilled with waste. The waste was covered and contoured with shale in 1987 and 1988.

In 2005, locally derived armour material was stockpiled adjacent to the portal cover for construction of the final armour layer. In late 2006, the stockpiled armour materials were spread over the portal area.

Area 14 could not be visited by BGC during the annual inspection due to logistical constraints. However, inspections in the past 15 years have demonstrated physical stability. As such, there are no concerns about Area 14, but the area should be visited during the 2020 inspection.

5.4.6. 09 South Portal

Construction Details

The 09 South (09S) Portal is located at the western end of the mine, as shown on Drawing 01. The 09S Portal is a culverted entry giving access to the Main Ore Zone. The 09 South drift is approximately 5 m by 5 m in cross section. The culvert is round with a diameter of 5 m and a length of 28 m. The bottom of the culvert is filled with rockfill to provide a smooth floor. The culvert extends approximately 13 m inside the shale bedrock of 09 south drift, leaving 15 m exposed on surface, a portion of which is covered with talus from the slope above.

The 09 South Portal remained open until the fall of 2008 to provide access to the underground workings during the underground waste disposal program. Once the underground waste disposal program was complete in September 2008, work on permanent closure of the 09 South Portal began.

In 2008, the culvert was removed and the portal was backfilled with granular shale derived from the Mill Area deposit. The backfill was placed to within 0.5 m of the top of the portal and extended into the portal for approximately 5 m. The backfill extended outside the portal face and was sloped at an angle of approximately 4(H):1(V) and graded into the surrounding topography. A 0.25 m (minimum thickness) layer of locally derived armour material was then applied to the surface of the shale backfill.

Inspection Conditions

A photo from the inspection is provided in Appendix I (Photo 69). The main observations are summarized by the following:

- No erosion of the cover was observed.
- No seepage was noted at the toe of the cover.
- Some minor cracking and deformation of the cover was noted, in a similar condition as was observed in previous inspections. The area appears to have stabilized since the cracking was first noted in 2009.
- Some shale from rock outcrops upslope was deposited on the surface of the portal cover.

In general, the 09 South Portal cover appears to be physically stable. As such, no maintenance is recommended.

5.4.7. Lower Adit

Construction Details

The Lower Adit is located at the western end of the mine near the Industrial Complex, as illustrated on Drawing 01. The Lower Adit provided the main access into the underground crusher and fine ore bin, as well as secondary access to the Main Ore Zone.

The Lower Adit Portal remained open until the fall of 2008 to provide ventilation to the underground workings during the underground waste disposal program. Once the underground waste disposal program was complete in September 2008, work on permanent closure of the Lower Adit Portal began.

In 2008, the portal was backfilled with granular shale derived from the Mill Area deposit. The backfill was placed to within 0.5 m of the top of the portal and extended into the portal for approximately 5 m. The backfill extended outside the portal face and was sloped at an angle of approximately 4(H):1(V) and graded into the surrounding topography. A 0.25 m (minimum thickness) layer of locally derived armour material was then applied to the surface of the shale backfill.

Inspection Conditions

A photo from the inspection is provided in Appendix I (Photo 70). The main observations are summarized by the following:

- No erosion of the cover was observed.
- No seepage was noted at the toe of the cover.
- No cracking or deformation of the cover was noted.

In general, the Lower Adit portal plug appears to be physically stable. As such, no maintenance is recommended.

5.4.8. Portal to Mill Foundation

Construction Details

A portal was driven beneath the Mill building in 1980 as part of emergency repair operations for the Mill. The portal is located approximately 70 m south of the Mill, adjacent to Twin Lakes Creek. The portal provided access to an ice lens which was present beneath the mill building. As part of the repair operations, the ice lens was mined out and concrete pillars were constructed to provide additional support for the Mill. After the repair operations were complete, the portal was plugged with shale rock fill.

Inspection Conditions

The main inspection observations for the Portal to Mill Foundation are summarized by the following:

- No erosion of the armoured portal plug was observed.
- No seepage was noted at the toe of the portal plug.

In general, the portal plug appears to be physically stable. No maintenance is recommended.

5.4.9. Shale Hill Raise

Construction Details

The Shale Hill Raise provided ventilation for the underground workings in the Shale Hill area. The location of the raise (E582524, N8107427, UTM NAD 83 Zone 16) is illustrated on Drawing 01.

The 3 m diameter raise was approximately 47 m deep. During mining operations, the raise was sealed with a 3 m diameter steel tank with the bottom cut out and with two adaptors in the top for 36-inch ventilation fans. The tank was fixed to a cemented collar at the top of the raise.

Prior to 2005, the surface structure was removed and, according to mine site records, the Shale Hill raise was backfilled with waste rock. A mound of shale was constructed at surface with side slopes of approximately 3(H):1(V). In 2005, a 0.35 m thick layer of locally derived armour material was applied to the surface of the mound to complete the remediation of this raise.

Inspection Conditions

A photo from the inspection is provided in Appendix I (Photo 71). During the inspection, the armour surface appeared to be stable with no visual indications of erosion or surface deformation. As such, no maintenance is recommended.

5.4.10. Oceanview East Raise

Construction Details

The Oceanview East Raise was situated at the extreme east end of the Oceanview underground workings. The location of the raise (E585123, N8107506, UTM NAD 83 Zone 16) is illustrated on Drawing 01. The 4 m by 4 m raise was approximately 10 m deep and provided ventilation for the underground workings in the Oceanview area. During mining operations, the raise was covered with a wooden wind deflector with a locked door.

In 2002, the wooden deflector was removed and, according to mine site records, the raise was backfilled with waste rock. During backfilling, it was noted that an ice plug was present in the raise at a depth of approximately 1.5 m below ground surface. As such, waste rock was placed only to this depth. A 3 m high mound was placed on top of the raise to accommodate for possible future settlement of the ice plug. The mound was constructed of shale and surfaced with coarse rock.

Inspection Conditions

A photo from the inspection is provided in Appendix I (Photo 72). During the inspection, the armour surface appeared to be stable with no visual indications of erosion or surface deformation. As such, no maintenance was recommended.

It was noted that periodic flows of groundwater seepage from upslope of the raise has caused acid rock drainage (ARD) staining of the ground surface around the raise. The source of the ARD is not known, but is likely related to near surface exposure of sulphidic soils and/or bedrock. This water is collecting in a disturbed area downslope of the raise. This low spot could be backfilled to prevent collection of this water.

5.4.11. Oceanview West Raise

Construction Details

The Oceanview West raise was located near the west end of the Oceanview underground workings (E584851, N8107466, UTM NAD 83 Zone 16), as shown on Drawing 01. The 3 m diameter raise is approximately 26 m deep and provided ventilation for the underground workings. The raise was covered by a steel enclosure with a locked wooden cover.

In 2002, the steel enclosure was removed and, according to mine site records, the raise was backfilled with waste rock as part of the progressive reclamation of the mine site. During backfilling, it was noted that an ice plug was present in the raise at a depth of approximately 1.5 m below ground surface. As such, waste rock was placed only to this depth. A 3 m mound was placed on top of the raise to accommodate for possible future settlement of the ice plug. The mound was constructed of shale and surfaced with coarse rock.

Inspection Conditions

A photo from the inspection is provided in Appendix I (Photo 73). During the inspection, the armour surface appeared to be stable with no visual indications of erosion or surface deformation. As such, no maintenance is recommended.

5.4.12. Area 14 Raise

Construction Details

The location of the Area 14 Raise (E584187, N8105663, UTM NAD 83 Zone 16) is illustrated on Drawing 01. The raise had a cross section of 5 by 5 m and an approximate depth of 8 m. Mining ceased in this area around 1987 and the raise was completely backfilled to the floor of the underground workings. Backfilling was completed with waste rock and the surface was then covered and contoured with shale in the summer of 1987 and 1988.

Inspection Conditions

Due to limitations of available transportation, Area 14 was not visited during the site inspection.

5.5. Shale and Armour Borrow Areas

5.5.1. Shale Borrow Areas

Several shale borrow areas were developed during the reclamation process to provide material for construction of the thermal covers. The borrow areas include the following:

- Mt. Fuji
- Area 14
- West Twin
- East Twin
- Shale Hill
- Townsite.

The borrow areas were reclaimed when no longer required. The reclamation efforts included re-grading of slopes for stability and sufficient grading of the floor of each borrow area to provide for positive drainage of surface water.

Select photos from the inspection are provided in Appendix I (Photos 74 through 76). The main observations are summarized by the following:

Mt. Fuji

- The benches are continuing to slowly fill in from the raveling of the remaining bench faces and are expected to eventually form a stable slope at the natural angle of repose.
- The floor had no significant areas of ponded water and is considered generally well drained.
- No issues requiring maintenance were observed.

Area 14

Area 14 could not be visited by BGC during the annual inspection due to logistical constraints. The Area 14 shale borrow area experienced thermokarsting in the first few years following development of the area but has since demonstrated physical stability. As such, there are no concerns about Area 14, but the area should be visited during the 2020 inspection.

West Twin

- In general, the re-graded pit walls appear to be stable.
- No ponding was observed in the floor of the pit.
- No issues requiring maintenance were observed.

East Twin

- In general, the re-graded pit walls appear to be stable.
- No ponding was observed in the floor of the pit.
- Some thermokarst features were noted on some of the remnant benches within the interior of the pit. These thermokarst features have resulted in some ponding within the interior benches of the pit.
- No issues requiring maintenance were observed.

Shale Hill

- In general, the re-graded pit walls appear to be stable.
- No ponding was observed in the floor of the pit.
- No issues requiring maintenance were observed.

Townsite

- In general, the re-graded pit walls appear to be stable.
- No ponding was observed in the floor of the pit.
- No issues requiring maintenance were observed.

5.5.2. Armour Borrow Areas

Several armour borrow areas were developed during the reclamation process to provide material for construction of the thermal covers. The borrow areas include the following:

- Twin Lakes Delta deposit
- Chris Creek "A" and "B" deposits
- Kuhulu Lake Road deposit
- 09S/17N Road deposit
- Area 14 deposit.

The borrow areas were reclaimed once no longer required. The reclamation efforts included sufficient grading of the floor of each borrow area to provide for positive drainage of surface water.

Select photos from the inspection are provided in Appendix I (Photos 77 & 78). The main observations are summarized by the following:

<u>Twin Lakes Delta deposit</u>

- The floor of the quarry was, in general, well drained. The surface water flows to the north edge of the borrow area and then proceeds to flow west to the Reservoir.
- Only isolated thermokarst features were observed in the floor of the quarry.
- No issues requiring maintenance were observed.

<u>Chris Creek "A" and "B" deposits</u>

- The floor of the quarry was observed to be well drained.
- Some minor thermokarst features were observed in the floor of the quarry.
- No issues requiring maintenance were observed.

<u>Kuhulu Lake Road deposit</u>

- The floor of the borrow area was graded in late 2006 in response to thermokarst features identified during the 2006 inspection.
- Since the grading in 2006, some additional thermokarst features have developed, but the area appears to be well drained with only limited ponding occurring in the bottom of the pit.
- No additional maintenance was recommended.

<u>09S/17N Road deposit</u>

- The face of the borrow area did not exhibit any indications of erosion or thermokarst development.
- No issues requiring maintenance were observed.

<u>Area 14 deposit</u>

- Due to limitations of available transportation, Area 14 was not visited during the site inspection. Previous inspections noted some minor thermokarst features in the borrow area.
- Given the stability exhibited by the area over the past few years, additional grading is no longer considered necessary, but the area should continue to be monitored.

5.6. Summary of 2019 Maintenance Recommendations

The maintenance items recommended throughout Section 5.0 are summarized in Table 5-1.

Table 5-1. Recommended maintenance and action items for 2019.

Inspection Item	Recommended Maintenance and Action Items
West Twin Dyke Spillway	The area should continue to be visually monitored for any signs of erosion or permafrost degradation induced deformation of the side slopes and channel bottom.
West Twin Outlet Channel	Monitor the water elevation in the Reservoir and Polishing Pond. Monitor slopes along perimeter of Polishing Pond for stability considerations.
East Twin Creek Diversion Channel	The diversion dyke should continue to be monitored for additional signs of erosion. Monitor seepage discharge at toe of dyke.
Surface Cell Tailings Cover	Continue to monitor thermokarst areas for additional deformation. Monitor areas of cover where heave related cracking has been observed.
East Open Pit/ East Trench Waste Rock Cover	Continue to visually monitor cracking in EOP crown pillar and minor surficial erosion of EOP and East Trench covers.
Oceanview Pit Waste Rock Cover	Continue to visually monitor surficial erosion along backslope.
00/01 Portals and Crown Pillar	Continue to visually monitor cracking in WOP crown pillar.
Area 14	Area 14 could not be visited during the 2019 inspection so should be visited in 2020.
Instrumentation/ Monitoring	Download the water level loggers installed in the Reservoir and Polishing Pond during the 2020 inspection.

No maintenance or action items are recommended for other areas not specifically noted in Table 5-1.

5.7. 2020-2029 Monitoring Schedule

As part of the Water License renewal process in 2019/2020, BGC undertook a review of the geotechnical monitoring requirements for the Nanisivik Mine site. The intent of the review was to develop a reduced monitoring schedule for the term of the New License (2020-2030). The results of this review are documented in a project memorandum (BGC, April 24, 2019). As part of the New License, the monitoring frequency of geotechnical instrumentation (thermistors, piezometers, frost gauges) will be reduced to a single monitoring event per year, provided that current performance trends and general site stability continue to be observed. In addition to a reduction in per-annuum monitoring, the New License allows a further reduction in the monitoring frequency to omit monitoring years in a tapered fashion such that annual inspections are gradually spaced farther apart. Annual inspections are intended to be performed concurrent with monitoring events.

The 2020-2030 monitoring schedule incorporated within the New License is provided in Appendix IV.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The following paragraphs provide a summary of the significant observations, conclusions, and recommendations based on the results of the 2019 Geotechnical Inspection Program undertaken at the Nanisivik Mine site.

Embankments

The West Twin Dyke and Test Cell Dyke were physically stable with no signs of erosion or seepage. The breaches in the remnant dykes at the East Adit Treatment Facility continue to permit natural drainage of the area with only limited ponding in the Retention Pond.

Hydraulic Structures

The West Twin Dyke Spillway continues to effectively drain water from the Surface Cell cover into the Reservoir and is generally functioning as intended. Previous inspections recommended maintenance to address erosion at the base of the spillway channel, as well as additional erosion of the left bank, likely caused by elevated flows during freshet in combination with ice and snow blockage within the spillway channel. In response to these recommendation, some minor grading and re-sloping were undertaken during the 2018 inspection with the objective of improving the hydraulic performance of the spillway. The maintained areas were visually assessed during the 2019 inspection and appeared to have performed favourably, as no further erosion was noted in 2019. However, given the nature of the flows causing the previously observed erosion, it is possible that additional maintenance may be required in the future. The spillway should continue to be inspected for additional erosion and maintenance should be undertaken as necessary.

As observed during previous inspections, a small head pond developed on the Surface Cell cover at the spillway inlet. The presence of the shallow head pond is not considered to negatively impact the overall cover performance; hence the elimination of the head pond is not considered necessary.

The seepage at the West Twin Outlet Wall seems to have slowed in recent years, as the water level upstream of the wall has been maintained more consistently at or above the invert of the outlet wall.

Additional deformation of the perimeter slopes of the upstream Polishing Pond was observed in 2019, though the area of instability was further removed from the outlet wall compared to previous years. Based on the water quality measurements collected since the East Twin Lake access road was breached in 2008, the seepage losses from the Polishing Pond do not appear to be affecting the overall performance of the West Twin Area reclamation measures. The seepage losses should continue to be monitored. Additional seepage control measures could be considered, if necessary.

Previous inspections made recommendations to repair left bank armouring material following observations of erosion along a section of the East Twin Creek Diversion Channel. In response to these observations, maintenance was undertaken at the diversion dyke during the 2018 inspection. The maintenance included re-sloping of the affected area and addition of locally available armour materials. The maintained areas were visually assessed during the 2019 inspection and appeared to have performed favourably. seepage discharge observed at the toe of the left bank of the dyke during previous inspections was observed again in 2019. The seepage water is likely originating in the Polishing Pond and is also likely related to excavation of Polishing Pond sediments during site reclamation. The seepage flow rate was visually observed to have increased compared to the 2018 inspection, likely due to a greater active layer thickness in 2019. The flow seepage was observed to be clear and free of sediment. No further maintenance of the diversion dyke is recommended at this time but should continue to be monitored for additional erosion and seepage flows.

Thermal Covers

Based on monitoring data collected from various frost gauges and thermistors, the thermal covers performed adequately throughout 2019. The thermal covers maintained the active layer thaw within the cover profile through much, if not all of the summer thaw season. In general, the active layer thaw was observed to be greater than 2018 but within the range of historical values, reflecting the warmer air temperatures experienced at site this spring and summer. Only minor erosion, cracking, and thermokarsting/settlement was observed, which were not seen to negatively impact the thermal performance nor the water quality in the surrounding areas. Many of these features have been noted previously and have been observed to be physically stable for the past several years. The water quality observed at the final discharge point for the West Twin Disposal Area was observed to remain well below the discharge criteria throughout the open water season in 2019. This is an indication of the beneficial impacts related to geothermal performance of the cover system.

No maintenance is required for the thermal covers at this time; however, visual monitoring is recommended to check for additional surface deformation and erosion.

Talik and Mine Waste Freeze-back

Freeze-back of the talik in the Surface Cell and Test Cell appears to be proceeding faster than anticipated. Since 2018, a downward migration of the freezing front and continued cooling of ground temperatures below approximately 10-15 m was observed. On the other hand, shallow ground temperature at depths above 10 m bgs generally showed slight warming since 2018, reflective of warm spring and summer air temperatures at site in 2019. All piezometers within the Surface Cell, and three out of five piezometers within the Test Cell, have frozen back due to continued downward migration of the freezing front. The piezometers have been observed to freeze back at lower temperatures when the piezometer tip is at a lower elevation, as well as when it is further away from the edge of the original lake bed. These relationships are likely related to the increasing solute concentrations in the unfrozen pore water contained within the remnant talik.

In areas where no talik exists (e.g., landfill, open pits), freeze-back of the materials underlying the cover systems has occurred and the rate of cooling has generally slowed over recent years, suggesting ground conditions are approaching thermal equilibrium at depth.

Mine Openings, Crown Pillars and Raises

The covers constructed over the mine openings generally appear to be physically stable. Cracking at the East Open Pit crown pillar does not appear to have progressed in many years. No maintenance is recommended, but continued visual inspection is warranted.

Shale and Armour Borrow Areas

In general, the shale and armour borrow areas appear to be physically stable and are not causing any significant ponding to occur. No maintenance was recommended at any of the borrow areas.

7.0 CLOSURE

We trust the above satisfies your requirements at this time. Should you have any questions or comments, please do not hesitate to contact us.

Yours sincerely,

BGC ENGINEERING INC.
per:

REGISTERED PROFESSIONAL ENGINEER
S.D. GARRISON
LICENSEE Feb 24/20
NT/NU

Scott Garrison, M.Eng., P.Eng.
Geological Engineer

Karlee Isfeld, B.Sc.E, EIT
Geological Engineer

Reviewed by:

Geoff Claypool, M.Eng., P.Eng.
Principal Geological Engineer

SG/GC/jwc/cs

PERMIT TO PRACTICE
BGC ENGINEERING INC.
Signature
Date 24-Feb-2020
PERMIT NUMBER: P 285
NT/NU Association of Professional Engineers and Geoscientists

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APPENDIX I
INSPECTION PHOTOS

LIST OF APPENDIX I INSPECTION PHOTOS

Photo 1. East Adit Treatment Facility - Retention Pond as seen from road to East Open Pit.

Photo 2. East Adit Treatment Facility - Breach in treatment pond dyke.

Photo 3. West Twin Dyke Spillway – On left bank of spillway looking upstream at inlet. Note the headpond at the spillway net.

Photo 4. West Twin Dyke Spillway – On the left bank of the spillway looking upstream at the upper spillway.

Photo 5. West Twin Dyke Spillway – Looking downstream from access ramp.

Photo 6. West Twin Dyke Spillway – On the right bank of the spillway approximately 50 metres downstream of the access ramp looking downstream at an overview of the lower spillway.

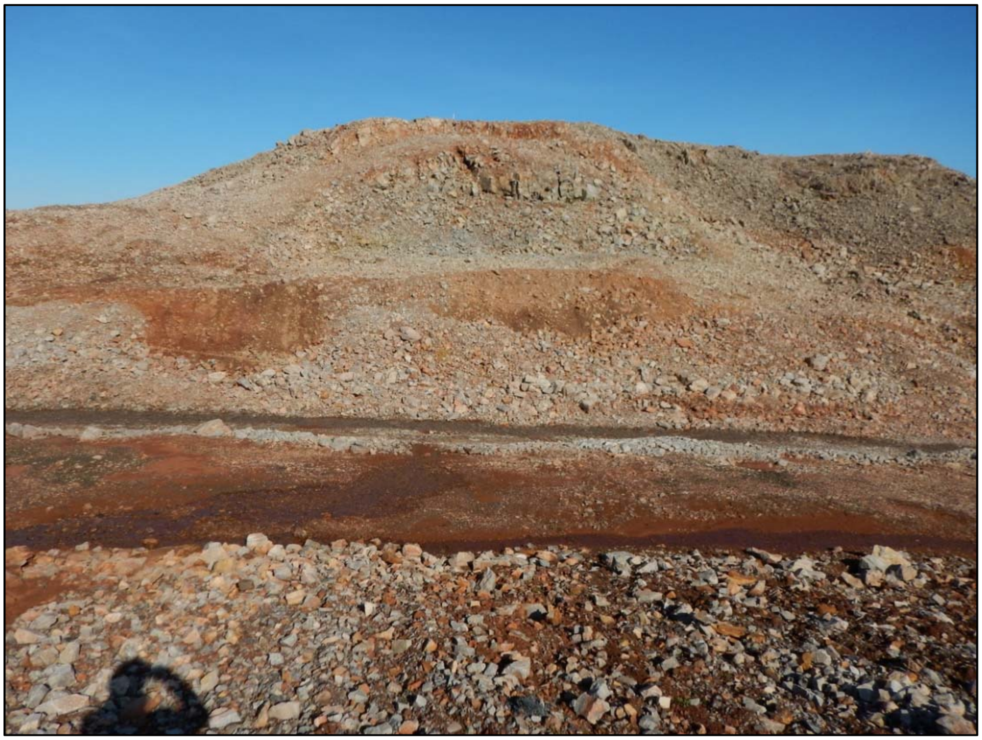


Photo 7. West Twin Dyke Spillway – On right bank looking at area where 2018 left bank maintenance was performed.

Photo 8. West Twin Dyke Spillway – On right bank looking downstream along location of 2018 left bank maintenance.

Photo 9. West Twin Dyke Spillway – Looking downstream at spillway outlet where 2018 maintenance was performed.

Photo 10. West Twin Outlet Wall – As seen from downstream.

Photo 11. West Twin Outlet Wall – As seen from left bank.

Photo 12. Reservoir and Polishing Pond – As seen from a drone near the left abutment of the West Twin Dyke.

Photo 13. Polishing Pond – Thermokarsting around Polishing Pond.

Photo 14. Polishing Pond – Thermokarsting around Polishing Pond.

Photo 15. East Twin Creek Diversion – Looking at area where 2018 left bank maintenance was performed.

Photo 16. East Twin Creek Diversion – Looking at area where 2018 left bank maintenance was performed.

Photo 17. East Twin Creek Diversion – Looking upstream.

Photo 18. Surface Cell Cover System – Minor thermokarsting along main E-W drainage swale.

Photo 19. Surface Cell Cover System – Near north end of cover looking south.

Photo 20. Surface Cell Cover System – At crest of West Twin Dyke looking northeast across Surface Cell Cover System.

Photo 21. Surface Cell Cover System – Thermal cracking along the edge of the main swale.

Photo 22. Surface Cell Cover System – Thermal cracking in the southwest quadrant of the Surface Cell cover system.

Photo 23. Surface Cell Cover System – As seen from a drone near the left abutment of the West Twin Dyke.

Photo 24. West Twin Dyke – As seen from a drone near the left abutment.

Photo 25. West Twin Dyke – Looking along the dyke face from the right abutment.

Photo 26. West Twin Dyke – Looking along the crest of the West Twin Dyke from the left abutment.

Photo 27. Test Cell Cover System – West Twin Dyke and Test Cell Cover System.

Photo 28. Test Cell Cover System – As seen from a drone near the left abutment of the West Twin Dyke.

Photo 29. Test Cell Cover System – Minor settlement trough along N/S arm of Test Cell Dyke.

Photo 30. Test Cell Cover System – Minor thermal cracking.

Photo 31. Test Cell Cover System – Flat surface of cover system, looking southwest.

Photo 32. Test Cell Cover System – Flat surface of cover system, looking northwest from near the breach in the Test Cell Dyke.

Photo 33. Test Cell Cover System – Erosion protection along the East Arm of the Test Cell Dyke, view looking northwest.

Photo 34. Test Cell Cover System – Erosion protection along the N/S arm of the Test Cell Dyke, view looking north.

Photo 35. Test Cell Cover System – Outlet of breach in Test Cell Dyke.

Photo 36. Toe of West Twin Dyke Tailings Cover – As seen from the West Twin Dyke.

Photo 37. Toe of West Twin Dyke Tailings Cover – View looking northeast.

Photo 38. Toe of West Twin Dyke Tailings Cover – At the toe of the West Twin Dyke looking toward the right abutment.

Photo 39. Landfill – Flat surface of cover system.

Photo 40. Landfill – Diverted water flowing around north side of cover system.

Photo 41. Landfill – Diversion berm upstream of the landfill.

Photo 42. Landfill – Sloping face of cover system.

Photo 43. Landfill – Toe area of the cover system.

Photo 44. West Open Pit – Looking downslope from remnant highwall at cover system.

Photo 45. West Open Pit – Crack behind remnant highwall.

Photo 46. West Open Pit – Sloping face of cover system.

Photo 47. East Open Pit – Upper portion of East Open Pit cover system.

Photo 48. East Open Pit – Cracking in crown pillar.

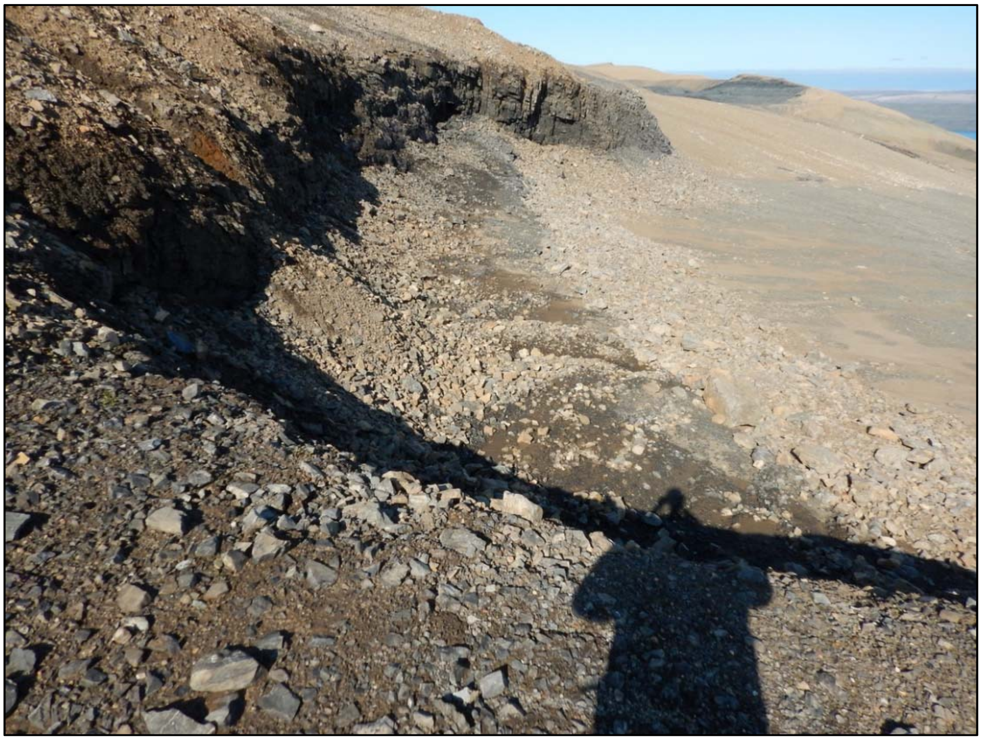


Photo 49. East Open Pit – Remnant highwall.

Photo 50. East Open Pit – Looking upslope at rilling on cover system. Note self-armouring.

Photo 51. East Open Pit – Sloping face of lower cover system.

Photo 52. East Open Pit – Toe of the cover system.

Photo 53. East Trench – Upper portion of cover system.

Photo 54. East Trench – Lower portion of cover system.

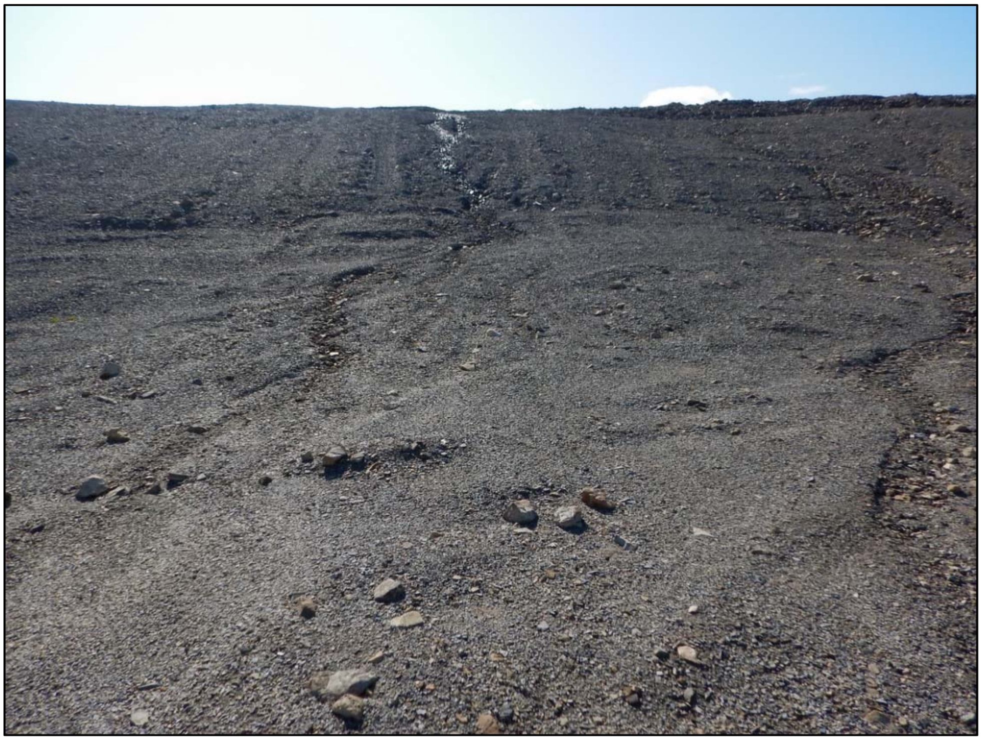


Photo 55. Oceanview Pit – Rilling on the south end of the cover system.

Photo 56. Oceanview Pit – As seen from south side of cover.

Photo 57. Oceanview Pit – Minor thermal cracking on south end of the cover.

Photo 58. Oceanview Pit – Cover system as seen from SE corner of cover.

Photo 59. Oceanview Pit – Seepage flowing into the cover system from upstream.

Photo 60. Upper Dump Pond – Flat surface of thermal cover system.

Photo 61. Upper Dump Pond – Looking upstream at road breach to Townsite.

Photo 62. Upper Dump Pond – Breach in road to mill site.

Photo 63. Industrial Complex – Flat surface of cover system.

Photo 64. Industrial Complex – Area of former Day Tank Farm.

Photo 65. Industrial Complex – Sloping face of cover system.

Photo 66. 17N Portal – As seen from road.

Photo 67. Oceanview Portal Cover – Looking upslope at cover system.

Photo 68. K-Baseline – As seen from East Trench.

Photo 69. 09S Portal – Looking upslope at plug.

Photo 70. Lower Adit – Sloping face of cover system.

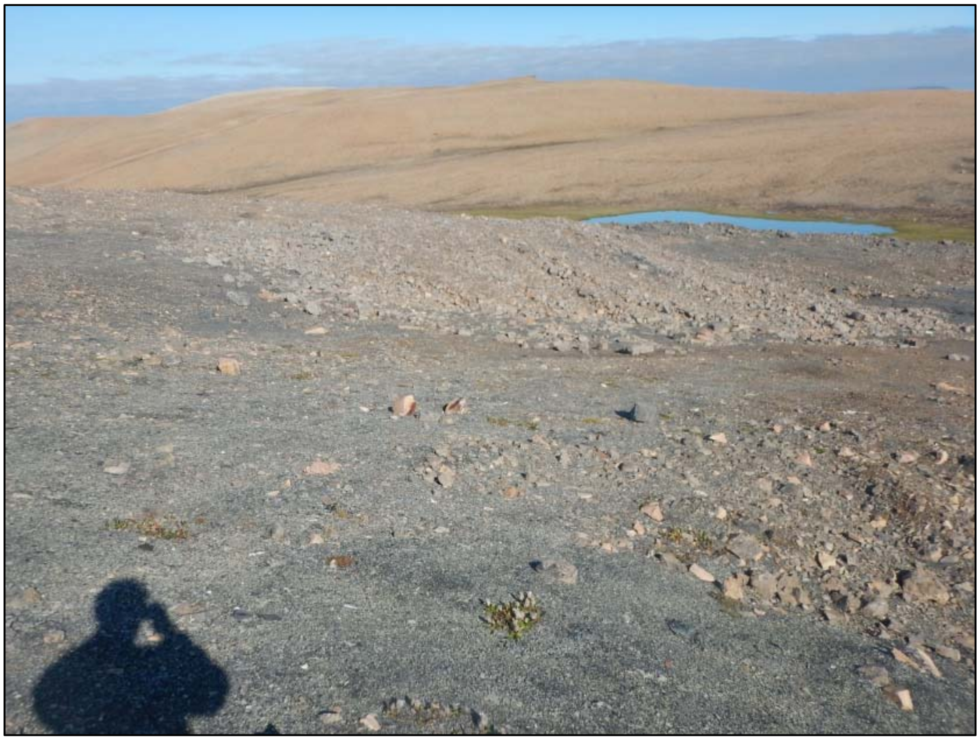


Photo 71. Shale Hill Vent Raise – As seen from road.

Photo 72. Oceanview East Raise – ARD staining around the plug and mound.

Photo 73. Oceanview West Raise – Plug and mound.

Photo 74. Mt. Fuji Shale Quarry – As seen from road.

Photo 75. Shale Hill Borrow Area – As seen from road.

Photo 76. Townsite Shale Borrow – As seen from road.

Photo 77. Chris Creek A Gravel Borrow – As seen from East Trench.

Photo 78. Chris Creek B Gravel Borrow – As seen from road.

APPENDIX II
2019 GEOTECHNICAL MONITORING EVENTS

2019 Completed Geotechnical Monitoring

BGC Engineering Inc.

		01-Jan	01-Feb	01-Mar	01-Apr	15-Apr	01-May	11-May	21-May	01-Jun	07-Jun	14-Jun	21-Jun	01-Jul	07-Jul	14-Jul	21-Jul	01-Aug	07-Aug	14-Aug	21-Aug	01-Sep	07-Sep	14-Sep	21-Sep	01-Oct	11-Oct	21-Oct	01-Nov	01-Dec	08-Dec	15-Dec	22-Dec	29-Dec
West Twin Dyke																																		
TC12	Thermocouple	Not functioning																																
TC13A	Thermocouple	Not functioning																																
TC31	Thermocouple	Not functioning																																
TC32	Thermocouple	Not functioning																																
TC33	Thermocouple	Not functioning																																
BGC03-33	Thermistor																																	
BGC03-34	Thermistor																																	
BGC05-09	Thermistor																																	
BGC05-15	Thermistor																																	
BGC05-17	VW Piezo.																																	
Surface Cell																																		
BGC02-03	Thermistor	Not functioning																																
BGC03-07	Thermistor																																	
BGC03-09	Thermistor																																	
BGC03-10	Thermistor																																	
BGC03-11	Thermistor																																	
BGC03-12	Vibrating Wire																																	
BGC03-14	Vibrating Wire																																	
BGC03-15	Thermistor																																	
BGC03-20	Thermistor																																	
BGC03-21	Thermistor	Not functioning																																
BGC03-32	Vibrating Wire																																	
BGC03-35	Vibrating Wire																																	
BGC03-36	Thermocouple	Not functioning																																
BGC03-37	Thermistor	Not functioning																																
BGC05-05	Thermistor																																	
BGC05-06	VW Piezo.																																	
BGC05-07	VW Piezo.																																	
BGC05-08	Contingency																																	
BGC05-10	VW Piezo.																																	
BGC05-11	Monitoring Well	Not functioning																																
BGC05-12	Monitoring Well	Not functioning																																
BGC05-13	VW Piezo.	Partially Functioning																																
BGC05-14	Contingency																																	
BGC05-16	Contingency																																	
FG-1	Frost Gauge																																	
FG-2	Frost Gauge																																	
FG-3	Frost Gauge																																	
FG-4	Frost Gauge																																	
FG-5	Frost Gauge																																	
FG-6	Frost Gauge																																	

Weekly Reading

Monthly Reading

Bi-Weekly Reading

		01-Jan	01-Feb	01-Mar	01-Apr	15-Apr	01-May	11-May	21-May	01-Jun	07-Jun	14-Jun	21-Jun	01-Jul	07-Jul	14-Jul	21-Jul	01-Aug	07-Aug	14-Aug	21-Aug	01-Sep	07-Sep	14-Sep	21-Sep	01-Oct	11-Oct	21-Oct	01-Nov	01-Dec	08-Dec	15-Dec	22-Dec	29-Dec
Toe of West Twin Dyke																																		
BGC03-18	Thermocouple	Not functioning																																
BGC03-19	Thermistor																																	
BGC05-26	Thermistor																																	
Test Cell																																		
BGC05-04	Thermistor																																	
BGC05-18	VW Piezo.																																	
BGC05-19	Thermistor																																	
BGC05-20	VW Piezo.																																	
BGC05-21	Monitoring Well	Not functioning																																
BGC05-22	VW Piezo.																																	
BGC05-23	Monitoring Well	Not functioning																																
BGC05-24	VW Piezo.																																	
BGC05-25	Contingency																																	
FG-7	Frost Gauge																																	
FG-8	Frost Gauge																																	
Test Cell Dyke																																		
BGC02-09	Thermistor	Not functioning																																
BGC03-22	Thermistor																																	
BGC05-29	Thermistor																																	
Toe of Test Cell Dyke																																		
BGC05-27	Thermistor																																	
BGC05-28	VW Piezo.																																	
FG-9	Frost Gauge	Not functioning																																
FG-10	Frost Gauge																																	
Oceanview Pit																																		
BGC05-01	Thermistor																																	
FG-16	Frost Gauge																																	
East Open Pit																																		
BGC05-02	Thermistor																																	
BGC05-03	Thermistor																																	
FG-13	Frost Gauge																																	
FG-14	Frost Gauge	Not functioning																																
Landfill																																		
BGC05-30	Thermistor																																	
FG-11	Frost Gauge																																	
Area 14																																		
TC7	Thermocouple	Not functioning																																
FG-15	Frost Gauge																																	
Upper Dump Road																																		
FG-17	Frost Gauge																																	
West Open Pit																																		
BGC08-01	Thermistor																																	
Mill Cover																																		
BGC08-02	Thermistor																																	
Water Quality / Levels																																		
159-4	Water Level																																	
159-4	Water Quality																																	
Spillway Inlet	Water Quality																																	

	Weekly Reading
	Monthly Reading
	Bi-Weekly Reading

APPENDIX III
2020-2029 GEOTECHNICAL MONITORING PROGRAM SCHEDULE

2020-2029 Geotechnical Monitoring Program Schedule

BGC Engineering Inc.

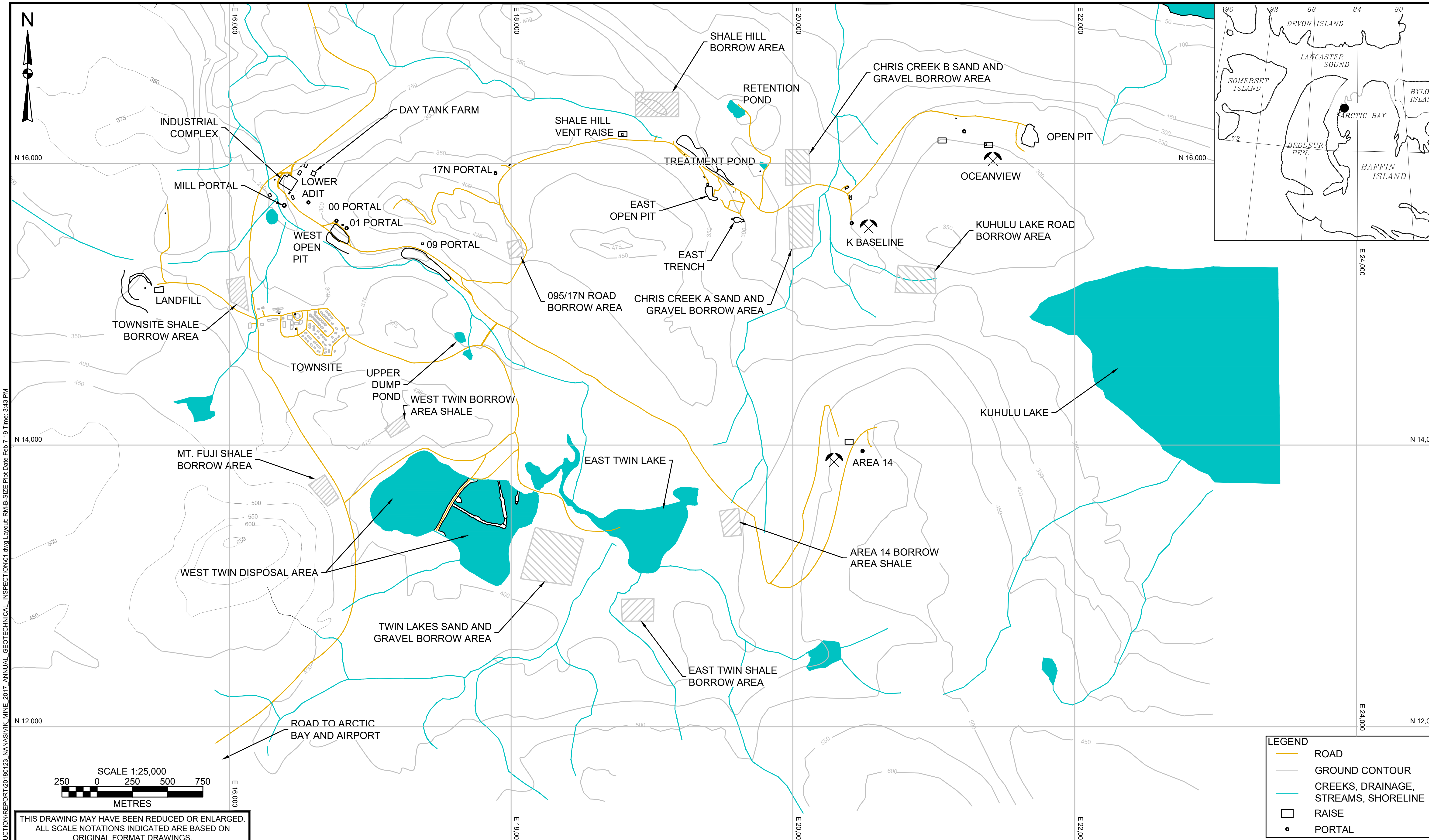
		Status of Instrument	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
West Twin Dyke												
TC12	Thermocouple	Not functioning										
TC13A	Thermocouple	Not functioning										
TC31	Thermocouple	Not functioning										
TC32	Thermocouple	Not functioning										
TC33	Thermocouple	Not functioning										
BGC03-33	Thermistor											
BGC03-34	Thermistor											
BGC05-09	Thermistor											
BGC05-15	Thermistor											
BGC05-17	VW Piezo.											
Surface Cell												
BGC02-03	Thermistor	Not functioning										
BGC03-07	Thermistor											
BGC03-09	Thermistor											
BGC03-10	Thermistor											
BGC03-11	Thermistor											
BGC03-12	Vibrating Wire											
BGC03-14	Vibrating Wire											
BGC03-15	Thermistor											
BGC03-20	Thermistor											
BGC03-21	Thermistor	Not functioning										
BGC03-32	Vibrating Wire											
BGC03-35	Vibrating Wire											
BGC03-36	Thermocouple	Not functioning										
BGC03-37	Thermistor	Not functioning										
BGC05-05	Thermistor											
BGC05-06	VW Piezo.											
BGC05-07	VW Piezo.											
BGC05-08	Contingency											
BGC05-10	VW Piezo.											
BGC05-11	Monitoring Well	Not functioning										
BGC05-12	Monitoring Well	Not functioning										
BGC05-13	VW Piezo.	Partially functioning										
BGC05-14	Contingency											
BGC05-16	Contingency											
FG-1	Frost Gauge											
FG-2	Frost Gauge											
FG-3	Frost Gauge											
FG-4	Frost Gauge											
FG-5	Frost Gauge											
FG-6	Frost Gauge											

Instruments to be read

		Status of Instrument	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Toe of West Twin Dyke												
BGC03-18	Thermocouple	Not functioning										
BGC03-19	Thermistor		■	■	■		■		■			■
BGC05-26	Thermistor		■	■	■		■		■			■
Test Cell												
BGC05-04	Thermistor		■	■	■		■		■			■
BGC05-18	VW Piezo.		■	■	■		■		■			■
BGC05-19	Thermistor		■	■	■		■		■			■
BGC05-20	VW Piezo.		■	■	■		■		■			■
BGC05-21	Monitoring Well	Not functioning										
BGC05-22	VW Piezo.		■	■	■		■		■			■
BGC05-23	Monitoring Well	Not functioning										
BGC05-24	VW Piezo.		■	■	■		■		■			■
BGC05-25	Contingency											
FG-7	Frost Gauge		■	■	■		■		■			■
FG-8	Frost Gauge		■	■	■		■		■			■
Test Cell Dyke												
BGC02-09	Thermistor	Not functioning										
BGC03-22	Thermistor		■	■	■		■		■			■
BGC05-29	Thermistor		■	■	■		■		■			■
Toe of Test Cell Dyke												
BGC05-27	Thermistor		■	■	■		■		■			■
BGC05-28	VW Piezo.		■	■	■		■		■			■
FG-9	Frost Gauge	Not functioning										
FG-10	Frost Gauge		■	■	■		■		■			■
Oceanview Pit												
BGC05-01	Thermistor		■	■	■		■		■			■
FG-16	Frost Gauge		■	■	■		■		■			■
East Open Pit												
BGC05-02	Thermistor		■	■	■		■		■			■
BGC05-03	Thermistor		■	■	■		■		■			■
FG-13	Frost Gauge		■	■	■		■		■			■
FG-14	Frost Gauge	Not functioning										
Landfill												
BGC05-30	Thermistor		■	■	■		■		■			■
FG-11	Frost Gauge		■	■	■		■		■			■
Area 14												
TC7	Thermocouple	Not functioning										
FG-15	Frost Gauge											
Upper Dump Road												
FG-17	Frost Gauge		■	■	■		■		■			■
West Open Pit												
BGC08-01	Thermistor		■	■	■		■		■			■
Mill Cover												
BGC08-02	Thermistor		■	■	■		■		■			■
Water Quality / Levels												
159-4	Water Level		■	■	■		■		■			■
159-4	Water Quality		■	■	■		■		■			■
Spillway Inlet	Water Quality		■	■	■		■		■			■

■ Instruments to be read

DRAWINGS



NOTES:
1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION" AND DATED FEBRUARY 2020.
3. PROJECTION IS UTM NAD 83 Z16N.
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SCALE:	AS SHOWN
DATE:	FEB 2020
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APPROVED:	GKC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

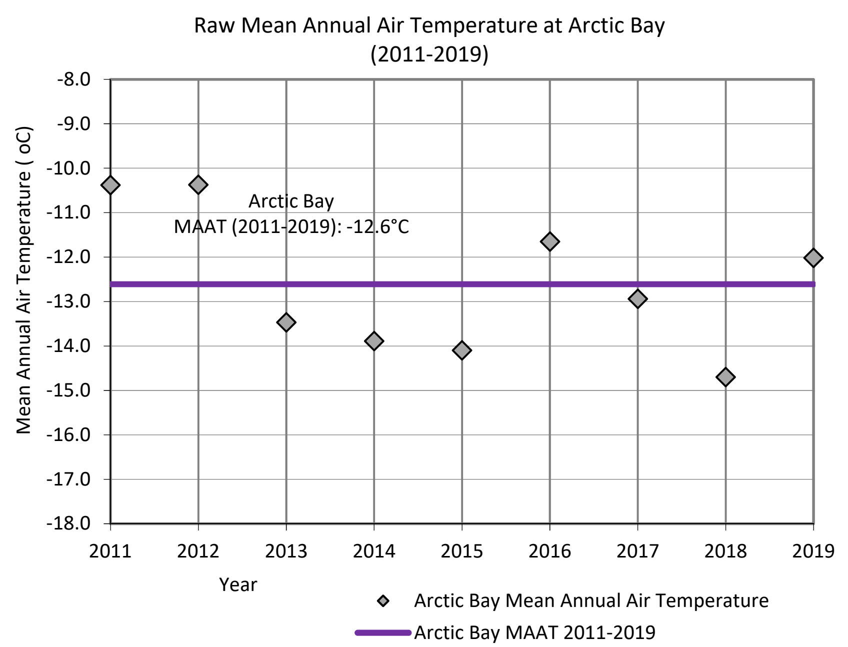
CLIENT:

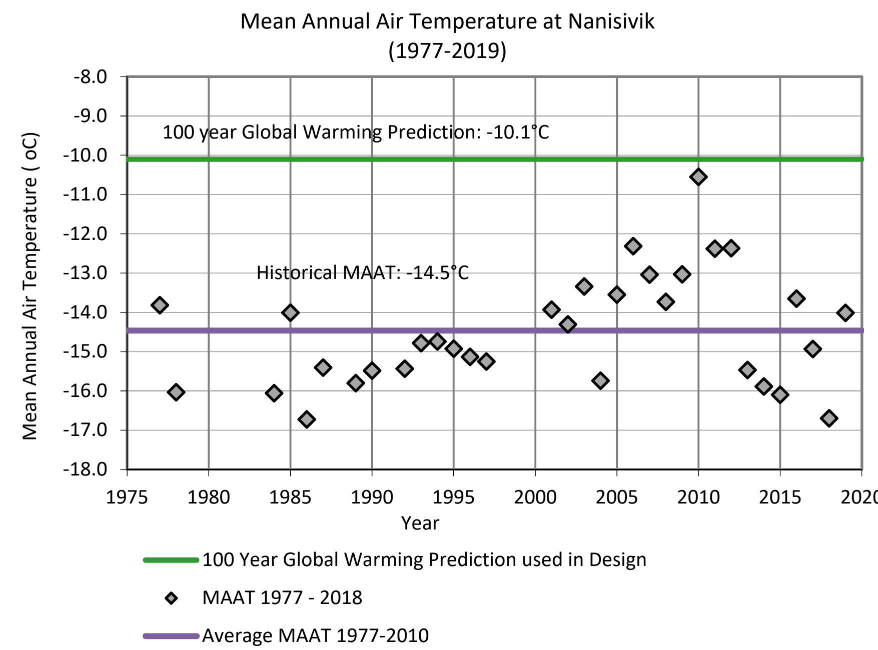
PROJECT: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION

TITLE: SITE LOCATION PLAN

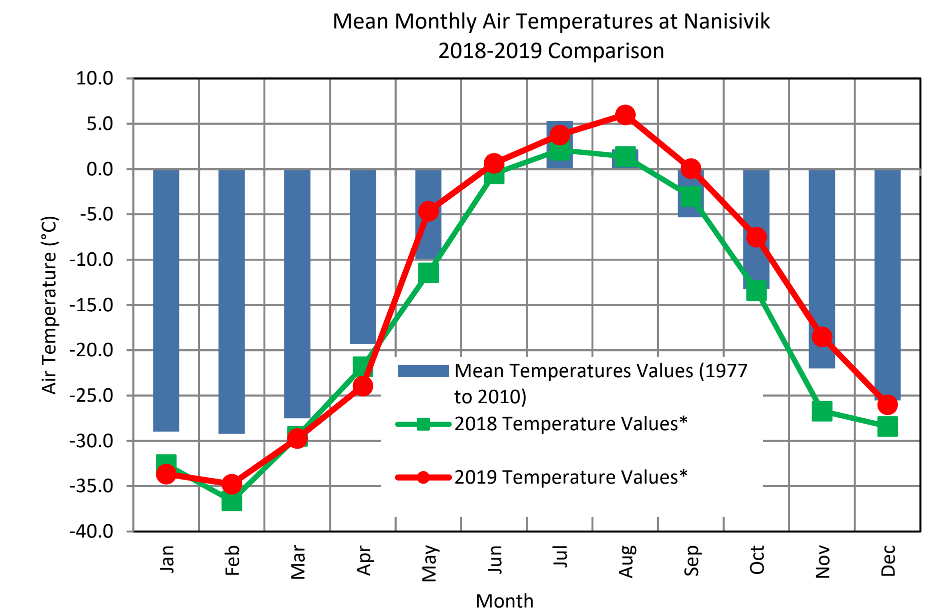
PROJECT No.:	DWG No.:
0255-030	01

X:\Projects\0255028\CAD\PRODUCTION\REPORT\20180123_NANASIVIK_MINE_2017_ANNUAL_GEOTECHNICAL_INSPECTION01.dwg Layout: RM-B-SIZE Plot Date Feb 7 19 Time: 3:43 PM





*Historical average taken from 1977-2010 when data was available at the Nanisivik Airport
*2011-2019 temperature corrected by -2 °C to adjust for new weather station location (Arctic Bay).



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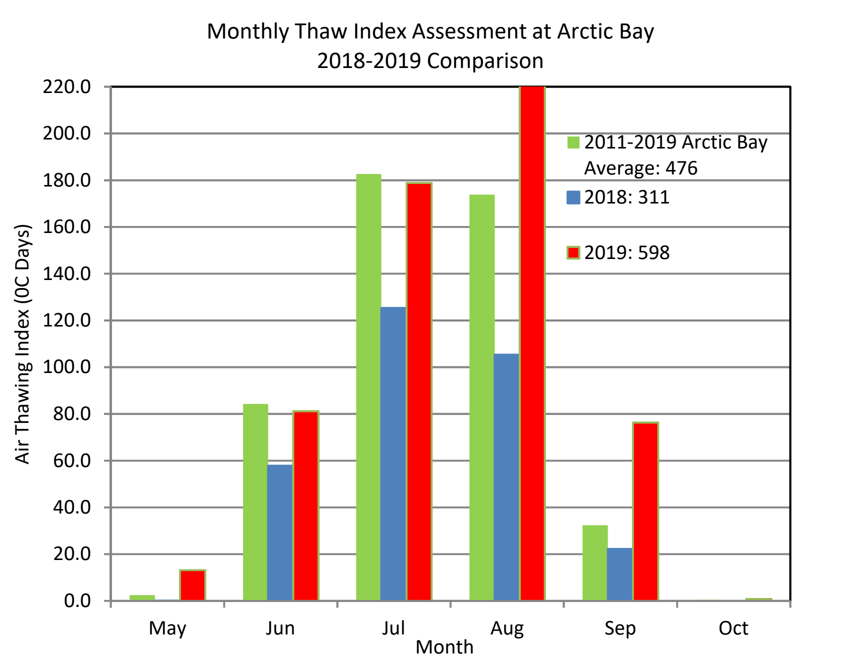

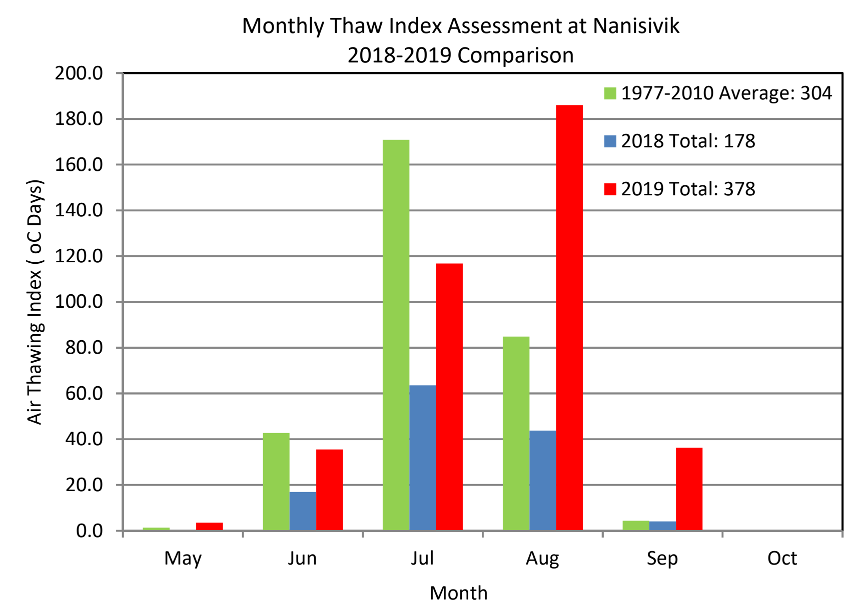

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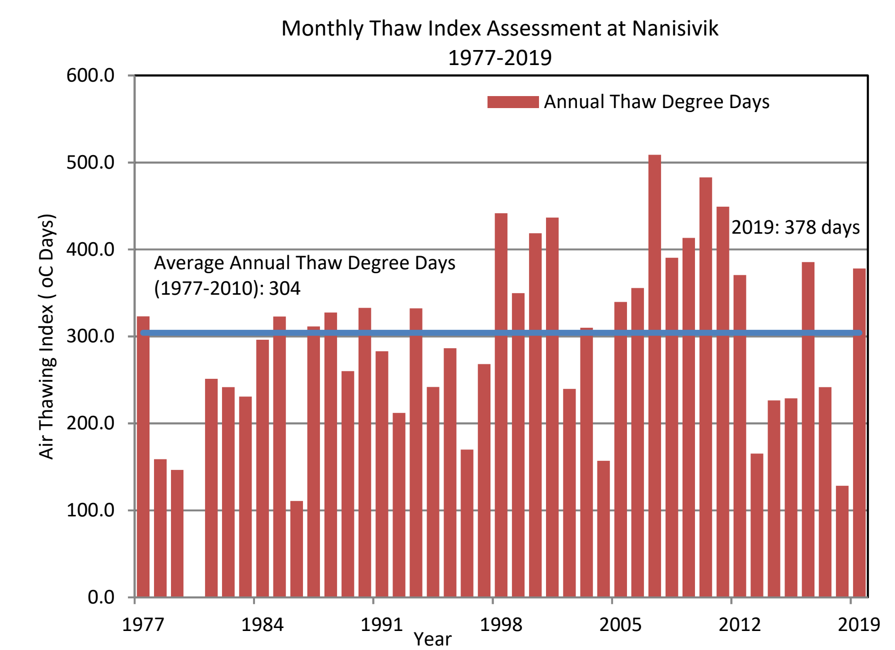

*Historical average taken from 1977-2010 when data was available at the Nanisivik Airport
*2011-2019 Air Thawing Index corrected by -2 °C to adjust for new weather station location (Arctic Bay).

DRAWING TO BE READ WITH BGC REPORT TITLED: "NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION", DATED FEBRUARY 2020

BGC ENGINEERING INC.
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REPORT TITLE: NANISIVIK MINE
2019 ANNUAL GEOTECHNICAL INSPECTION

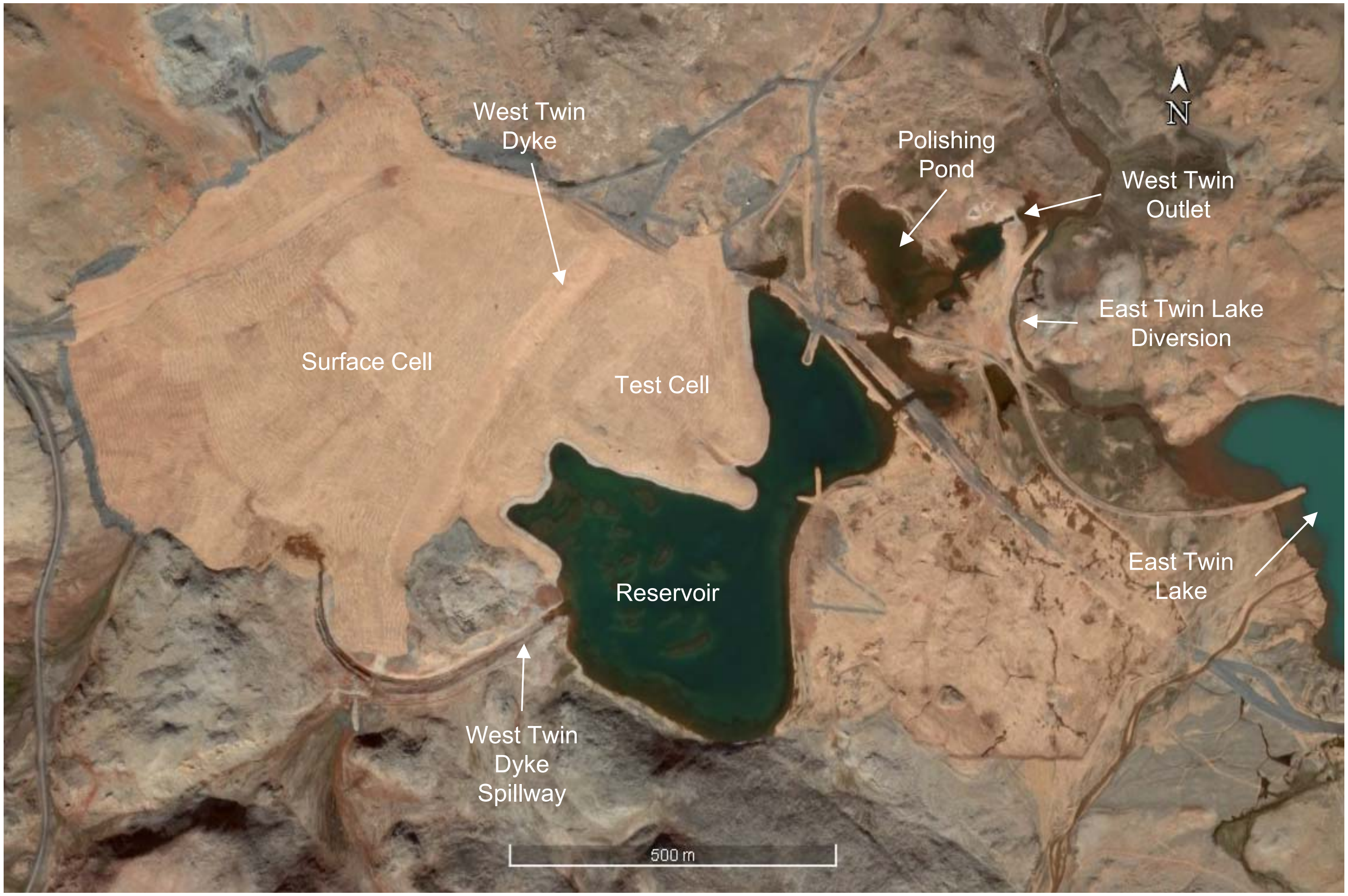
DRAWING TITLE: CLIMATE DATA

CLIENT: nyrstar

PROJECT NO.: 0255-030

DRAWING NO.: 02

FEB 2020



Note:

1. Photo derived from Google Earth, imagery date July 28, 2015.

Approximate Scale
1:10,000

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

REPORT TITLE:
NANISIVIK MINE
2019 ANNUAL GEOTECHNICAL INSPECTION

DRAWING TITLE:
SITE PLAN OF THE WEST TWIN DISPOSAL AREA

CLIENT: nyrstar

PROJECT NO.: 0255-030

DRAWING NO.: 03

DRAWING TO BE READ WITH BGC REPORT TITLED:
"NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION", DATED FEBRUARY 2020

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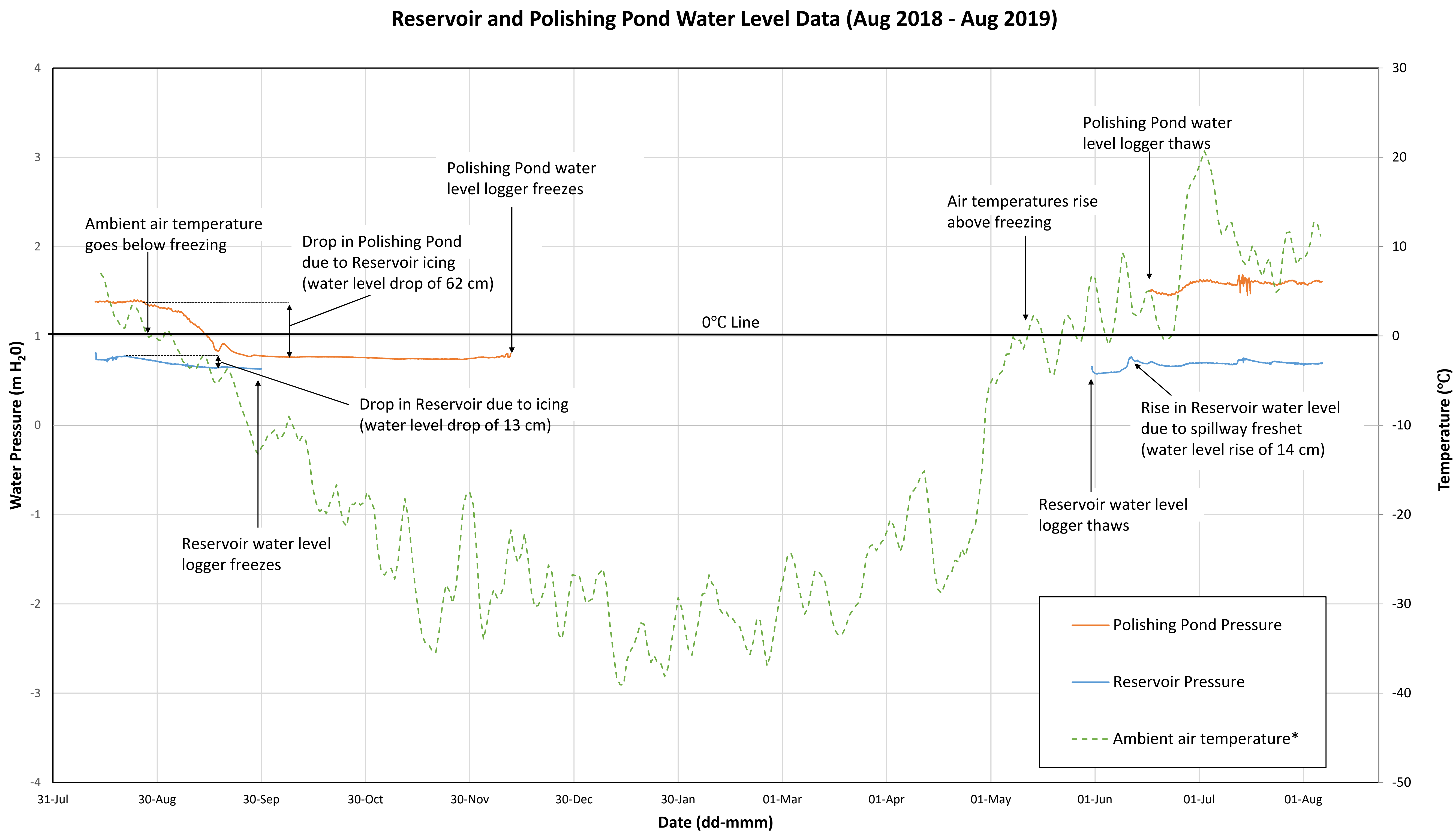

*Ambient air temperature data was collected on the Surface Cell Cover at 3 hour intervals. 3-day moving average shown.

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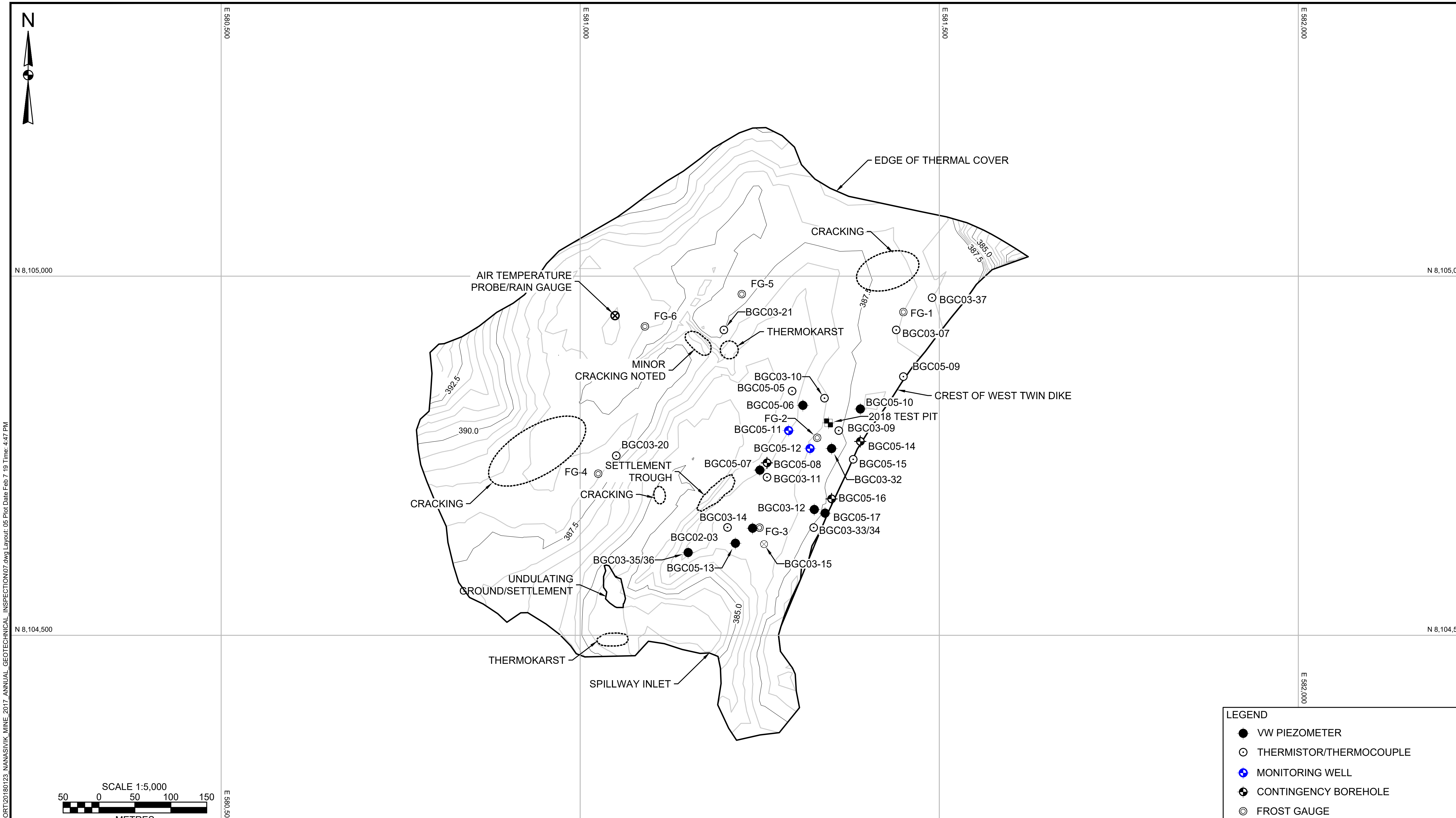
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: nyrstar

REPORT TITLE: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION	
DRAWING TITLE: RESERVOIR AND POLISHING POND WATER LEVEL DATA	
PROJECT NO.: 0255-030	DRAWING NO.: 04

FEB 2020



THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

NOTES:
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3. CONTOUR INTERVAL IS 0.5 m.
4. PROJECTION IS UTM NAD 83, Z16N.
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SCALE:	1:5,000
DATE:	FEB 2020
DRAWN:	AL
CHECKED:	SG
APPROVED:	GKC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: nyrstar

PROJECT: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION

TITLE: SURFACE CELL TAILINGS COVER

PROJECT No.:	DWG No.:
0255-030	05

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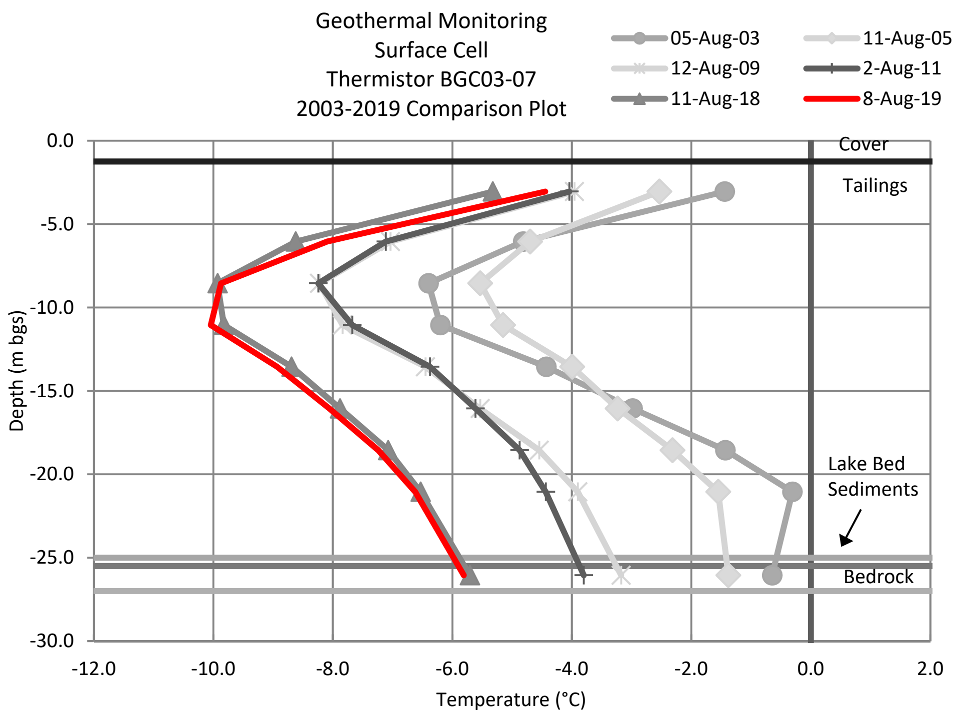

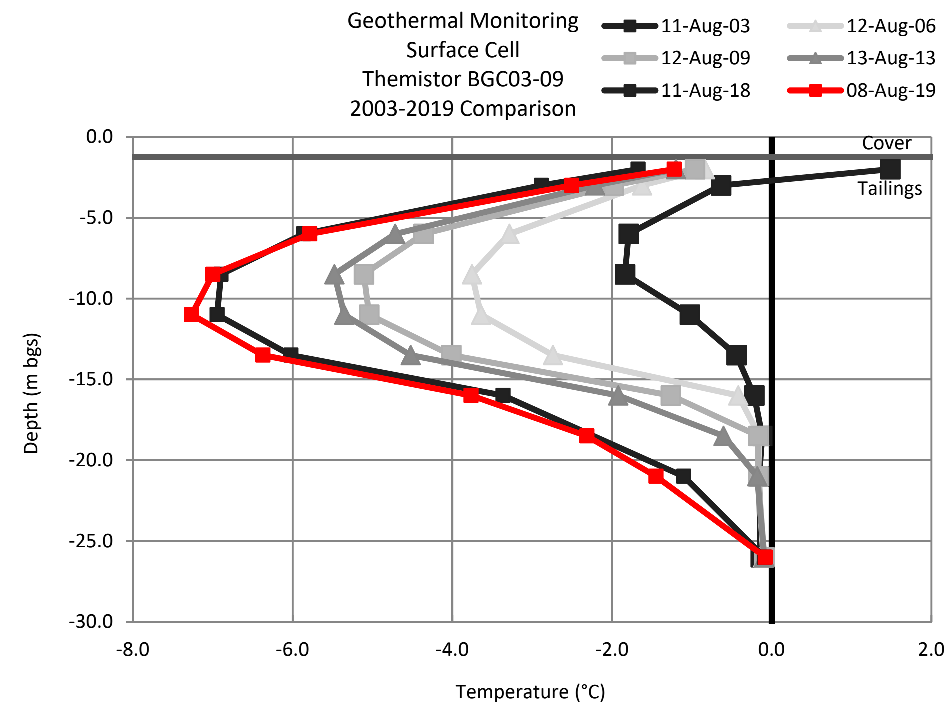

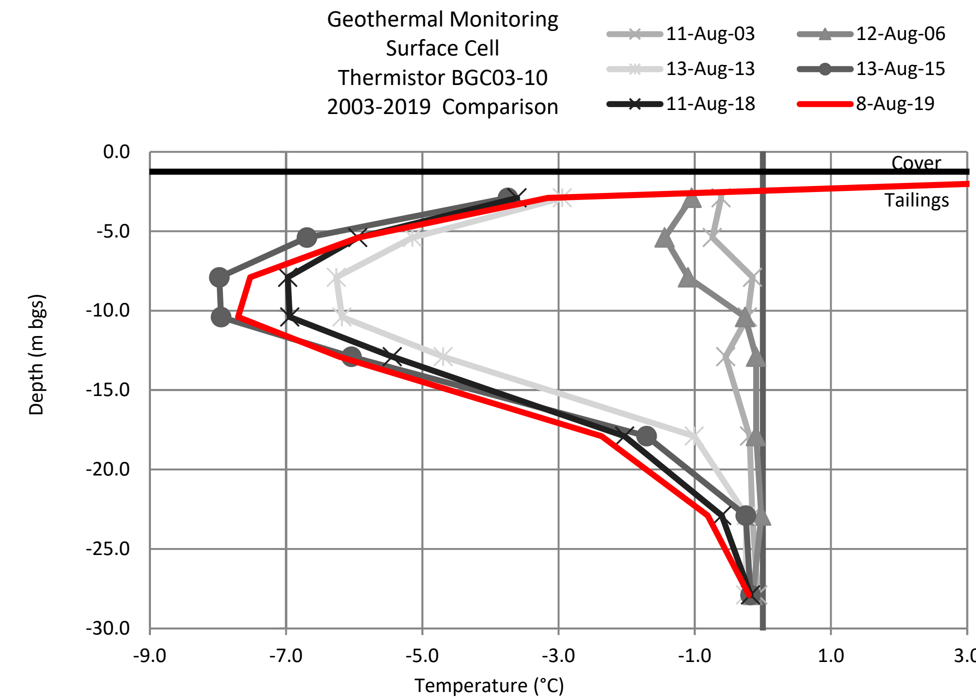

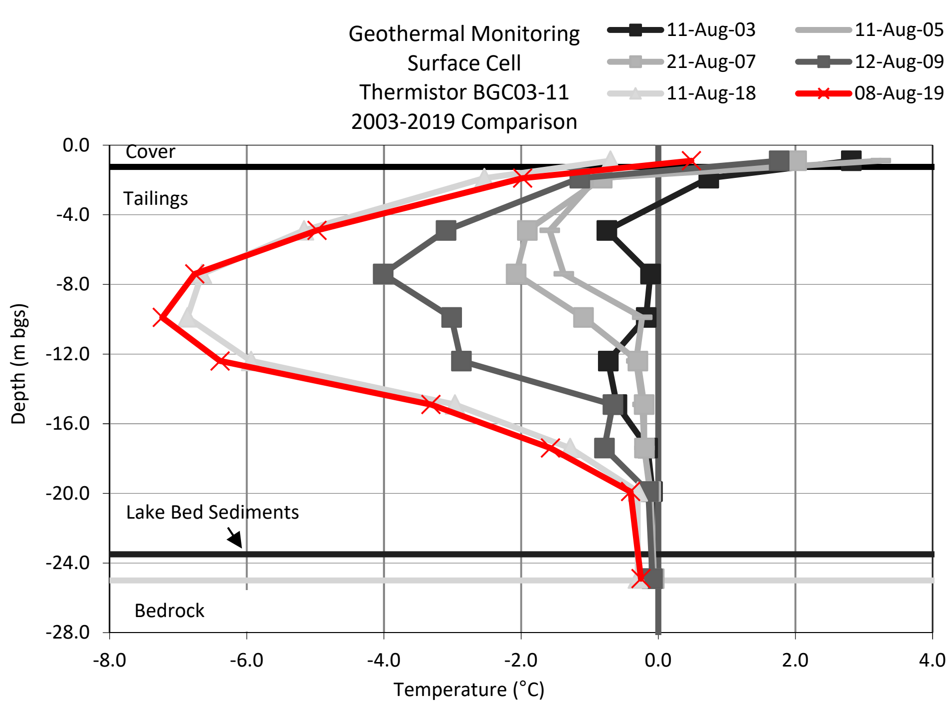

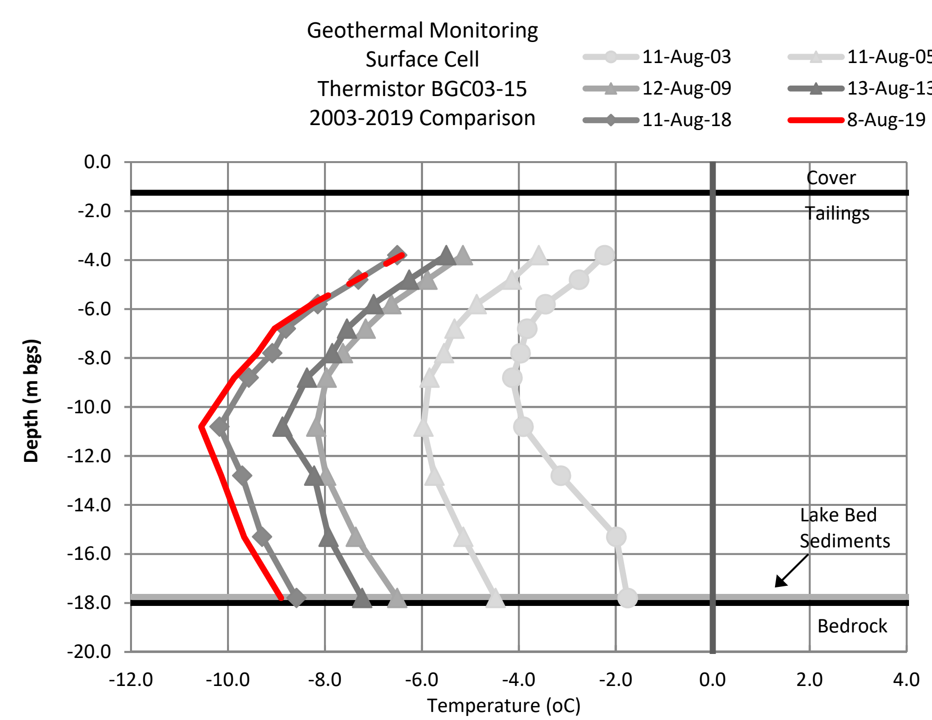

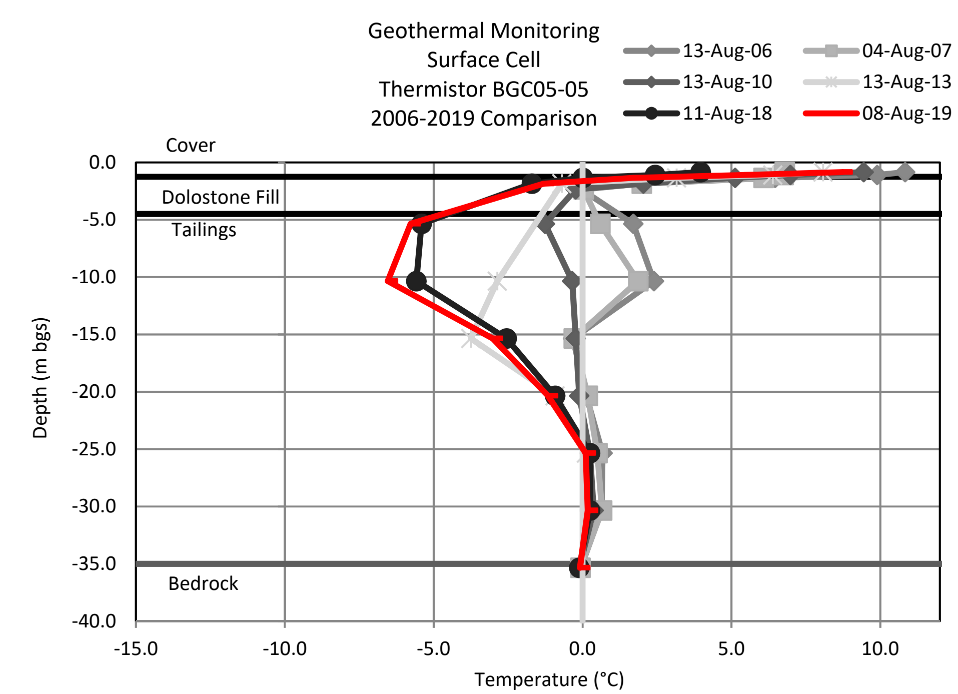

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REPORT TITLE: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION	
DRAWING TITLE: SURFACE CELL TAILINGS COVER GEOTECHNICAL MONITORING DATA 1	
CLIENT: nyrstar	
PROJECT NO.: 0255-030	DRAWING NO.: 06

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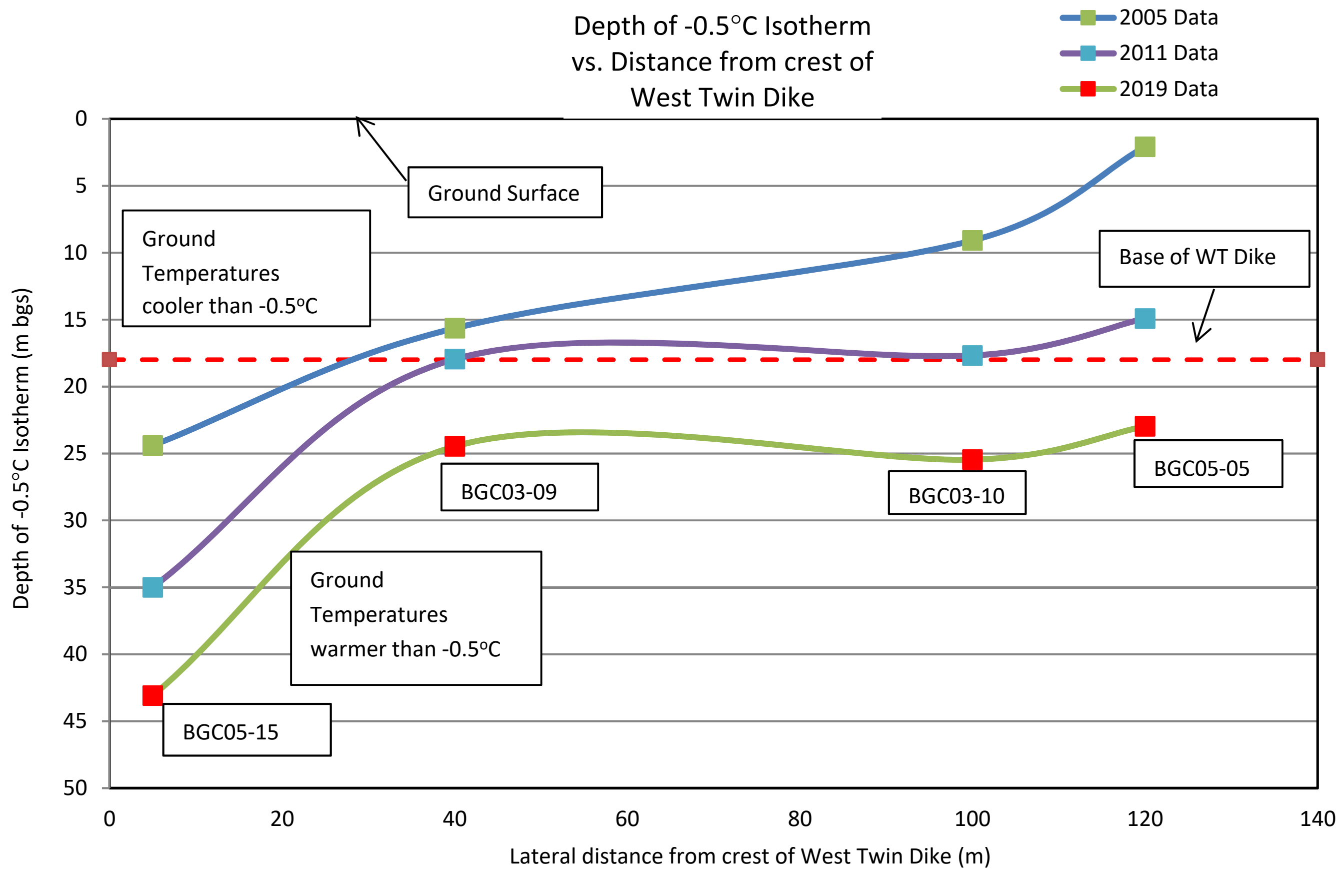

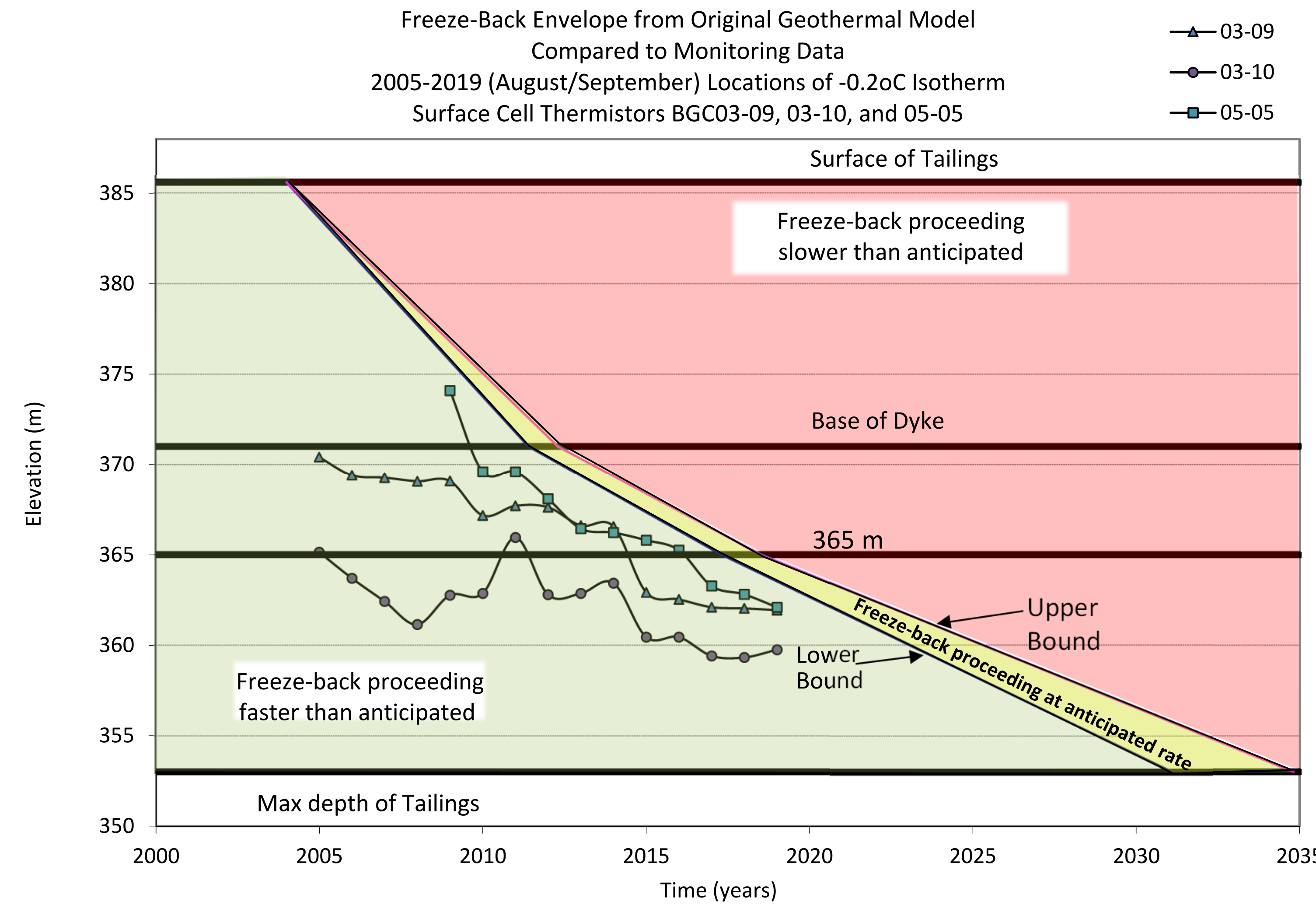

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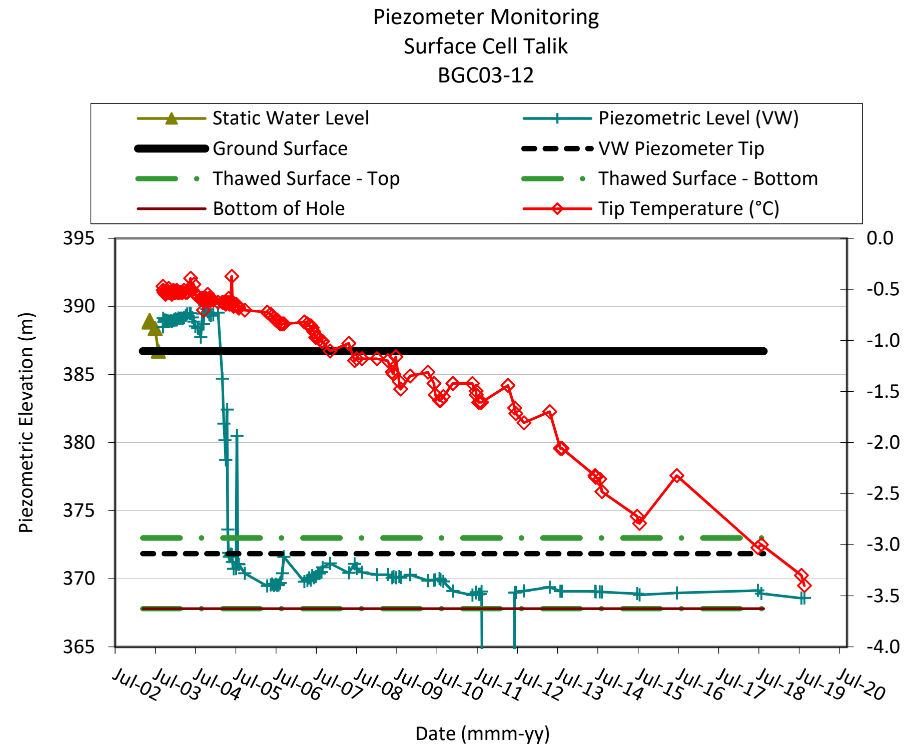
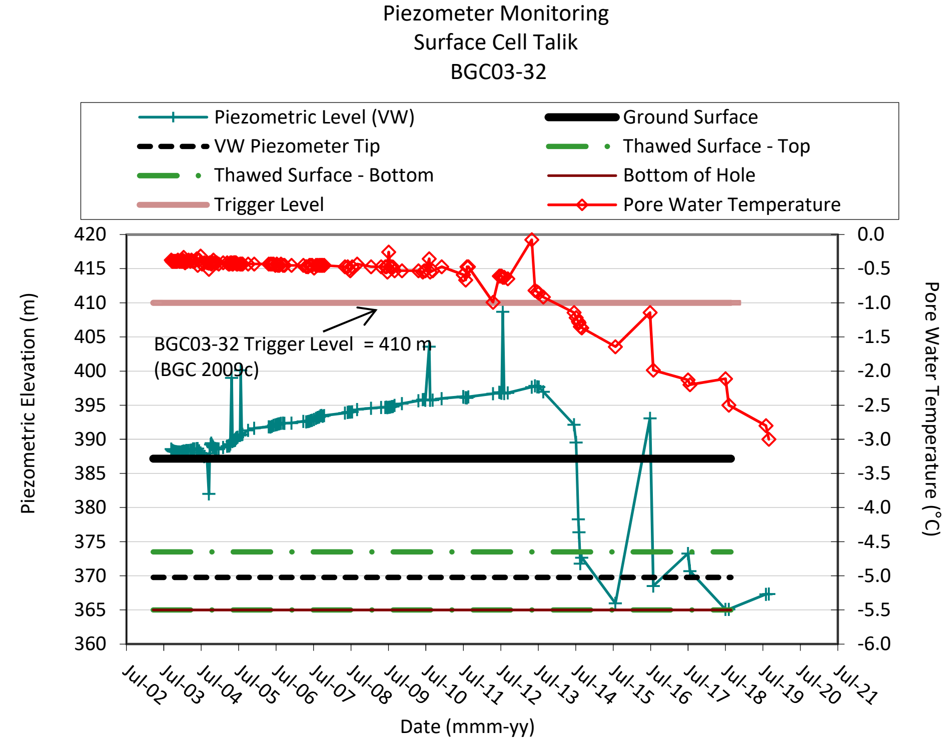
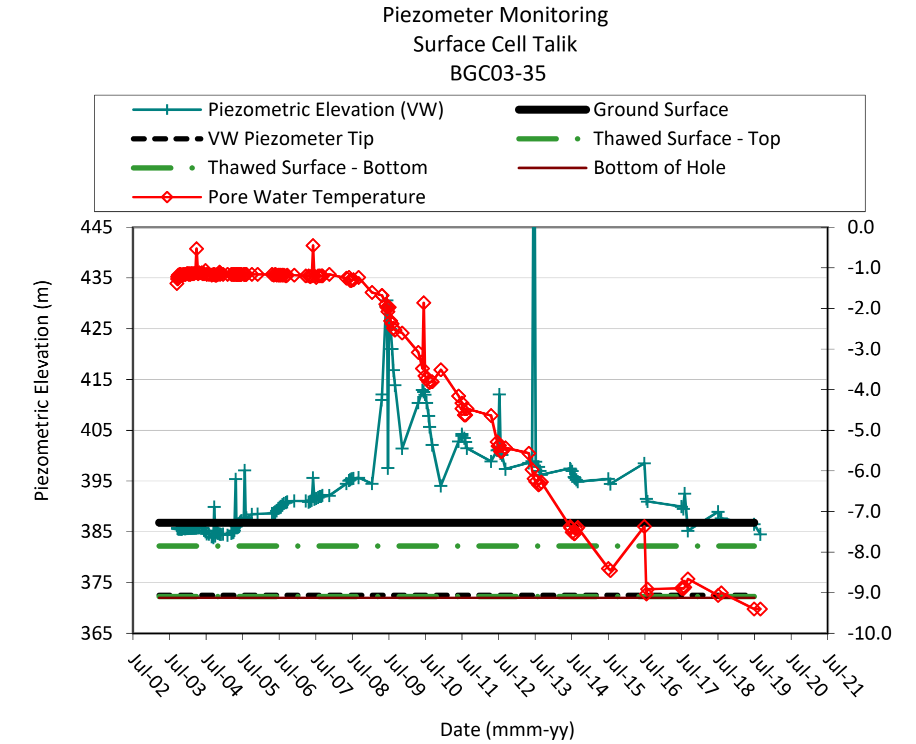
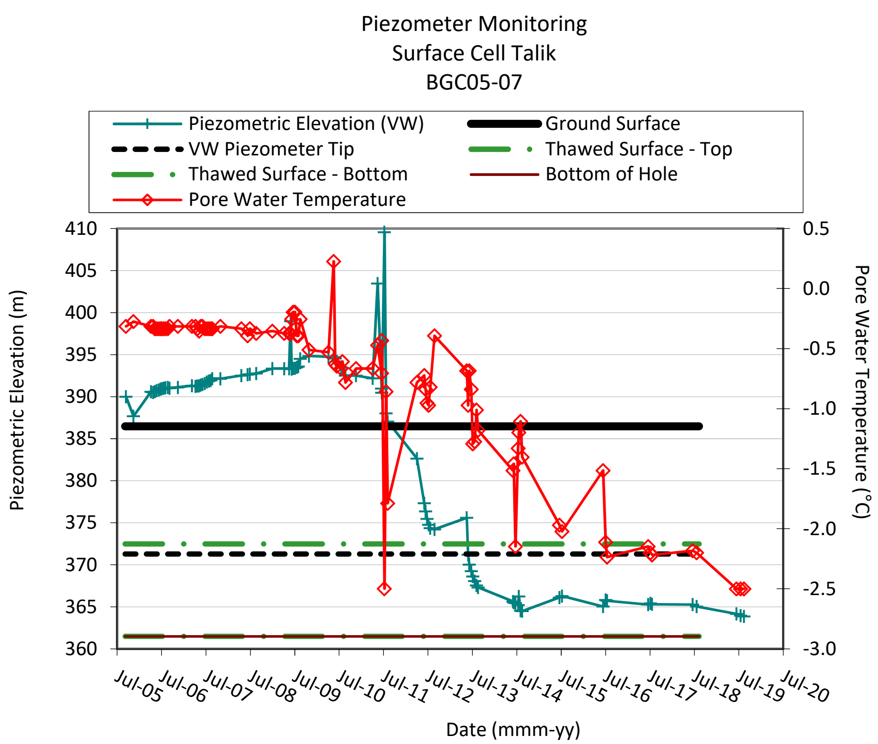
BGC ENGINEERING INC. AN APPLIED EARTH SCIENCES COMPANY	REPORT TITLE: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION
	DRAWING TITLE: SURFACE CELL TAILINGS COVER GEOTECHNICAL MONITORING DATA 2
CLIENT: nyrstar	PROJECT NO.: 0255-030 — DRAWING NO.: 07

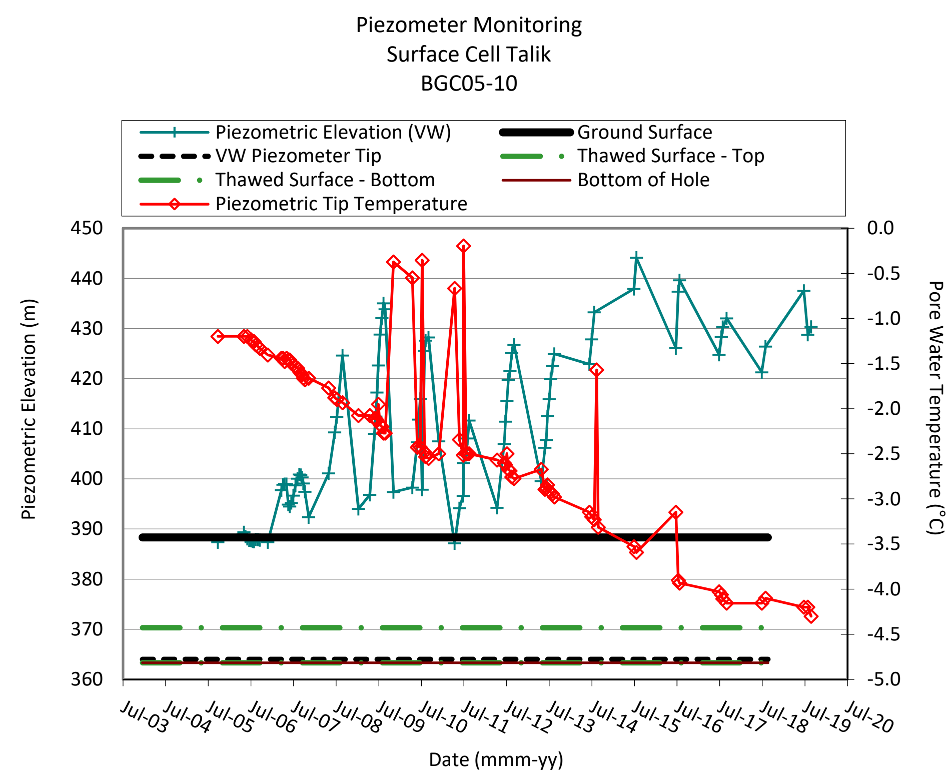
FEB 2020

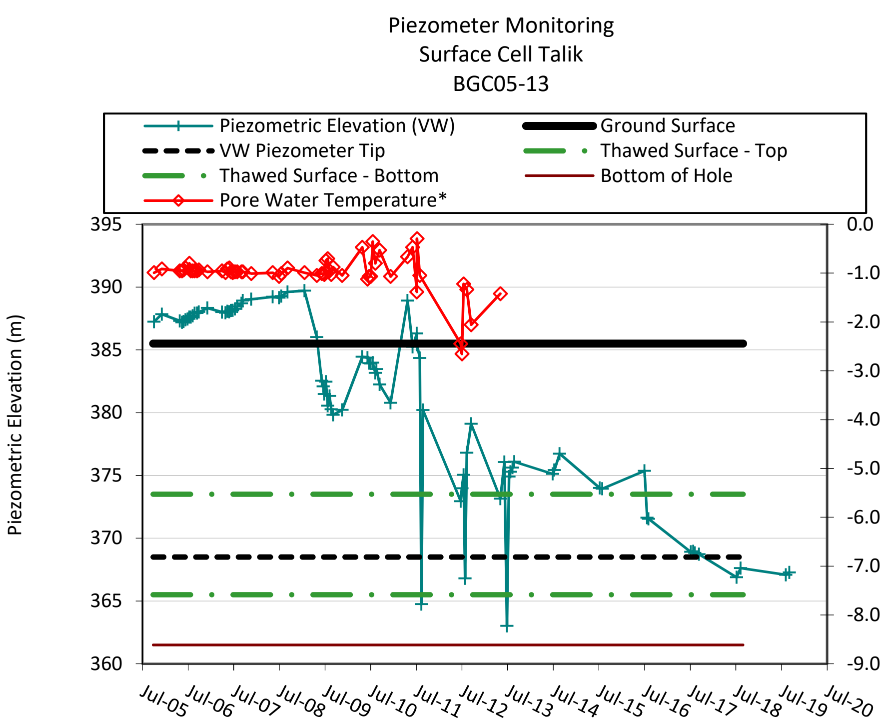












*No resistance measurements obtained from 2012 through 2018. Pore Water Temperature measured directly beginning in 2019.

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BGC ENGINEERING INC. AN APPLIED EARTH SCIENCES COMPANY	REPORT TITLE: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION
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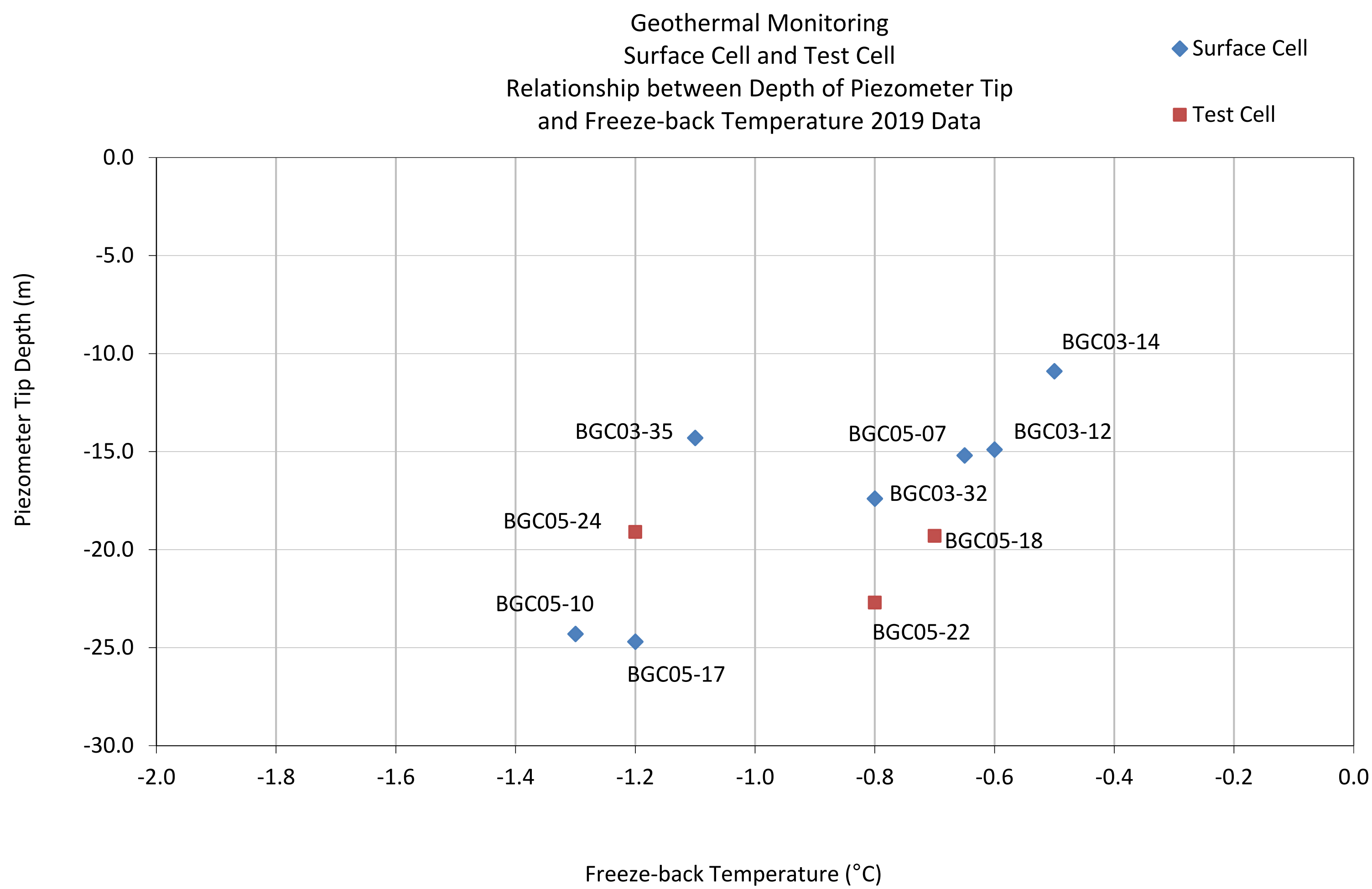
CLIENT: nyrstar	PROJECT NO.: 0255-030 / DRAWING NO.: 08

FEB 2020



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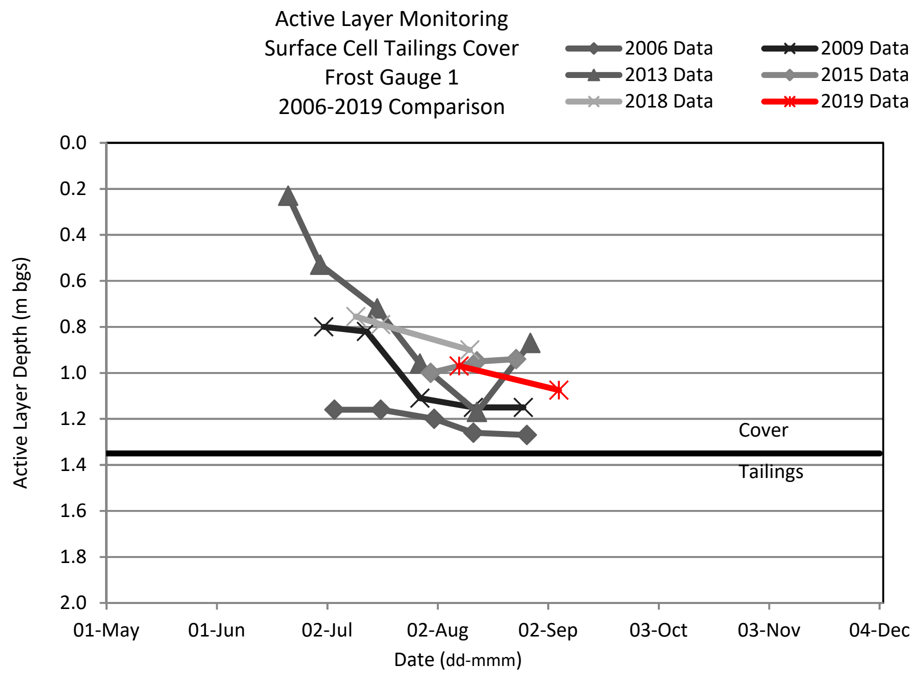
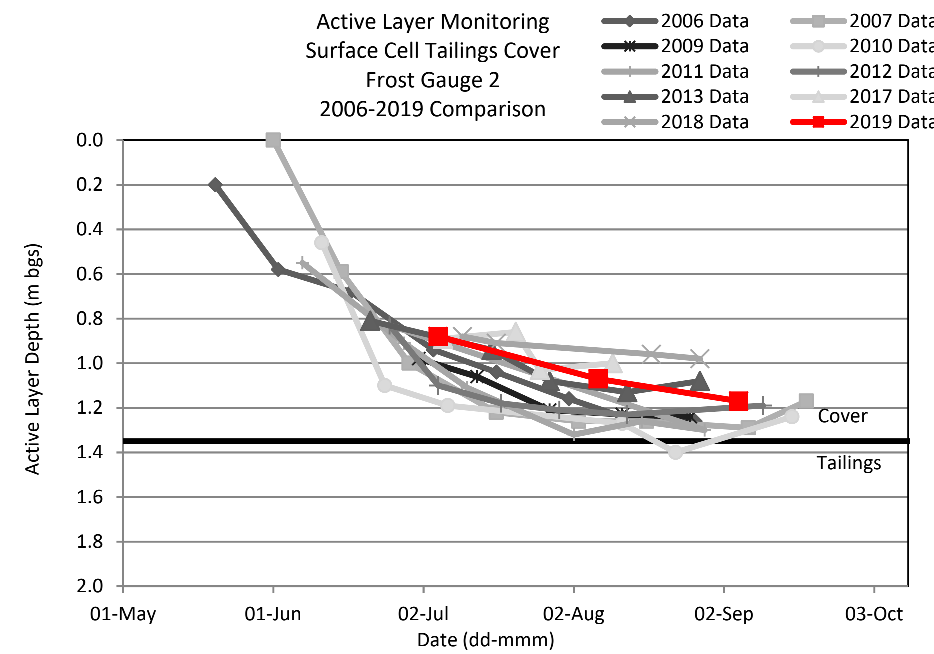
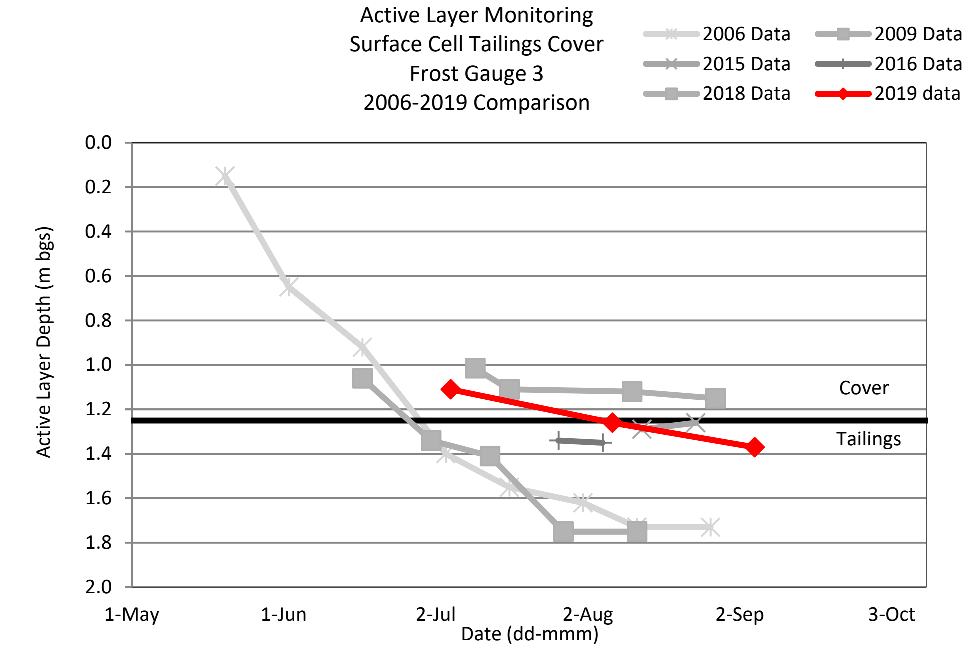
"NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION", DATED FEBRUARY 2020

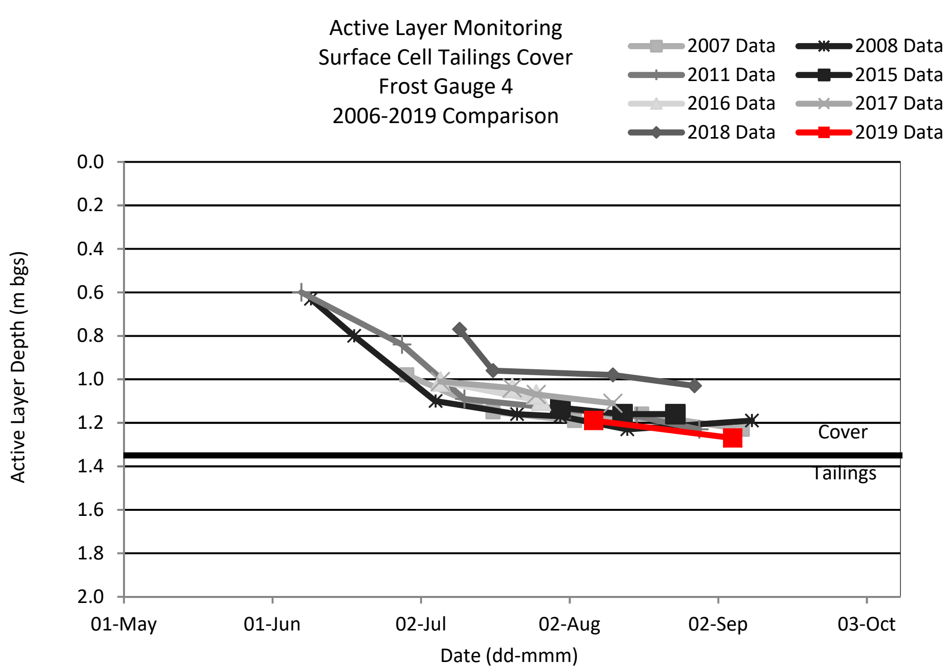
BGC ENGINEERING INC. AN APPLIED EARTH SCIENCES COMPANY		REPORT TITLE: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION	
		DRAWING TITLE: SURFACE CELL TAILINGS COVER GEOTECHNICAL MONITORING DATA 4	
CLIENT: nyrstar		PROJECT NO.: 0255-030	DRAWING NO.: 09

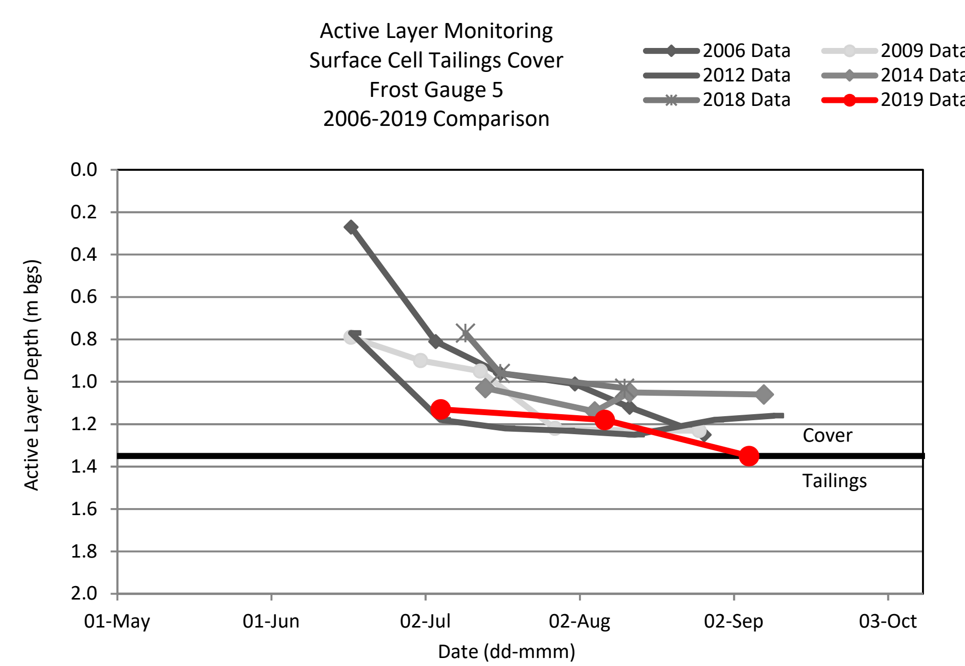
FEB 2020

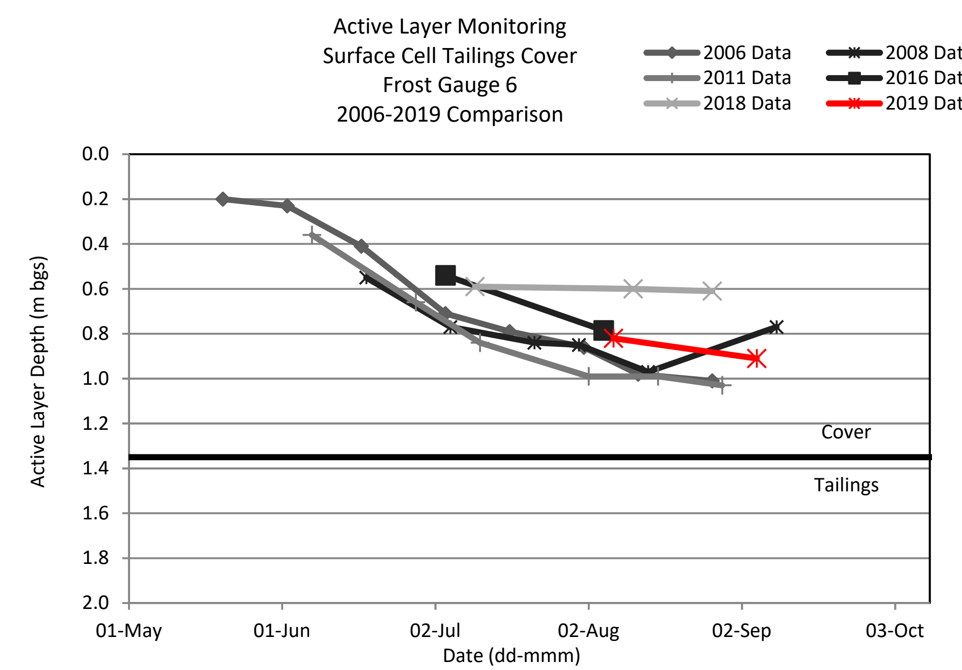












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REPORT TITLE:	NANISVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION
DRAWING TITLE:	SURFACE CELL TAILINGS COVER GEOTECHNICAL MONITORING DATA 5
CLIENT:	nyrstar
PROJECT NO.: 0255-030	DRAWING NO.: 10

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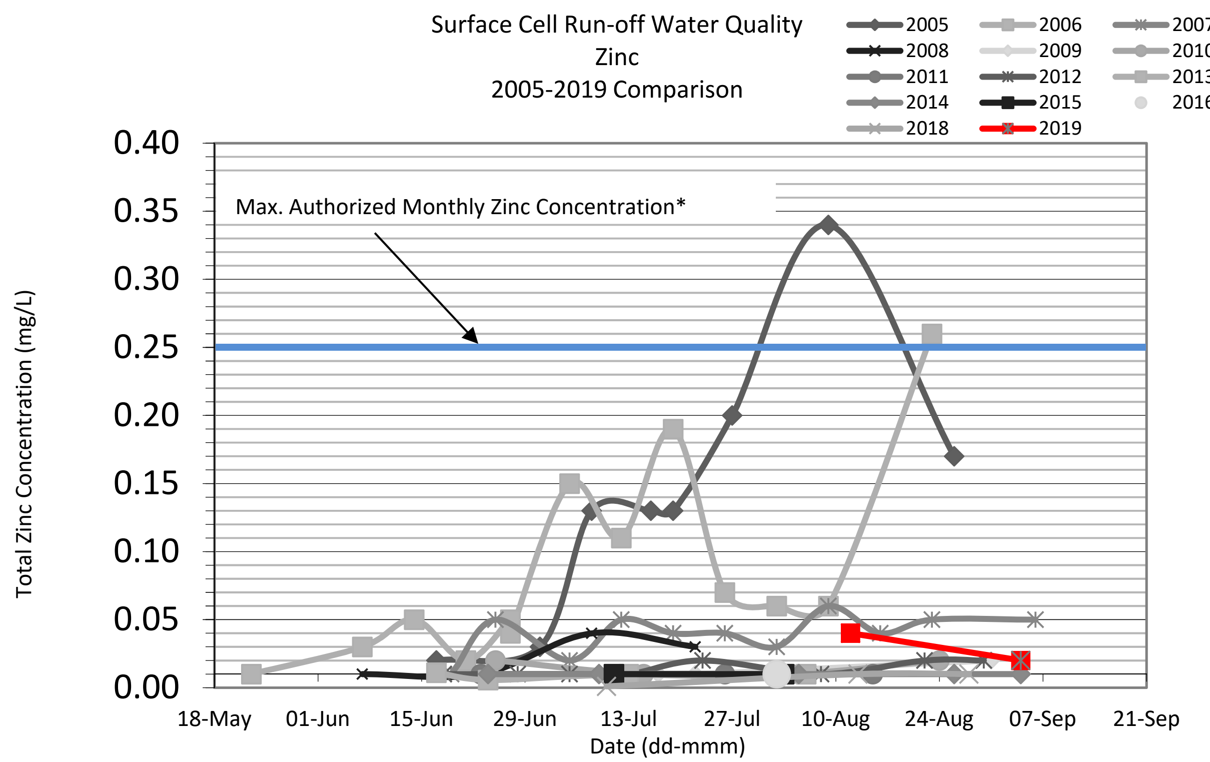
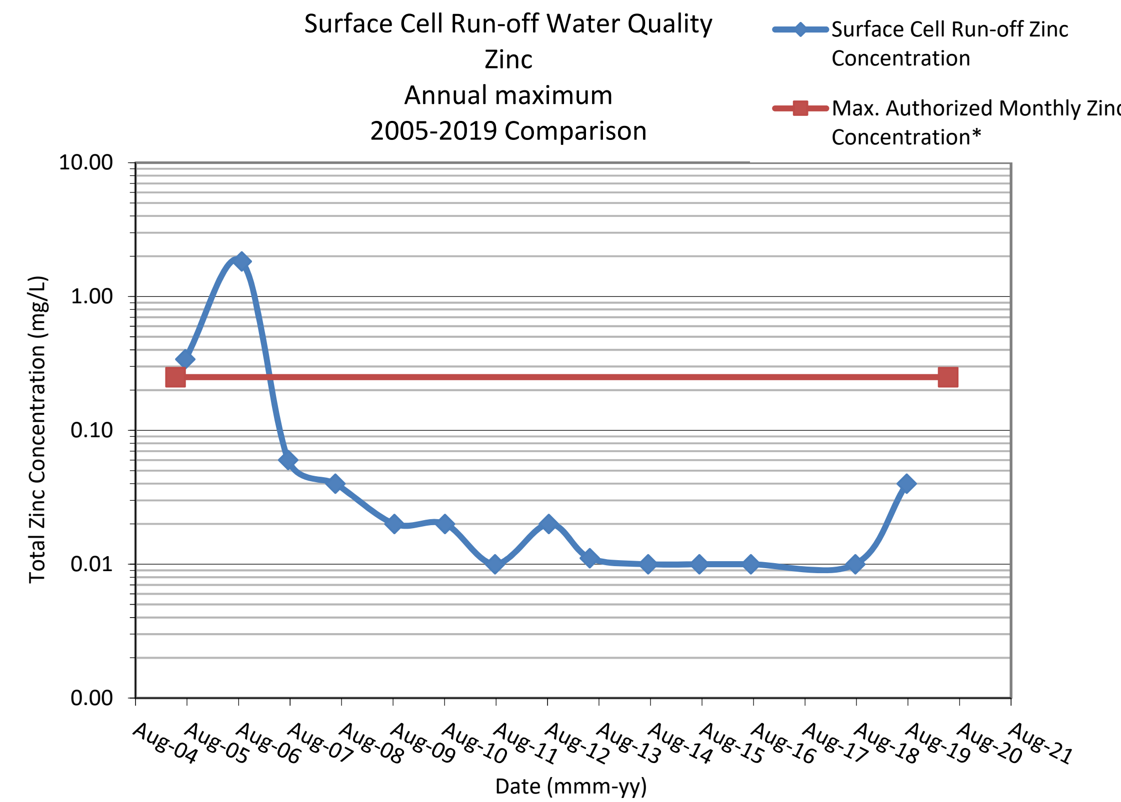


*Maximum authorized monthly Zinc concentration for water quality monitoring station 159-4 downstream.



*Maximum authorized monthly Zinc concentration for water quality monitoring station 159-4 downstream.

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

REPORT TITLE:	NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION
DRAWING TITLE:	SURFACE CELL RUN-OFF WATER QUALITY DATA
CLIENT: nyrstar	PROJECT NO.: 0255-030
	DRAWING NO.: 11

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DATE:	FEB 2020
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APPROVED:	GKC

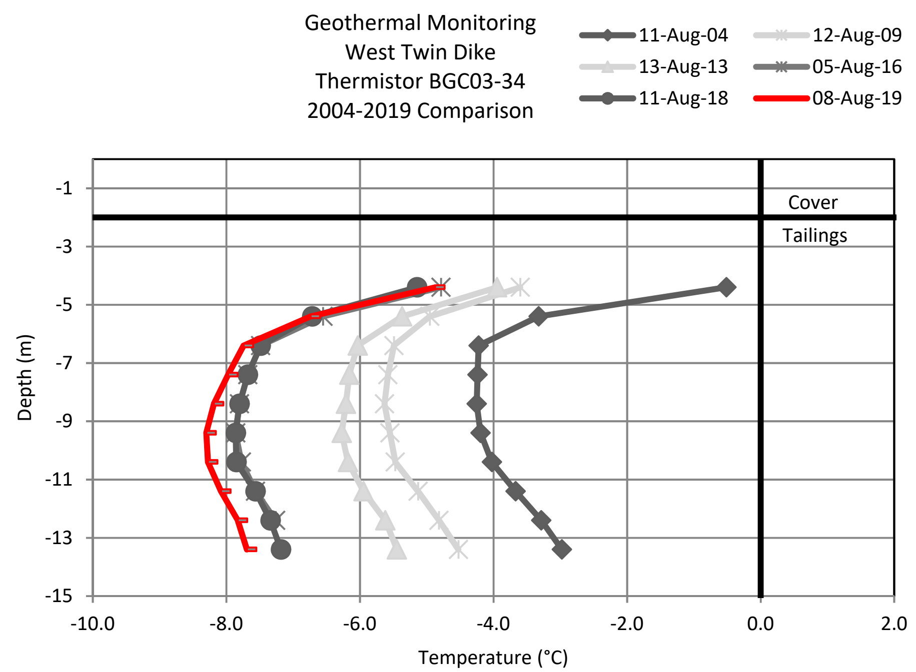
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

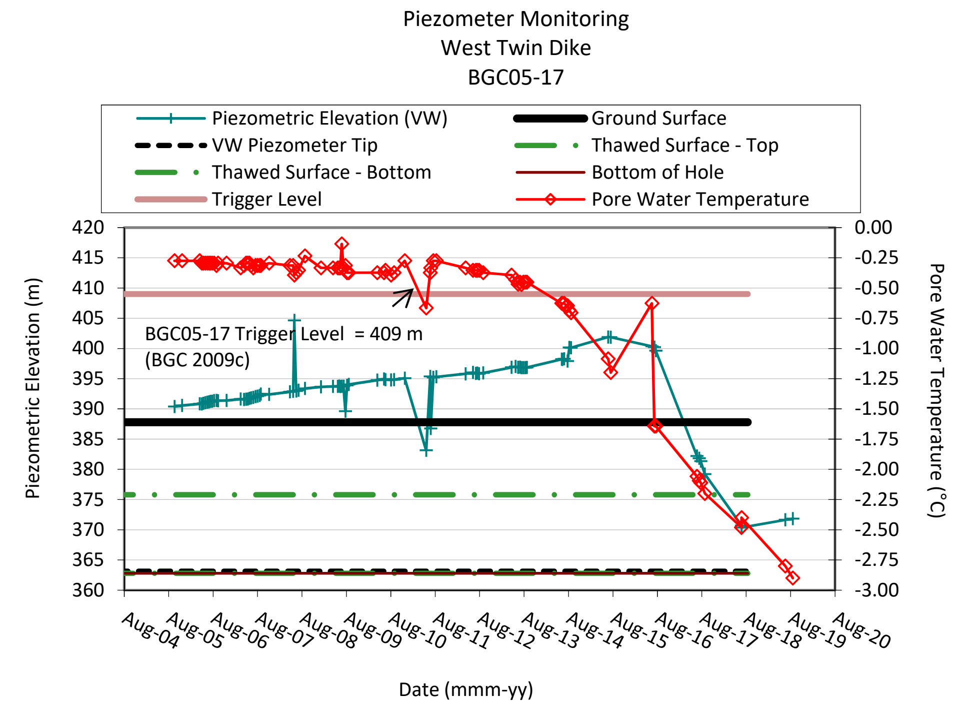
CLIENT:
nyrstar

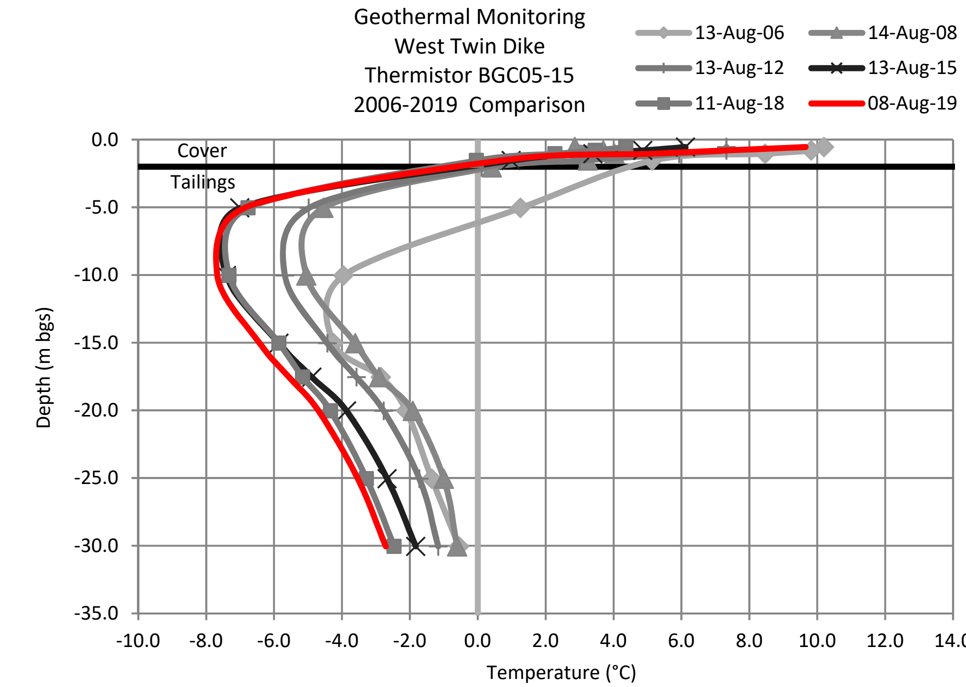
PROJECT:
NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION

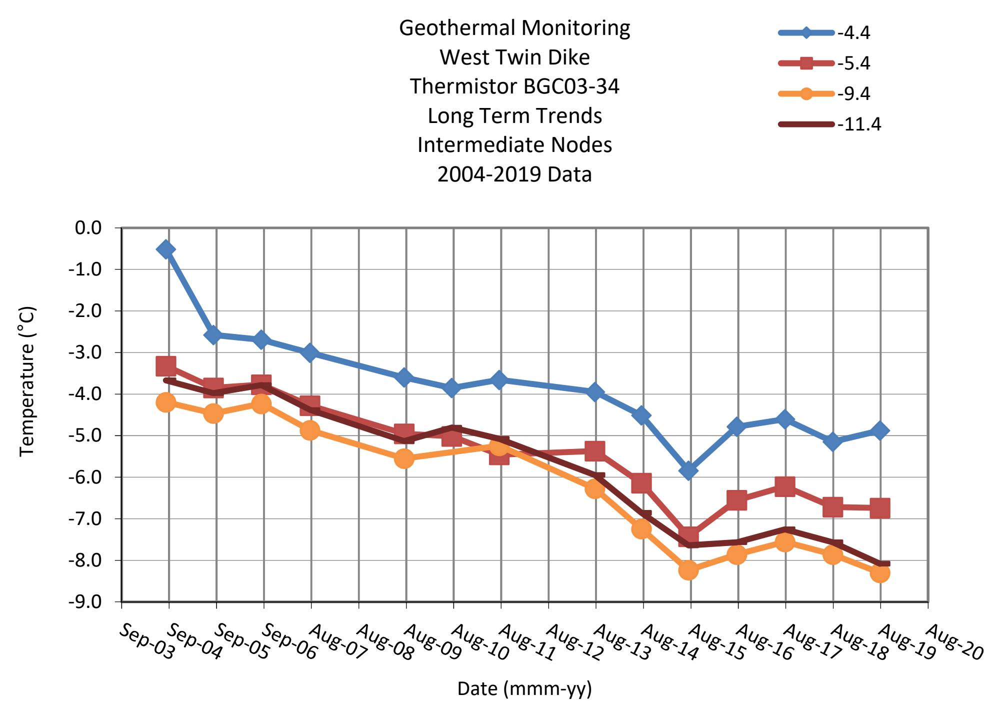
TITLE:
TEST CELL TAILINGS COVER

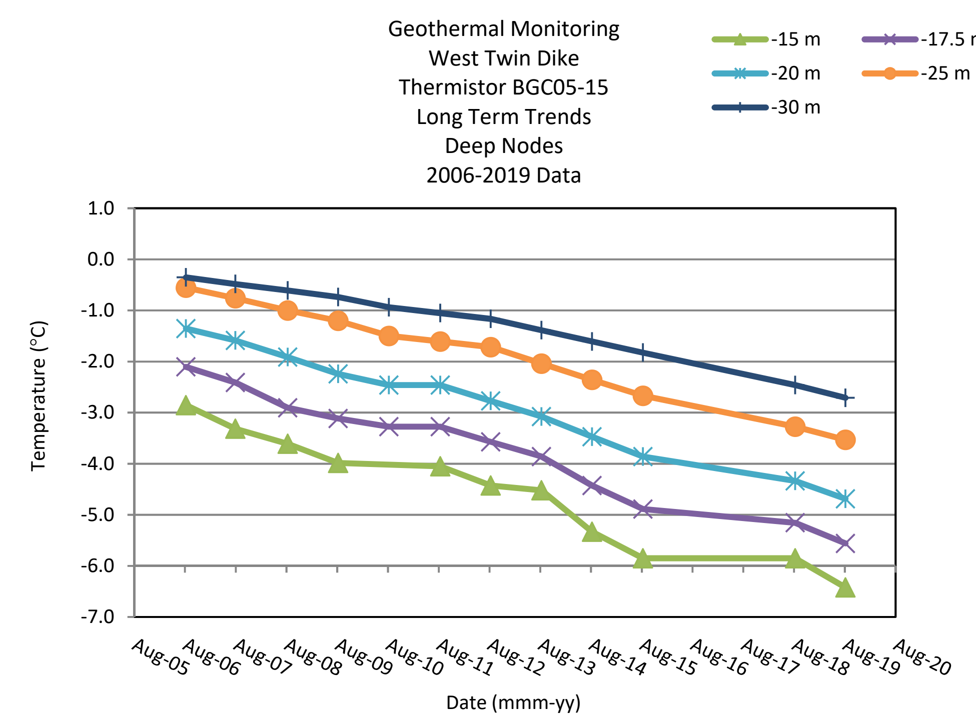
PROJECT No.:	DWG No.:
0255-030	12











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BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: nyrstar

REPORT TITLE: NANISIVIK MINE
2019 ANNUAL GEOTECHNICAL INSPECTION

DRAWING TITLE: WEST TWIN DYKE
GEOTECHNICAL MONITORING DATA

PROJECT NO.: 0255-030

DRAWING NO.: 13

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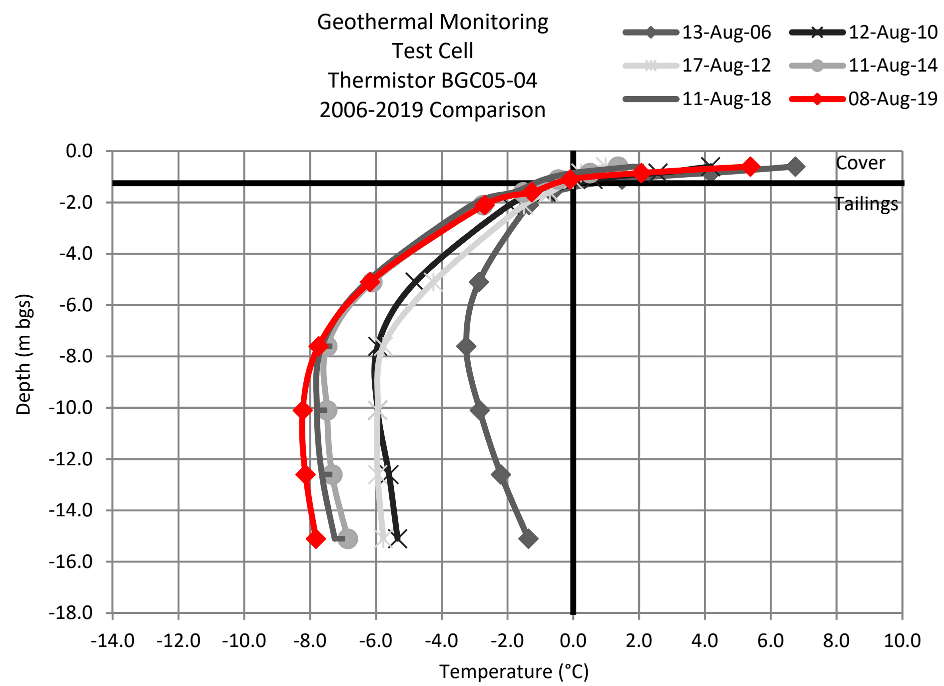

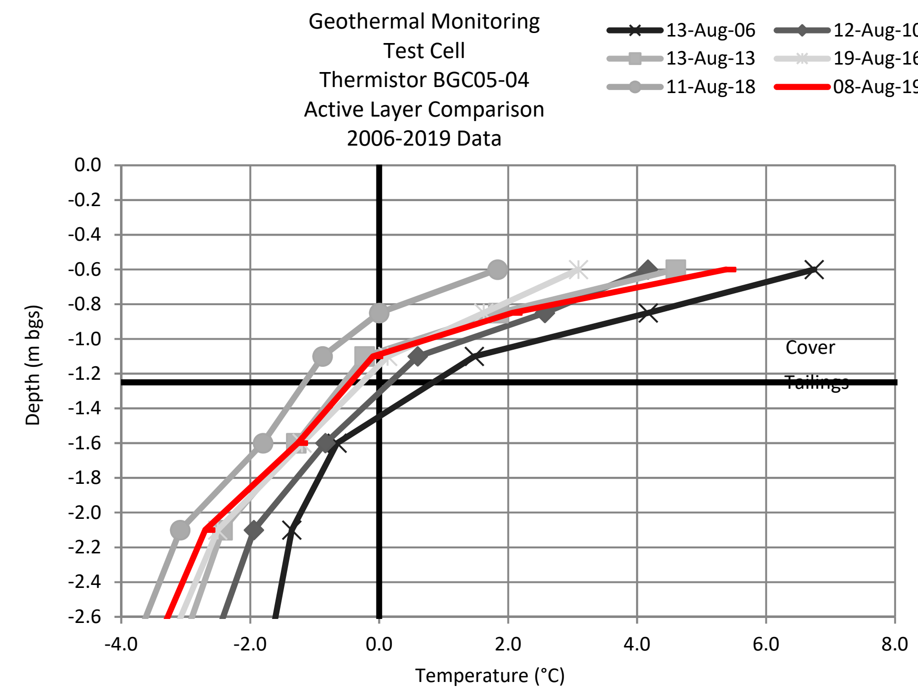

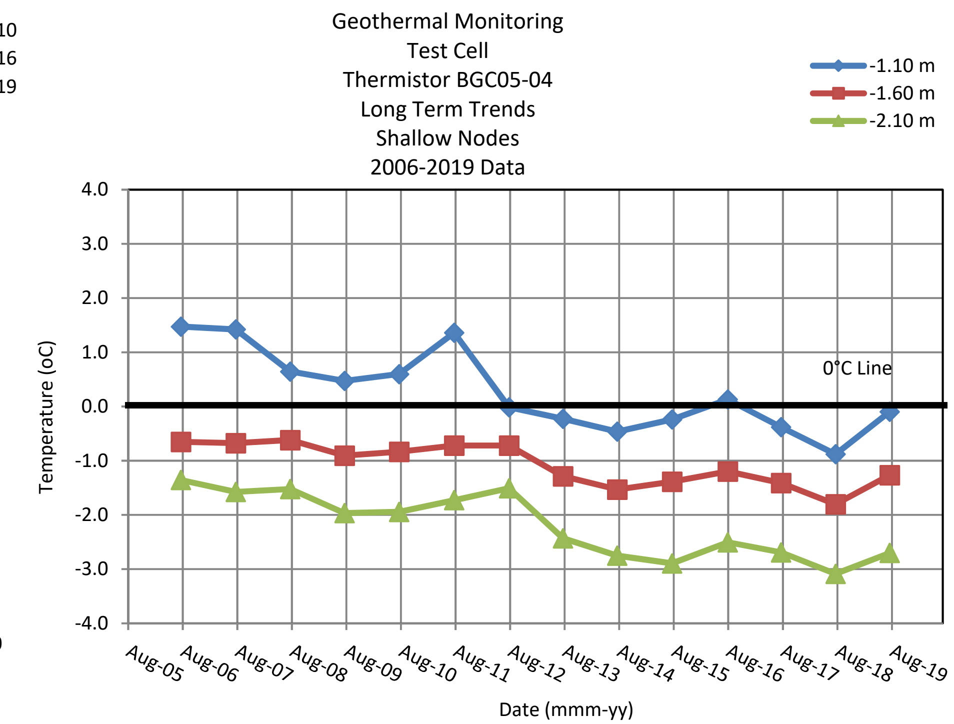

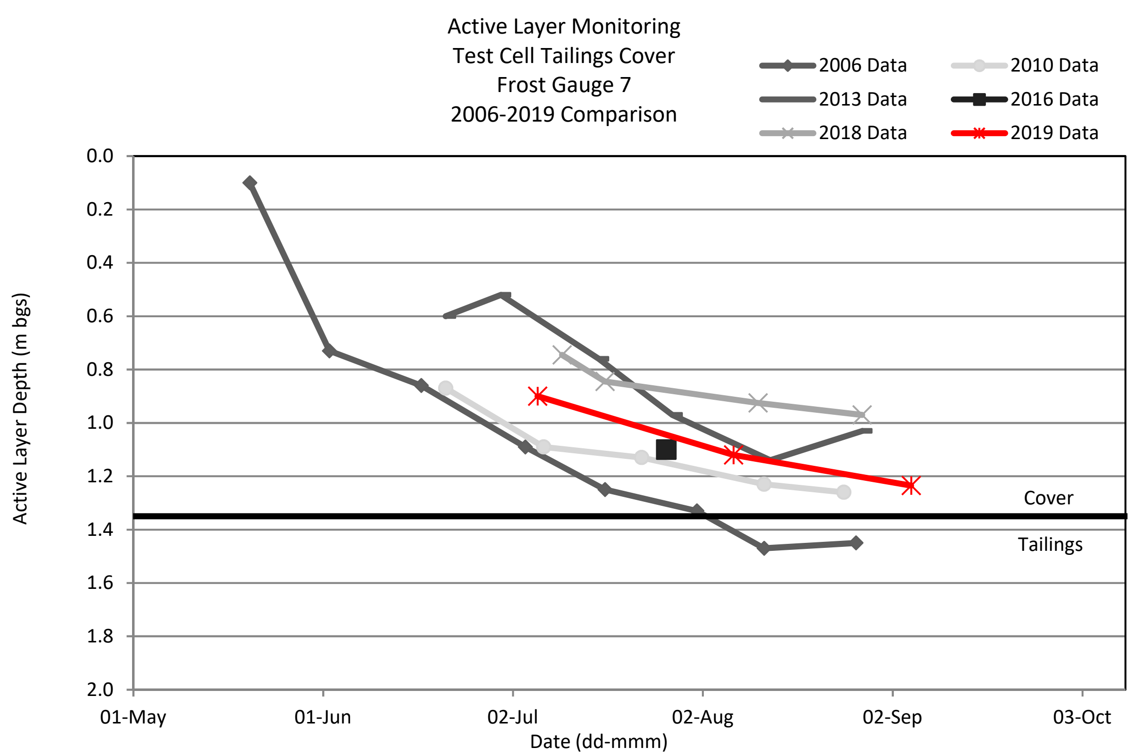

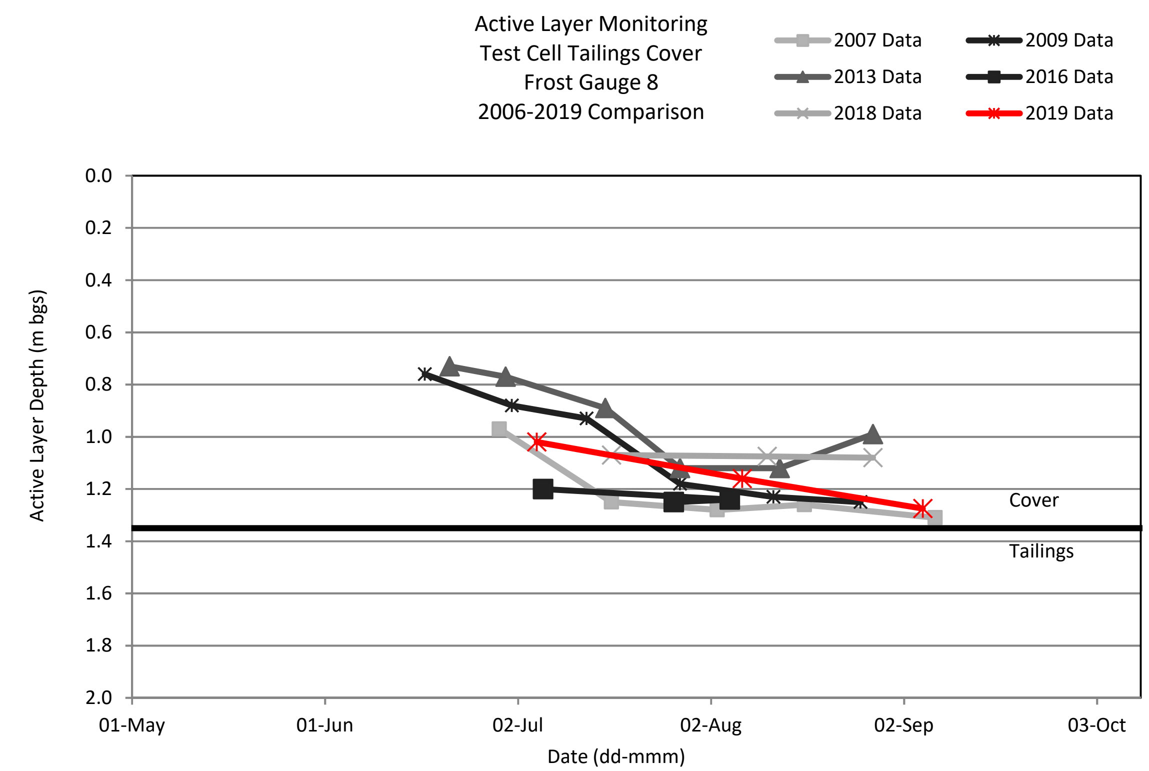

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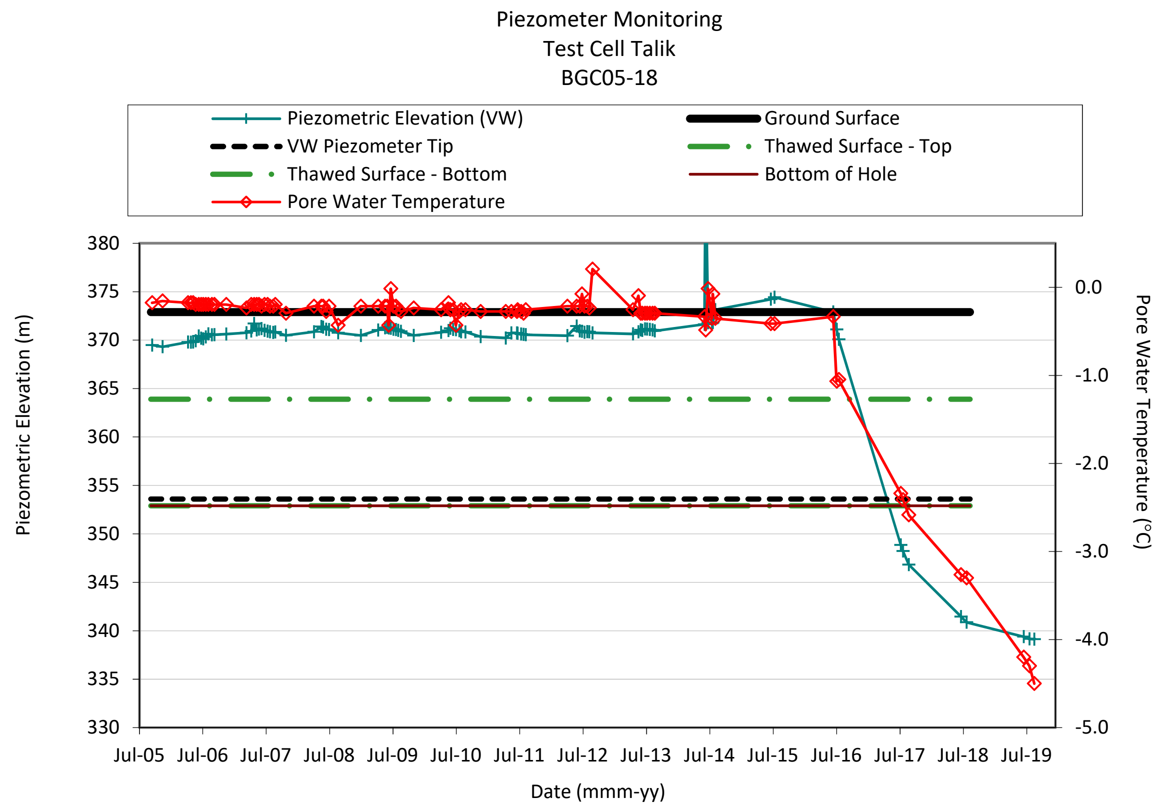
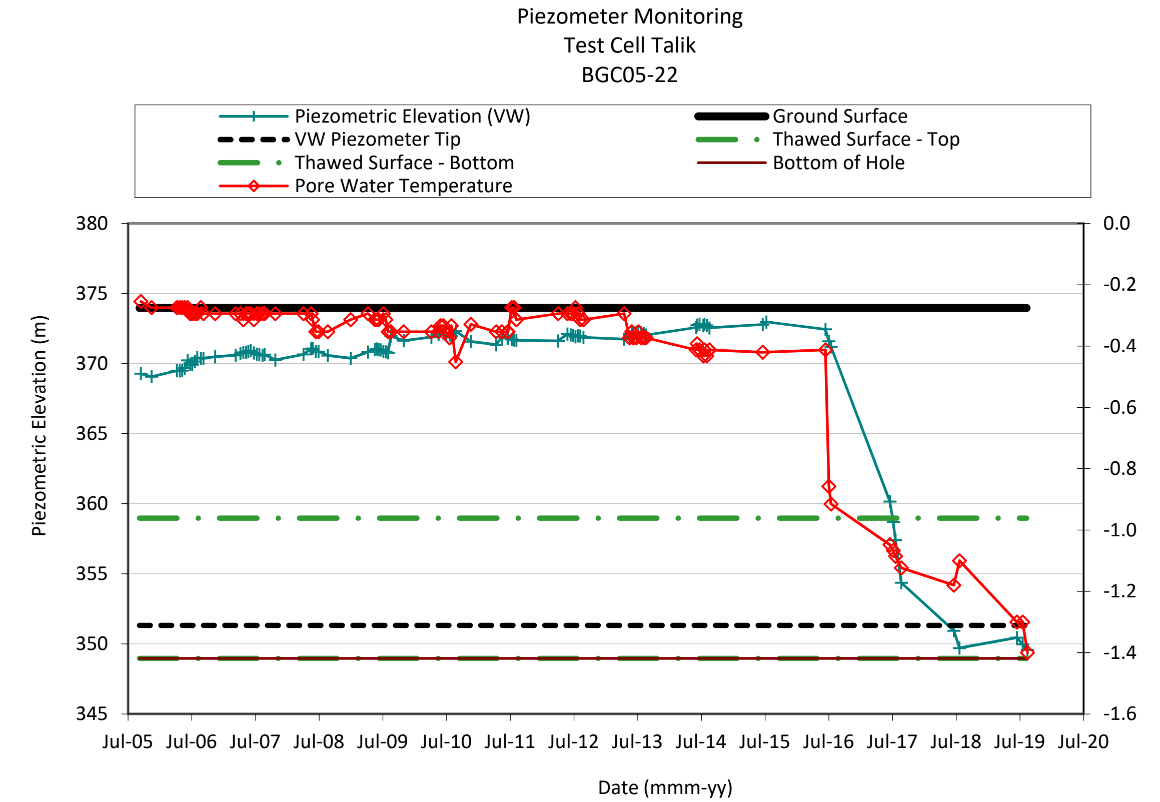
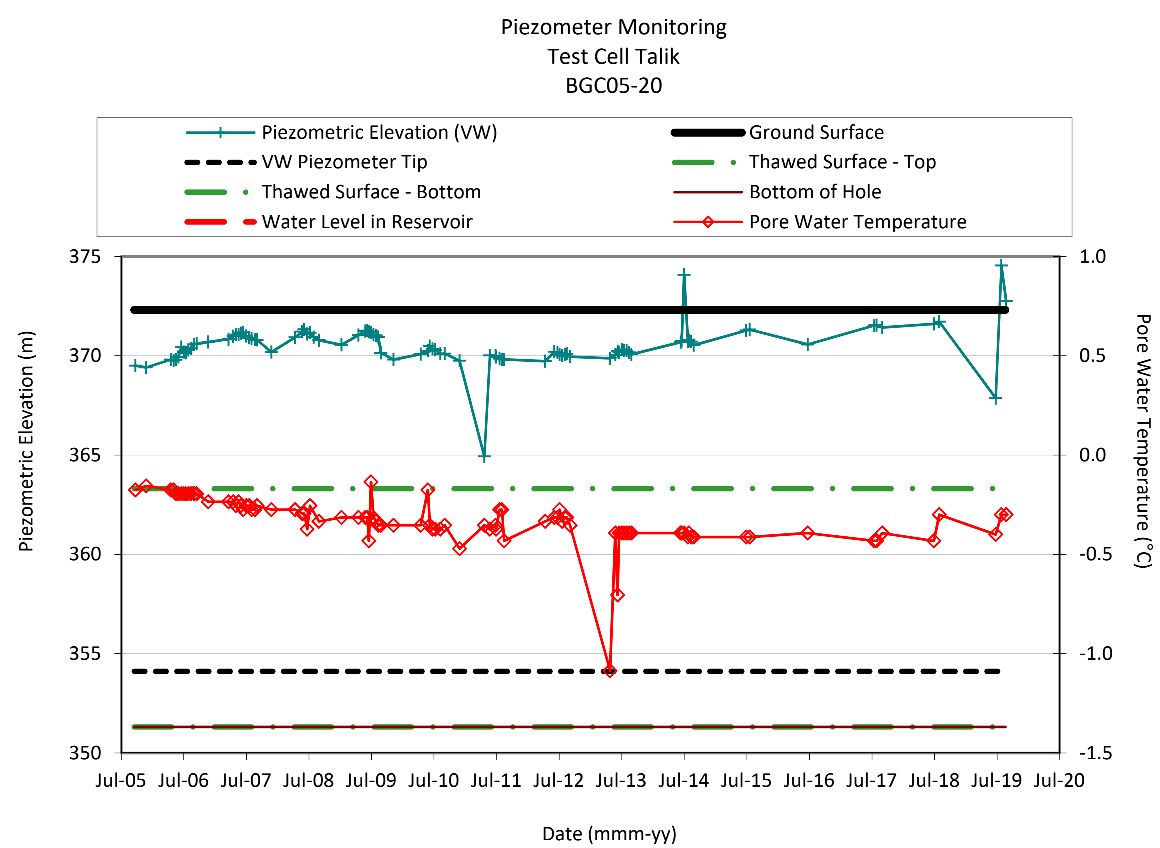
BGC ENGINEERING INC. AN APPLIED EARTH SCIENCES COMPANY	REPORT TITLE: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION
	DRAWING TITLE: TEST CELL TAILINGS COVER GEOTECHNICAL MONITORING DATA 1
CLIENT: nyrstar	PROJECT NO.: 0255-030 / DRAWING NO.: 14

FEB 2020







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BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: nyrstar

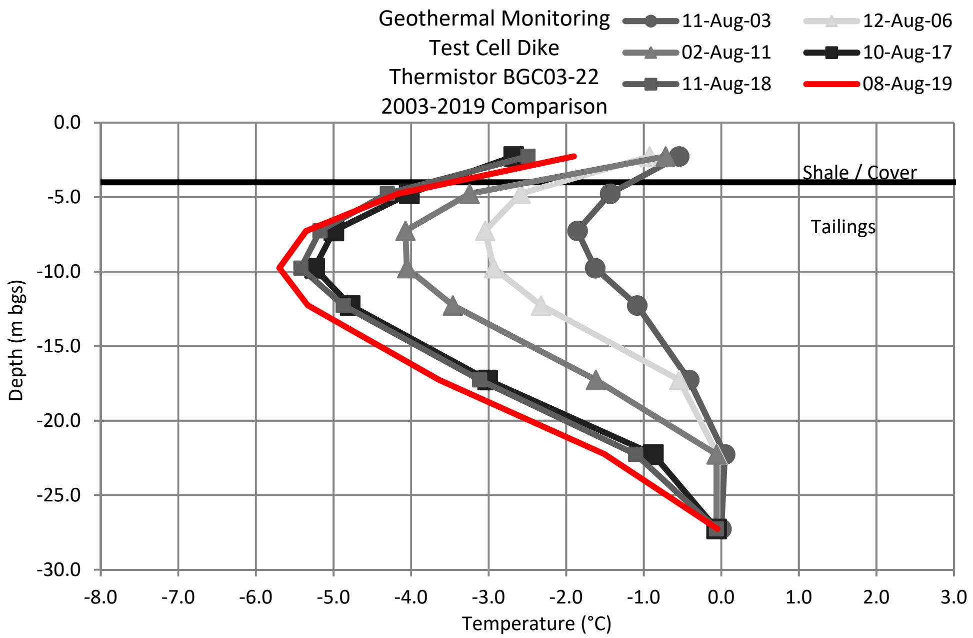
REPORT TITLE: NANISVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION

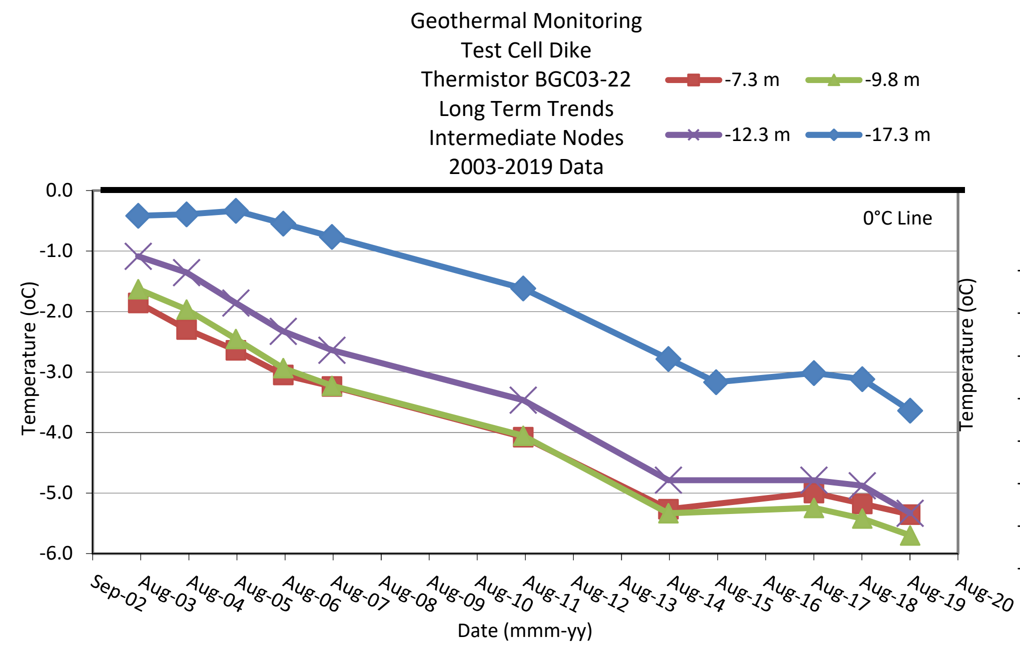
DRAWING TITLE: TEST CELL TAILINGS COVER GEOTECHNICAL MONITORING DATA 2

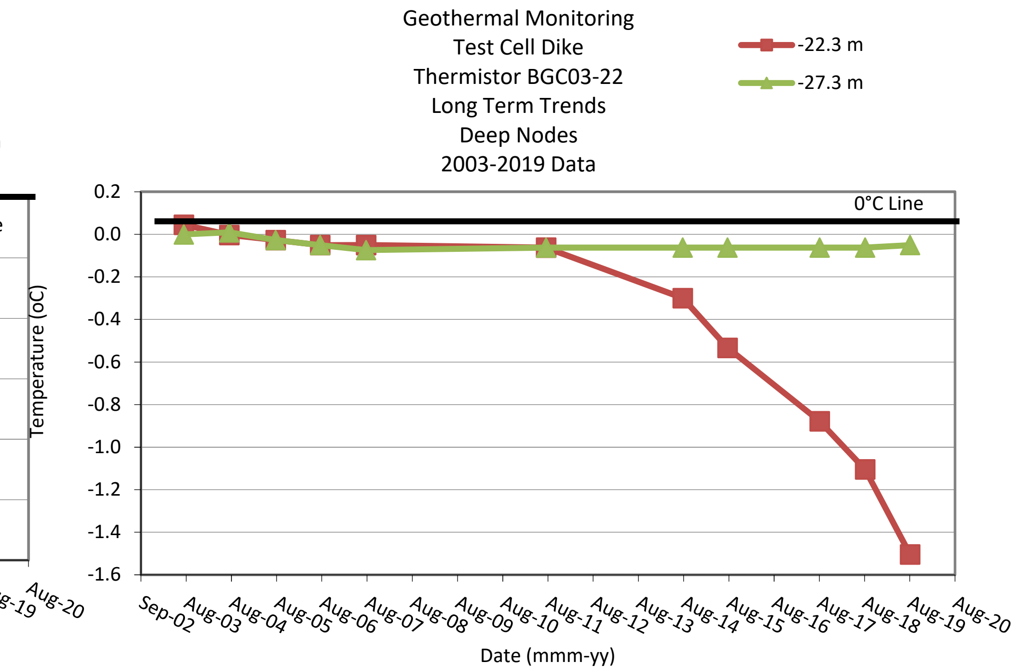
PROJECT NO.: 0255-030

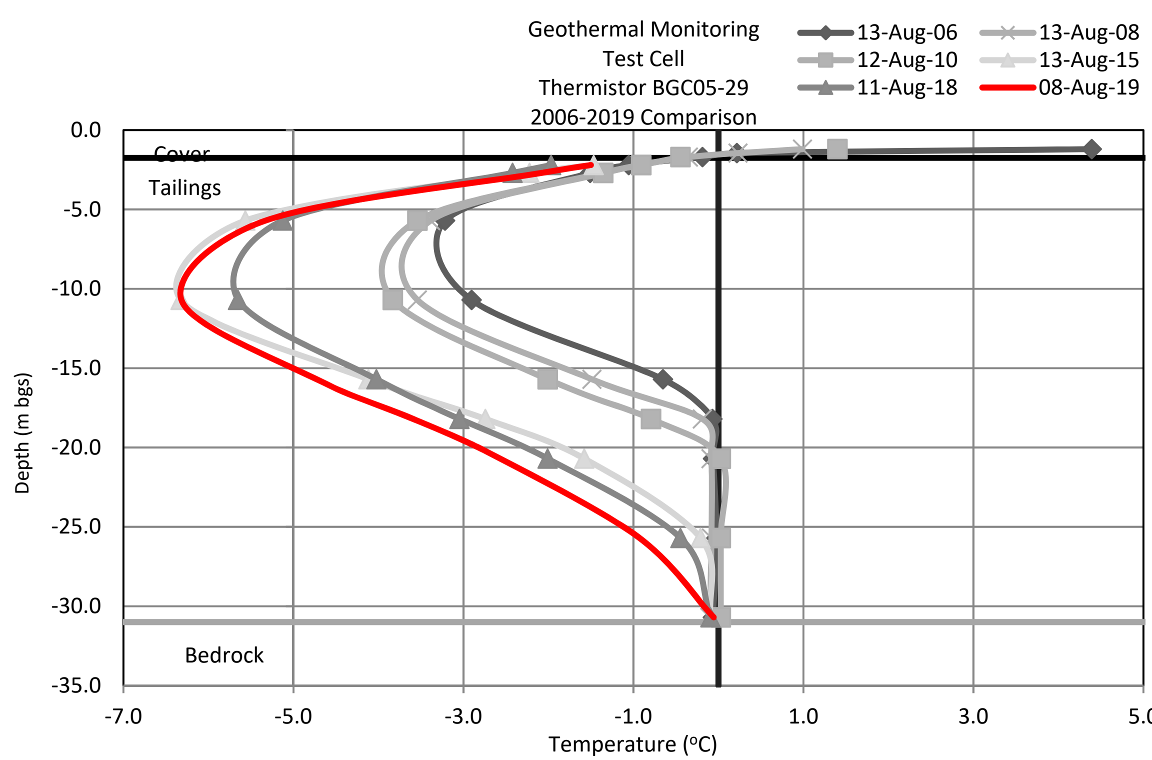
DRAWING NO.: 15

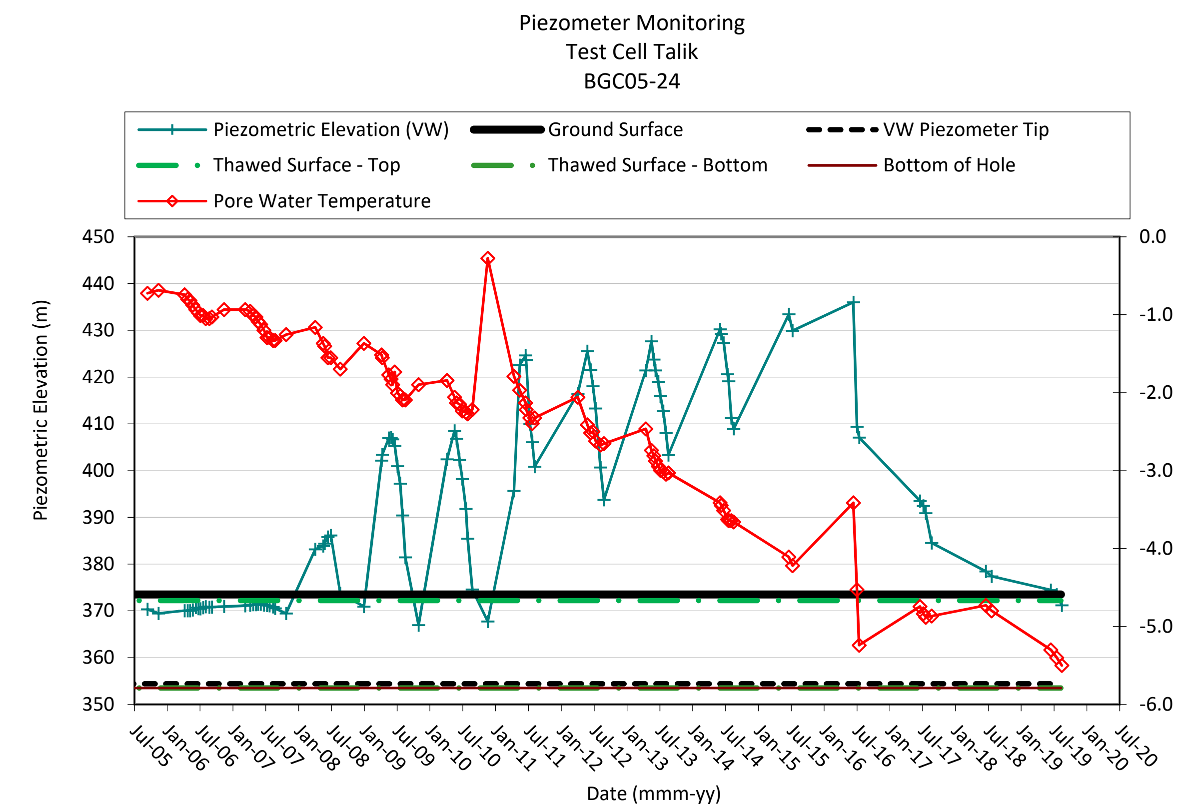
FEB 2020









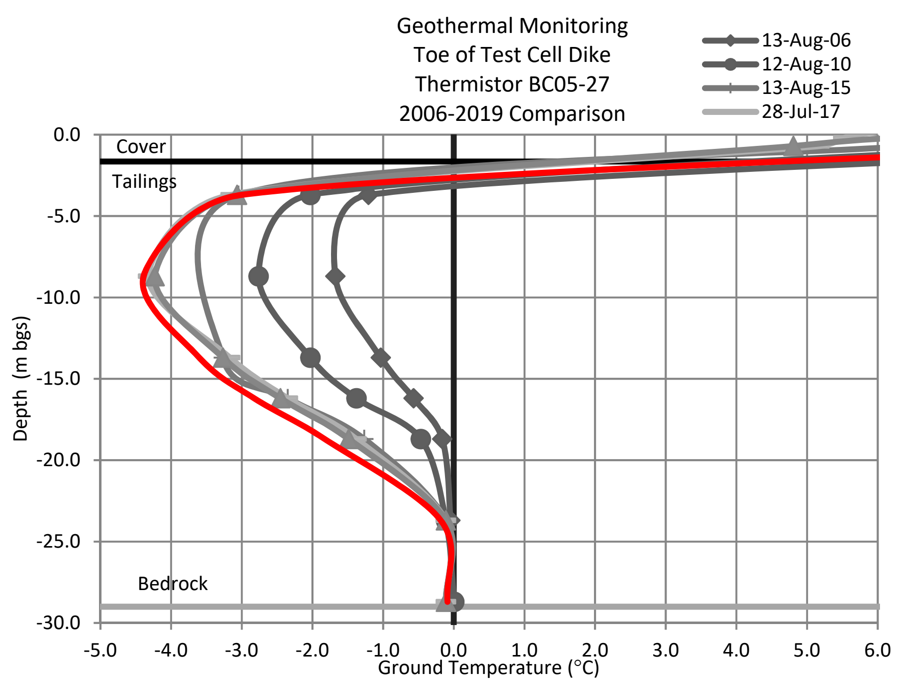


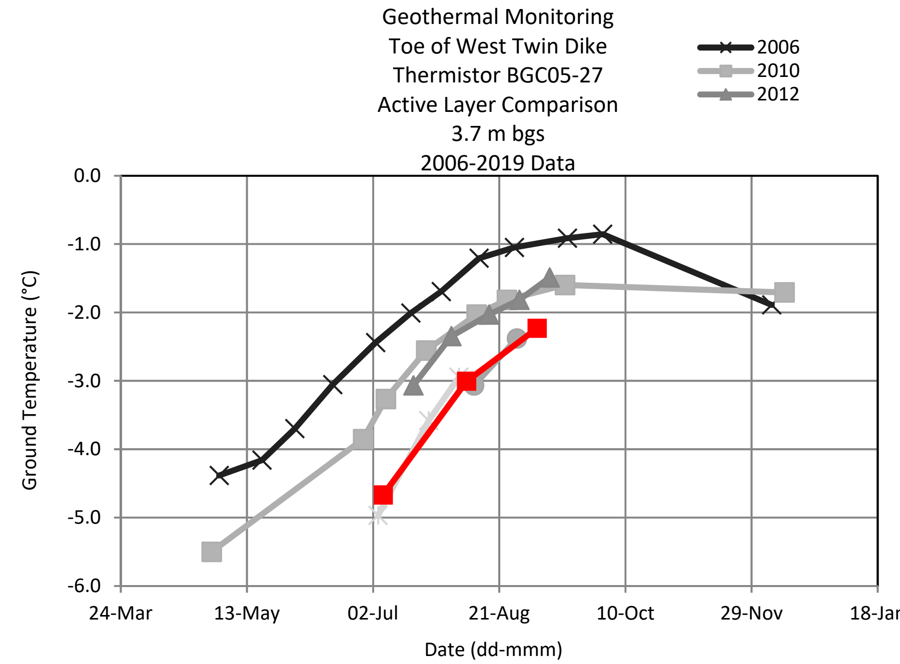
DRAWING TO BE READ WITH BGC REPORT TITLED: "NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION", DATED FEBRUARY 2020

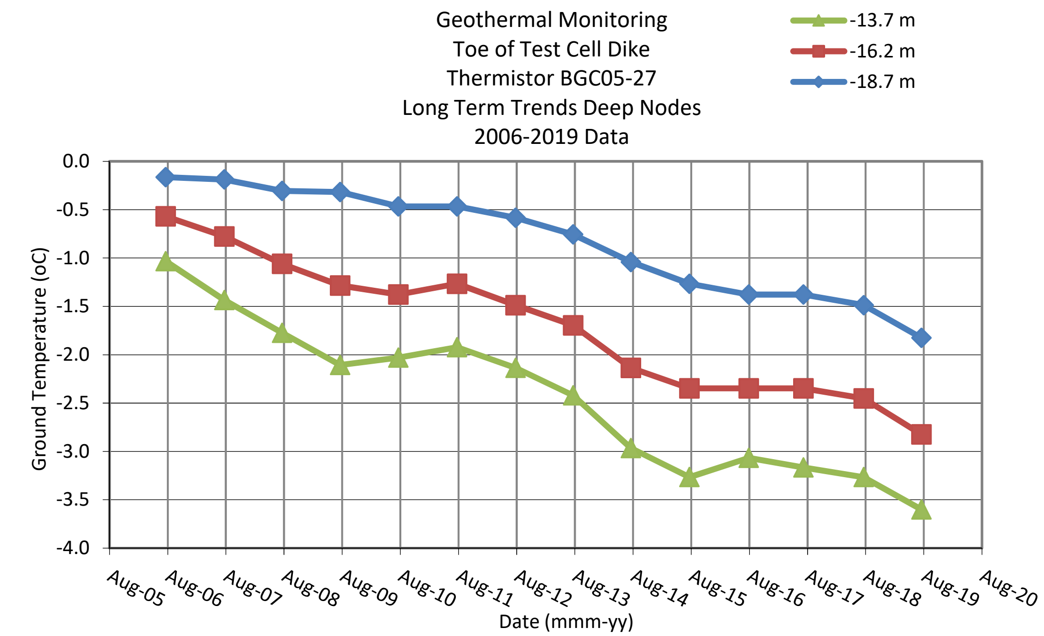
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

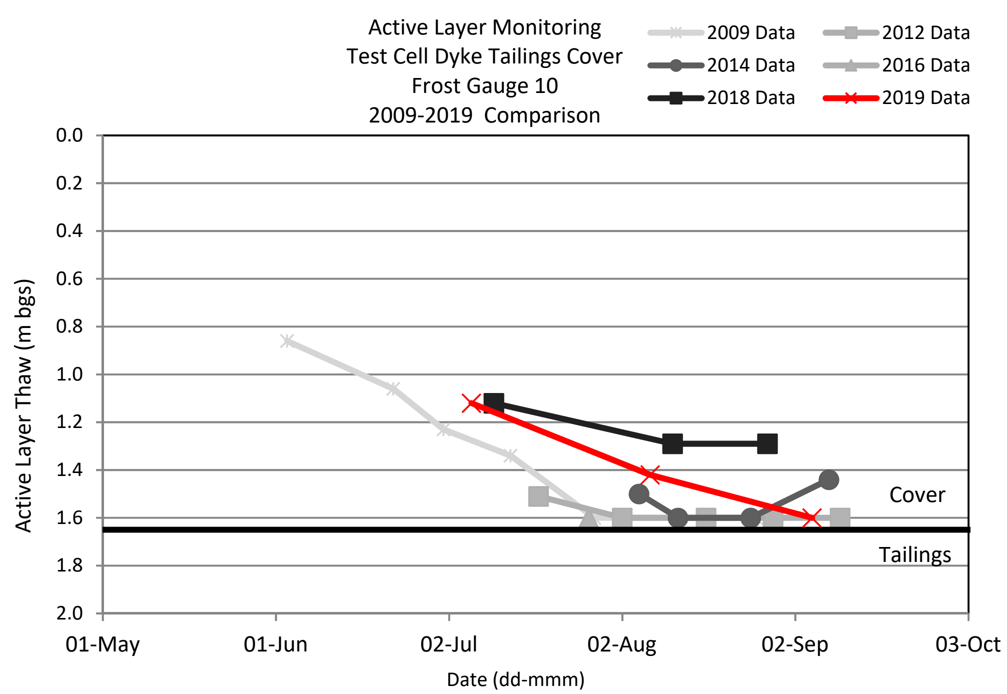
REPORT TITLE:	NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION
DRAWING TITLE:	TEST CELL DYKE GEOTECHNICAL MONITORING DATA
CLIENT: nyrstar	PROJECT NO.: 0255-030
	DRAWING NO.: 16

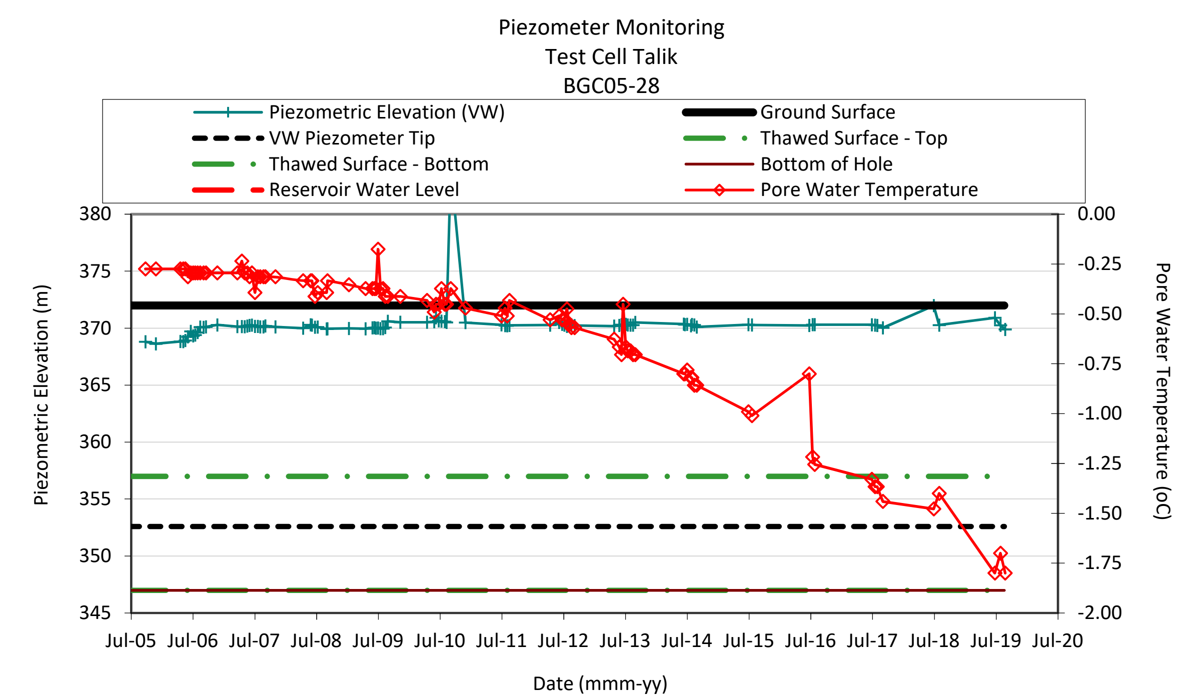
FEB 2020











DRAWING TO BE READ WITH BGC REPORT TITLED: "NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION", DATED FEBRUARY 2020

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: nyrstar

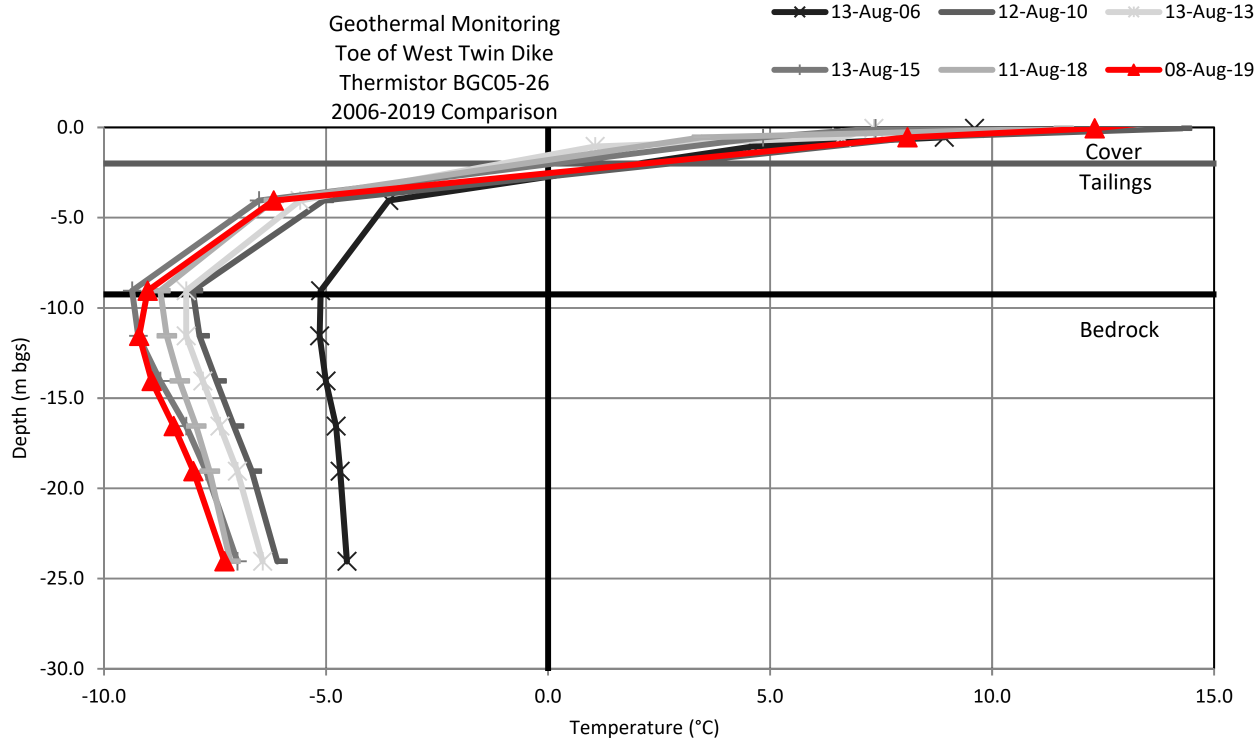
REPORT TITLE: NANISIVIK MINE
2019 ANNUAL GEOTECHNICAL INSPECTION

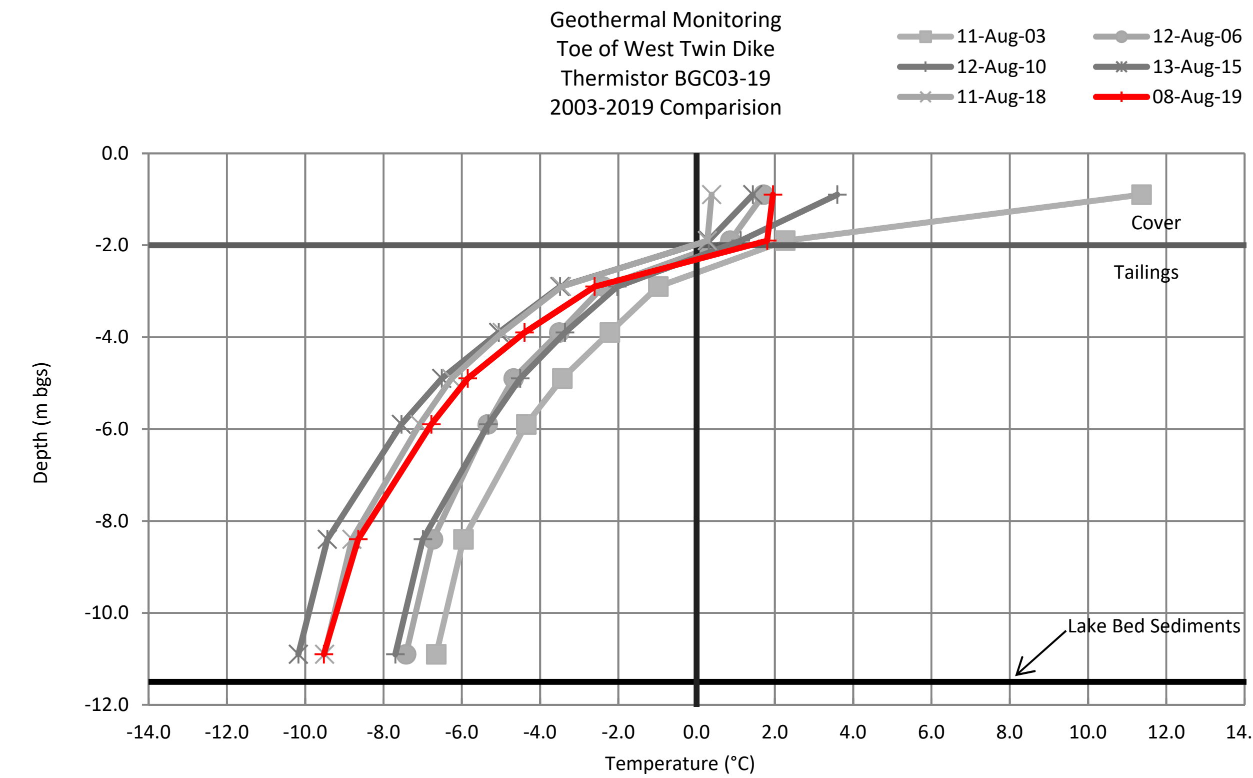
DRAWING TITLE: TOE OF TEST CELL DYKE TAILINGS COVER
GEOTECHNICAL MONITORING DATA

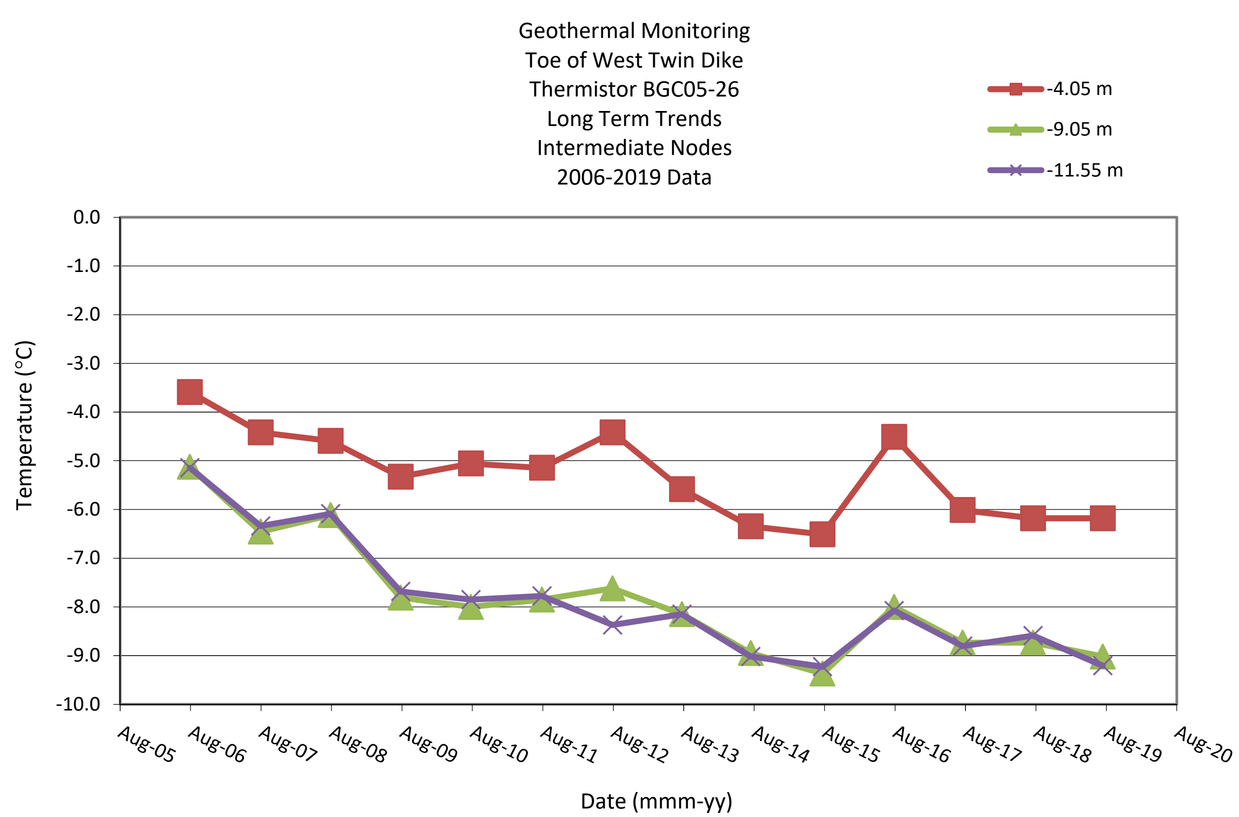
PROJECT NO.: 0255-030

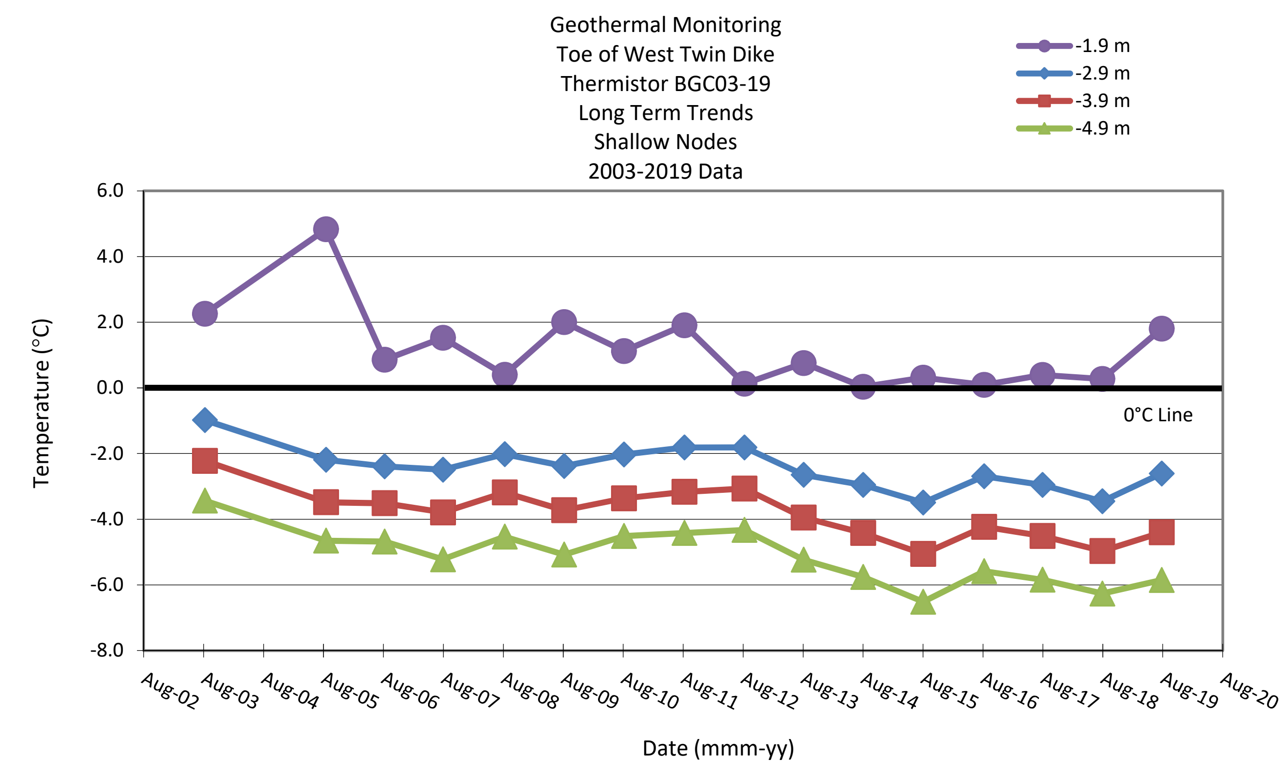
DRAWING NO.: 17

FEB 2020







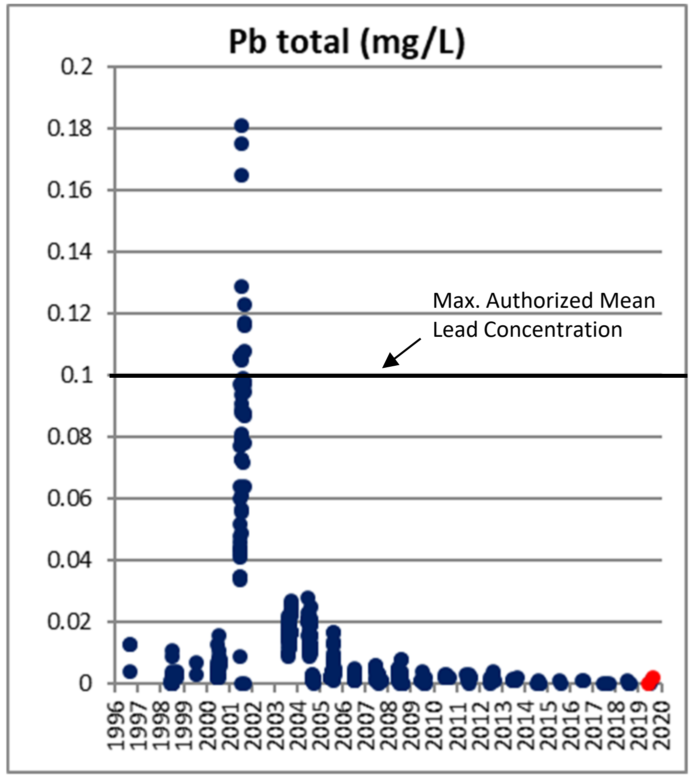


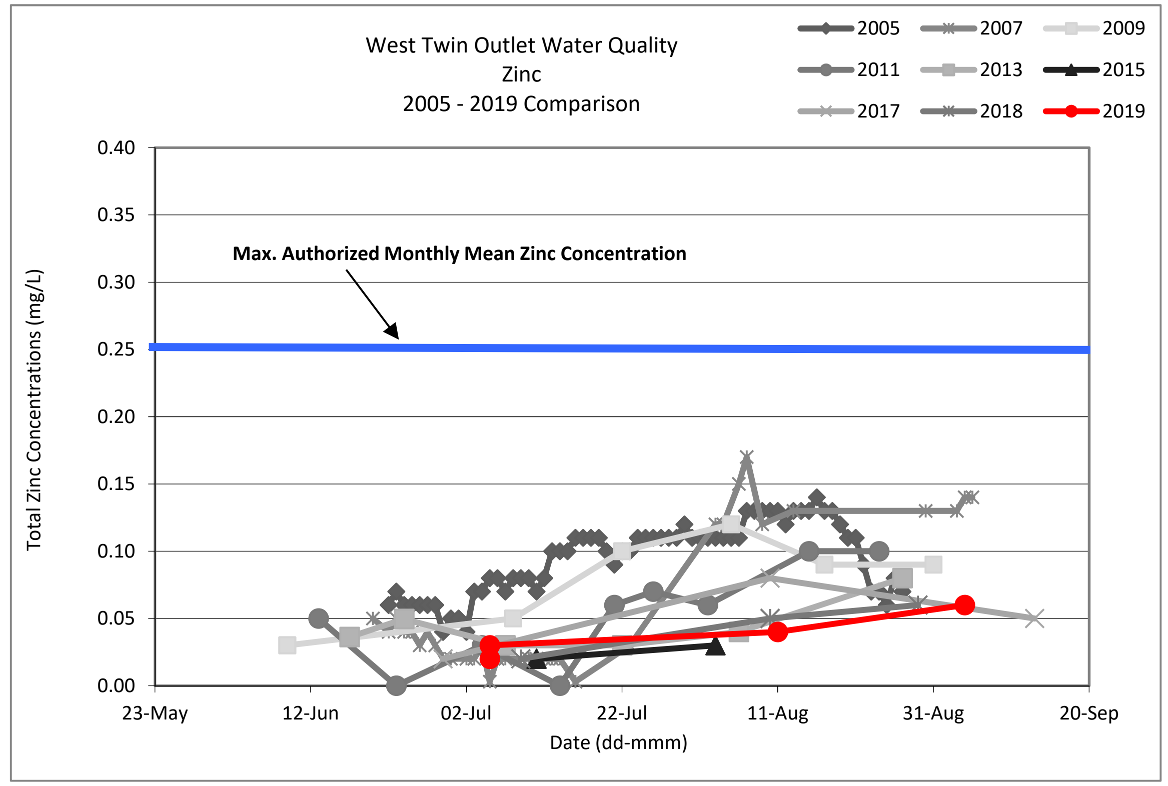
DRAWING TO BE READ WITH BGC REPORT TITLED: "NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION", DATED FEBRUARY 2020

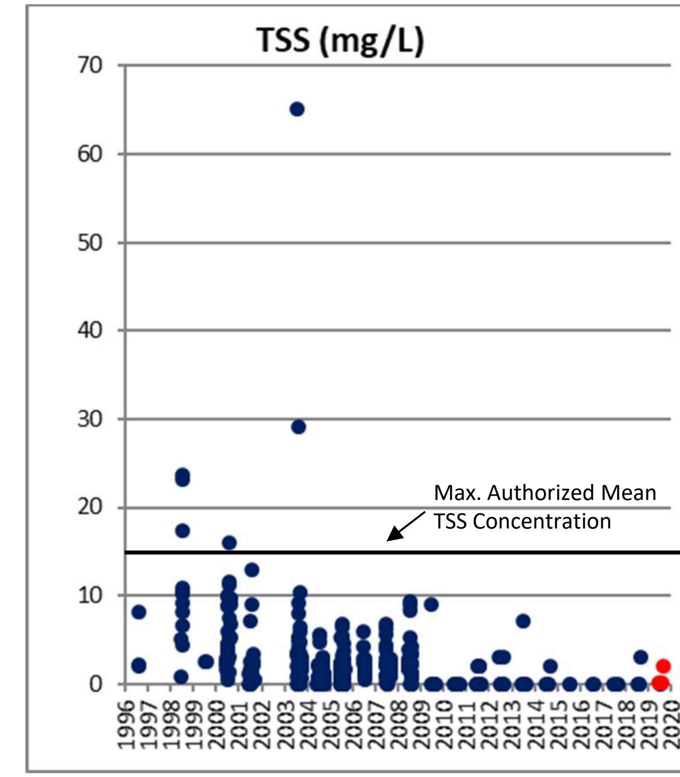
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

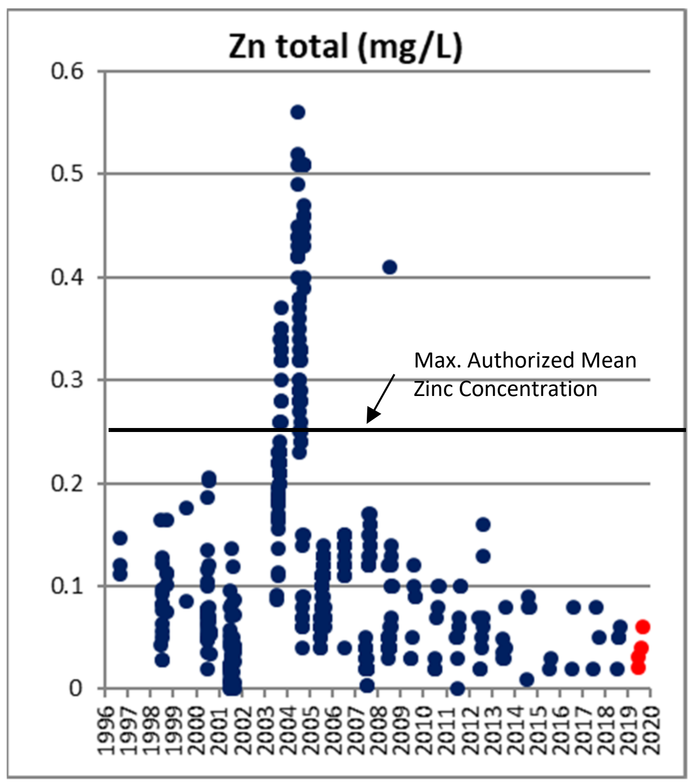
REPORT TITLE: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION	
DRAWING TITLE: TOE OF WEST TWIN DYKE TAILINGS COVER GEOTECHNICAL MONITORING DATA	
CLIENT: nyrstar	
PROJECT NO.: 0255-030	DRAWING NO.: 18

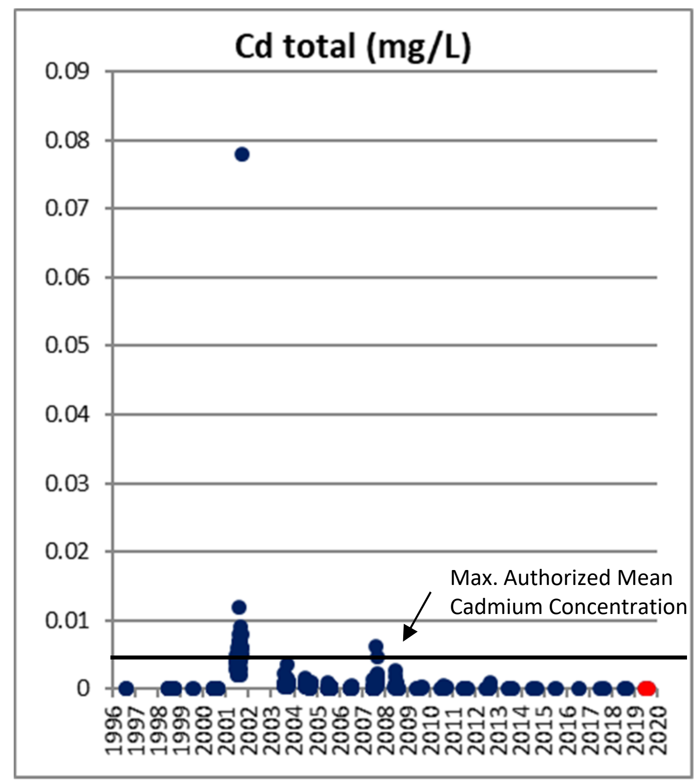
FEB 2020

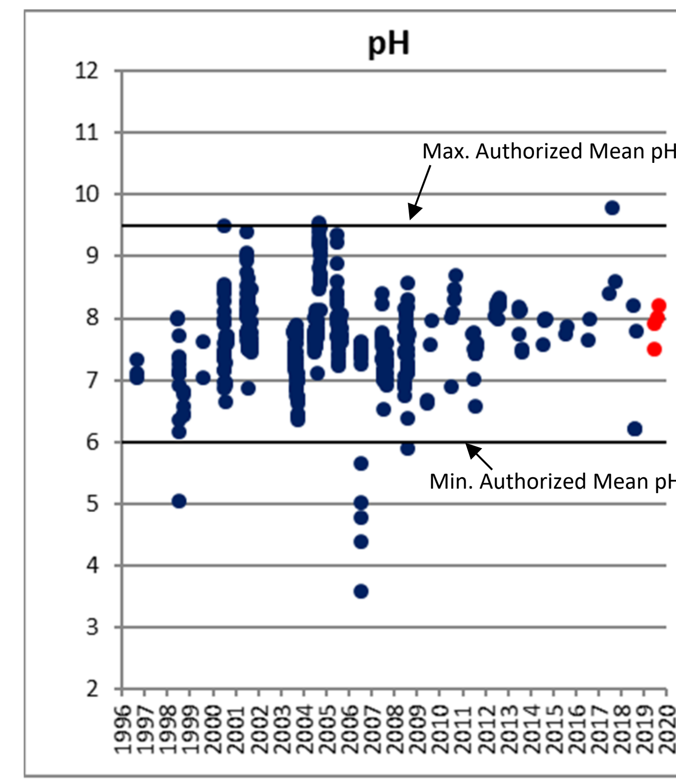












*Draft water quality data supplied by Stantec by email to BGC on November 26, 2019.
*Data points represent individual water samples, and may not be representative of the true annual maximum concentrations.
*Maximum authorized mean concentrations according to Part D of Water Licence 1AR-NAN2030 (NWB 2020).

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BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: nyrstar

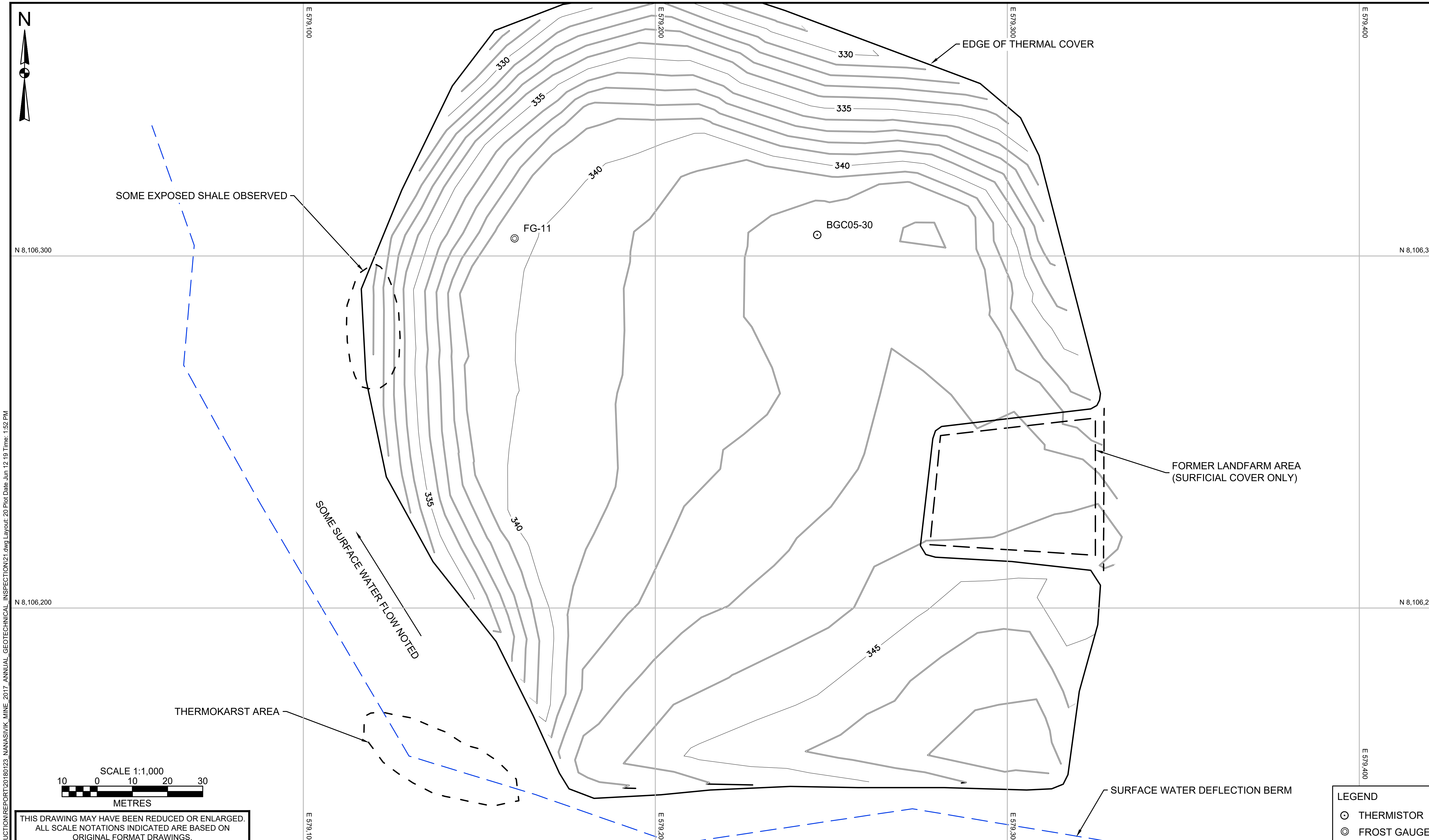
REPORT TITLE: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION

DRAWING TITLE: WEST TWIN DISPOSAL AREA WATER QUALITY DATA

PROJECT NO.: 0255-030

DRAWING NO.: 19

FEB 2020



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DATE:	FEB 2020
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CHECKED:	SG
APPROVED:	GKC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT:
nyrstar

PROJECT:
NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION

TITLE:
LANDFILL COVER

PROJECT No.:	DWG No.:
0255-030	20

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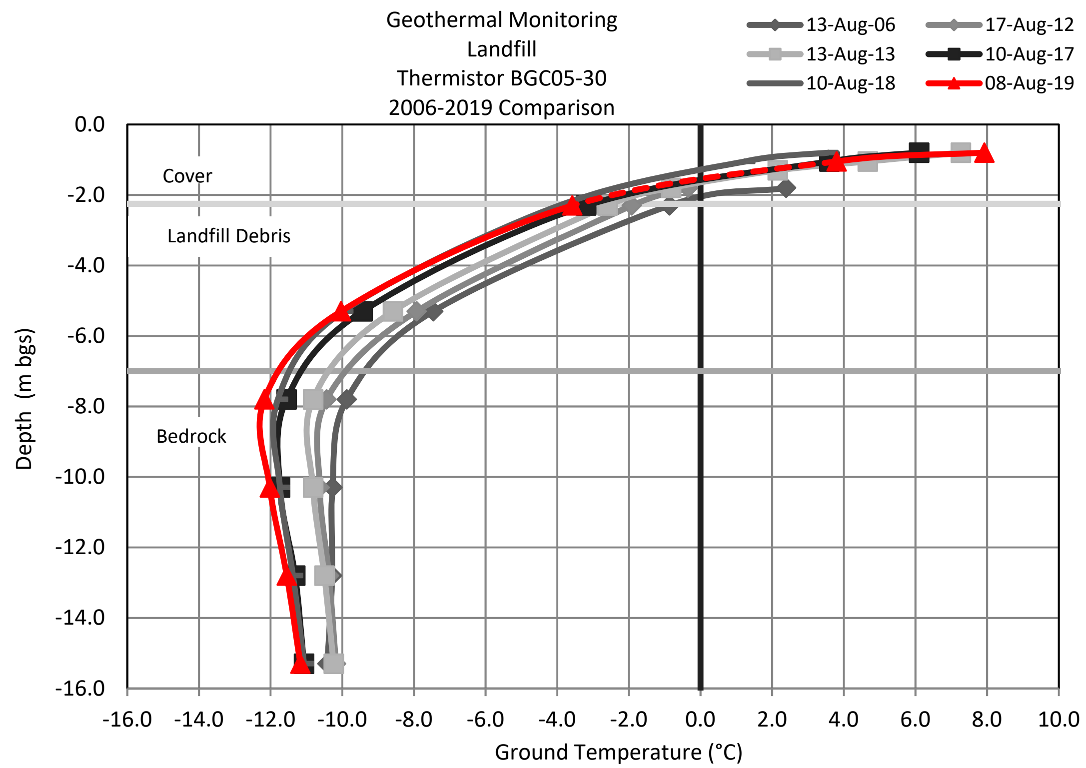

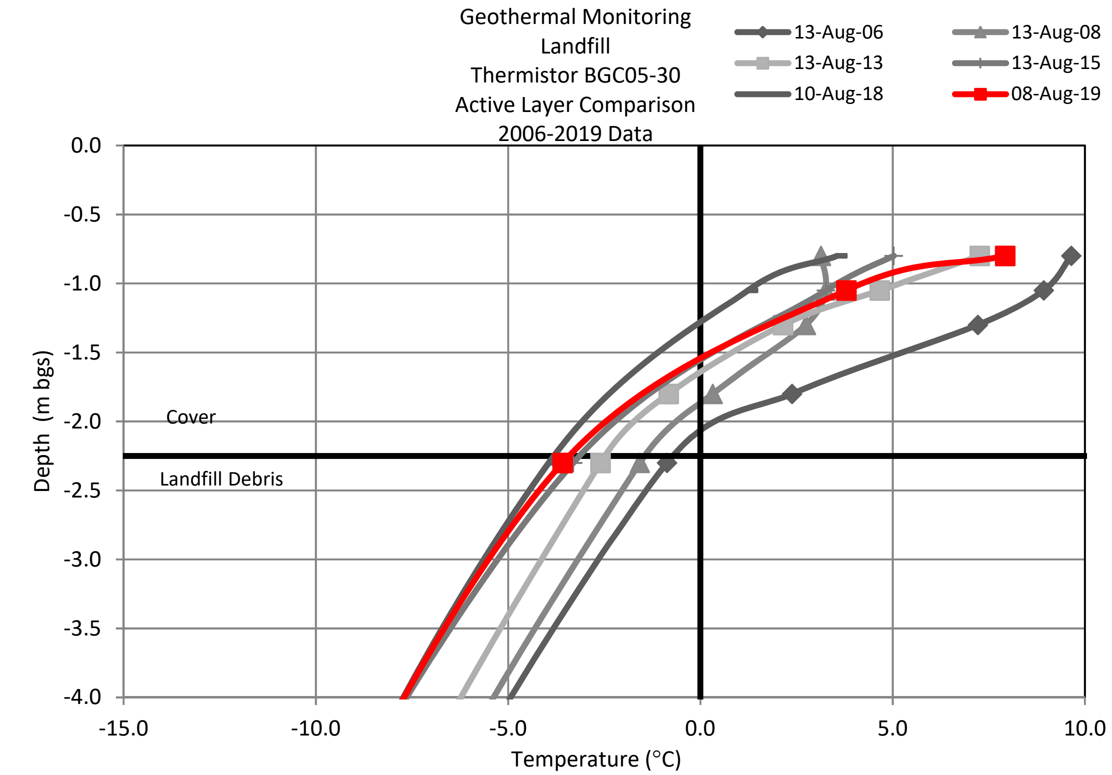

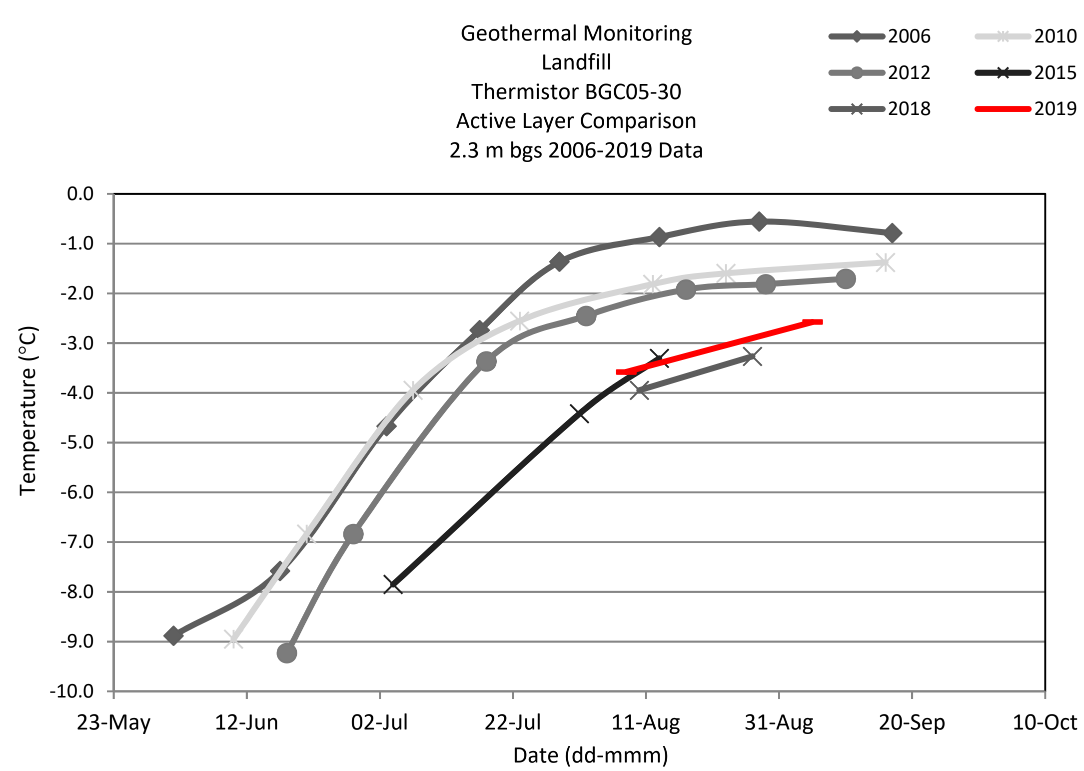

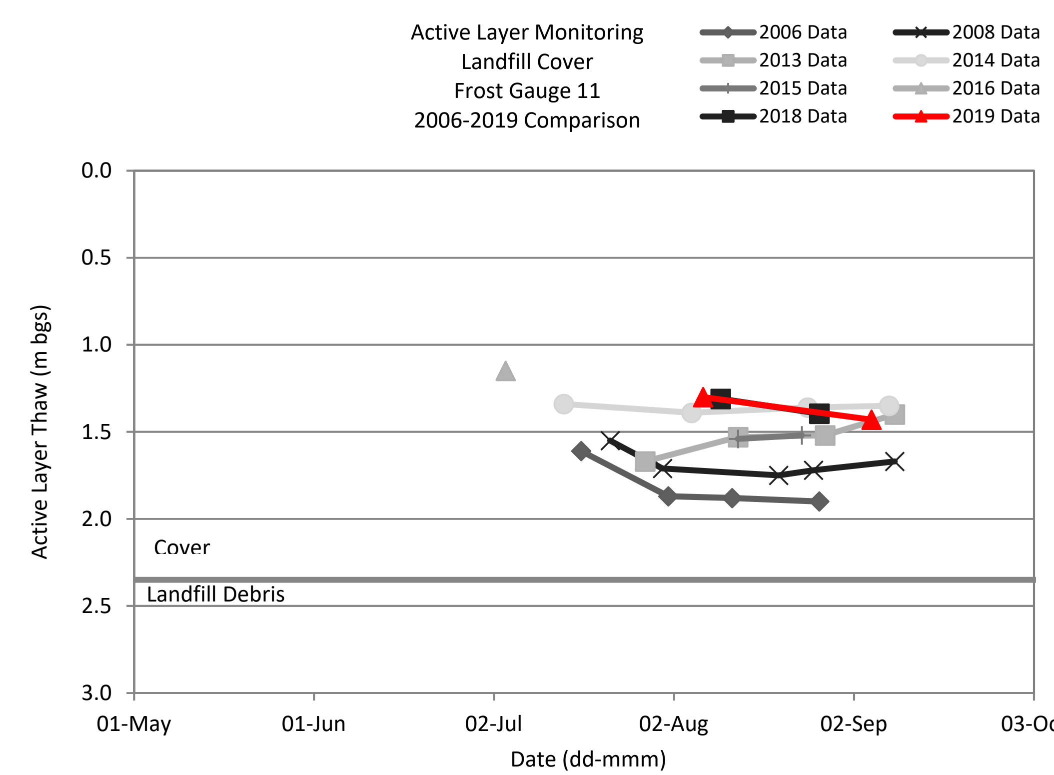

DRAWING TO BE READ WITH BGC REPORT TITLED: "NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION", DATED FEBRUARY 2020

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT:

REPORT TITLE:
NANISIVIK MINE
2019 ANNUAL GEOTECHNICAL INSPECTION

DRAWING TITLE:
LANDFILL COVER
GEOTECHNICAL MONITORING DATA

PROJECT NO.: 0255-030

DRAWING NO.: 21

FEB 2020

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3. CONTOUR INTERVAL IS 1 m.
4. PROJECTION IS UTM NAD 83, Z16N.
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DATE:	FEB 2020
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CHECKED:	SG
APPROVED:	GKC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: nyrstar

PROJECT: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION

TITLE: WEST OPEN PIT WASTE ROCK COVER

PROJECT No.:	DWG No.:
0255-030	22

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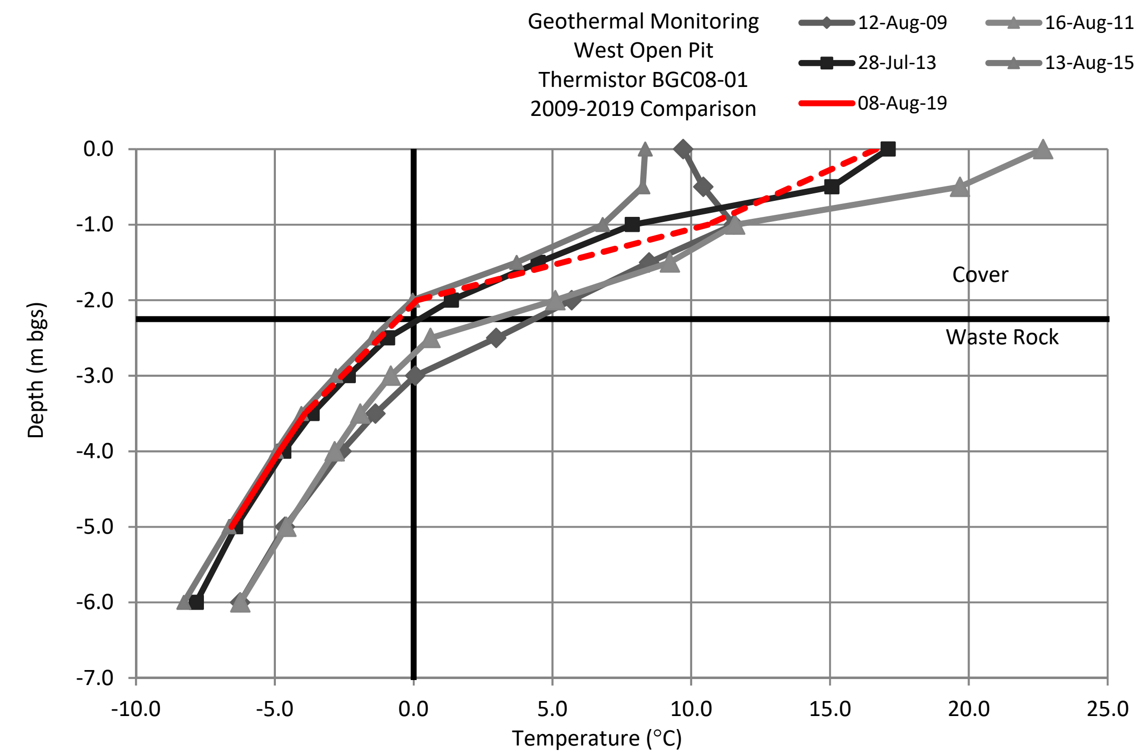
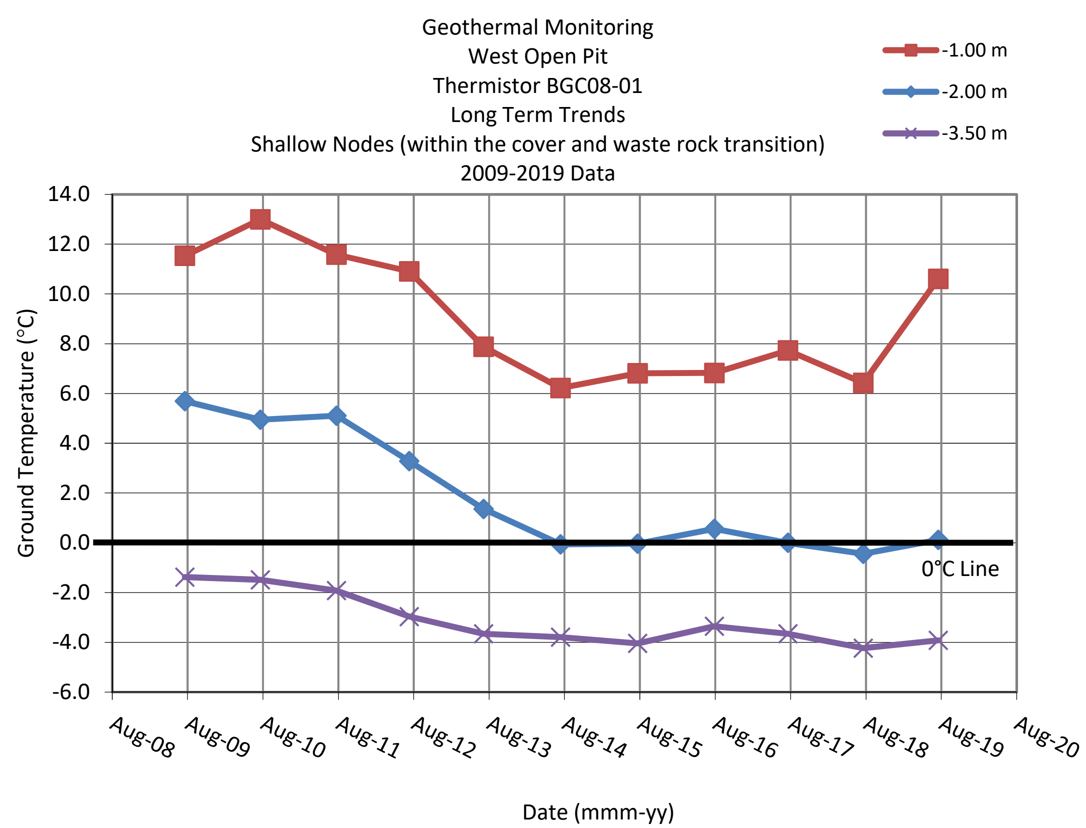
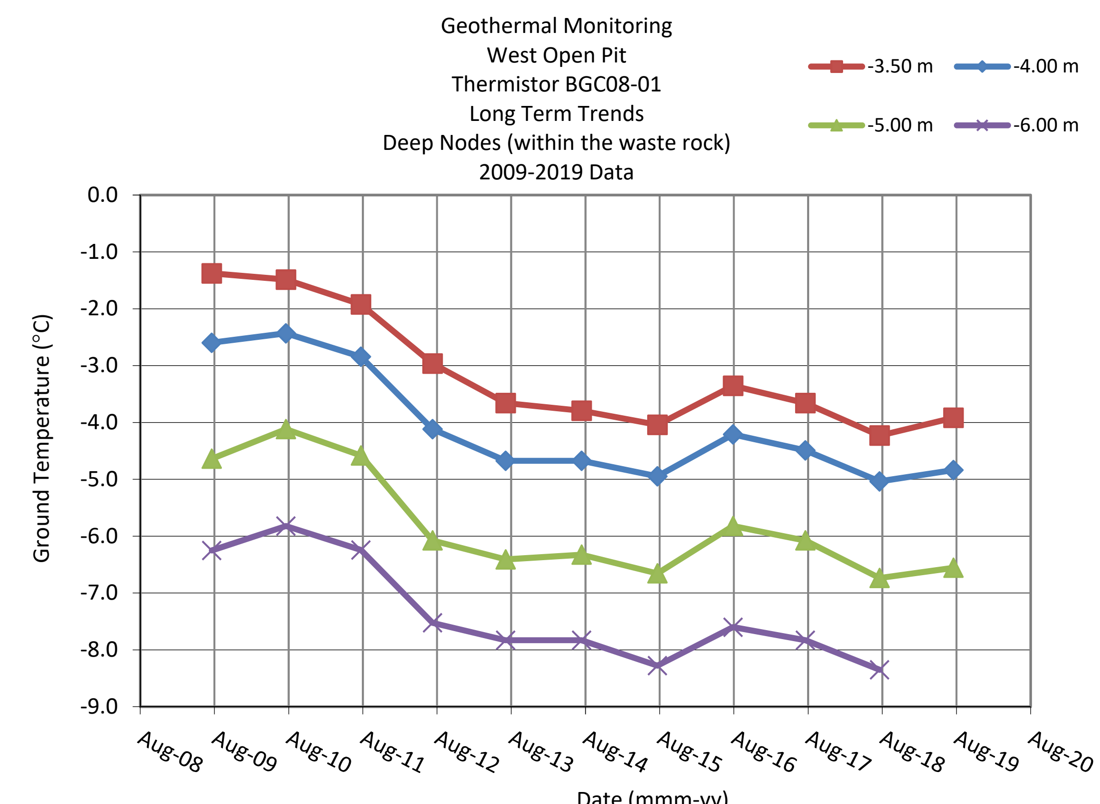






Note: No data for the -6.00 m node in 2019.

DRAWING TO BE READ WITH BGC REPORT TITLED: "NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION", DATED FEBRUARY 2020

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: nyrstar

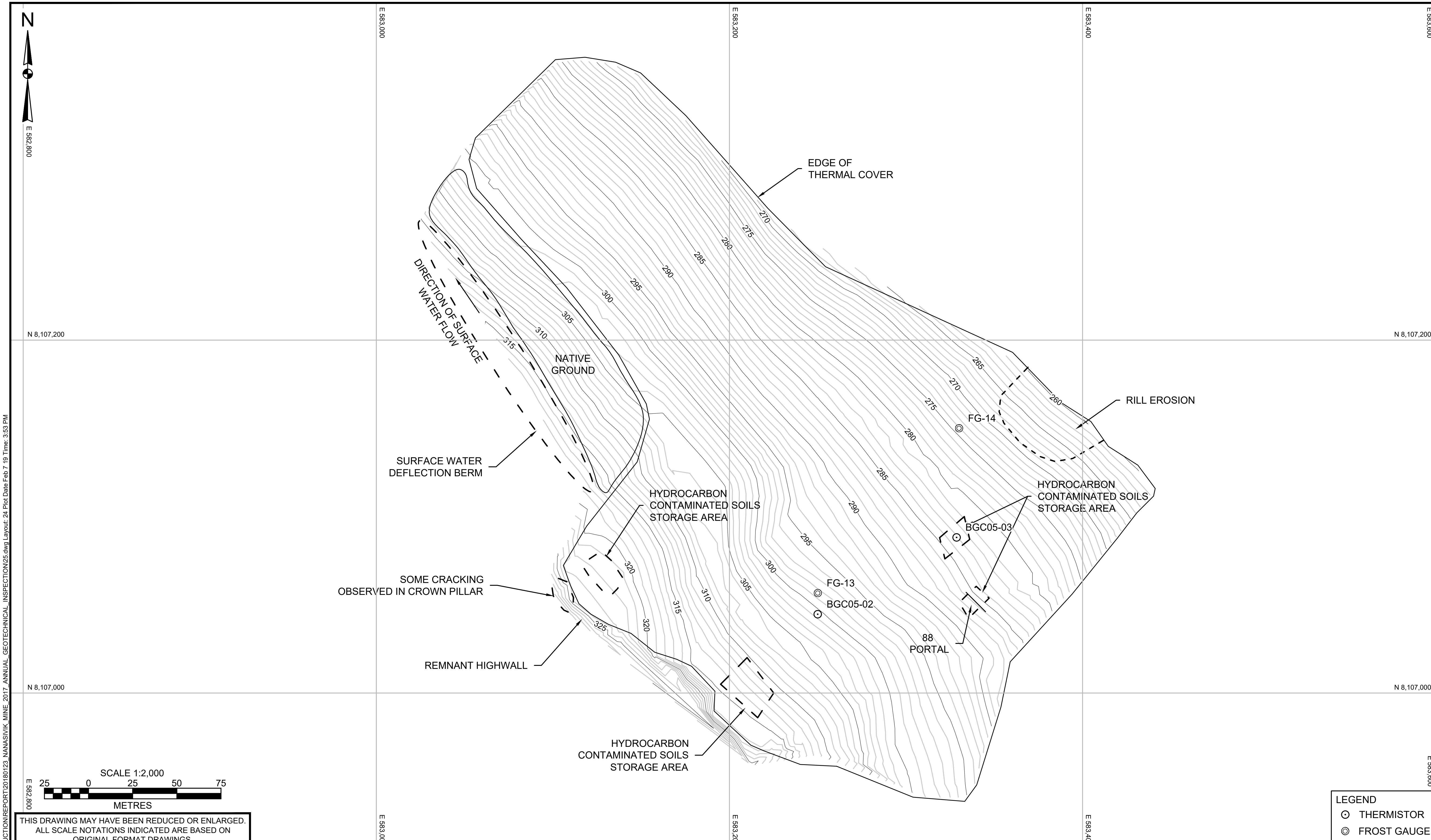
REPORT TITLE: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION

DRAWING TITLE: WEST OPEN PIT WASTE ROCK COVER GEOTECHNICAL MONITORING DATA

PROJECT NO.: 0255-030

DRAWING NO.: 23

FEB 2020



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NOTES:
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3. CONTOUR INTERVAL IS 1 m.
4. PROJECTION IS UTM NAD 83, Z16N.
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DATE:	FEB 2020
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CHECKED:	SG
APPROVED:	GKC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

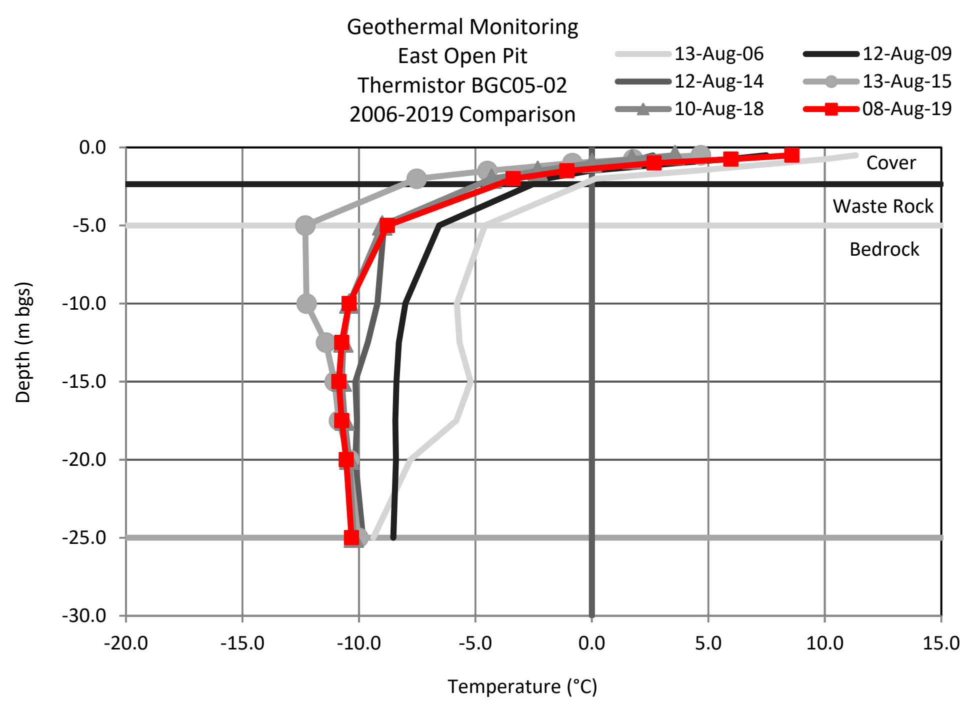
CLIENT: nyrstar

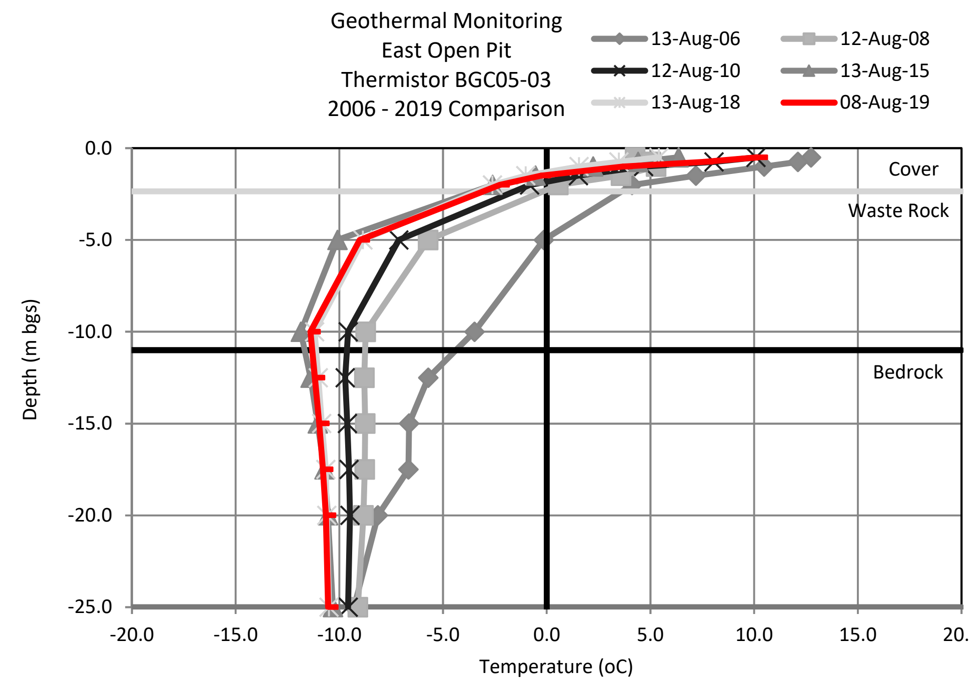
PROJECT: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION

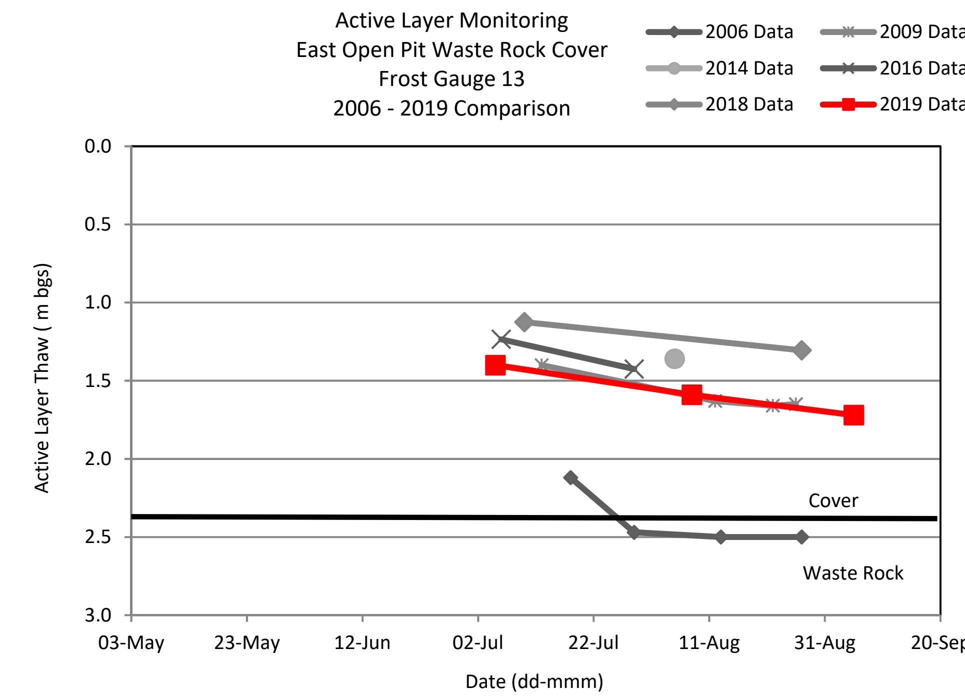
TITLE: EAST OPEN PIT WASTE ROCK COVER

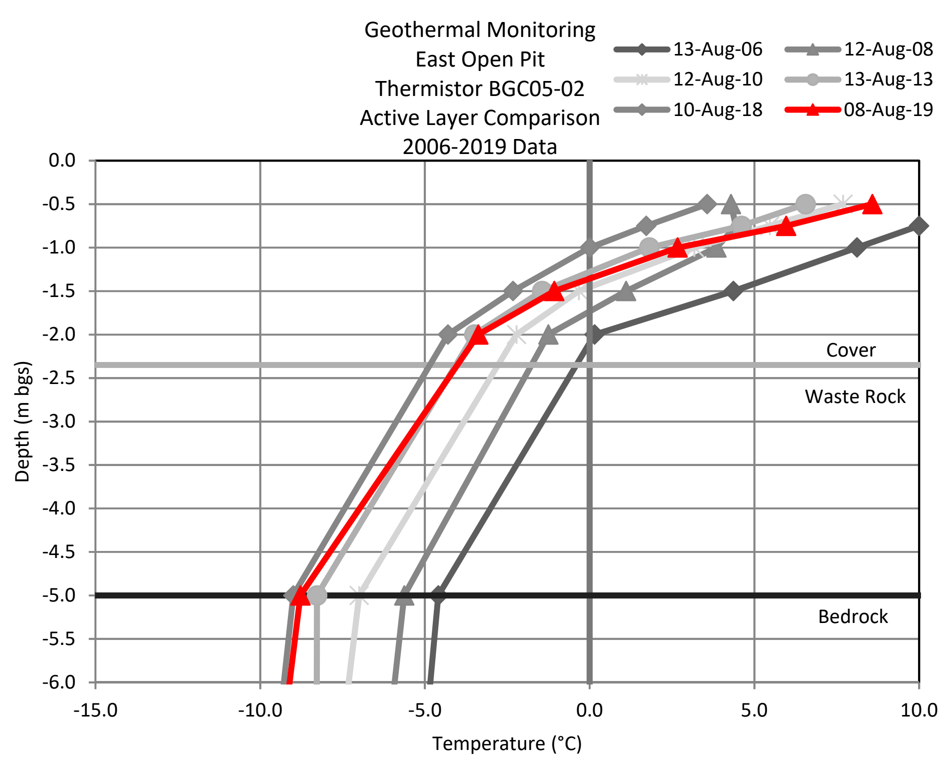
PROJECT No.: 0255-030

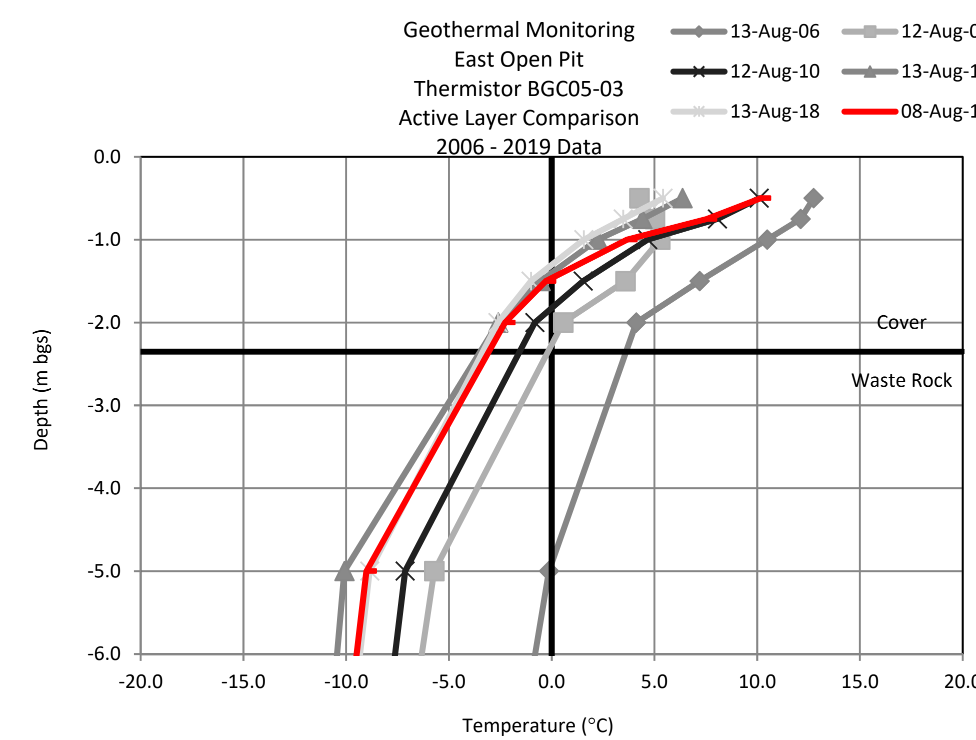
DWG No.: 24











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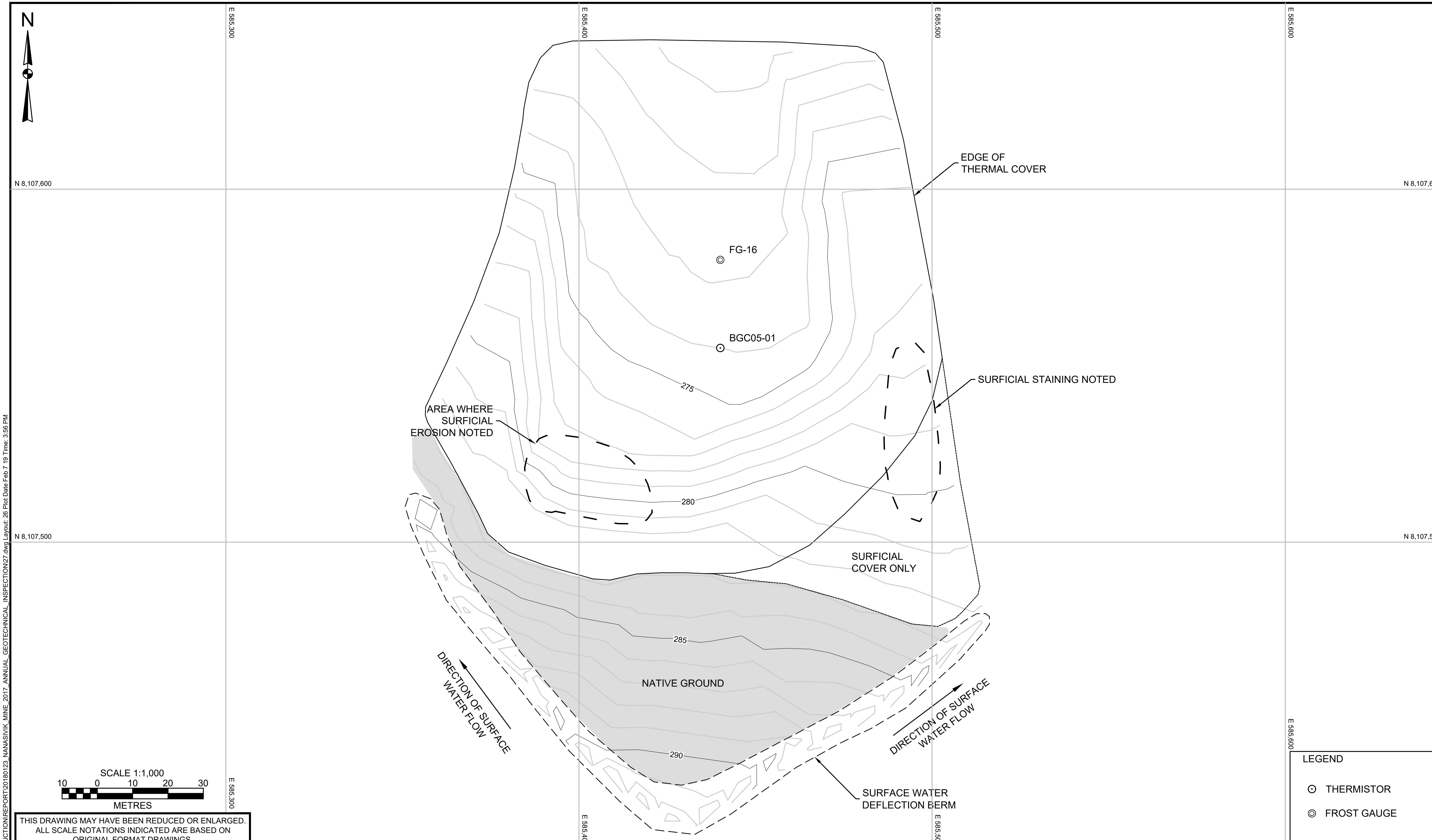
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

REPORT TITLE:	NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION
DRAWING TITLE:	EAST OPEN PIT WASTE ROCK COVER GEOTECHNICAL MONITORING DATA
CLIENT: nyrstar	PROJECT NO.: 0255-030
	DRAWING NO.: 25



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LEGEND

⊙ THERMISTOR

◎ FROST GAUGE

NOTES:
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3. CONTOUR INTERVAL IS 1 m.
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DATE:	FEB 2020
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CHECKED:	SG
APPROVED:	GKC

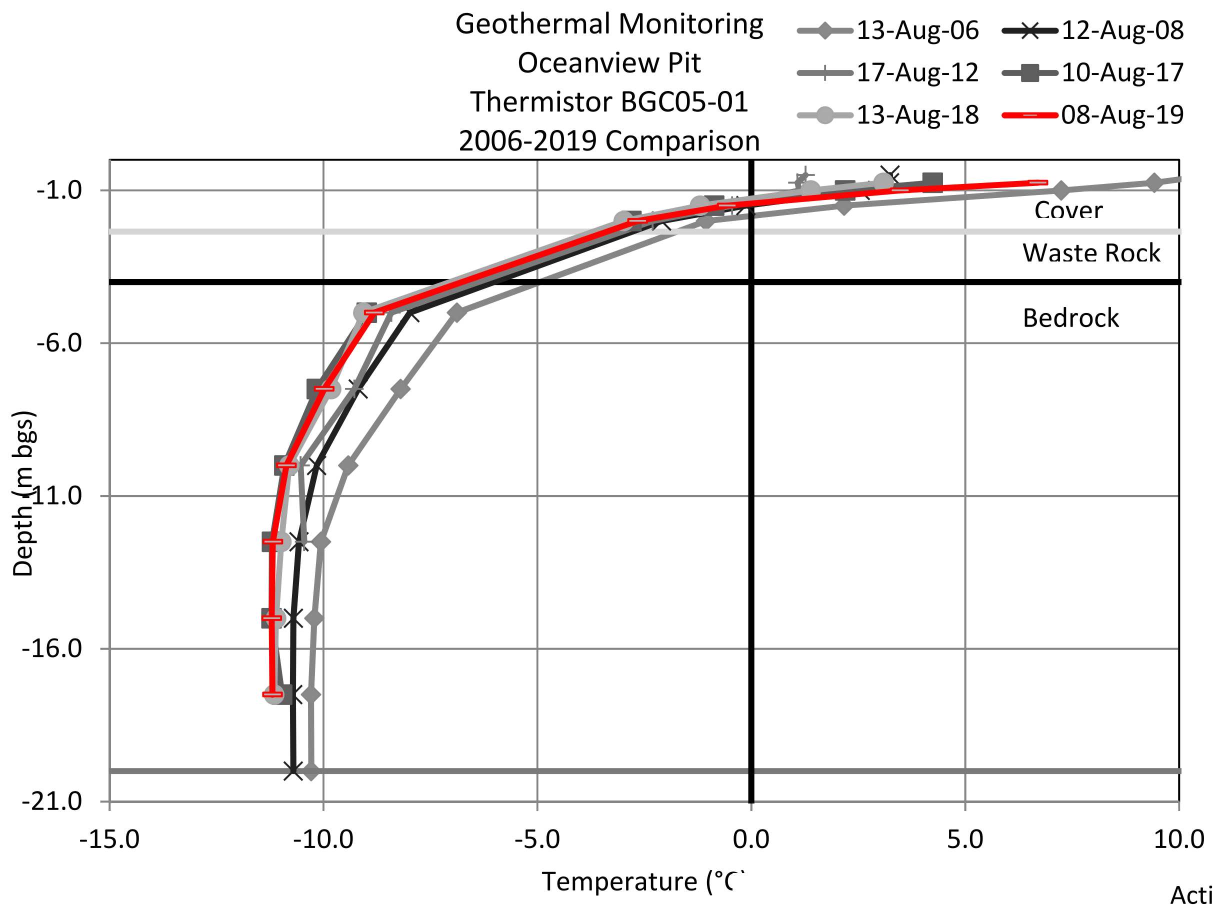
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

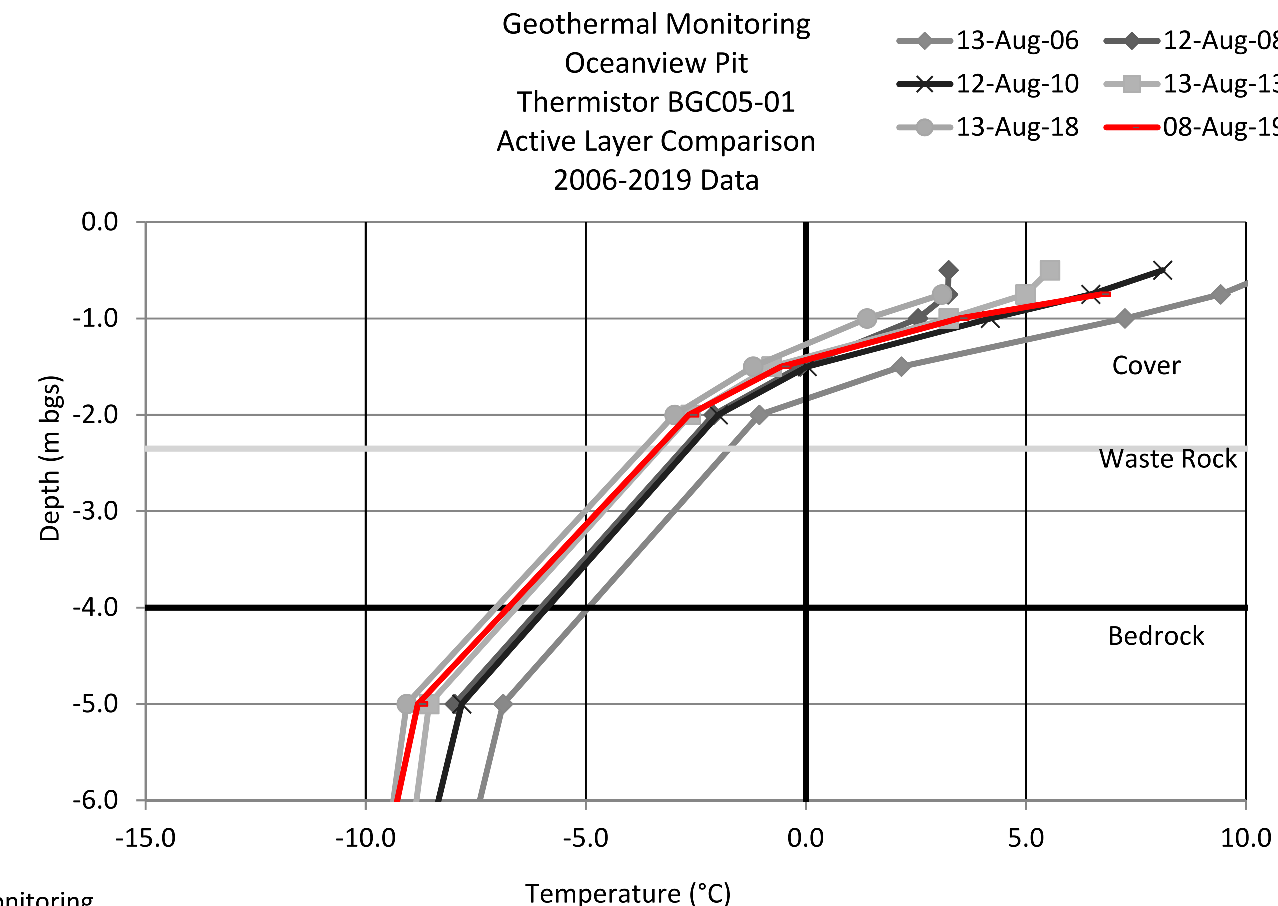
CLIENT:

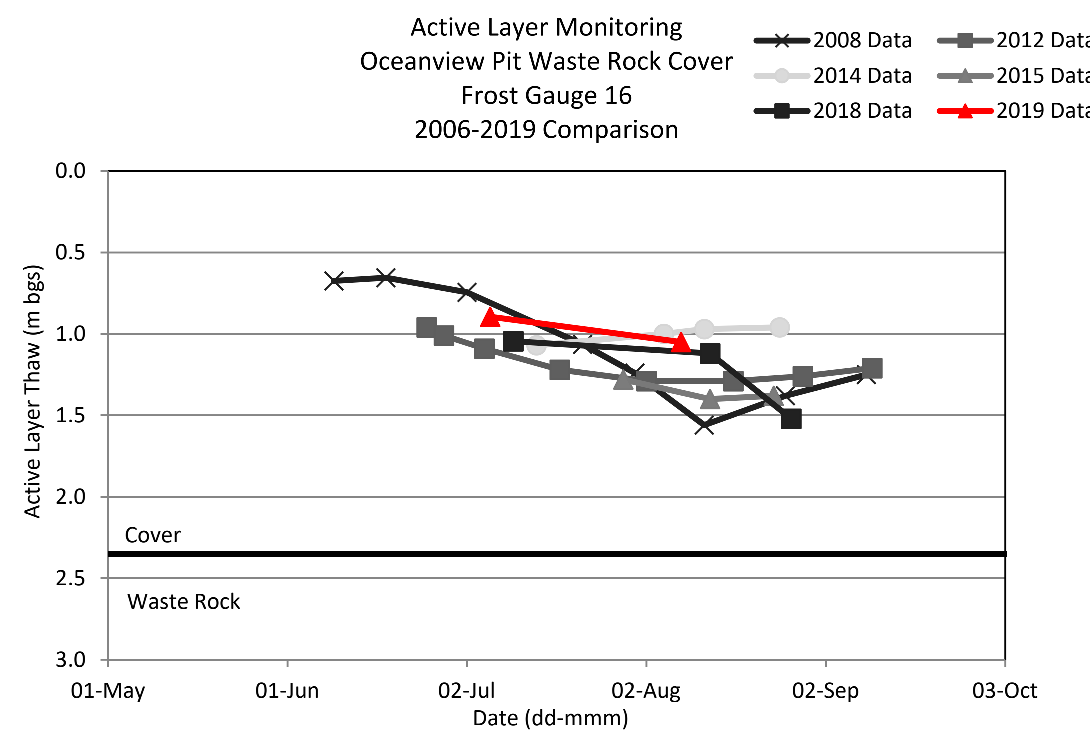
PROJECT:
NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION

TITLE:
OCEANVIEW OPEN PIT WASTE ROCK COVER

PROJECT No.:	DWG No.:
0255-030	26





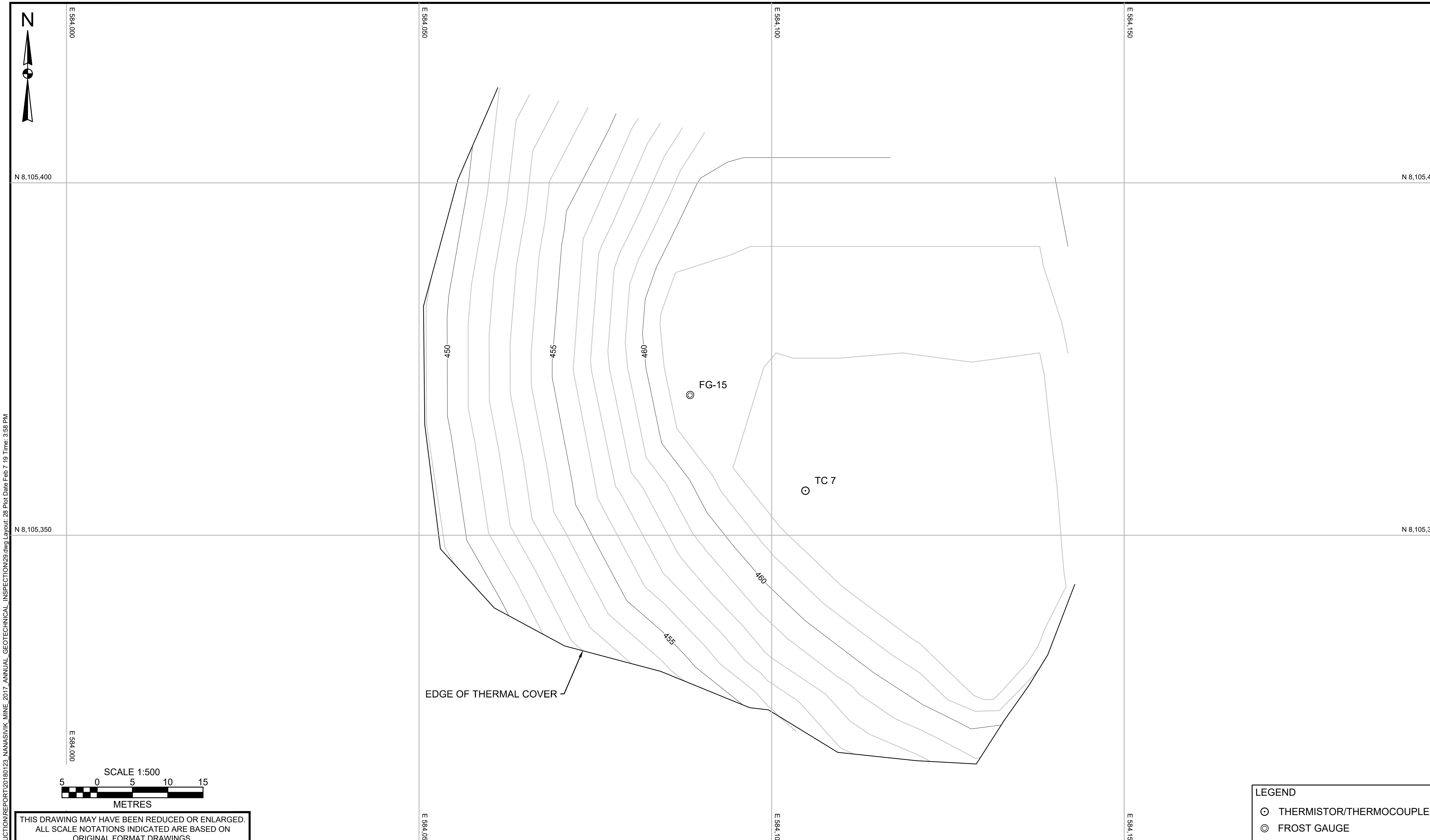


DRAWING TO BE READ WITH BGC REPORT TITLED: "NANISVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION", DATED FEBRUARY 2020

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

REPORT TITLE: NANISVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION	
DRAWING TITLE: OCEANVIEW PIT WASTE ROCK COVER GEOTECHNICAL MONITORING DATA	
CLIENT: nyrstar	
PROJECT NO.: 0255-030	DRAWING NO.: 27

FEB 2020



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APPROVED:	GKC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: nyrstar

PROJECT: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION

TITLE: AREA 14 WASTE ROCK COVER

PROJECT No.: 0255-030

DWG No.: 28

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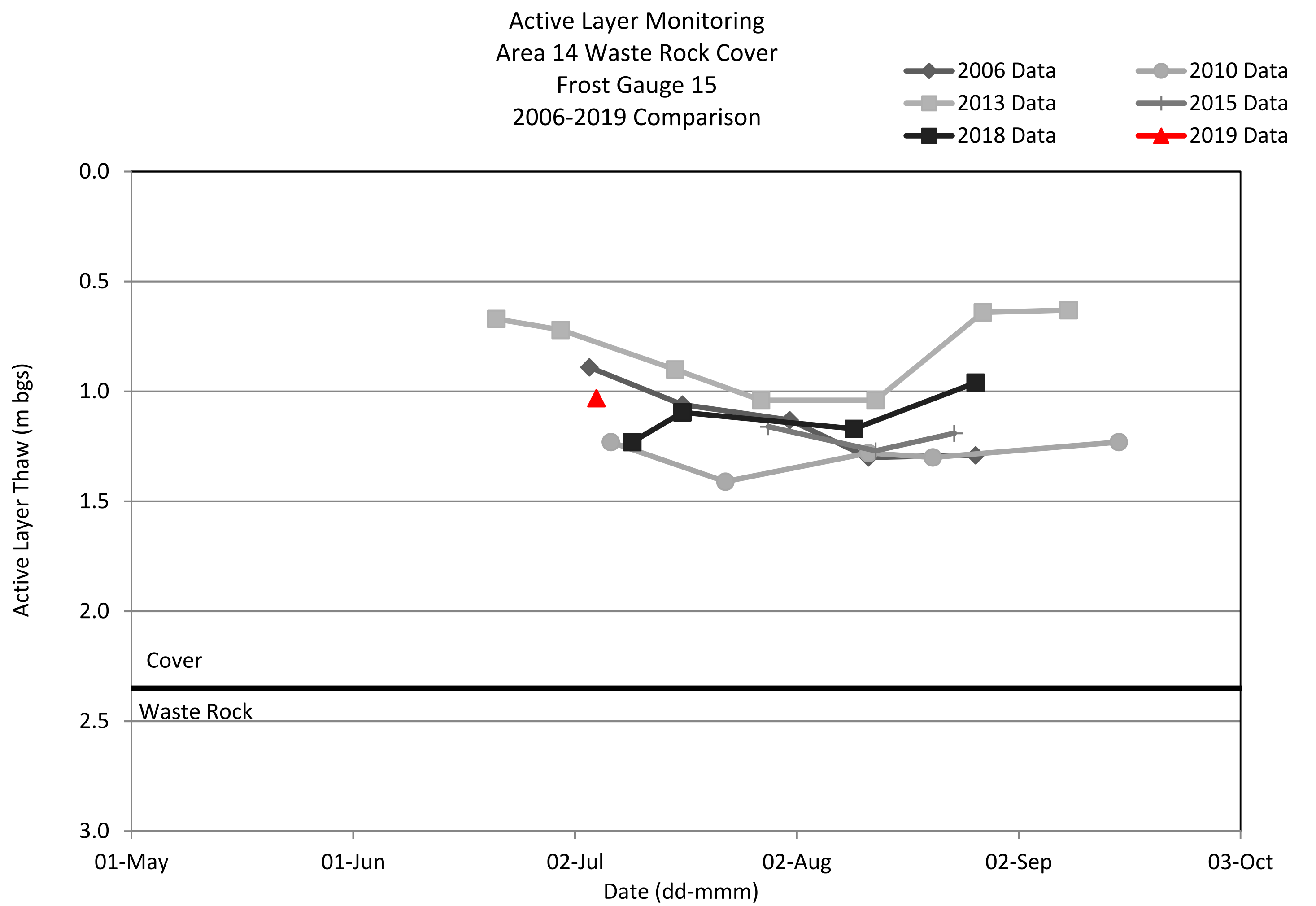

DRAWING TO BE READ WITH BGC REPORT TITLED:
"NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION", DATED FEBRUARY 2020

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

REPORT TITLE:	NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION
DRAWING TITLE:	AREA 14 WASTE ROCK COVER MONITORING DATA
CLIENT:	nyrstar
PROJECT NO.:	0255-030
DRAWING NO.:	29

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DATE:	FEB 2020
DRAWN:	AL
CHECKED:	SG
APPROVED:	GKC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: nyrstar

PROJECT: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION

TITLE: UPPER DUMP POND TAILINGS COVER

PROJECT No.: 0255-030

DWG No.: 30

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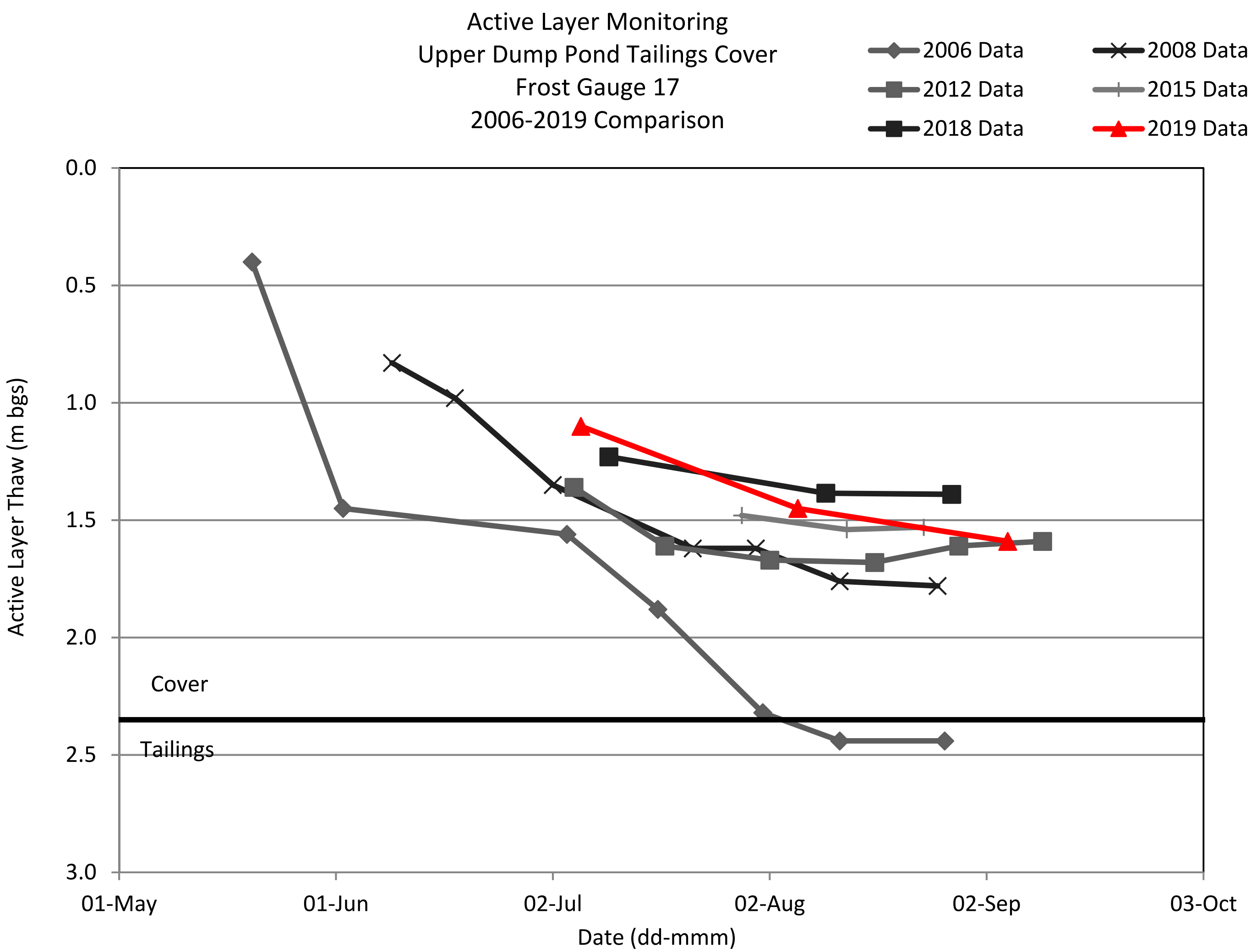
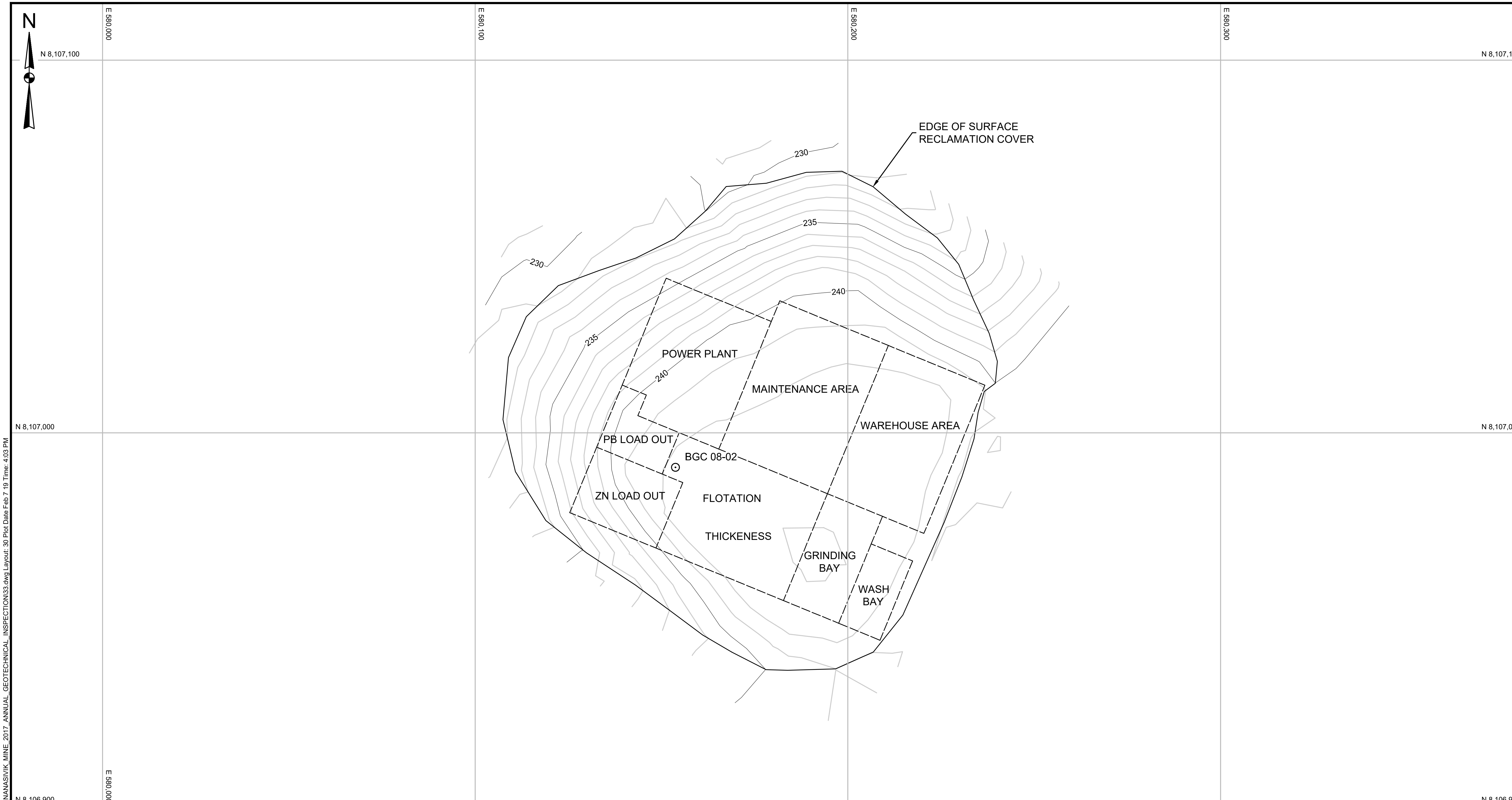


DRAWING TO BE READ WITH BGC REPORT TITLED:
“NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION”, DATED FEBRUARY 2020

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

REPORT TITLE:	NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION
DRAWING TITLE:	UPPER DUMP POND TAILINGS COVER MONITORING DATA
CLIENT:	nyrstar
PROJECT NO.: 0255-030	DRAWING NO.: 31

FEB 2020



SCALE 1:1,000

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METRES

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LEGEND

⊙ THERMISTOR INSTALLATION

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2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION" AND DATED FEBRUARY 2020.
3. CONTOUR INTERVAL IS 1 m.
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BGC ENGINEERING INC.
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CLIENT: nyrstar

PROJECT: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION

TITLE: INDUSTRIAL COMPLEX COVER

PROJECT No.:	DWG No.:
0255-030	32

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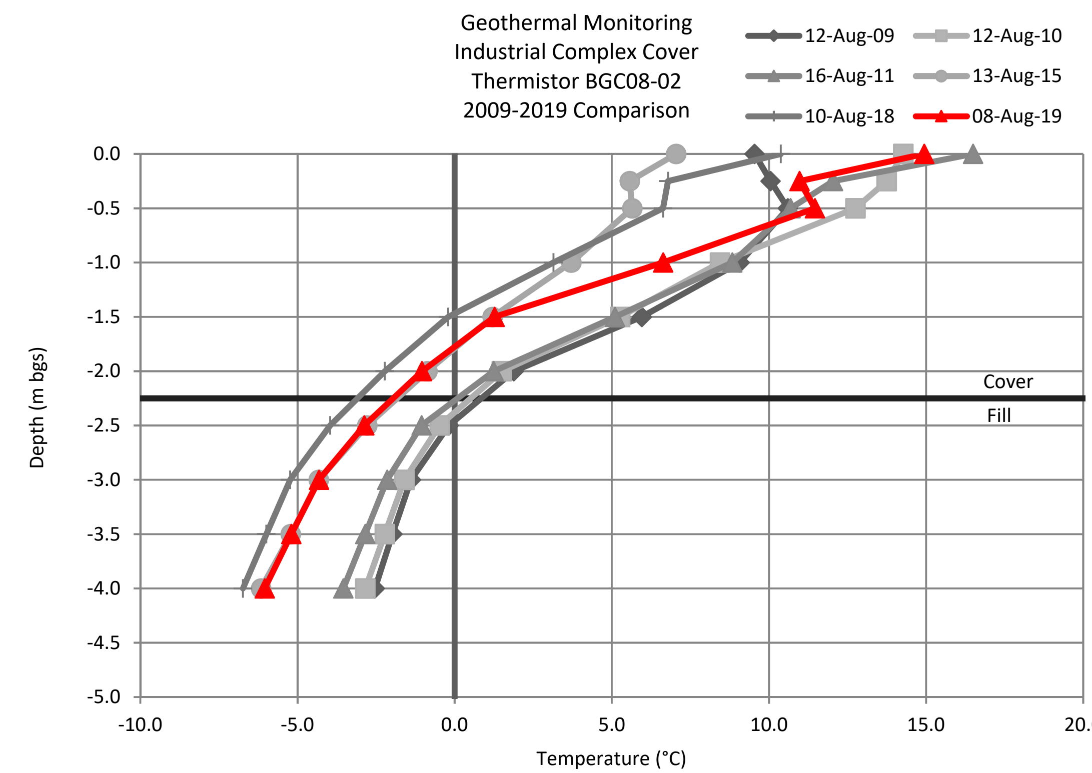

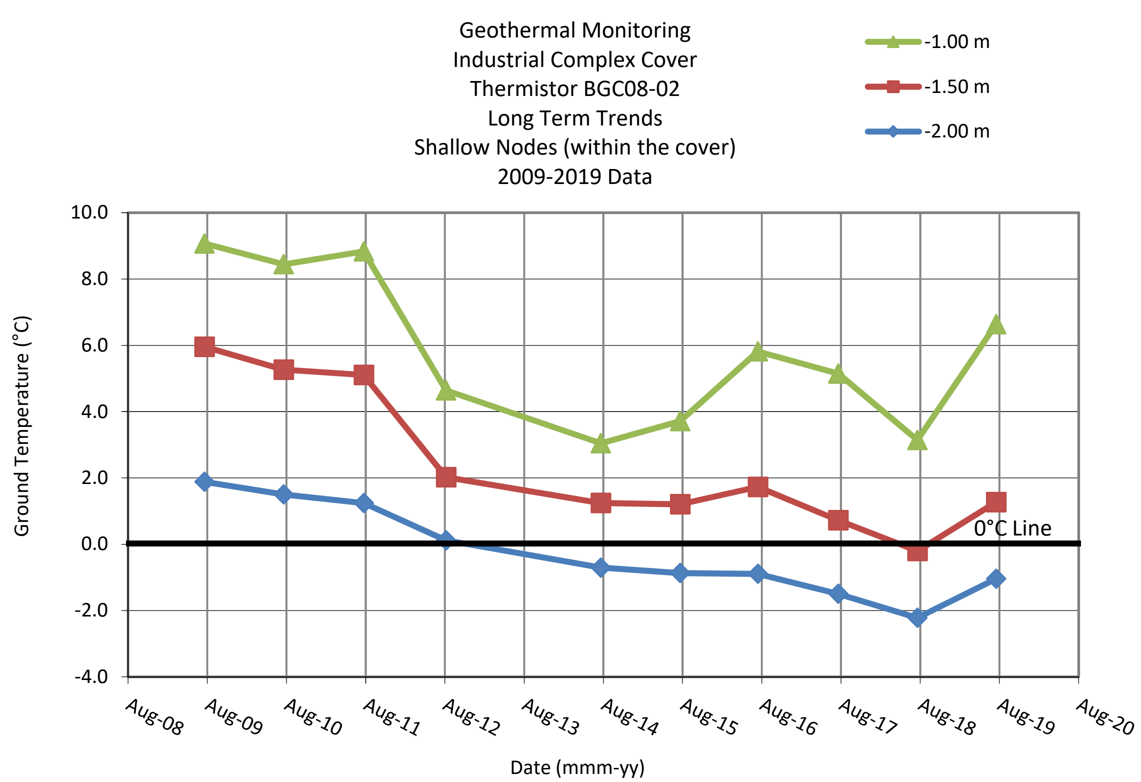

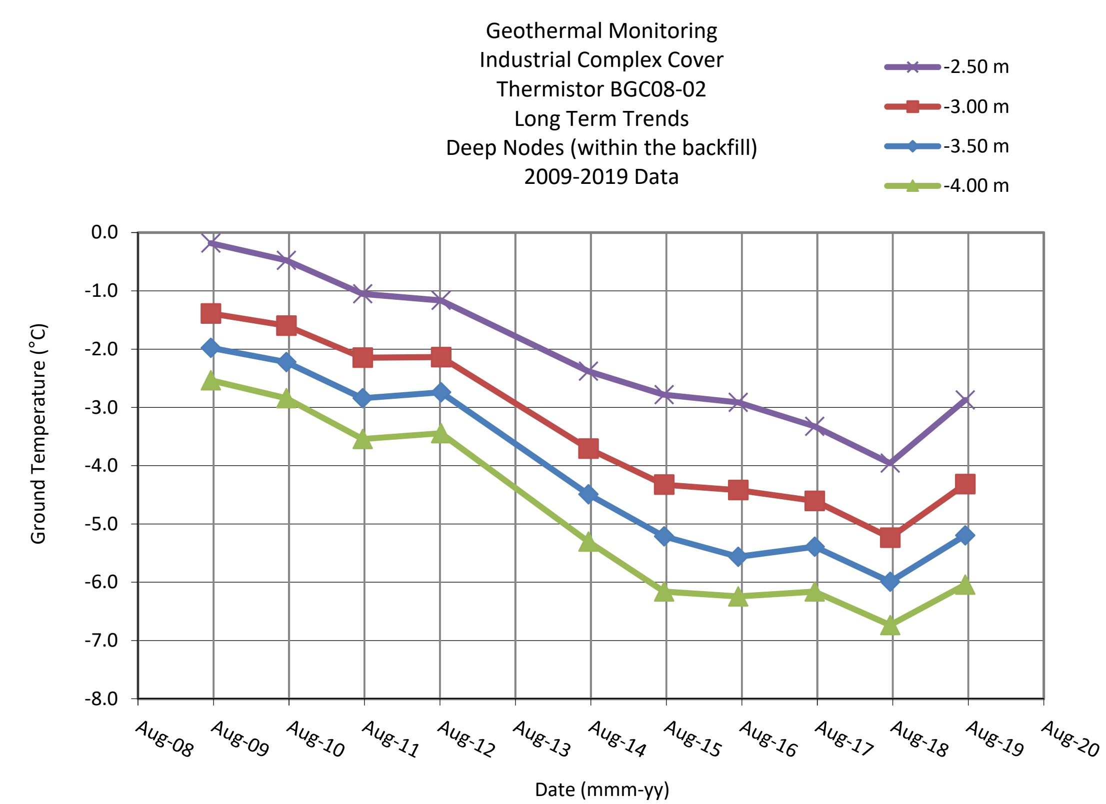

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BGC ENGINEERING INC. AN APPLIED EARTH SCIENCES COMPANY	REPORT TITLE: NANISIVIK MINE 2019 ANNUAL GEOTECHNICAL INSPECTION
	DRAWING TITLE: INDUSTRIAL COMPLEX COVER GEOTECHNICAL MONITORING DATA
CLIENT: nyrstar	PROJECT NO.: 0255-030 — DRAWING NO.: 33

FEB 2020